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International Comparison of Renewable Energy and Grid Integration Planning Schemes

재생에너지-전력망 통합계획 제도화방안 연구

Lee, Jae-hyuck et al.

KEI Korea Environment Institute

Authors

Lee, Jae-hyuck | Kim, Dokyun | Kim, Leejin | Lee, Jukyung | Simioli, Cristina (contributed to the parts concerning Renewables Grid Initiative) | Shefer, Ira (contributed to the parts concerning Renewables Grid Initiative)

Research Staff

Lead Researcher

Lee, Jae-hyuck	Senior Research Fellow, Korea Environment Institute

Participating Researcher

Kim, Dokyun	Senior Research Fellow, Korea Environment Institute
Kim, Leejin	Senior Researcher, Korea Environment Institute
Lee, Jukyung	Researcher, Environmental Planning Institute in Seoul National University
Simioli, Cristina	Director - Offshore Energy and Nature, Renewables Grid Initiative (contributed to the parts concerning Renewables Grid Initiative)
Shefer, Ira	Manager - Energy Systems, Renewables Grid Initiative (contributed to the parts concerning Renewables Grid Initiative)

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Foreword

As the expansion of renewable energy accelerates, the urgent need for grid connection and expansion has led the National Assembly to pass the Special Act on National Core Power Grid Expansion and the Special Act on the Promotion and Development of the Offshore Wind Industry. However, since renewable energy site selection has been conducted without sufficient consideration of grid capacity, issues such as generation curtailment and transmission constraints have arisen due to the shortage of power grid infrastructure for renewable energy facilities.

According to the United States Agency for International Development (USAID), the construction of renewable energy generation facilities takes approximately three years, while the construction process for 345kV or higher transmission lines takes about nine years. This time discrepancy between power plant completion and grid expansion causes delays in grid connection. Therefore, renewable energy and power grids must be considered in an integrated manner. Additionally, spatial planning for renewable energy generation zones, such as offshore wind farms, and transmission corridor routes should be conducted in an integrated way.

In this study, we aim to propose legal and policy alternatives for integrated planning of offshore wind power and power grids in South Korea. To achieve this, we analyze the current domestic situation and conduct a comparative analysis of cases in the EU, the UK, and Germany, where renewable energy and grid integration planning has already been implemented in advance.

Finally, we would like to express our gratitude to Dr. Jae-hyuk Lee, Dr. Dokyun Kim, and Senior Researcher Leejin Kim from the Korea Environment Institute (KEI), as well as Dr. Jookyung Lee from the Environmental Planning Research Institute, for their contributions to this study. We also extend our sincere appreciation to Ki-Seon Cho, Power Grid Program Director at the Korea Institute of Energy Technology Evaluation and Planning (KETEP); Dr. Seung-Moon Lee from the Korea Energy Economics Institute (KEEI); and Professor Jun-Kyu Gil from Ajou University Law School, all of whom provided valuable advice despite their busy schedules.

Hongkyun Kim,
President,
Korea Environment Institute

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1. Current Status and Key Issues of Renewable Energy Grid Access in Korea

While renewable energy, including offshore wind power, is expanding nationwide, the supporting power grid remains severely inadequate. As a result, the Korea Electric Power Corporation (KEPCO) has been forced to curtail renewable power generation and restrict output. In particular, there are growing concerns about uncoordinated development, for offshore wind. This is due to private offshore wind developers independently selecting locations for shared connection facilities without properly coordinating with other local power generation stakeholders. Even when offshore wind projects are connected to shared facilities, transmitting electricity inland remains difficult due to challenges in constructing onshore transmission lines.

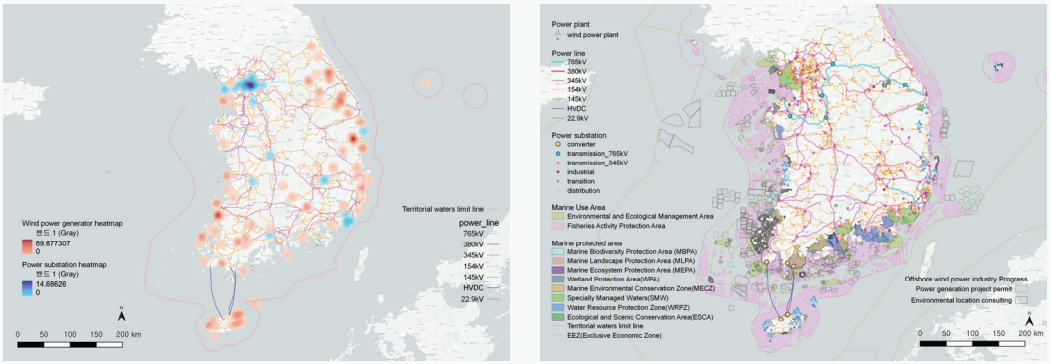
The first major issue is the geographic imbalance between supply and demand: most substations are concentrated in metropolitan areas such as the Seoul Capital Area (SCA), while renewable energy generation sites, including offshore wind farms, are typically located in provincial regions (See left panel of Figure ES 1). The second issue lies in the underdeveloped marine grid infrastructure between offshore wind farms and the mainland, which continues to hinder the efficient transmission of electricity from offshore generation sites (See right panel of Figure ES 1).

Therefore, this study presents a plan for the integrated design and operation of a power grid that effectively incorporates renewable energy sources, comparing and analyzing the legal systems and domestic circumstances major players in renewable energy, such as EU, the UK, and Germany, with a focus on offshore wind power.

Figure ES 1 **Current status of renewable energy and power grids in Korea**

Comparison of substations (demand) and offshore wind power generation (supply)

Insufficient offshore wind power and inland connection power grids



Source Adapted by the authors from Korean power grid data provided by the Open Infrastructure Map.

2. Comparison of Relevant Korean and International Systems

As shown in Table ES 1, power grid legislation in the EU, the UK, and Germany emphasizes integrated marine and terrestrial power generation and transmission planning. And both Germany and the UK have spatial planning guidance in place for terrestrial substations and other facilities necessary to facilitate offshore wind power generation. However, the Korean Special Act on the Expansion of the National Basic Power Grid (hereinafter referred to as the Power Grid Special Act) limits the number of members of the Power Grid Committee to three members, who can be experts in one of several fields. The small pool of expertise makes it possible that marine experts may be excluded. In addition, the Committee often discusses matters only distantly related to power generation, such as maritime traffic, suggesting overlap between the Power Grid Special Act and the Special Act on Maritime Spatial Planning and Offshore Wind Power. It also makes overdevelopment of the marine space an issue of concern.

Of course, the Special Act on the Promotion of Offshore Wind Power and the Development of the Industry (hereinafter referred to as the Offshore Wind Power Special Act) also requires the Minister of Trade, Industry and Energy (MOTIE) to connect the system through the transmission operator (KEPCO), but there is insufficient discussion on how offshore wind power and the offshore power grid will be connected to the onshore system through joint access facilities. The Act on the Planning and Management of Marine Space (hereinafter referred to as the Marine Space Planning Act) does not discuss transmission zones for the development of marine energy.

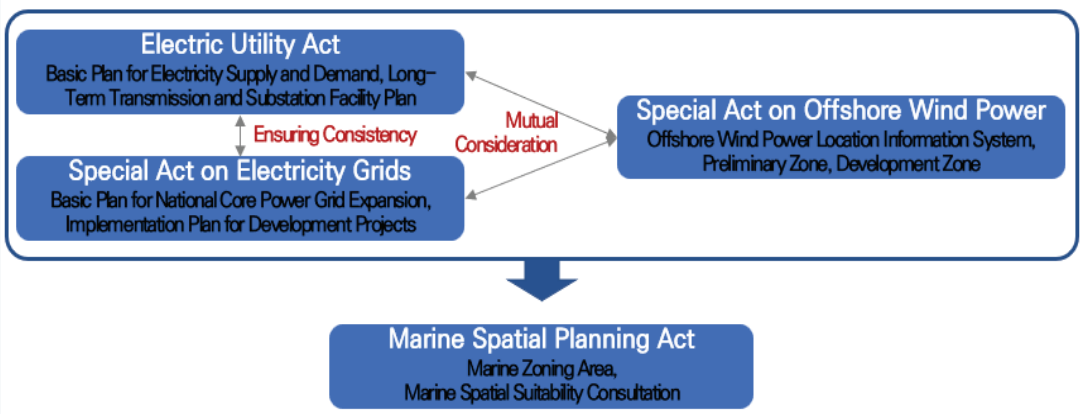
Table ES 1 **Comparison of onshore and offshore aspects of domestic and international power grids**

Category	EU	Germany	UK	South Korea
Onshore	Onshore and Offshore Grid Integration Plan	Regional development, offshore connection lines	Integrated design of offshore and onshore grids and substations Based on the HND method	Surveying in accordance with the Electric Power Development Promotion Act
Offshore	Separate configuration of offshore power grid items	Submarine connection lines		-

Source The authors.

3. Proposed Legal Improvements

Figure ES 2 **Establishing an interconnection framework between laws**



Source The authors.

It is necessary to establish a linkage structure between the Special Act on Electricity Grids and the Special Act on Offshore Wind Power. When formulating the Basic Plan for Electricity Supply and Demand and the Long-Term Transmission and Substation Facility Plan under the Electric Utility Act, as well as the Basic and Implementation Plans under the Special Act on Electricity Grids, considerations should include the Offshore Wind Power Location Information System, Preliminary Zones, and Development Zones stipulated in the Special Act on Offshore Wind Power.

Similarly, when designating Preliminary Zones and Development Zones under the Special Act on Offshore Wind Power, provisions should be established to ensure alignment with the Basic Plan for

Electricity Supply and Demand and the Long-Term Transmission and Substation Facility Plan under the Electric Utility Act, as well as the Basic Plan and Implementation Plan under the Special Act on Electricity Grids.

The Marine Spatial Planning Act should incorporate transmission and distribution in addition to energy development and production. Constraints on offshore wind power development can be effectively mitigated by integrating transmission and distribution infrastructure into marine zoning regulations and discussions on spatial feasibility in marine space (See Figure ES 2 and Table ES 2).

Table ES 2 **Establishing an interconnected legal framework**

Category		Current Legislation	Proposed by this study
Electric Utility Act	Basic Plan for Electricity Supply and Demand	Insufficient attention paid to marine power considerations and details	Considerations for the Special Act on Offshore Wind Power
Special Act on Electricity Grids	Definition		
	Basic Plan		
	Implementation Plan		
Special Act on Offshore Wind Power	Preliminary Zone	Considers Offshore Wind Power Location Information System (Including Power Grid)	Considerations for the Special Act on Electricity Grids
	Power Generation Zone	Proposal for Power Grid Connection Plan	
Marine Spatial Planning Act	Energy Development Zone	Marine Energy Development and Production Zone	Include transmission and distribution in addition to current provisions
	Marine Spatial Suitability Consultation		

Source The authors.

4. Future Directions for the Integration of Renewable Energy, Power Grids, and Spatial Planning

In order to refine the implementation of energy transition policies in the future, it is crucial that planning, environmental, and governance policies are integrated. First, it is necessary to develop a systematic plan for linking the Distributed Energy Act with national plans centered on large-scale renewable energy sources such as offshore wind power, power grids, and regional distributed energy plans. In addition, linkages between energy planning and spatial planning should be forged to ensure that energy infrastructure (grid infrastructure, power generation facilities, etc.) and land use plans (roads, railways, etc.) are in harmony. Furthermore, it is necessary to design and establish a “control

tower"— an oversight body capable of coordinating and integrating individual energy laws, such as the Electricity Grid Act, the Offshore Wind Power Act, and the Distributed Energy Act, so that they can maintain temporal and spatial consistency and operate organically in the implementation stage. In addition, reflecting the special nature of maritime infrastructure, the government should strongly consider the need for a separate Marine Power Grid Act that covers route designation for maritime power transmission infrastructure, access points, and licensing procedures is needed. Feasibility analysis is also important, and a plan should be put in place to establish a system that can identify major environmental factors early through a preliminary environmental review, reducing the time required for a strategic environmental impact assessment and the assessment of the main case. These challenges should be designed from an integrated perspective rather than a siloed approach, and would serve as the core foundation for increasing the predictability and policy consistency of the energy transition process (See Table ES 3).

Table ES 3 **Future policy directions**

No.	Policy direction	Details
1	Enhance linkages in the Distributed Energy Resources Act	Establish a system for linking transmission network plans related to large-scale renewable energy sources (offshore wind power, etc.) and distribution network plans related to small-scale energy generation sources in the region
2	Link grid planning and spatial planning	Develop a linkage plan that allows for the planning of power grid plans and land use plans, such as roads and railways, in conjunction with each other
3	Establish a "control tower" for coordinating energy-related laws	Establish a control tower that coordinates to ensure that different energy laws are aligned temporally and spatially.
4	Propose and pass a Marine Grid Act	If it is difficult to strengthen the interconnection between existing energy laws, establish a marine power grid law that takes into account the unique characteristics of the ocean and establish a marine power grid corporation.
5	Maximize the efficiency of assessments to shorten the project timeframes	By checking important matters in advance through appropriate assessments, a plan to reduce the time required for strategic environmental impact assessment and environmental impact assessment can be prepared

Source Compiled by the authors.

Keywords Renewable Energy, Offshore Wind, Transmission, Grid, Spatial Planning, Law

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Chapter 1

Introduction

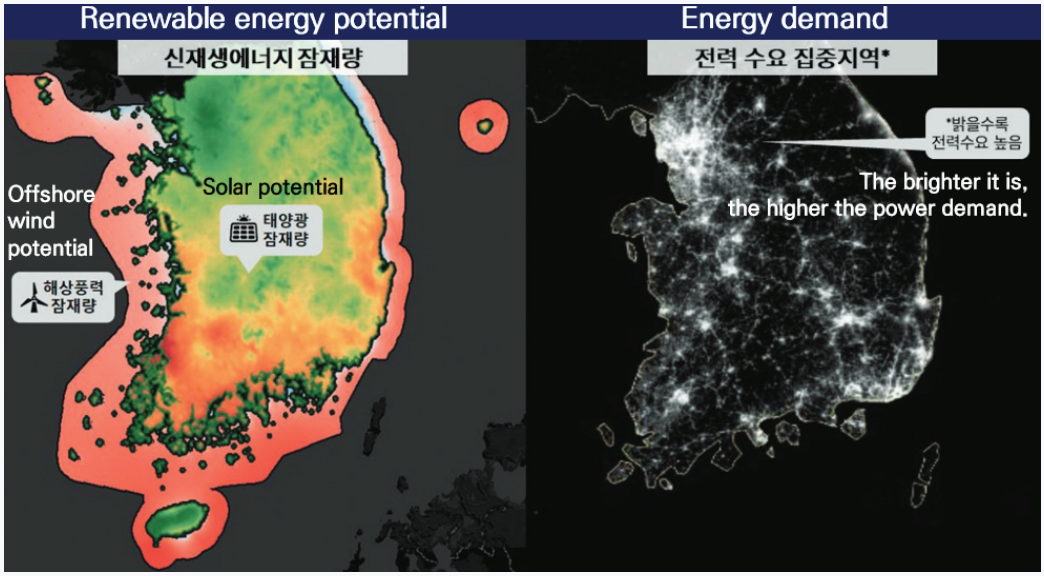
1.1 Background and necessity of the study

As the expansion of renewable energy requires urgent connection and expansion of the power system, the government of South Korea is proposing relevant legislation to implement an optimal system for renewable energy generation. The Special Act on the Expansion of the National Power Grid proposes an omnidirectional support system, improved licensing procedures, and differentiated compensation support for the purpose of efficiently expanding the power infrastructure to accommodate the expansion of renewable energy generation and implement the national energy mix. The Special Act on Planning and Development of Offshore Wind Power allows the Minister of Trade, Industry and Energy (MOTIE) to request a transmission service provider to build a connection facility to be used jointly by offshore wind power generators.

Adding large-scale power demand facilities, such as data centers in the Seoul Capital Area (SCA), potentially exacerbates supply and demand between the SCA and Korea's provincial areas. Renewable energy generation facilities are increasingly concentrated in the southwestern provinces of North Jeolla and South Jeolla (collectively known as Honam), far from the SCA. The structure of the Korean power grid is highly centralized, with electricity demand concentrated in the SCA and some major cities. In contrast, due to cost and environmental factors, power plants are mainly located in non-metropolitan areas. Long-distance transmission is essential as power generation is primarily distributed in Honam, Yeongnam, and the East Coast. The SCA and major cities are experiencing a rapid increase in electricity consumption, but building new power plants is difficult, leading to overreliance on existing facilities. LNG power plants are concentrated in and around the SCA. In

contrast, nuclear and coal power plants are located in the Yeongnam and East Coast regions, and renewable energy is mainly concentrated in the Honam and West Coast regions. The imbalance between power generation and consumption is causing overloads on long-distance transmission networks and increasing transmission bottlenecks. The imbalance in power plant locations is not sustainable in the long term, given the increasing electricity demand in the metropolitan area. This imbalance represents a major a structural issue that can undermine both the stability and economic efficiency of the power grid (See Figure 1).

Figure 1 **Current status of renewable energy supply and demand in the South Korean power grid**

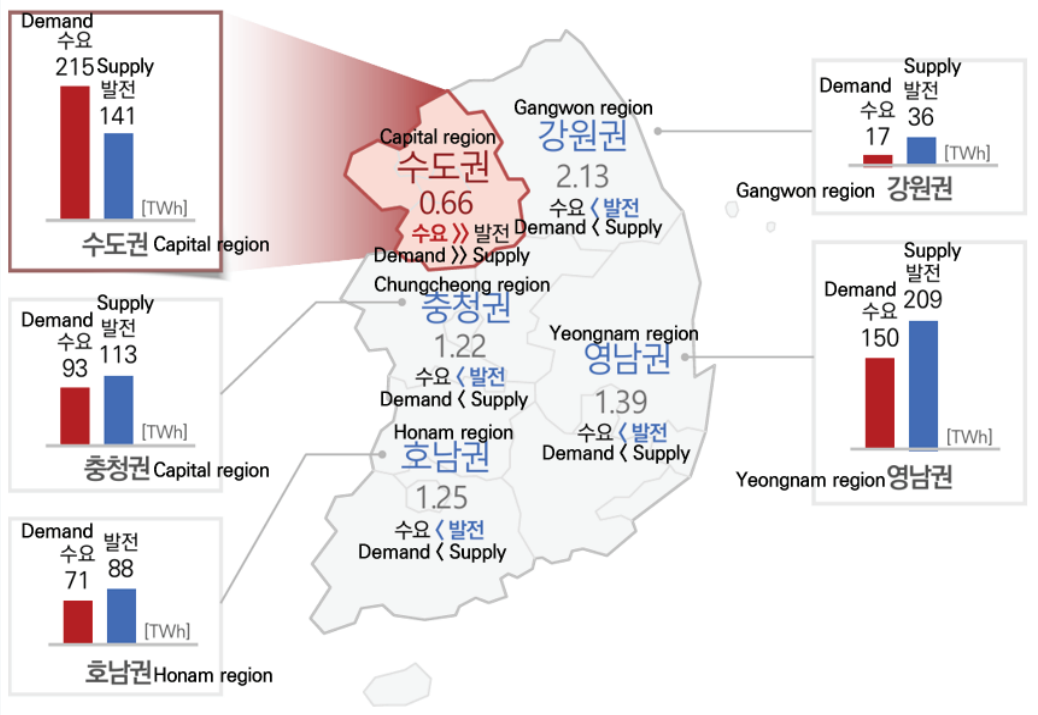


Source KEA Journal (October 15, 2024), "Government to Reflect Renewable Energy Generation Ratio in Power Plan... Experts 'Welcome' the Move", accessed on April 24, 2025.

With the expansion of renewable energy, a transition to distributed generation centered on solar and wind power is necessary. However, the power grid is currently unable to effectively accommodate this shift, and the mismatch between the pace of construction of renewable energy power generation facilities and the pace at which the transmission network is expanding has emerged as a critical issue. While renewable energy power plants can be built within three years, building out a suitable transmission network takes can take between nine and 13 years. The 10th Transmission and Substation Plan shows that 85% of projects have not even broken ground yet, illustrating how insufficient transmission infrastructure is a major obstacle to the expansion of renewable energy. Due to insufficient transmission infrastructure, the government has been forced to ask renewable energy producers to curtail production more and more often, creating a vicious cycle of deteriorating profitability and reduced investment. Over the past two years, the five major power generation

companies have been ordered to restrict generation of renewable power a combined 958 times, primarily due to delays in grid connection. A lack of transmission infrastructure prevents renewable energy producers from freely selling their electricity, leading to deteriorating business viability and reduced investment. Renewable energy is a rigid power source making it difficult to respond swiftly to fluctuations in electricity demand. As a result, concerns are growing that the imbalance between power supply and demand may worsen (See Figure 2).

Figure 2 **Regional energy self-sufficiency rate (as of 2023)**

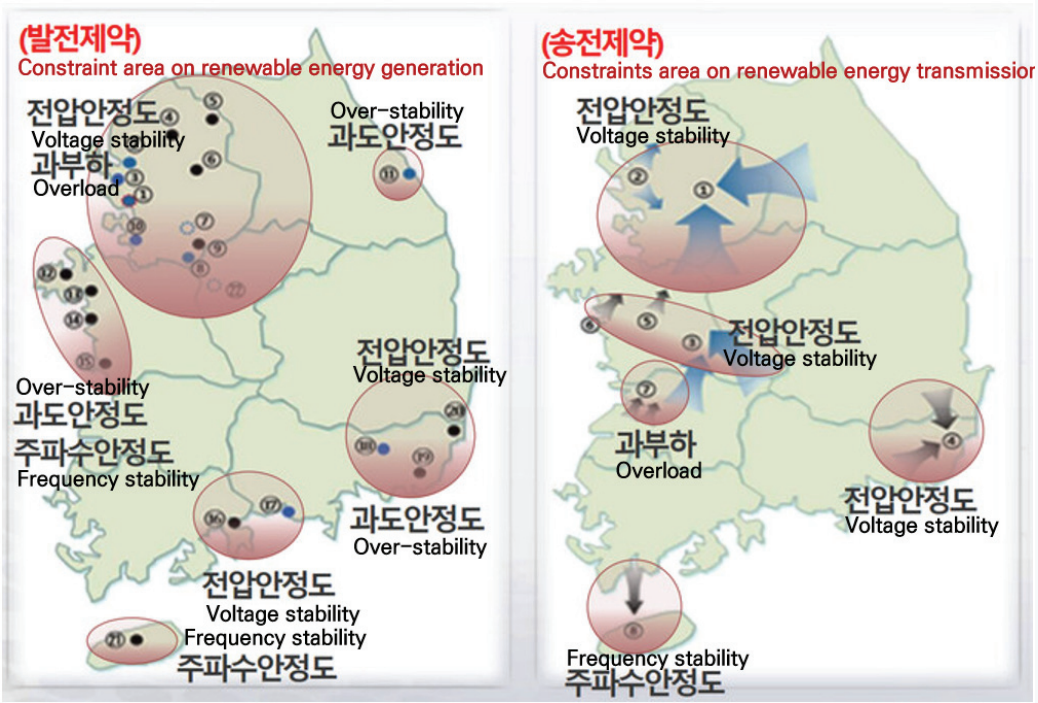


Source Lee, Sung-Kyu (2024), p. 6.

Expanding the supply of renewable energy is key to expanding the overall energy supply, and in response, the government is proposing relevant bills to provide the legal basis for systematic renewable energy generation. However, the Special Act on the Expansion of the National Basic Power Grid and the Special Act on the Promotion of Offshore Wind Power and the Development of the Industry fail to consider the connections between offshore wind power and the inland transmission network. The law should include provisions on the inclusion of offshore wind power in the national basic power grid and marine space. The Special Act on the Power Grid needs to consider offshore wind, and the Special Act on Offshore Wind Power, should ensure that wind development projects are limited to areas with sufficient transmission and distribution capacity. Offshore wind power generation is mainly concentrated on Korea's western and southern coastlines, which means that in order to supply power to the SCA, power generated in these areas must be adequately connected to

inland power distribution networks. However, the current transmission network infrastructure is insufficient, making it difficult to effectively transmit electricity generated by offshore wind to the SCA (See Figure 3).

Figure 3 **Constraints on renewable energy generation and transmission**



Source E2 News (May 31, 2024), "Power Grid in 'Hypertension and Atherosclerosis' Crisis", accessed on March 23, 2025.

In addition, conflicts between local governments have occurred during the construction of offshore wind power transmission networks, and disagreements have arisen over transmission routes between regions are constantly. In the case of the Jeonbuk Southwest Offshore Wind Farm, there was a request to change the offshore wind power transmission route from going through the town of Gochang to Buan. the county of Yeonggwang in South Jeolla province (known as Jeonnam in Korea), local council members expressed concerns over the offshore wind power transmission line to Gwangju, questioning why it had to a detour through Yeonggwang County instead of a direct route (See Figure 4).

Figure 4 **Opposition from local residents to renewable energy transmission infrastructure**

Source News Who Plus (January 4, 2024), "Chungnam Province to Lead Renewable Energy Transition through Community Engagement", accessed on April 24, 2025.

Source NEWSIS (November 11, 2024), "Ministry of Industry to Include Renewable Energy Generation Ratio in 10th Power Plan", accessed on April 24, 2025.

With a better understanding of how siloed offshore wind development planning can lead to major issues down the road, the European Union, the United Kingdom, and Germany plan offshore wind power development, transnational power grid interconnections, and the development of transmission networks simultaneously through high-level Marine Spatial Planning (MSP) committees. Doing so helps avoids delays and related problems. The EU is promoting cross-border transmission network integration to strengthen linkages among offshore wind power and the electricity grid, and through long-term power grid development plans, the EU is simultaneously planning the expansion of offshore wind power and its integration into the grid. The Renewables Grid Initiative (RGI), supported by the EU, promotes the energy transition by focusing on onshore and offshore grid integration. It also invites community participation and acts as an intermediary support organization. In the UK, private Offshore Transmission Owners operate and maintain electric power transmission infrastructure, delivering electric power generated by offshore wind farms to the national grid. This private sector-led approach while pursuing a strategy that expands offshore wind power alongside grid expansion. Germany is enhancing the connection between offshore wind power and the electricity grid by reforming laws and regulations, developing a long-term grid connection strategy linked to spatial planning, and simultaneously promoting transmission network expansion and offshore wind development. In contrast, South Korea's Marine Spatial Planning focuses primarily on environmental and ecosystem protection, resulting in limited space for offshore wind power development. As of 2018, under the Marine Spatial Planning and Management Act, only 0.7% of designated marine zoning areas are allocated for energy development. This highlights the lack of dedicated spatial planning and legal support for the expansion of offshore wind power.

Korea lacks the kind of integrated approach to planning offshore wind power and inland transmission described above. Currently, offshore wind power projects and transmission networks are developed separately. At present, power plants are built first, and transmission networks are expanded later. In 2024, Korea's Ministry of Trade, Industry and Energy (MOTIE) released the Strategy for Expanding Renewable Energy Deployment and Supply Chain Diversification, which emphasizes a more balanced approach. The plan encourages placing solar and wind facilities near high-demand areas such as industrial zones in order to ease the pressure on long-distance transmission lines and make better use of existing infrastructure.

That said, offshore wind power presents a more complicated challenge. Because the electricity is generated far from shore, it must travel long distances to reach inland users. This means extra steps—selecting landfall points, building substations, and coordinating marine and land infrastructure—must all be carefully planned. Given these factors, offshore wind development will only succeed if grid expansion, spatial planning, and infrastructure investment are designed together from the outset. A siloed approach can guarantee failure. There is a need to establish laws and regulations that enable the joint planning of offshore wind power and transmission networks. South Korea should adopt a marine spatial planning-based development approach, similar models seen in Europe. Based on analysis of integrated planning and development initiatives in Europe (focusing on the EU, the UK, and Germany), this study proposes improvements to the legal and institutional framework of offshore wind power generation and transmission in South Korea.

The scope of the study focuses on:

- Offshore wind power as a representative type of renewable energy.
- Transmission networks for offshore wind power transmission.
- Integrated spatial planning approaches to offshore wind power and transmission networks.
- Legal and institutional frameworks for systematic policy development and implementation.

1.2 Research methodology

This study investigates the current challenges in integrating renewable energy and power grids in South Korea by analyzing the spatial disconnect between renewable energy facilities and grid infrastructure using Geographic Information System (GIS) analysis. Subsequently, a literature review and in-depth expert interviews were conducted to examine laws and policies related to the integrated planning of renewable energy and power grids in both domestic and international contexts. A comparative legal analysis was also performed to assess relevant regulatory frameworks. Furthermore, the authors of the study visited Germany for discussions with EU and German experts, and also attended in a conference organized by the UK's National Grid. Based on these insights, the study proposes policy recommendations and legal strategies to enhance the integration of renewable energy and with the power grid in South Korea (See Figures 5, 6, 7, and Table 1).

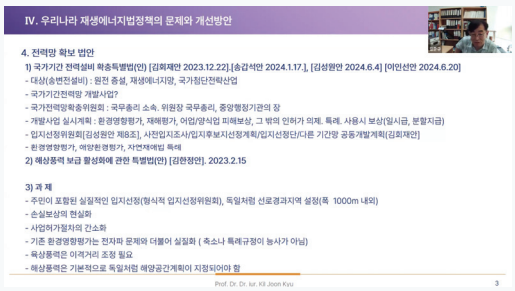
Subsequent chapters feature an analysis of the current state of renewable energy and the power grid in South Korea using GIS, as well as a review of current institutional challenges. The latter portion of the study compares policies and regulatory frameworks in the European Union, Germany, and the United Kingdom, and identifies the implications carried for policy in South Korea (see Figure 8).

Figure 5 **Site visits in Korea**

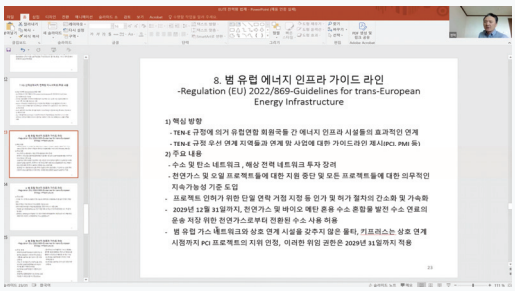
Landfall point of the Subsea Transmission Line in Mokpo

Source The authors.

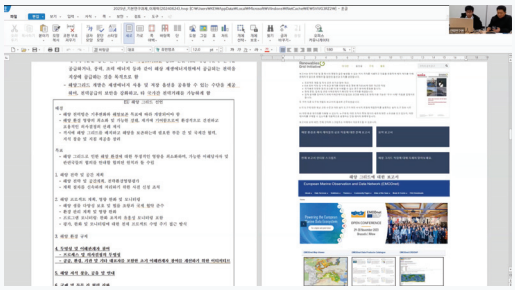
Figure 6 **Online seminars and expert consultations**



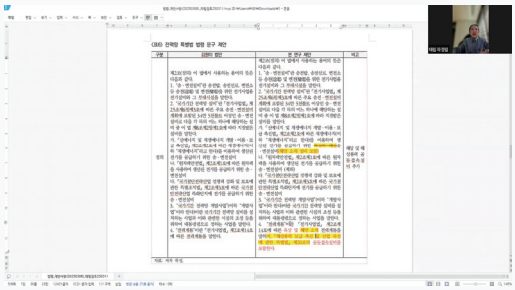
Seminar with Korean legal experts (June 24, 2024)



Seminar with Korean power grid policy experts (October 17, 2024)



Consultation with Korean power grid technical experts (January 9, 2025)



Consultation with Korean legal experts (March 11, 2025)

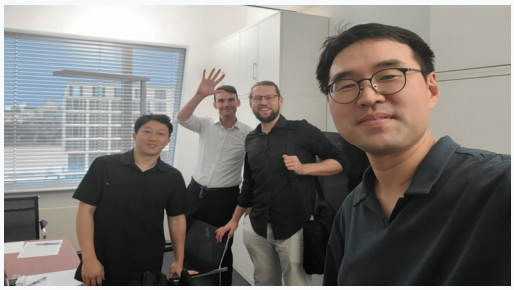
Source The authors.

Figure 7 **Site visits to Germany**

Ruhr University in Bochum, Germany (August 21, 2024)

German Federal Network Agency (August 25, 2024)

Renewables Grid Initiatives (September 4, 2024)



German Energy Cooperative (August 30, 2024)

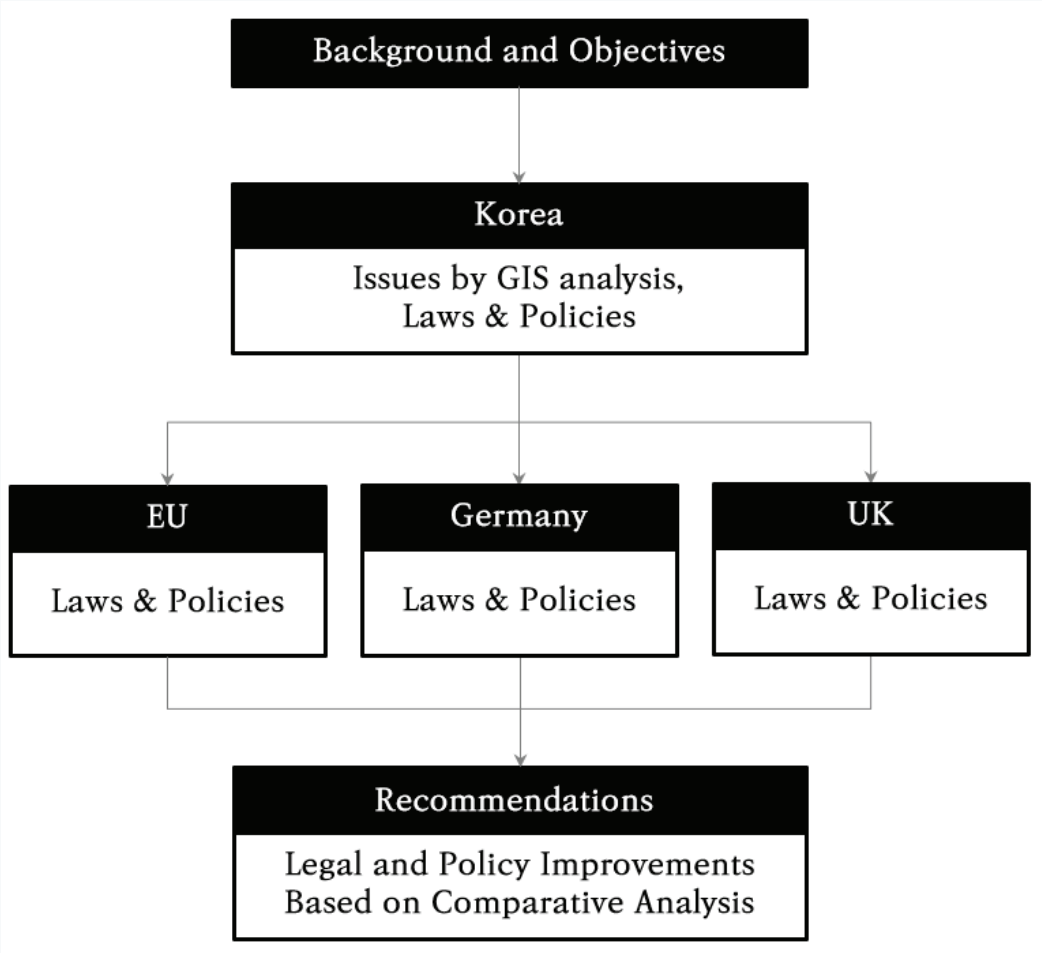
Source The authors.

Table 1 **Status of interviews and seminars conducted**

Division		Content	Date
Korea	Seminar	Korean legal experts	Jun. 24, 2024
	Seminar	Korean legal experts	Jul. 26, 2024
	Seminar	Korean power grid policy experts	Oct. 17, 2024
	Interview	KEPCO experts	Nov. 11, 2024
	Interview	Korean power grid technical experts	Jan. 9, 2025
	Interview	Ministry of Trade, Industry and Energy of Korea	Jan. 21, 2025
	Interview	Korean power grid technical experts	Feb. 14, 2025
	Interview	Korean legal experts	Mar. 11, 2025
	Interview	Korean legal experts	Mar. 20, 2025
EU	Interview	Renewables Grid Initiatives	Aug. 14, 2024
	Seminar at Berlin	Renewables Grid Initiatives	Sep. 4, 2024
Germany	Seminar at Ruhr Univ.	CURE research team at Ruhr Univ.	Aug. 20, 2024
	Interview at Born	Federal Network Agency in Germany	Aug. 25, 2024
	Interview	German Energy Cooperative	Aug. 30, 2024
	Interview	Berlin City Hall	Aug. 30, 2024
	Interview	Agora Energiewende	Sep. 2, 2024
	Seminar at Dresden	Local government policies on power grids in Germany	Sep. 10, 2024
	Seminar	Federal Network Agency in Germany	Sep. 11, 2024
UK	Forum	National Grid	Sep. 12, 2024
Institution alization	Forum	Jeonbuk Region	Nov. 18, 2024
	TV (KBS)	Jeonbuk Region	Nov. 18, 2024
	TV (JTV/SBS)	Jeonbuk Region	Nov. 18, 2024
	TV (JTV)	Jeonbuk Region Current Affairs Program	Nov. 22, 2024
	Forum	National Assembly	Jan. 8, 2025
	Roundtable Meeting	National Assembly	Jan. 24, 2025
	Forum	National Assembly	Feb. 12, 2025

Source The authors.

Figure 8 Research process



Source The authors.

Chapter 2

Spatial Status and Legal Framework in Korea

2.1 Analysis of renewable energy and the power grid in Korea

2.1.1 Spatial mismatch between wind power generation and power infrastructure

As the transition to renewable energy is in full swing, wind power generation is gaining attention as a sustainable source of electricity. In particular, wind power plants, including offshore wind power, are concentrated around coastal areas and islands with favorable wind speeds. However, the actual demand for electricity is concentrated in metropolitan areas and large-scale industrial zones, creating a spatial mismatch between wind power plants and power infrastructure.

Figure 9 visualizes the density of wind power plants and substations in Korea using the kernel density estimation technique. Red areas represent the density of wind power plants, and the blue areas represent the density of substations. Looking at the map, wind power plants are concentrated around the coasts and islands of Korea, including the island of Jeju—which is also its own province—while substations are concentrated in the Seoul Capital Area (SCA), which includes the cities of Seoul and Incheon and the surrounding province of Gyeonggi, as well as the industrial cities of Busan and Ulsan and South Gyeongsang, the province that surrounds them.

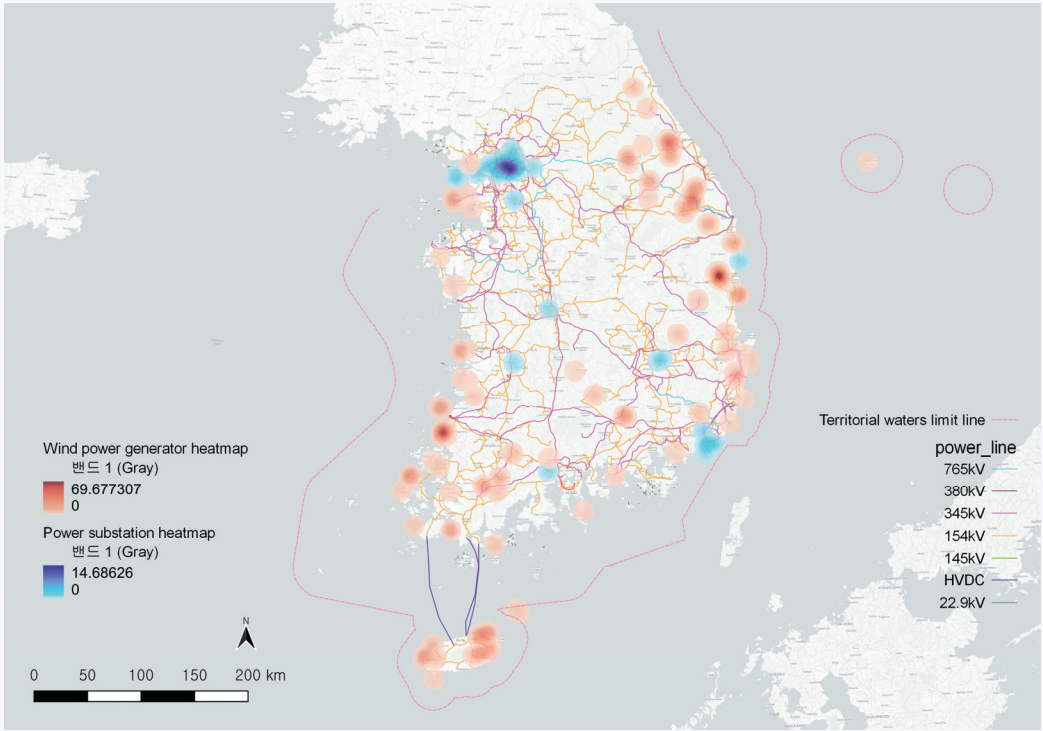
This spatial mismatch makes it difficult to efficiently connect power production and consumption,

and highlights the need for new infrastructure such as high-voltage direct current (HVDC) distribution networks capable of long-distance transmission. One HVDC power line has been built between Jeju Island and the mainland, but additional transmission lines are required to expand offshore wind power and balance the power supply across the country.

Existing 765kV and 380kV extra-high voltage transmission lines are located predominantly in the SCA and near industrial zones, with few direct connections to the coastal areas where wind power generation is concentrated. This necessitates the construction of new substations around wind power generation facilities that connect to existing transmission networks inland.

In conclusion, the spatial mismatch between the location characteristics of wind power generation and electricity demand centers is a major challenge facing the South Korean government as it seeks to expand its supply of renewable energy, and it is urgent to establish a spatial-based power infrastructure plan to resolve this.

Figure 9 **Analysis of kernel density of domestic wind power generators and substations and distribution of power grids**



Source Created by the authors using data from Open Infrastructure Map, "Open Infrastructure Map", accessed on March 22, 2025.

2.1.2 Spatial mismatch between wind power generation and power infrastructure

As the offshore wind power industry continues to expand, ensuring spatial alignment between power generation sites and supporting grid infrastructure has become increasingly critical. Figure 10 presents a comprehensive visualization of offshore wind power plants, substations, transmission lines, and the current development status of offshore wind projects in South Korea.

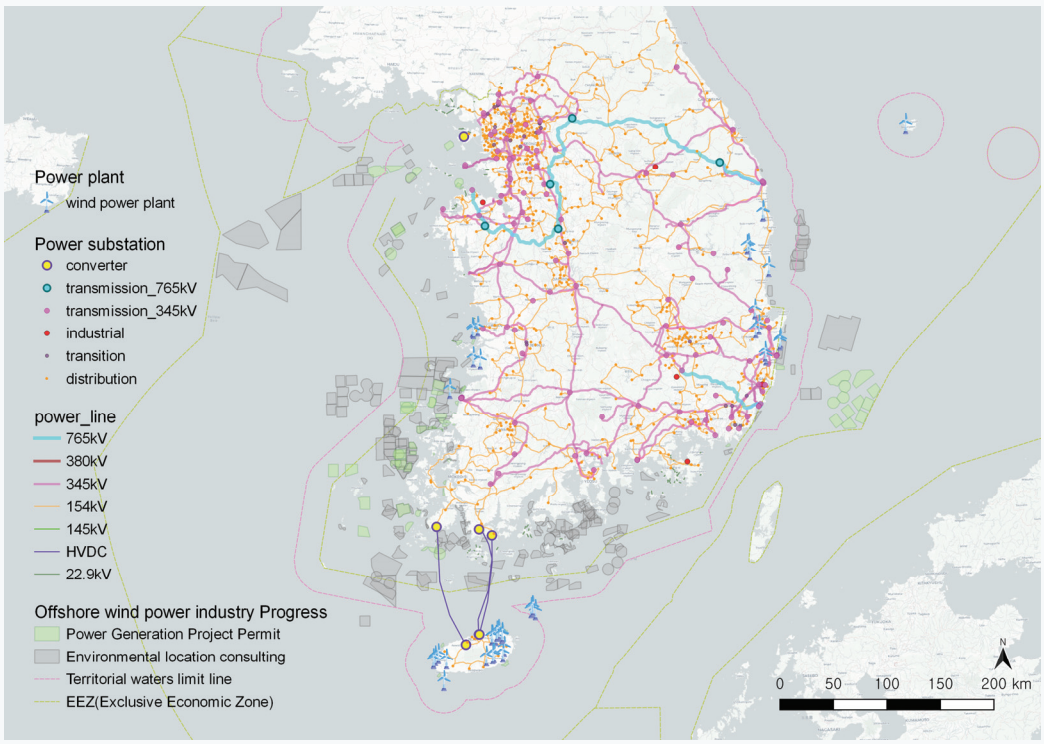
Wind power plants are primarily distributed in nearby offshore areas, with extensive zones for power generation permits and environmental location consulting concentrated along the west and south coasts, indicating that offshore wind development is actively underway in these regions. In addition, the industry is gradually expanding in parts of the Yeongnam (southeastern) region as well.

The 765kV and 345kV ultra-high-voltage transmission lines are mainly concentrated in inland areas, particularly around the Seoul Capital Area (SCA) and major industrial zones, illustrating how the core of the national power grid remains mostly inland. In contrast, key offshore wind zones along the west and south coasts are lack nearby large-scale substations and transmission infrastructure. Although there are HVDC lines connecting Jeju Island to the mainland, these alone cannot accommodate all offshore wind generation capacity, and the density of substations near these areas remains low. In particular, many of the planned offshore wind sites along the west coast are not located near converter substations or ultra-high-voltage transmission lines.

This spatial mismatch suggests a lack of landfall points (grid connection points) and limited grid capacity to stably integrate offshore-generated electricity into the inland power system. The east coast is also included in national offshore wind development plans, but connecting such systems to nearbly high-voltage transmission networks is currently infeasible.

In conclusion, although offshore wind development is progressing actively, the supporting infrastructure needed to connect offshore and onshore systems—such as substations, HVDC links, and high-voltage transmission lines—is insufficient. To ensure the stable expansion of offshore wind power, the identification and development of landfall points and corresponding grid connection infrastructure must become a top priority.

Figure 10 **Spatial distribution of offshore wind power and grid infrastructure**



Source Created by the authors using data from Open Infrastructure Map, "Open Infrastructure Map", accessed on March 22, 2025.

2.1.3 Spatial overlap of offshore wind power development and environmental conservation areas

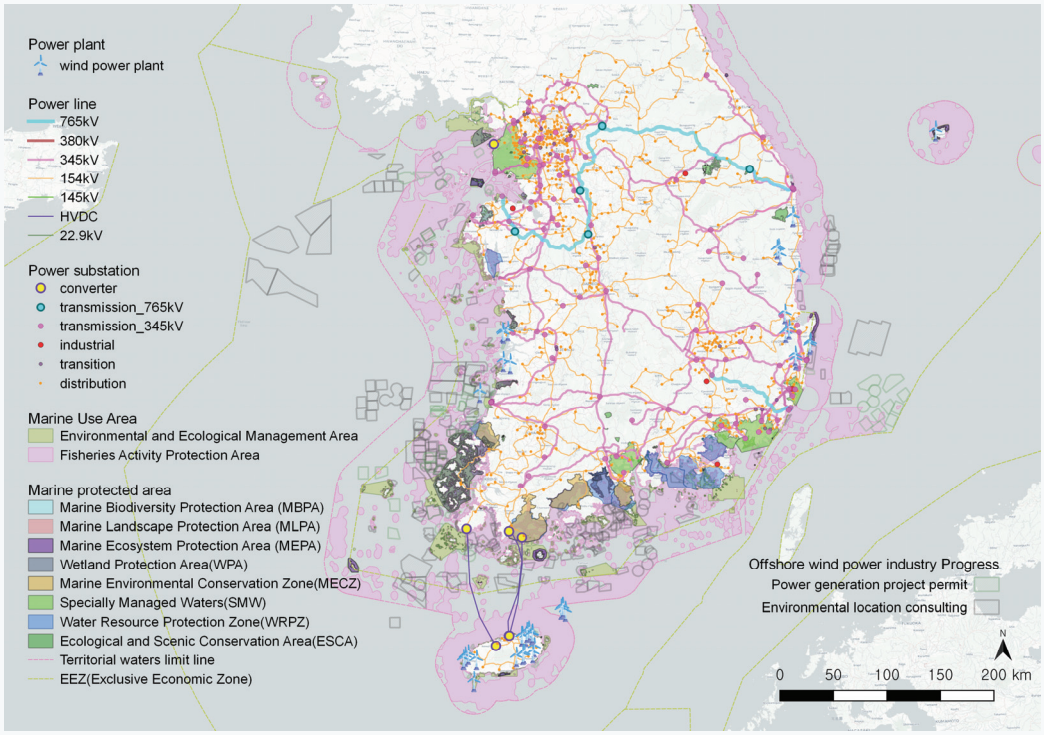
As offshore wind power development rapidly expands in South Korea, concerns are increasing over its spatial overlap with marine environmental conservation areas and fishery activity zones. Figure 11 presents a comprehensive visualization of offshore wind power plants, power grid infrastructure (transmission lines and substations), marine protected areas (MPAs), marine use areas, and the current status of offshore wind project development. This map enables a multi-dimensional understanding of the spatial relationships between renewable energy development, marine environmental planning, and ocean use.

Offshore wind power plants are distributed along the west, south, and east coasts, with a particularly high concentration of projects in South Jeolla (Jeollanam-do) and the southwestern coastal areas. At the same time, these regions overlap with or are adjacent to various marine conservation areas protected by fisheries. Such overlaps increase the potential for spatial conflicts involving marine ecosystem services, fishing rights, and local communities. Furthermore, the presence of marine

protected areas in these locations highlights the difficulty of constructing new power infrastructure, such as transmission lines and substations.

Figures 11 clearly illustrate that significant spatial overlap exists between offshore wind development areas, MPAs, and fisheries in South Korea. This overlap poses a critical challenge to achieving harmony between renewable energy expansion and marine conservation and use. Therefore, the sustainable advancement of offshore wind power will require an integrated spatial coordination system that considers both Marine Spatial Planning (MSP) and a grid connection strategy. A scientific and strategic approach is essential to minimize impacts on ecosystems and local communities while achieving the national goal of energy transition.

Figure 11 **Spatial distribution of domestic offshore wind power infrastructure, marine conservation areas, protected fisheries, and grid networks**



Source Created by the authors using data from Open Infrastructure Map, "Open Infrastructure Map", accessed on March 22, 2025.

2.2 Discussion of individual laws

2.2.1 Renewable Energy Act[1)]

(1) Overview

The main objectives of the Renewable Energy Act are to diversify energy sources, secure the stability of the energy supply, and promote an environmentally friendly energy transition by promoting the development, use, and dissemination of energy and renewable energy technologies. Through this, the Act aims to reduce greenhouse gas emissions and contribute to the sustainable development of the national economy and the promotion of national welfare (See Table 2).

Table 2 **Overview of the Renewable Energy Act**

Category	Content
Name	• Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy (Renewable Energy Act)
Date of enactment	• October 13, 2005
Date of enforcement	• November 15, 2022
Organizing agency	• Ministry of Trade, Industry and Energy
Main goals	• Energy diversification, greenhouse gas reduction, sustainable development
Planning cycle	• Basic plan established every five years

Source Korea Law Information Center, "Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy", accessed on March 22, 2025.

(2) Main aspects

Korea's Renewable Energy Act embodies a comprehensive and strategic framework aimed at accelerating the transition toward a future powered by sustainable energy. Rather than focusing solely on technological innovation, the Act emphasizes the systemic nature of renewable energy governance by integrating national planning, institutional accountability, market-based regulation, and community engagement.

By requiring a national master plan every five years (Article 5), the Act ensures that renewable energy development is not driven by short-term incentives but rather by a consistent, long-term strategy

1) This section is based on the Act on the Promotion of the Development, Use, and Diffusion of New and Renewable Energy from the Korea Law Information Center.

aligned with the country's energy and climate goals. Furthermore, the Act mandates public institutions and government-affiliated entities to install renewable energy systems in newly constructed or renovated buildings (Article 12), thereby setting a precedent for the private sector and fostering a stable demand for renewable technologies in the public sphere.

In addition, a Renewable Portfolio Standard (RPS)- like mechanism obliges designated electricity suppliers—such as licensed generators and public institutions—to supply a minimum share of electricity from renewable sources (Article 12-5). This strengthens market signals and communicates the government's commitment to clean energy to producers and investors.

A particularly innovative element of the Act is its promotion of resident participation in local energy projects. By allowing individuals to invest, join cooperatives, or engage through other mechanisms (Article 27-2), the Act enhances social acceptance, encourages local ownership, and helps to mitigate conflicts over energy infrastructure.

Overall, Korea's Renewable Energy Act serves as a model policy that balances national planning with local empowerment, regulatory obligations with market incentives, and technological progress with social inclusion. It offers valuable insights for countries aiming to develop integrated and holistic renewable energy policies (See Table 3).

Table 3 **Main aspects of the Renewable Energy Act**

Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy (Renewable Energy Act)
Article 5 (Formulation of Master Plan) (1) The Minister of Trade, Industry and Energy shall formulate a master plan for the promotion of technological development, use, and distribution of new and renewable energy (hereinafter referred to as "master plan") every five years, after deliberation by the New and Renewable Energy Policy Council established under Article 8 after consulting with the heads of related central administrative agencies. <Amended on Mar. 23, 2013; Jan. 21, 2014>
Article 12 (Investment Recommendation and Mandatory Use of New and Renewable Energy) (2) Where the Minister of Trade, Industry and Energy deems it necessary to facilitate the use or distribution of new and renewable energy, and to vitalize the new and renewable energy industry, he/she may require any of the following entities to mandatorily install new and renewable energy facilities in a building newly built, extended, or remodeled by such entities in order to use energy supplied utilizing new or renewable energy over a certain percentage of the estimated amount of energy used computed as at the time of its design, as prescribed by Presidential Decree: <Amended on Mar. 23, 2013; Jan. 28, 2015>

Table 3 (continued)

Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy (Renewable Energy Act)
1. The State or local governments; 2. A public institution; 3. A government-contributed institution to which the Government has contributed at least an amount prescribed by Presidential Decree; 4. A government-invested corporation defined in subparagraph 6 of Article 2 of the State Property Act; 5. A corporation to which a local government, public institution, government-contributed institution, or government-invested corporation referred to in subparagraphs 2 through 4 has invested at a ratio or at least an amount prescribed by Presidential Decree; 6. A corporation incorporated under any special Act. Article 12-5 (Mandatory Supply of New and Renewable Energy) (1) Where the Minister of Trade, Industry and Energy deems it necessary to facilitate the use and distribution of new and renewable energy, and to vitalize the new and renewable energy industry, he/she may require a person prescribed by Presidential Decree (hereinafter referred to as "mandatory supplier"), among the following persons, to mandatorily supply at least a certain amount of electricity generated by using new and renewable energy: <Amended on Mar. 23, 2013> 1. An entity engaged in electricity generation business defined in Article 2 of the Electric Utility Act; 2. A person deemed to have obtained a license to engage in electricity generation business under Article 7 (1) of the Electric Utility Act pursuant to Articles 9 and 48 of the Integrated Energy Supply Act; 3. A public institution. Article 27-2 (Residents' Participation in New and Renewable Energy Power Generating Business) (1) Residents in an area where new and renewable energy facilities are installed may participate in a new and renewable energy power generating business in of relevant area by any of the following methods: 1. Investing in a new and renewable energy power generating business; 2. Contributing to a cooperative (referring to a cooperative established under the Framework Act on Cooperatives) whose objective is a new and renewable energy power generating business as a member of the cooperative; 3. Other means determined by the Minister of Trade, Industry and Energy.

Source Korea Law Information Center, "Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy".

(3) Expected effects

The expansion of renewable energy is expected to reduce greenhouse gas emissions and contribute to achieving the national goal of achieving carbon neutrality by 2050. This means shifting away from the existing fossil fuel-centered energy structure to eco-friendly energy sources, and contributing to the international community's efforts to achieve carbon neutrality globally.

Promoting the development of renewable energy-related technologies can enhance the competitiveness of domestic companies and induce the creation of new industries and jobs. It is important to create a foundation for domestic renewable energy companies to gain a competitive edge in the global market through active government support.

Introducing a resident-participation-type business model to enable local residents to actively participate in renewable energy projects can increase the acceptance of local residents and minimize conflicts during the construction of renewable energy power plants.

(4) Problems and improvement tasks

Insufficient discussion of the renewable energy grid

Currently, the Renewable Energy Act includes provisions for improving the connectivity of the power grid, but lacks specific legal measures. As the number of renewable energy power generation facilities increases, the problem of connecting to the power grid is becoming increasingly serious, and this is causing difficulties for power generation companies in supplying power to the power grid in a stable manner. As the plan for expanding the transmission network is not clearly stipulated by law, the the imbalance of power supply and demand may only worsen if the number of renewable energy power plants increases. This necessitates the creation of a legal foundation for long-term planning and investment in transmission and distribution network expansion projects.

- Article 2 (Definitions) 3. The term “new energy and renewable energy facilities” (hereinafter referred to as “new and renewable energy facilities”) means facilities determined by Ministerial Decree of Trade, Industry and Energy for producing or utilizing new energy and renewable energy (hereinafter referred to as “new and renewable energy”), or for improving the link condition of the power system of new and renewable energy.

Problems with output limits for renewable energy facilities

The amount of electricity generated by renewable energy power generation facilities tends to heavily depend on the weather. This often results in power providers being told to curtail power generation. For example, in regions with a high proportion of solar and wind power generation, the amount of power generation is often forcibly limited to prevent grid overload when the amount of power generated exceeds demand for electricity.[2] The current renewable energy law does not sufficiently consider this potential bottleneck, making the prospect of running a renewables plant less enticing to potential investors, which may lead to a decline in investment and economic losses.

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2) Kwak, Eun-Sup et al. (2025).

2.2.2 Special Act on Activation of Distributed Energy[3)]

(1) Overview

The Special Act on the Promotion of Distributed Energy aims to increase the stability of energy supply and reduce the burden on the power grid by promoting regional-based energy production and consumption. It is intended to strengthen national energy security and contribute to the development of the national economy. It also aims to shift energy policy in the direction of reducing reliance on existing large-scale centralized power grids by promoting the use of renewable energy and distributed energy sources.

Distributed energy refers to energy produced and supplied in a certain volume or less in the area of use, and is mainly supplied in the form of renewable energy (solar, wind), fuel cell power generation, and hydrogen power generation. The distributed energy industry refers to the business of responsible production, supply, and operation of distributed energy sources, and the law stipulates registration and management standards in this industry.

The Special Act on the Promotion of Distributed Energy obliges the national and local governments to establish and implement a plan for the promotion of distributed energy. It also encourages participation from the private and public sectors by expanding various regulatory exemptions and support policies for the implementation of the law (See Table 4). Its main duties are as follows:

- Establish and implement a plan for the promotion of distributed energy
- Expand regulatory exemptions and support for distributed energy
- Secure the stability of renewable energy projects through power system impact assessments
- Promote regionally-focused energy distribution policies

Table 4 **Overview of the Special Act on Activation of Distributed Energy**

Category	Content
Name	• Special Act on Activation of Distributed Energy (Distributed Energy Act)
Date of enactment	• June 13, 2023
Date of enforcement	• December 14, 2023
Organizing agency	• Ministry of Trade, Industry and Energy
Main goals	• Increasing energy stability, revitalizing regionally-focused distributed energy, and alleviating the burden of power transmission
Planning cycle	• Basic Plan established every five years

Source Korea Law Information Center, "Special Act on Activation of Distributed Energy".

3) This section is based on the Special Act on Activation of Distributed Energy from the Korea Law Information Center.

(2) Main aspects

In response to the growing need for energy decentralization and carbon neutrality, Korea enacted the Special Act on the Promotion of Distributed Energy to establish a legal framework for accelerating the transition to a distributed energy system. This Act defines “distributed energy” as energy produced and consumed within the same or neighboring area within a limited scale (Article 2). It seeks to promote its adoption through systematic regulation and institutional support.

A key feature of the Act is that it takes precedence over existing laws, such as the Renewable Energy Act, the Smart Grid Act, and the Electric Utility Act, in matters related to distributed energy (Article 4). This ensures legal clarity and priority in policy implementation. The Act also introduces a registration system for distributed energy businesses (Article 8) and obligates electricity distribution entities to install and manage appropriate infrastructure to accommodate distributed energy generation (Article 16).

Moreover, the law requires large-scale electricity users in designated areas to conduct power system impact assessments (Article 23) and to submit those results as part of the project approval process (Article 24). During project implementation, these entities must also comply with mandates derived from the assessments (Article 28). In addition, electricity distributors must submit expansion and operation plans for distribution networks that reflect the needs of distributed energy systems in their regions (Article 18). These provisions aim to facilitate the safe integration of decentralized energy sources while maintaining the electricity system’s reliability (Article 17).

Importantly, the Act encourages market flexibility by allowing distributed energy producers in designated special zones to directly supply electricity to consumers without going through the traditional electricity market (Article 43). It also introduces regulatory exemptions or decentralization of authority within these designated zones to promote innovation and regional autonomy in energy governance (Article 38).

Overall, the Act signifies a paradigm shift from a centralized power system to a local flexible, and participatory energy model. It reflects Korea’s commitment to building a more resilient, sustainable, and inclusive energy future through proactive legislative support (See Table 5).

Table 5 **Main aspects of the Distributed Energy Act**

Special Act on Activation of Distributed Energy (Distributed Energy Act)
Article 2 (Definitions)
1. The term "distributed energy" means energy supplied or produced in a space, area, or neighboring area where energy is used, which does not exceed a certain scale prescribed by Presidential Decree;
Article 4 (Relationship to Other Statutes)
This Act shall take precedence over other statutes, such as the Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy, the Act on the Establishment and Use of Smart Grids, and the Electric Utility Act, with respect to the activation of distributed energy; provided, this shall not apply to matters related to Articles 27-2, 29, and 46 of the Electric Utility Act.
Article 8 (Registration of Distributed Energy Business)
(1) A person who intends to engage in distributed energy business shall file for registration of each type of distributed energy business with the Minister of Trade, Industry and Energy; provided, he or she shall be deemed to have filed for registration in any of the following cases: 1. A business entity who supplies distributed energy among smart grid business entities registered under Article 12 of the Smart Grid Construction and Utilization Promotion Act; 2. A business entity who supplies distributed energy among electric utility business entities licensed under Article 7 of the Electric Utility Act; 3. A business entity who supplies distributed energy among new electric utility business entities registered under Article 7-2 of the Electric Utility Act; 4. A business entity who supplies distributed energy among wind power generation business entities who have obtained permission from the Jeju Special Self-Governing Province Governor under Article 303 of the Special Act on the Establishment of Jeju Special Self-Governing Province and the Development of Free International City.
Article 16 (Obligation of Electric Distribution Business Entity to Install and Manage Appropriate Facilities)
(1) An electric distribution business entity shall install and manage facilities meeting the standards determined and publicly notified by the Minister of Trade, Industry and Energy so that distributed energy business entities connected to distribution networks can smoothly supply electricity through the distribution networks in response to changes in the demand and supply of electricity. (2) An electric distribution business entity shall disclose a policy on the management of distribution networks stating the objectives, scope, conditions, procedures, methods, etc., as prescribed by Presidential Decree, and shall notify the relevant electric distributed energy business entity of the facts, impacts, etc. of measures for the management of distribution networks, if any; provided, where it is impracticable to notify the relevant electric distributed energy business entity of such facts, impacts, etc. for any unavoidable reason, official notice may be substituted for such notification.
Article 17 (Obligation for Stable Operation of Distribution Networks)
(1) An electric distribution business entity shall operate the electric power system in a stable manner through power output prediction, monitoring, evaluation, etc. of electric power generated from a distributed energy business within a project area connected to distribution networks.

Table 5 **(continued)**

Special Act on Activation of Distributed Energy (Distributed Energy Act)
Article 18 (Submission of Plans for Expansion and Operation of Distribution Networks) (1) An electric distribution business entity shall conduct a fact-finding survey on distributed energy to cover matters prescribed by Presidential Decree, such as the types and scale of distributed energy business the facilities of which are installed or operated within an electric distribution business area, and shall submit to the Minister of Trade, Industry and Energy a plan to expand and operate distribution networks necessary for accommodating distributed energy in the relevant area. In such cases, the Minister of Trade, Industry and Energy may request changes in the plan for expanding and operating distribution networks, in consideration of the characteristics of the distributed energy linked to the relevant distribution networks and the current status of the activation of distributed energy.
Article 23 (Subjects of Power System Impact Assessments) (1) A business entity who intends to use electricity exceeding a certain amount prescribed by Presidential Decree (hereinafter referred to as "business entity subject to power system impact assessments") in an area subject to power system impact assessments designated and publicly notified by the Minister of Trade, Industry and Energy, as prescribed by Presidential Decree, shall conduct power system impact assessments; provided, any of the following projects may be exempted from the power system impact assessments: 1. Projects for emergency measures under Article 37 of the Framework Act on the Management of Disasters and Safety; 2. Projects on which the Minister of National Defense has consulted with the Minister of Trade, Industry and Energy as deemed necessary for protecting military secrets or urgently carrying out military operations; 3. Projects on which the Director of the National Intelligence Service has consulted with the Minister of Trade, Industry and Energy, as deemed necessary for national security; 4. Other projects prescribed by Presidential Decree as necessary to attract high-tech industries, etc.
Article 24 (Submission and Examination of Statement of Power System Impact Assessments) (1) Where a business entity subject to power system impact assessments is required to obtain approval, authorization, permission, designation, etc. (hereinafter referred to as "approval, etc.") for a project subject to power system impact assessments or a plan of such project under Article 23 (1) (hereinafter referred to as "project plan, etc."), he or she shall submit the written results of power system impact assessments (hereinafter referred to as "statement of power system impact assessments") to the Minister of Trade, Industry and Energy before applying for such approval, etc. by the deadline prescribed by Presidential Decree.
Article 28 (Implementation of Power System Impact Assessments) (1) When implementing a project subject to power system impact assessments under Article 23 (1) (hereinafter referred to as "project subject to assessments"), a business entity subject to power system impact assessments shall comply with the mandates (hereinafter referred to as "mandates") reflected in the relevant project plan, etc. following the power system impact assessments.

Table 5 **(continued)**

Special Act on Activation of Distributed Energy (Distributed Energy Act)
Article 38 (Effects of Designation of Distributed Energy Specialized Areas) (1) The State and local governments shall endeavor to partially or wholly exclude the application of administrative regulations under Article 2 (1) 1 of the Framework Act on Administrative Regulations or to devolve regulatory authority (hereinafter referred to as "regulatory exceptions, etc.") in relation to an area designated as a distributed energy specialized area pursuant to Article 36 in implementing a plan for a distributed energy specialized area. Article 43 (Electricity Transaction between Distributed Energy Business Entities and Electric Sales Business Entities) (1) Notwithstanding the Electric Utility Act, a distributed energy business entity that has installed power generation facilities in a distributed energy specialized area may directly supply electricity to electricity consumers not through the electricity market defined in subparagraph 13 of Article 2 of that Act (hereafter referred to as "electricity market" in this Article) within the distributed energy specialized area. In such cases, consultations on charges, other terms and conditions of supply, etc. shall be held individually to conclude a contract. (2) A distributed energy business entity may make a transaction with an electric sales business entity where an accident in a distributed energy specialized area or any other cause prescribed by Ministerial Decree of Trade, Industry and Energy results in shortage of electricity, or may make a transaction in the electricity market or with an electric sales business entity in accordance with the rules on the operation of the electricity market under Article 43 of the Electric Utility Act, where surplus power exists.

Source Korea Law Information Center, "Special Act on Activation of Distributed Energy".

(3) Expected effects

If distributed power generation systems are widely adopted, the need for large-scale power generation facilities and long-distance transmission networks will decrease. In the existing centralized power grid, electricity is generated at large-scale power plants and then distributed to each region through long-distance transmission networks. But distributed energy is produced and supplied directly in the regions where the power is consumed, which can reduce the cost of building long-distance transmission networks. A structural shift toward distributed energy production and consumption would result in significantly lower capital expenditures and maintenance costs associated with the construction and operation of power generation facilities and distribution networks. In particular, a more dfistributed energy system would alleviate public backlash and mitigate environmental issues associated with the construction of transmission towers, which would in turn minimize the frequency and intensity of social conflicts that arise as a result of power construction projects.

A system for producing and consuming energy on a local level would increase regional self-sufficiency in terms of energy. This would have the knock-on benefit of reducing reliance on the national power grid and helping specific regions independently tackle power shortages. Local residents could participate directly in the energy production process or consume the power generated by distributed energy generation facilities within the region.

Under a distributed system of power generation and consumption, regions would be better able of dealing with their own power problems, increasing the stability of the country's power supply as a whole. In the existing centralized power grid, if a problem occurs at a specific large-scale power plant, there is a risk of a widespread blackout. However, a distributed energy system could prevent this problem, since each region would have a more independent system of power production and consumption. As the stability of energy supply and demand increases, national energy security is strengthened, and the foundation is laid for flexible response to fluctuations in the international energy market.

(4) Problems and improvement tasks

Incompatibility with large-scale renewable energy

The Special Act on the Promotion of Distributed Energy was designed to promote regionally- focused energy production and consumption, and suffers from a lack of connectivity with power generated by large-scale power plants such as offshore wind farms. Large-scale power plants produce large amounts of power and transmit it to several regions, so it is difficult to directly connect them to distributed energy systems that consume power on a more regional basis. Overall, the law lacks clarity on how to effectively utilize the power generated through offshore wind power generation on a regional basis, and legal and policy solutions are needed to address this shortcoming.

Insufficient discussion of connecting the distribution and transmission networks

The Special Act on the Promotion of Distributed Energy was designed with a focus on the operation of regional distribution networks how to connect them to long-distance transmission networks. Transmission and distribution networks play a critical role in regulating the regional supply and demand of electricity and maintaining the reliability of the power system, but the Act lacks specific provisions on how to effectively link the electricity generated by large-scale power plants with local transmission networks. In order to strengthen connections between transmission network distribution networks, it is necessary to take the appropriate steps, both technical and legal, to enable smooth interactions between distribution energy sources and the national power grid.

2.2.3 Special Act on the Promotion of Offshore Wind Power Deployment and Industry Development

(1) Overview

The Special Act on the Promotion of Offshore Wind Power and the Development of the Industry (hereinafter referred to as the "Special Act on Offshore Wind Power") aims to establish an integrated administrative procedure for the installation of offshore wind power generation facilities and the creation of offshore wind power generation districts, contributing to the achievement of carbon neutrality and strengthening the global competitiveness of the offshore wind power industry.

Currently, the offshore wind power industry is attracting attention as a nationally-important important new source of renewable energy, but various problems have arisen in the process of promoting the business. Typical problems include complex licensing procedures, public acceptance issues a lack spatial coordination, and inefficiencies in connecting offshore wind to the national power grid. Accordingly, the Offshore Wind Special Act aims to promote more systematic and efficient offshore wind power development by strengthening the principle of public nature and introducing a government-led planning approach (See Table 6).

Table 6 **Overview of Special Act on Offshore Wind Power**

Category	Content
Name	• Special Act on the Promotion of Offshore Wind Power Deployment and Industry Development (Special Act on Offshore Wind Power)
Date proposed	• December 13, 2024
Date passed by the National Assembly (plenary session)	• February 27, 2025
Main goals	• Establishing an integrated administrative process for offshore wind power deployment • Enhancing public interest and ensuring an orderly expansion of offshore wind power • Strengthening global competitiveness of the offshore wind power industry • Contributing to carbon neutrality and energy security

Source Korea National Law Information Center, "Special Act on Offshore Wind Power", accessed on April 24, 2025.

(2) Main aspects

The Draft Special Act on the Promotion of Offshore Wind Power was proposed to systematize and accelerate the expansion of offshore wind energy in Korea, aiming to contribute to carbon neutrality, energy security, and industrial competitiveness. The legislative framework emphasizes the planned development of offshore wind power generation sites, the balanced utilization of marine space, and the creation of a sustainable industrial ecosystem.

The Act outlines the responsibilities of national and local governments (Article 3) and establishes governance mechanisms such as the Offshore Wind Power Committee and the Development Task Force (Articles 6–10). Key decisions on site designation, operator selection, and plan approvals are centralized and streamlined through these bodies to enhance administrative efficiency and coordination.

A notable provision of the draft law calls for creating an Offshore Wind Power Site Information Network and a phased planning process that includes the designation of preliminary districts (Articles 12–16). These areas are the foundation for site selection, technical planning, and environmental consultation, ensuring that development proceeds with spatial and ecological considerations in mind.

To enhance inclusiveness and public acceptance, the Act mandates the creation of public-private councils and encourages the participation of residents and fishing industry workers in offshore wind projects (Articles 17–18). These provisions reflect efforts to align clean energy development with community engagement and benefit-sharing.

Additionally, the Act facilitates early project implementation by enabling exemptions from preliminary feasibility studies (Articles 22–23) and offering preferential bidding to public institutions transitioning from coal-based generation (Article 24). Development plans (Article 25) are supported by a streamlined permit, license, and environmental assessment process, minimizing bureaucratic delays (Articles 26–27).

To prevent speculative development and preserve planned frameworks, the Act restricts offshore wind projects in undesignated areas after a grace period (Article 33). It also emphasizes long-term industry growth through support for technology development, workforce training, supply chain stabilization, and international cooperation (Articles 34–43) (See Table 7).

Table 7 **Main aspects of the Special Act on Offshore Wind Power**

Special Act on the Promotion of Offshore Wind Power Deployment and Industry Development (Special Act on Offshore Wind Power)
Articles 1-2: Purpose and key terms
(Article 1) The purpose of this Act is to promote the spread of offshore wind power through the planned creation of offshore wind power generation sites, and to contribute to the reduction of greenhouse gases and the realization of carbon neutrality through balanced development and utilization of marine space in consideration of the public nature of marine space by stipulating matters concerning support for the development of the offshore wind power industry and the creation of a sound ecosystem, and to contribute to strengthening the competitiveness of the offshore wind power industry, national energy security, and the development of the national economy. (Article 2) Defines the terms "offshore wind power generation business," "offshore wind power generation facility," "offshore wind power industry," "offshore wind power generation preliminary district," "basic design," and "offshore wind power generation district."
Article 3: Clarifies the responsibilities of the national and local governments. It defines the responsibilities of the national and local governments and offshore wind power generation operators for the dissemination and expansion of offshore wind power generation and the promotion of the offshore wind power industry.
Articles 6-10: Operation of the Offshore Wind Power Committee and the Offshore Wind Power Development Task Force
(Article 6) The Offshore Wind Power Committee, under the Prime Minister, is established to deliberate and resolve matters related to offshore wind power generation, such as the designation of preliminary districts and development districts, the selection of offshore wind power generation operators, and the approval of implementation plans. (Article 10) To support the smooth operation of the committee, the Ministry of Trade, Industry and Energy shall establish the Offshore Wind Power Generation Promotion Task Force.
Articles 12-16: Establishment of the Offshore Wind Power Site Information Network and Designation of Preliminary Districts
(Article 12) The Minister of Trade, Industry and Energy and the Minister of Oceans and Fisheries shall establish and operate the Offshore Wind Power Site Information Network. (Article 14) The Minister of Trade, Industry and Energy and the Minister of Oceans and Fisheries may designate preliminary districts through deliberation and resolution of the committee for areas that meet the requirements for offshore wind power generation using the offshore wind power location information network. (Article 16) The Minister of Trade, Industry and Energy shall establish a basic design plan for the preliminary district, which shall be finalized after deliberation and resolution by the committee, and shall request the Minister of Oceans and Fisheries (or the Minister of Environment if the basic design plan includes areas outside the public waters) to hold a consultation after conducting an impact assessment on the marine environment.

Table 7 (continued)

Special Act on the Promotion of Offshore Wind Power Deployment and Industry Development (Special Act on Offshore Wind Power)
Articles 17-18: Operation of the public-private council and expansion of participation by residents and fishermen (Article 17) The mayor, county magistrate, or district head who has jurisdiction over the reserve district (or the provincial governor if the reserve district spans the waters under the jurisdiction of two or more local governments) shall form and operate a public-private council in which stakeholders participate to discuss matters related to the basic design plan, and shall notify the council of the results of the discussions. (Article 18) Residents of the area where the offshore wind power generation facility is installed and fishermen whose fishing activities are affected by the installation may participate in the offshore wind power generation project, and preferential treatment may be given to fishermen in terms of investment scale, etc.
Articles 19-20: Designation of offshore wind power generation districts and connection to the power grid (Article 19) The Minister of Trade, Industry and Energy may designate all or part of a preliminary district as a development district after deliberation and resolution by the committee after consultation with the public-private council. (Article 20) ① The Minister of Trade, Industry and Energy may request a transmission service provider to construct an access facility (joint access facility) to be used jointly by multiple offshore wind power generation companies in a development district of a certain size or larger as prescribed by Presidential Decree.
Articles 22-23: Special provisions on preliminary feasibility studies (Article 22) The Minister of Economy and Finance may exempt preliminary feasibility studies from Article 38(1) of the National Finance Act if it is deemed necessary to expedite and facilitate the development of offshore wind power projects within the development district. (Article 23) The head of a public corporation or quasi-governmental agency may apply to the Minister of Economy and Finance for exemption from the preliminary feasibility study, in accordance with the main text of Article 40(3) of the "Act on the Operation of Public Institutions", for a project that is deemed to require the particularly rapid and smooth promotion of an offshore wind power generation project within a development district.
Articles 24-25: Selection of offshore wind power generation operators and approval of development implementation plans (Article 24) The Minister of Trade, Industry and Energy may select a marine wind power generator through the deliberation and resolution of the committee in accordance with the bidding method prescribed by Presidential Decree, and may give preferential treatment to public institutions that own coal-fired power plants of 200 megawatts or more when bidding. (Article 25) An offshore wind power generator must establish a development and implementation plan and obtain approval from the Minister of Trade, Industry and Energy after deliberation and resolution by the committee.

Table 7 (continued)

Special Act on the Promotion of Offshore Wind Power Deployment and Industry Development (Special Act on Offshore Wind Power)
Article 26: Special cases concerning environmental impact assessment and marine use impact assessment (Article 26) The offshore wind power generator shall conduct an environmental impact assessment as prescribed by Presidential Decree, prepare an environmental impact assessment report, and submit it to the Minister of Trade, Industry and Energy. The Minister of Trade, Industry and Energy shall request the Minister of Environment and the Minister of Oceans and Fisheries to consult on the environmental impact assessment report. In addition, the environmental impact assessment under Article 22 of the 「environmental impact assessment Act」 and the consultation of the marine use impact assessment under Article 13 of the 「Marine Use Impact Assessment Act」 are deemed to have been completed.
Article 27: Agenda of permits and licenses, etc. (Article 27) When an offshore wind power generator receives approval of the development implementation plan, etc., permits and licenses, etc. under other laws are to be included in the agenda.
Article 33: Restrictions on offshore wind power generation projects From the date of promulgation of this law, the installation of wind measurement instruments for the purpose of offshore wind power generation projects is prohibited, and from the date three years after promulgation, the permission of offshore wind power generation projects in areas other than preliminary and power generation districts is prohibited.
Articles 34-43: Development of offshore wind power technology and support for the industry The Act stipulates matters related to the promotion of the offshore wind power generation industry, including technology development, training of professionals, revitalization of the supply chain, creation and operation of demonstration complexes, designation of specialized research institutes, international cooperation, support for port facilities and hinterland facilities, support for the fishing industry, special cases for the use and rental fees for shared waters, and support for energy transition.

Source Korea National Law Information Center, "Special Act on Offshore Wind Power", accessed on April 24, 2025.

Expected effects

Offshore wind power is a source of renewable energy that can greatly contribute to achieving carbon neutrality. Actively introducing offshore wind power generation will help decarbonize the power supply and bring Korea one step closer to achieving its goal of going carbon neutral by 2050. The government can accelerate the implementation of the national energy transition policy by systematically creating offshore wind power generation zones and building related infrastructure through the Offshore Wind Special Act. This is expected to help Korea play a leading role in achieving the global carbon neutrality goal.

In the global renewable energy market, offshore wind power is growing rapidly, and major countries such as Europe, the United States, and China are using large-scale offshore wind farms as central axes in their national energy policies. Currently, the domestic offshore wind power industry is still in its infancy in terms of technology and market size. Once the Special Act on Offshore Wind Power is implemented, the government will be able to provide various support measures, such as promoting the development of offshore wind power technology, training skilled workers and creating an offshore wind power demonstration complex. In addition, once the legal and institutional foundations are established, companies will be able to invest in offshore wind power projects in a more stable environment, and the opportunities for domestic companies to enter the global offshore wind power market will also expand.

The Special Act on Offshore Wind Power legally guarantees affected local communities the right to participate in decision making and profit sharing, and stipulates that the opinions of local residents are actively reflected through public-private council. This will enable the government, businesses, and local communities to work together to minimize conflicts and promote offshore wind power generation in a sustainable manner. In addition, measures should be taken to provide tangible benefits to local residents, support the fishing industry, and expand port facilities so that offshore wind power generation projects can also contribute to revitalizing local economies. If the acceptance of residents is increased in this way, offshore wind power generation projects will be able to proceed more smoothly.

Currently, the offshore wind power generation business is constantly facing problems with delays in business promotion due to complex licensing procedures. Upon taking legal effect, the Offshore Wind Special Act will streamline licensing procedures. It will also make it possible to omit to environmental impact assessments or marine area impact assessments in some situations. In addition, by shifting the planning of offshore wind farms to a government-led approach, it is possible to reduce competition between operators and unnecessary administrative procedures that characterize the existing private-led approach. This is expected to shorten the project implementation period and enable offshore wind farms to be built in a more systematic manner. In addition, if the government systematically streamlines the licensing process for offshore wind power generation, it will create an environment in which companies can make investment decisions in a more predictable regulatory and competitive environment.

(3) Problems and improvement tasks

Lack of linkages with the Special Act on the Power Grid

To ensure a stable supply of power generated by offshore wind to consumers inland, seamless linkages with the onshore power grid are essential. However, there is currently a lack of systematic linkages among offshore wind power generation and the Special Act on the Power Grid, which is likely to lead to inefficiencies in the design of the power grid, a lack of transmission infrastructure, and reduced power grid stability.

Even if an offshore wind power generation zone is created, it may be difficult to effectively transmit the power generated by the power plant if the plant is designed without fully considering how it will be integrated with the onshore power grid. Currently, the Special Act on the Power Grid and the offshore wind power generation policy are being promoted separately, which may lead to an weak connections between the power generation zone and the power grid.

Even if the government officially designates offshore wind power generation districts, there is a lack of transparency with regards to the construction of a transmission network to connect this new power with demand centers. Connecting to the land-based transmission network is essential, but the Act fails to address this need in a concrete way.

Even if an offshore wind farm is built, if the infrastructure for transmitting the power to land is not yet online, the power generated cannot be used effectively, which can lead to instability in the power supply. If the transmission and distribution facilities are still being built even after the power plant starts generating electricity, there is a high probability that this electricity will be unusable, and that the government will instruct the generator to curtail output. This would not only reduce the economic viability of offshore wind power generation projects, but also increase the burden on the overall national power grid.

As the number of offshore wind farms increases, the capacity of the existing power grid may reach its limit, which could have a negative impact on overall grid stability. The current power grid is designed to accommodate the existing fossil fuel and nuclear power-based generation methods, and there is simply not enough distribution or storage capacity in place to effectively accommodate highly variable renewable energy sources such as offshore wind power. As a result, when a large-scale offshore wind power plant is put into operation, the existing transmission network may not be able to handle it, overloading the power grid.

Lack of coordination with marine spatial planning

Offshore wind farms occupy large plots of marine space which increases the likelihood of conflicts with marine ecosystem protection, and maritime traffic. However, there is currently a lack of coordination between offshore wind power generation and marine spatial planning, which is likely to lead to various conflicts in the process of project implementation.

Marine spatial plans are established in consideration of sea lanes, fisheries, and environmental protection, but there is a high possibility that offshore wind power generation projects will conflict with these existing plans. In particular, the construction of offshore wind power plants may overlap with fishing rights and conservation areas which may intensify conflicts with stakeholders in the fishing industry.

2.2.4 Special Act on the Expansion of the National Power Grid

(1) Overview

The Special Act on the Expansion of the National Power Grid (the Power Grid Special Act) is designed to expand national power grid facilities to ensure a stable supply of electricity and promote the development of the national economy. It also deigns to build a high-quality, large-capacity power grid help Korea achieve its 2050 carbon neutrality goal and strengthen the competitiveness of high-tech industries.

Currently, expanding the national power grid is legally governed by the Act on the Promotion of Development of Electric Power Sources, making it difficult to accommodate rapidly increasing demand for electricity and the increase in the number of renewable energy power generation facilities. In particular, as the share of renewable energy increases, it has become clear that Korea lacks enough transmission and distribution capacity (substations) to handle the peaky nature of renewable power generation and it is becoming an urgent national task to establish government-wide cooperation and a rapid licensing process. The reasons for expanding the power grid are as follows:

- Carbon neutrality and response to the climate crisis: In order to achieve its 2030 Nationally Determined Contribution (NDC) on greenhouse gas emissions, Korea must expand its power grid to reduce carbon emissions and expand the use of carbon-free power sources.
- Surging electricity demand: It is essential to ensure a stable supply of electricity in line with the increasing demand from AI, data centers, and electric vehicles.
- Resolving regional imbalances in power generation and consumption: Power generation is concentrated in the provinces and consumption is concentrated in the Seoul Capital Area requiring the construction long-distance transmission networks, but these projects are often

fraught with delays due to opposition by affected.

- **Risk of delays in the construction of core infrastructure:** If the expansion of the power grid is delayed, there is a risk of instability in the supply and demand of electricity and damage to the industry, so it is necessary to establish a legal basis for building out more infrastructure.

The law would establish a basic plan for expanding the national power grid every five years, establish a national power grid expansion committee under the Prime Minister, streamline relevant licensing procedures, and strengthen the compensation system to establish a national-level full-cycle management system. The main goal of the bill is to support the transition to carbon neutrality and strengthen the competitiveness of the country's high-tech strategic industries (See Table 8).

Table 8 Overview of the Special Act on the Expansion of the National Power Grid

Category	Content
Name	• Special Act on the Expansion of the National Power Grid (Special Act on Power Grid)
Date proposed	• February 26, 2025
Date passed by the National Assembly (plenary session)	• February 27, 2025
Main goals	• Establish a systematic and comprehensive framework for the expansion of national transmission infrastructure • Ensure a stable power supply and strengthen industrial competitiveness • Support the expansion of renewable energy sources and contribute to the achievement of carbon neutrality • Enhance national energy security through high-capacity transmission networks • Improve administrative efficiency by streamlining the permitting process for transmission infrastructure

Source Korea Law Information Center, "Special Act on Expansion of National Power Grid", accessed on April 24, 2025..

(2) Main aspects

The Draft Special Act on the Expansion of the National Power Grid was introduced to accelerate the construction and modernization of grid infrastructure crucial for achieving carbon neutrality, enhancing energy security, and scaling up renewable energy. The Act provides the legal foundation for promoting national grid development projects while streamlining procedures and coordinating energy policies.

The Act ensures the timely and stable supply of electricity through early expansion of transmission and substation facilities (Article 1), defined as key infrastructure (Article 2). It mandates the Minister of Trade, Industry and Energy to create a 30-year master plan, updated every five years (Article 6), and

aligns it with other energy plans, including those for renewables, distributed energy, and smart grids (Article 7).

To oversee this process, a National Power Grid Expansion Committee is established under the Prime Minister to deliberate on major decisions (Articles 8–9). Based on its resolutions, business operators can formulate implementation plans (Articles 10–11), which, once approved, are deemed to satisfy permit and licensing requirements under other laws (Article 13).

The Act includes special provisions for national key grid projects (Articles 14–21), streamlining or exempting procedures under laws related to site selection, environmental review, disaster management, and land acquisition. These reflect the urgency of grid expansion and reduce regulatory delays. It also enables regulatory improvement and fast-tracks the construction of infrastructure.

To ease local opposition and promote cooperation, the Act offers compensation and support to areas near grid facilities (Article 22) and encourages local participation in renewable energy projects (Article 23). Financial support for local governments hosting overhead power lines (Articles 24–25) reflects a balance between national infrastructure needs and regional equity (See Table 9).

Table 9 **Main aspects of the Special Act on Power Grid**

Special Act on the Expansion of the National Power Grid (Special Act on Power Grid)
Articles 1-2: Purpose and key terms
(Article 1) This Act aims to contribute to carbon neutrality and the sustainable development of the national economy by early expansion of power grid facilities necessary for the stable supply of electric energy, strengthening the competitiveness of major national industries, and expanding renewable energy.
(Article 2) Defines transmission and substation facilities, national key power grid facilities, national key power grid development projects, and power systems.
Articles 6-7: Basic plan for expanding the power grid
(Article 6) The Minister of Trade, Industry and Energy shall establish a basic plan for the expansion of the national power grid that includes a long-term outlook every five years for 30 years in order to systematically and efficiently expand the national power grid facilities and improve the effectiveness of the plan.
(Article 7) When establishing or changing the plans listed below, the contents of the master plan under this Act shall be harmonized with each plan.
1. Master plan for electricity supply and demand under Article 25 of the Electricity Business Act.

Table 9 **(continued)**

Special Act on the Expansion of the National Power Grid (Special Act on Power Grid)
2. Master plan under Article 5 of the Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy. 3. Master plan for the promotion of distributed energy under Article 5 of the Special Act on the Promotion of Distributed Energy. 4. Basic Plan for Intelligent Power Grids under Article 5 of the Act on the Establishment and Promotion of Intelligent Power Grids. Articles 8-9: Establishment and Operation of the Power Grid Expansion Committee (Article 8) The Prime Minister shall establish the National Power Grid Expansion Committee (hereinafter referred to as the "Power Grid Committee") to deliberate and resolve important matters related to the expansion of the national power grid. (Article 9) The Power Grid Committee shall be composed of 35 members, including one chairperson, and the chairperson shall be the Prime Minister. Articles 10-13: Establishment of implementation plans and permits/approvals (Article 10) The business operator may conduct research or surveying of the land, buildings, works, and other necessary matters at the location selected in accordance with Article 5-3 of the 「Act on the Promotion of Rural Development」 in order to establish an implementation plan in accordance with Article 11, as prescribed by Presidential Decree. (Article 11) The business operator shall establish an implementation plan and obtain approval from the Minister of Trade, Industry and Energy. (Article 13) Once the implementation plan for the national power grid development project is approved, it shall be deemed as having obtained the permits and licenses stipulated in other laws. Articles 14-25 of the bill: Special provisions on power grid facilities (Article 14) For the national key power grid development project, it is stipulated that the operation period of the location selection committee under the "Power Development Promotion Act" can be shortened or omitted. (Article 15) It stipulates special cases for the application of the "environmental impact assessment Act" to the national key power grid facility development project. (Article 16) It stipulates special cases for the application of the "Natural Disaster Countermeasures Act" to the national key power grid facility development project. (Articles 17-19) Provisions for special cases for expedited processing of permits and approvals for ancillary works for the purpose of promoting rapid development projects, application for regulatory improvement, and special cases for regulatory improvement management and supervision. (Articles 20-21) Provisions for special cases for the consignment of land purchase work, etc. and the use and compensation of land. (Article 22) Provides special provisions for compensation and support under the Act on Compensation and Support for Areas Surrounding Transmission and Substation Facilities. (Article 23) Supports participation in renewable energy generation projects by residents of areas surrounding development project areas. (Articles 24-25) Provides financial support for local governments with overhead power lines and the basis for national support.

Source Korea Law Information Center, "Special Act on Expansion of National Power Grid", accessed on April 24, 2025.

(3) Expected effects

The Special Act on the Power Grid enables the rapid construction of a state-led power grid and greatly improves the stability of the national power supply.

- In a situation where the existing power grid is aging and the volatility of power supply and demand is increasing due to the expansion of renewable energy, it is necessary to secure energy stability through the systematic expansion of the national power grid.
- By expanding and improving transmission and distribution facilities, the imbalance between the power generation and consumption regions can be ameliorated and inefficiencies in the national grid can be addressed.

A stable power supply is essential for high-tech industries such as semiconductors, AI, and data centers, and the Special Act on the Power Grid can strengthen the competitiveness of these industries, and by prioritizing the expansion of the power grid in industrial cluster areas to ensure a stable power supply, the growth of high-tech industries can be supported. Moreover, expanding the power grid would contribute to the economic vitality of local communities, strengthen national competitiveness, and contribute to the development of the renewable energy industry.

Expanding renewable energy is essential to achieve carbon neutrality, and the expansion of the power grid is one of the key factors that make this possible. Since the production of renewable energy is not constant, flexible operation of the power grid is necessary, and for this, the expansion of the power grid led by the state is necessary. Moreover, it is necessary to modernize and digitize the power grid to effectively link various new and renewable energy sources, such as offshore wind power, solar power, and hydrogen energy.

In addition, expanding the national power grid can ensure a stable supply of electricity even in areas with insufficient power infrastructure and contribute to the revitalization of regional economies. By increasing compensation and support to residents in areas where power grid facilities are being built, projects can increase the acceptance of local residents and contribute to local development. And in connection with offshore wind power generation, expanding the national energy grid can foster renewable energy-related industries, especially in coastal areas, and attract investment in related infrastructure.

Expanding the power grid is an essential element of national economic and industrial development, so it is necessary to facilitate its process. The Special Act on the Power Grid can shorten the approval process for power grid development projects and streamline the licensing process to prevent project delays. It could also minimize opposition from residents by providing them with opportunities to

participate in renewable energy projects or by expanding financial support for them around the development project area.

(4) Problems and improvement tasks

Lack of connection between offshore wind power and national power grid plans

The Special Act on the Power Grid stipulates that the mid- to long-term plan for the national power grid should be established in consideration of the demand and supply of electricity, but there is a lack of a plan for direct connection to offshore wind power generation. It is essential to build an offshore power grid to reliably transmit the electricity generated by offshore wind farms to land. However, the Special Act on the Power Grid does not include specific details on this, and there is a lack of a plan for connecting the new offshore wind power generation to the national grid. In addition, the Special Act on the Power Grid promotes the installation and operation of transmission and distribution facilities under state leadership, but it is not directly linked to the power generation districts specified in the Special Act on Offshore Wind Power, and it does not include a strategy for building a transmission network that reflects the characteristics of offshore wind power generation, which may undermine long-term power supply stability.

Lack of mid- to long-term planning for offshore power grids

As offshore wind power generation expands, it is essential to connect these new facilities to the power grid, but there is a lack of mid- to long-term planning for how to transmit the power generated offshore to land. As the number of offshore wind farms increases, major investment sin transmission infrastructure will be needed to connect to the onshore power grid, but there is no strategy-by-stage strategy for building the offshore transmission network. In addition, since the direction of expansion of the national power grid is set to focus on land, it is necessary to lay the legal and institutional foundation for the integrated design of the offshore and onshore power grids. Currently, the Special Act on the Power Grid does not include specific plans for the construction of transmission networks related to offshore wind power, and there are concerns about power grid imbalances due to the expansion of offshore wind power in the future.

Insufficient discussion of grid connection

The purpose of the Special Act on the Power Grid is to increase the use of renewable energy and prepare the power grid for a carbon-neutral future, but the law fails to consider needed improvements to the existing distribution network. To achieve carbon neutrality, a system is needed that can more flexibly absorb and distribute electricity generated from renewable sources, but the provisions of the law to not adequately consider this. Since renewable energy is intermittent, the power grid must be

able to flexibly and efficiently accommodate it. In addition, when offshore wind power generation begins in earnest, a comprehensive power grid expansion plan that fully and holistically considers generation, generation, and distribution is necessary.

Resident acceptance and environmental issues

the licensing process to expedite the expansion of the power grid, but this may lead to local opposition and environmental issues. The law contains a provision that automatically closes the period for public consultation if the local governing authority fails to file a petition within 60 days, meaning that the law equates a lack of communication from residents with tacit approval, raising the possibility that some projects break ground without explicit cooperation from local communities. This may lead to backlash from residents and cause social conflict in expanding the transmission network. The law's provision on environmental impact assessments contains a similar flaw. It states that if no environmental objections are raised within 45 days, the period for environmental consultations is closed. This, too, creates the possibility that projects may begin without a thorough review of environmental issues. In addition, if the transmission network is expanded, it may infringe upon residents' property and human rights in the affected areas, so it is necessary to enhance compensation and support policies.

2.2.5 Act on Marine Spatial Planning and Management[4)]

(1) Overview

The Act on Marine Spatial Planning and Management was enacted for the purpose of establishing and implementing systematic plans for the sustainable use, development, and conservation of marine space. This law provides the legal basis for promoting public welfare and using the oceans in a more methodical and sustainable manner.

The ocean plays an important role in the national economy and performs essential environmental services but it is also a space where fishing, marine tourism, renewable energy development, ports and logistics, and military activities conflict. Therefore, the key objective of this law is to systematically manage the marine space to prevent overdevelopment and enable balanced use of the ocean (See Table 10).

4) This section is based on the Act on Marine Spatial Planning and Management from the Korea Law Information Center.

Table 10 **Overview of the Act on Marine Spatial Planning and Management**

Category	Details
Name	• Act on Marine Spatial Planning and Management (Marine Spatial Planning Act)
Date of enactment	• April 17, 2018
Date of enforcement	• July 6, 2021
Organizing agency	• Ministry of Oceans and Fisheries
Main goals	• Establishing a systematic framework for the sustainable use, development, and conservation of marine space • Enhancing public welfare and creating a well-balanced marine environment • Preventing conflicts among various marine activities such as fisheries, tourism, renewable energy, and shipping
Planning cycle	• Basic plan established every ten years

Source Korea Law Information Center, "Act on Marine Spatial Planning and Management", accessed on April 24, 2025.

(2) Main aspects

The Marine Spatial Planning and Management Act establishes a comprehensive legal framework to ensure the sustainable use, conservation, and development of Korea's marine space. Recognizing the increasing demand for marine resources and space—from fisheries and energy to tourism and defense—the Act aims to balance diverse uses while preserving ecological and cultural value.

The Act is grounded in principles of integrated and future-oriented spatial planning. It emphasizes the coexistence of ecological, economic, and cultural functions of marine space, prioritizes public interest areas such as maritime safety and national security, and calls for public participation and international cooperation in marine policy (Article 3). These principles reflect a holistic vision of marine governance that goes beyond sector-specific regulation.

To operationalize these goals, the Act mandates that the Minister of Oceans and Fisheries formulate a national Marine Spatial Master Plan every 10 years, subject to expert deliberation (Article 5). Local governments are empowered to establish their own management plans at the regional level through Regional Committees on Marine Spatial Management, ensuring that local priorities and contexts are reflected in marine planning (Article 9).

A key tool within the Act is the designation of marine use zones, which classify marine areas based on their dominant function. These include fishery zones, energy development zones, tourism zones, environmental conservation zones, research zones, ports and logistics zones, and defense-related

zones (Article 12). The zoning process is informed by scientific evaluation of spatial characteristics, including natural conditions, usability, and location-specific factors (Article 13), providing a data-driven basis for spatial decision-making (See Table 11).

Table 11 **Main aspects of the Marine Spatial Planning Act**

Act on Marine Spatial Planning and Management (Marine Spatial Planning Act)
Article 1 (Purpose) The purpose of this Act is to promote public welfare and establish a prosperous environment for the ocean by prescribing matters necessary for formulating, implementing, etc. of a plan for the sustainable use, development and conservation of marine space.
Article 3 (Basic Principles) Marine space shall be managed and used according to the following basic principles: 1. To use, develop and conserve marine space from a comprehensive and future-oriented perspective so as to ensure the coexistence of ecological, cultural and economic values; 2. To give priority to public demand, such as national defense safety and maritime traffic safety; 3. To ensure the participation of the public in policies for marine spatial management and sound use of marine space; 4. To promote international cooperation and inter-Korean cooperation to realize the integrated management of marine space.
Article 5 (Formulation of Marine Spatial Master Plans) (1) The Minister of Oceans and Fisheries shall formulate a master plan on marine space (hereinafter referred to as "master plan") including the following matters, every 10 years after undergoing deliberation by the Maritime Affairs and Fisheries Development Committee prescribed in Article 7 of the Framework Act on Marine Fishery Development: 1. Basic direction-setting for policies on marine space; 2. Direction-setting for marine spatial management planning; 3. Matters concerning collection, management and utilization of marine spatial data; 4. Matters concerning evaluation of marine spatial characteristics; 5. Matters concerning research and development and international cooperation necessary for marine spatial management; 6. Other matters prescribed by Presidential Decree.
Article 9 (Regional Committees on Marine Spatial Management) (1) A regional committee on marine spatial management (hereinafter referred to as "regional committee") shall be established under the jurisdiction of a Mayor/Do Governor to deliberate on formulating and amending a management plan formulated by a Mayor/Do Governor and other important matters pertaining to managing marine space.

Table 11 **(continued)**

Act on Marine Spatial Planning and Management (Marine Spatial Planning Act)
Article 12 (Designation of Marine Use Zones)
(1) The Minister of Oceans and Fisheries and Mayors/Do Governors may designate or amend marine use zones according to the following classification, in consideration of the guidelines for formulating management plans referred to in Article 7 (4), the results of the evaluation of marine spatial characteristics referred to in Article 13, etc.:
1. Fishery activity protection zones: Zones necessary for the protection and promotion of fishery activities, such as licensed fishery and permitted fishery, and for the sustainable production of fishery products;
2. Aggregate and mineral resource development zones: Zones necessary for the efficient and stable supply of aggregate and mineral resources from the sea;
3. Energy development zones: Zones necessary to develop and produce marine energy;
4. Marine tourism zones: Zones requiring maintenance and development of marine tourism functions;
5. Environment and ecosystem management zones: Zones requiring the conservation and management of the marine environment, ecosystem and landscape;
6. Research and education conservation zones: Zones necessary for marine fisheries research and education activities;
7. Port and navigation zones: Zones necessary for maintaining port functions, safe operation of ships, etc.;
8. Military action zones: Zones necessary to protect national defense and military activities;
9. Safety management zones: Zones necessary to protect marine installations and for marine safety.
Article 13 (Evaluation of Marine Spatial Characteristics)
(1) To designate or change any marine use zone referred to in Article 12 (1), the Minister of Oceans and Fisheries and Mayors/Do Governors shall evaluate marine spatial characteristics with respect to the natural characteristics, location, availability, etc. of marine spaces: Provided, that this shall not apply when changing minor matters prescribed by Presidential Decree.

Source Korea Law Information Center, "Act on Marine Spatial Planning and Management", accessed on April 24, 2025.

(3) Expected effects

The law was designed to facilitate the systematic management of marine space through the Marine Spatial Planning Act will prevent overdevelopment and maintain a balance between the health of the marine environment and economic activities. This law provides a legal basis for the systematic development, conservation, and use of marine space by dividing it into different uses, granting legal protection to marine ecosystems while facilitating the sustainable use of marine resources. In addition, by establishing long-term marine use strategies, it is possible to maximize the efficient use of marine space and establish a system that can guarantee both economic value and environmental conservation.

One of the most important provisions of the Marine Spatial Planning Act is its establishment of a legal system that can prevent and resolve conflicts over the use of the ocean in advance. The Act provides a legal basis for the division and coordination of marine spaces for different uses so that various stakeholders in the marine space including fisheries, marine tourism, shipping, and renewable energy players, do not conflict with each other. However, the coordination function could be strengthened to minimize spatial conflicts between the development of renewable energy such as offshore wind power and existing marine industries (fishing, shipping, tourism, etc.). This should reduce conflicts between stakeholders surrounding marine space, increase the efficiency of marine space use, and simultaneously achieve national-level marine economic development and environmental protection.

(4) Problems and improvement tasks

Low share of renewable energy in marine spatial planning

The Marine Spatial Planning Act is an important law that provides a legal basis for the systematic use and management of the ocean, but it fails to adequately consider renewable energy development in marine space. This case is typical of renewable energy development not being reflected as a key element of marine space use and of the government's lack of policy consideration.

Spatial conflict between offshore wind power plants and existing marine industries

As the construction of offshore wind farms expands, spatial conflicts with existing marine industries such as fisheries, shipping, and tourism are intensifying, and conflicts between stakeholders are increasing as a result. In particular, conflicts resulting from overlapping designated fishing zones and offshore wind farms have become increasingly frequent, and workers in the fishing industry are claiming that their right to pursue a living is being infringed upon. However, the current Marine Spatial Planning Act lacks a systematic mechanism to resolve conflicts between these stakeholders, which has led to cases where offshore wind power projects have been delayed for lengthy periods or even canceled outright. To this end, it is necessary to clearly distinguish between fishing rights protection areas and offshore wind power generation sites and to make reasonable adjustments to their locations to prevent conflicts with the shipping and tourism industries.

Lack of connection between offshore renewable energy power generation facilities and the onshore power grid

As as been discussed earlier in this paper, while offshore wind power generation has expanded rapidly, the power grid cannot accommodate this new electricity, lacking the necessary transmission and distribution equipment to do so. Currently, the Marine Spatial Planning Act lacks a systematic discussion on how to efficiently transmit the power generated by offshore wind power plants to the

main sources of electricity demand inland. This is preventing the smooth supply of power generated by offshore wind farms to the onshore power grid, which is a major obstacle to increased utilization of renewable energy. In particular, despite the rapid expansion of offshore wind power, there are an increasing number of cases of power overload and transmission restrictions due to the insufficient capacity of the onshore power grid. The most salient example of this problem being in the Honam region in southwestern Korea, which lacks the necessary transmission infrastructure to distribute the significant amount of electricity generated by large offshore wind farms to the Seoul Capital Area (SCA) and other metropolitan sources of demand.

2.3 Problems arising from the interrelationship among laws

2.3.1 Lack of linkages between power sources and transmission networks

(1) Insufficient linkages between power sources and laws on power grids

Currently, the Renewable Energy Act, the Distributed Energy Act, and the Special Act on Offshore Wind Power, etc. focus on promoting the development and distribution of individual power sources, but there is a lack of systematic discussion on how the power generated by these power sources will be connected to the transmission network. In particular, the number of renewable and distributed energy power generation facilities is rapidly increasing, but the output limitation (curtailment) problem is becoming more serious due to the poor connection with the power grid. Even if the amount of power generation increases in a situation where the capacity of the power grid is limited, the amount of power that can be actually used is decreasing, and therefore, the expansion of power generation sources without the expansion of the transmission infrastructure is likely to hinder the practical effects of the transition to renewable energy.

In addition, if the number of power generation sources increases without expanding the transmission network, the power grid may become saturated, which could lead to a decline in the stability of the power system. To prevent this, it is necessary to better link power generation sources and the power grid, and ensure that the grid is expanded before power generation facilities come online.

Therefore, it is essential to consider the harmonious expansion of power generation facilities and transmission infrastructure when establishing long-term national power grid plans, and legal and institutional improvements are needed to effectively link renewable energy and the power grid. To this end, cooperation between the government, power grid operators, and power generation companies should be strengthened, and active measures should be taken to expand financial and administrative support for the construction of transmission networks.

(2) Absence of a coordination mechanism

Currently, there is a time lag between the construction of power plants and the expansion of transmission networks due to a lack of coordination between the laws that deal with power generation sources and the the laws that govern the expansion of power grids. The Renewable Energy Act and the Special Act on Offshore Wind Power focus on promoting the dissemination of power generation sources and technological development, while the Special Act on the Power Grid deals with the stable operation of the national power grid and the construction of transmission infrastructure. However, as these laws are operated individually, there is a high possibility of temporal and spatial conflict, as power generation and transmission are not organically linked to each other.

In particular, since different ministries implement the laws related to power generation and the laws related to the power grid, there is a high possibility of a lack of consistency in the policy implementation process and administrative redundancies. New power plants should go hand in hand with new grid infrastructure, but new infrastructure projects are often siloed developments, and so the transmission and distribution network often finds itself overwhelmed with new supply as new power generation facilities come online. In addition, there are many cases where confusion occurs in the process of implementing policies because the roles between the central and local governments or between various administrative agencies are not clearly defined.

To solve these problems, it is necessary to establish a national coordination body and develop a plan for linking laws so that the development and expansion of power generation facilities and the transmission network can be planned in an integrated manner. The government and related organizations should establish a legal and institutional coordination mechanism to enable the simultaneous development of renewable energy and the construction of transmission infrastructure, and strengthen policy coordination to link the construction of power generation facilities and electricity distribution and transmission facilities.

2.3.2 Inconsistencies between land and marine spatial planning

(1) Potential for conflict between the Special Act on Offshore Wind Power and the Marine Spatial Planning Act

The Special Act on Offshore Wind Power aims to designate offshore wind power generation zones and promote their development, but there is a high risk of conflict with the Marine Spatial Planning Act due to a lack of coordination between the two acts. When designating offshore wind power generation areas, factors such as the environment, fisheries, and maritime traffic must be considered, but there

is a high probability that the existing Marine Spatial Planning Act's conservation and utilization zones will overlap with offshore wind power generation areas.

The Marine Spatial Planning Act prioritizes the protection of the marine environment and the sustainable management of resources, and if offshore wind power generation conflicts with these goals, conflicts between stakeholders are inevitable. For example, if a fishery protection zone and an offshore wind power generation zone are established in the same area, there is a high possibility that conflicts will arise between stakeholders in the fishing industry, whose rights to fishery access are legally guaranteed, and offshore wind power generation companies. Such problems can cause long-term administrative delays in the process of promoting power generation projects, which will ultimately contribute to business uncertainty.

Therefore, it is essential to harmonize the policies between the Marine Spatial Planning Act and the Special Act on Offshore Wind Power in terms of long-term marine spatial management. When designating an offshore wind power generation zone, legal and administrative adjustments are required to maintain consistency with the existing marine spatial plan, and a comprehensive plan for the use of marine space should be prepared to ensure that power generation projects harmonize with environmental and economic goals.

(2) Misalignment between the Special Act on the Expansion of the Power Grid and the Marine Spatial Planning Act

The existing laws lack explicit legal provisions that take into account the impact of power grid infrastructure projects that transmit offshore power inland on the use of marine space. The Marine Spatial Planning Act establishes spatial plans that focus on the sustainable use of the marine environment and resources, but it lacks adequate linkages with plans to build transmission networks for transmitting electricity from the sea to land.

Currently, Korea lacks a specific legal basis for the spatial planning of power transmission and distribution infrastructure in marine space. This makes the construction of much-needed offshore transmission networks even more uncertain. This legal gap is a major constraint on the supply of electricity from offshore wind farms to sources of demand inland and in particular, if the construction of transmission infrastructure is delayed, there is a high risk of bottlenecks that will prevent the effective use of the generated electricity.

In addition, if the expansion of the marine transmission network is promoted without fully considering the impact on the marine environment and existing fishing rights, there is a possibility that conflicts with local fishing communities will intensify. In order to prevent such conflicts while simultaneously

promoting the development of offshore wind power, it is necessary to establish a legal and administrative coordination mechanism for integrated the offshore and onshore power grids. This should ensure that offshore wind power generation and the construction of transmission infrastructure proceed in harmony, the rights and interests of all stakeholders are protected, and sustainable development is achieved at the same time.

2.3.3 Problems between the Special Act on Offshore Wind Power Generation and the Special Act on Expansion of the Power Grid

(1) Discrepancy between the plans for offshore wind power generation districts (offshore) and power grids (onshore)

Currently, the Special Act on Offshore Wind Power mainly aims to designate offshore wind power generation zones and promote their development, but the Special Act on the Power Grid does not clearly include plans for the installation of transmission networks tailored to these power generation zones. In order for offshore wind power plants to operate stably, infrastructure that can transmit power to land is essential, but there is a high possibility that the construction of transmission infrastructure will not be carried out in a timely manner due to the lack of coordination between the two laws.

If the transmission and distribution infrastructure needed to deliver electricity to the mainland is not in place after an offshore wind power plant comes online, it is highly likely that the lack of distribution capacity will create bottlenecks in the power grid that render the power generated unusable. This not only reduces the economic feasibility of offshore wind power generation projects, but can also act as a factor that weakens the effectiveness of the renewable energy expansion policy.

Therefore, in order to stabilize the production and distribution of offshore wind power, it is necessary to build a transmission network based on the legal framework of the Special Act on the Power Grid and simultaneously promote the development of offshore power generation. To this end, it is necessary to establish a comprehensive national power grid plan and to make legal and administrative adjustments that take into account offshore wind power generation and transmission infrastructure in an integrated manner.

(2) Failure of long-term power grid plans to account for offshore wind

The Special Act on the Power Grid focuses on establishing a legal basis for the long-term expansion and operation of the national power grid, but it fails to account for the rise and expansion of large-scale renewable energy, and especially offshore wind power. If the national power grid is not expanded to accommodate new generation capacity, the amount of electricity that can actually be utilized may be limited which is likely to be a major obstacle to the implementation of national renewable energy policies.

Curtailment orders are major factors influencing the viability of offshore wind power generation facilities, and are typically due to insufficient grid capacity.

To address this issue, it is necessary to include offshore wind power generation as a key consideration when establishing near-term and long-term power grid plans, and to strengthen legal and institutional links so that the power generation plans for offshore wind power zones and the power grid expansion plans can be promoted simultaneously and in harmony. This should lay the foundation for achieving both the expansion of renewable energy and the stability of the national power grid.

(3) Redundant permitting requirements and other administrative inefficiencies

Currently, the Special Act on Offshore Wind Power, the Special Act on the Power Grid, and the Marine Spatial Planning Act each stipulate different licensing requirements, and operators must meet these requirements individually. These redundancies increase the administrative burden on developers and are likely to lead to project delays.

When a project related to offshore wind power generation gets underway, developers must satisfy licensing requirements and stipulations for each law individually. This constitutes an enormous administrative burden and functions as a negative investment incentive.

Therefore, it is necessary to establish a cooperative system between the central and local governments to improve the inefficiency of these administrative procedures. This will enable businesses to quickly go through the licensing process and increase the efficiency of offshore wind power generation and power grid expansion projects.

Chapter 3

Legal Frameworks in the EU, the UK, and Germany

3.1 European Union (EU)

3.1.1 The Renewable Energy Act and offshore wind policy

(1) Renewable Energy Directive (RED)[5]

A) Introduction

The European Union (EU) has set the expansion of renewable energy as a key policy task to achieve its net-zero carbon target by 2050, and the Renewable Energy Directive (RED) is the representative legal framework for this. RED establishes legal standards for expanding the use of renewable energy and decarbonizing the energy system, and obliges member states to comply with them.

Through RED, the EU sets renewable energy targets for each country and prepares support measures to achieve them, while focusing on improving the power grid and enhancing energy efficiency. In particular, offshore wind power is considered one of the most important renewable energy sources in RED, and the EU aims to reduce its dependence on fossil fuels and build a sustainable energy system in part by leveraging offshore wind power. The EU has set a goal of expanding its offshore wind power generation capacity to 60 GW by 2030 and 300 GW by 2050. To achieve these goals, the EU is promoting large-scale investment, infrastructure construction, technology development, cooperation

5) European Union, "Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 on energy efficiency", accessed on February 17, 2025.

among member states, and environmental protection initiatives, among other other multifaceted policy projects.

B) Main content

Offshore wind power capacity targets

Offshore wind power plays a key role in the EU's renewable energy expansion strategy, and the EU is working to ensure a stable power supply by setting long-term capacity expansion targets. Currently, the EU's offshore wind power capacity is 12 GW, and the EU is working on a plan to expand this to 60 GW by 2030, and to 300 GW by 2050. To this end, it is essential to build large-scale transmission networks and infrastructure, develop new technologies, and strengthen public-private partnerships.

Development of marine energy

The EU has set a goal of increasing the power generation capacity of marine energy sources to 40 GW by 2050. The development of marine energy sources will create a synergistic effect with offshore wind power and play a role in stabilizing the power supply.

Investment and infrastructure construction

Large-scale investment and the construction of power grids and infrastructure are essential to accelerate the development of offshore wind and marine energy. The EU is establishing a long-term financial plan for this and working to attract private sector participation. Approximately EUR 800 billion (around KRW 1.6 trillion) will be needed to achieve the goal, of which about two-thirds will be used for the construction of power grids and infrastructure. In addition to building power plants, the key tasks include expanding energy transmission systems, such as offshore substations, transmission networks, and offshore-to-onshore connections. The EU is also strengthening public-private partnerships to facilitate financing and improving the legal and institutional framework to promote the development of offshore wind projects.

Regional cooperation and technology development

The EU is actively promoting cooperation and technology development among its member states to expand offshore wind power generation. In particular, it is accelerating the energy transition through joint developing offshore wind power projects by EU member states and promoting technological innovation. Emphasis is being placed on joint projects in the North Sea and Baltic Sea regions. It will continue to promote research and development (R&D) to improve the efficiency of offshore wind power generation, and strengthen EU-wide R&D support for reducing the cost of power generation and spurring technological advancement.

Environmental protection and sustainability

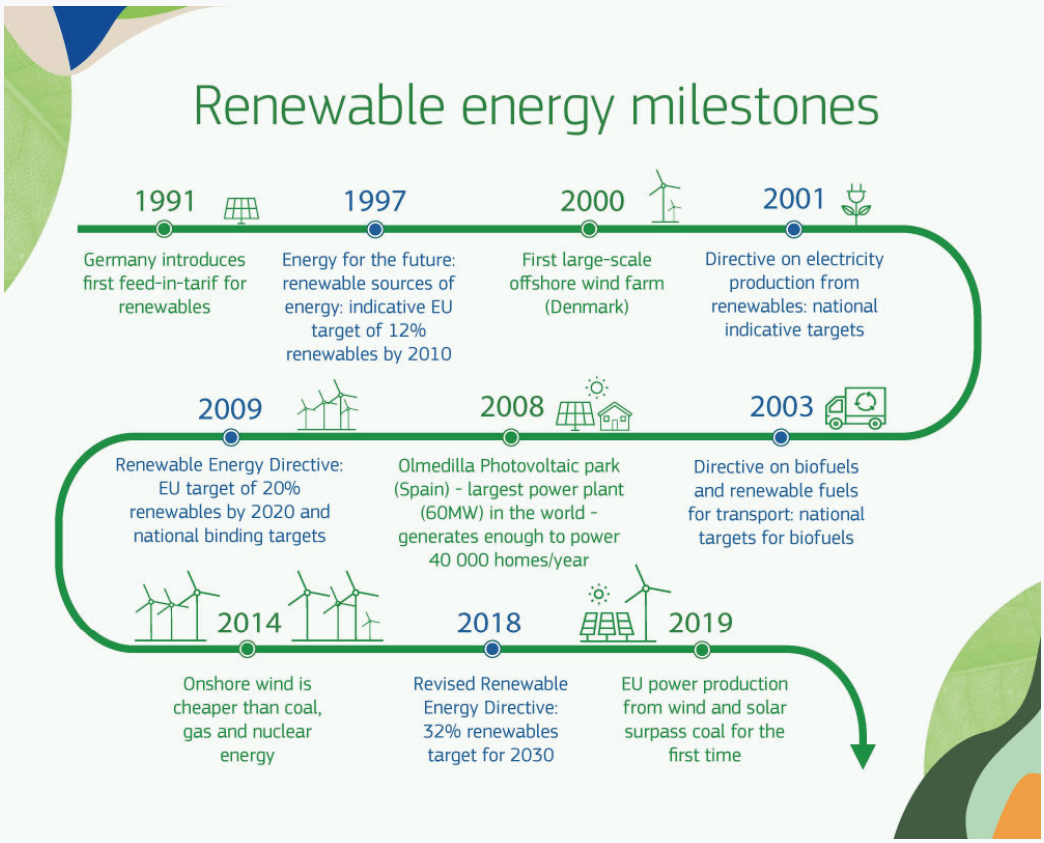
The key objective of offshore wind power generation is to ensure a a stable supply of energy while minimizing the impact of human economic activity on the environment. Accordingly, the EU is strengthening environmental protection measures and promoting policies that promote coexistence with marine ecosystems. In addition, it is coordinating the interests of stakeholders in the fishing, maritime transportation, and tourism industries and the offshore wind power generation sector, and looking to maintain a balance between various marine activities in connection in its maritime spatial planning (MSP) (See Table 12 and Figrue 12).

Table 12 Main content of the Renewable Energy Directive (RED)

Category	Key Content
Offshore Wind Power Capacity Targets	• Expand offshore wind capacity: 12 GW (current) → 60 GW by 2030 → 300 GW by 2050 • Requires transmission infrastructure, tech development, and PPPs
Marine Energy Development	• Target: 40 GW of marine energy by 2050 • Synergy with offshore wind; enhances supply stability
Investment & Infrastructure	• Estimated cost: EUR 800 billion (~1,058 trillion KRW) • Two-thirds allocated to grid & infrastructure (offshore substations, transmission networks, land-sea links) • Emphasis on PPPs and legal/institutional reform
Regional Cooperation & R&D	• Encourage joint offshore wind projects (e.g., North Sea, Baltic Sea) • Strengthen EU-level R&D for efficiency and cost reduction
Environmental Protection & Sustainability	• Minimize ecological impact, promote coexistence with marine ecosystems • Balance among offshore wind, fishing, tourism, and maritime transport through Marine Spatial Planning (MSP)

Source European Union, "Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 on energy efficiency", accessed on February 17, 2025.

Figure 12 Milestones for renewable energy in the EU



Note This timeline highlights how Europe has led the renewable energy transition, with a focus on offshore wind. Starting with the world's first offshore wind farm in 1991, Europe advanced wind power through technology and policy, achieving ever-greater efficiency and cost competitiveness. In 2019, wind and solar power capacity exceeded coal-fired capacity in the EU, marking a key turning point in the region's energy shift.

Source European Commission(March 18, 2020), "In focus: Renewable energy in Europe", accessed on March 22, 2025.

(2) Offshore renewable energy strategy[6)]

A) Introduction

The European Union (EU) is promoting the development of offshore renewable energy as a key policy to combat climate change and achieve its net-zero carbon emissions targets. As part of this policy, the EU released the Offshore Renewable Energy Strategy (COM/2020/741) in 2020, which set out specific targets and strategies for the expansion of offshore wind and marine energy.

6) European Union, "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Delivering on the European Green Deal through climate action in the EU and internationally (COM(2023) 668, final)", accessed on February 17, 2025.

The main goals of this strategy are to expand offshore wind power capacity to 60 GW and other forms of ocean energy to 1 GW by 2030, and to 300 GW and 40 GW, respectively, by 2050. To achieve these goals, the EU is promoting comprehensive policies including infrastructure expansion, grid connection, investment expansion, regulatory reform, environmental protection, and technological innovation.

B) Cross-border offshore grid development

The need for offshore renewable energy and grid infrastructure

Offshore wind farms are usually located far from the coast and are often promoted as large-scale projects. This makes it essential to upgrade related offshore and inland transmission and distribution infrastructure to accommodate the increased generation capacity. By expanding the offshore power grid, it will be possible to benefit from offshore renewable energy not only near the coast but also inland.

Cross-border cooperation and the revision of the Trans-European Energy Networks (TEN-E) Regulation

The EU recognizes the importance of international cooperation to expand offshore wind power generation and is therefore strengthening the interconnection of multinational power grids. To achieve this, the Trans-European Energy Networks (TEN-E) Regulation has been revised to establish a framework for cooperation among member states. The amendment introduces Hybrid Projects and the concept of "Energy Islands" that connect multiple countries. In particular, joint projects to integrate national power grids are being promoted in the North Sea and Baltic Sea regions, and are designed to strengthen energy supply security, reduce consumer costs, and minimize environmental impact.

Linking regional cooperation with Maritime Spatial Planning (MSP)

To expand offshore renewable energy in the EU, cooperation among member states is a necessity. But it is also vital to ensure that development projects are organically linked with Maritime Spatial Planning (MSP) laws and regulations. To this end, the EU has established a committee that includes a political High-Level Group (HLG) and a TEN-E regional group. The committee encourages offshore renewable energy expansion in coordination with relevant MSP rules. Currently, the North Sea Energy Cooperation (NSEC) and the Baltic Energy Market Interconnection Plan (BEMIP) are establishing the most advanced regional cooperation models, and cooperation is expanding in the Atlantic, Mediterranean, and Black Sea regions. The North Sea Energy Cooperation (NSEC) and the Baltic Energy Market Interconnection Plan (BEMIP) are at the center of regional cooperation, promoting the interconnection of national power grids.

Renewable Energy Directive (RED) joint projects

The EU has included provisions in the Renewable Energy Directive (RED) that encourage member states to promote joint projects to expand offshore renewable energy. Under RED, member states must cooperate with at least one other country to implement joint projects, set offshore renewable energy targets for each sea area in accordance with the TEN-E regulations, and make bidding information public. They must also encourage the allocation of space for offshore renewable energy projects in marine spatial plans.

Establishment of the Offshore Network Development Plan (ONDP)

The EU also establishes a long-term plan to expand the offshore power grid and renewable energy infrastructure. To this end, the European Transmission System Operators Association (ENTSO-E), EU member states, and the European Commission have collaborated to establish the Offshore Network Development Plan (ONDP). This plan forecasts offshore renewable energy generation potential and projects future infrastructure requirements up to 2050. It includes hybrid projects, radial connections, hydrogen infrastructure construction, and environmental protection measures. Through this, it aims to provide a comprehensive roadmap for the sustainable development of offshore renewable energy.

Cost and benefit sharing issues

The power generated by offshore wind farms in the waters of any one country can theoretically be sold to electricity providers in other countries and supplied to sources of demand through national distribution infrastructure, distributing the benefits of clean renewable energy among multiple countries. However, offshore wind power developments are often the result of investments made by and in the host country alone. This cost burden by act as a negative incentive for countries to pursue offshore wind development, and so the EU is working to establish a fair cost-sharing system. Currently, the EU Commission is evaluating measures to resolve the issue of cost sharing and will issue a future directive based on this.

Reforming Electricity Market Design (EMD)

Reform of the Electricity Market Design (EMD) is necessary for offshore renewable energy projects to operate stably. Reforms will help ensure strengthen investment incentives, and increase market accessibility. Measures are being promoted to reduce price volatility and secure long-term investment stability through the expansion of power purchase agreements (PPAs) and contracts for difference (CfDs). In addition, the EMD is being reorganized to increase market access for offshore renewable energy projects, and a TOTEX (Total Expenditure) approach is being considered to provide proactive investment incentives.

C) Acceleration and efficiency of the licensing process

The need for accelerating the permitting process

The EU must rapidly expand its offshore renewable energy projects to achieve its 2050 net-zero carbon targets, and is therefore pushing ahead with plans to secure 60 GW of offshore wind power capacity by 2030 and 300 GW by 2050. However, to achieve this goal, it is necessary to expedite the approval and licensing process for new projects. Offshore grid projects often involve lengthy pieces of transmission infrastructure that crosses national borders, so cooperation with various countries and organizations is essential. However, the current licensing process is very complex, and interminable approvals processes may lead to delays, hindering the electrification of the EU grid and a successful energy transition. Therefore, the EU is promoting legal and institutional improvements to ensure rapid licensing for offshore wind and power grid infrastructure projects.

Improving the licensing process through revised TEN-E regulations

The EU has revised the Trans-European Networks for Energy (TEN-E) to streamline licensing process related to offshore wind power generation. The revised TEN-E Regulation has introduced a one-stop contact point to streamline the authorization process. This allows companies and project developers to complete authorization and approvals procedures that previously required visits to multiple agencies at one place. In addition, measures have been included to facilitate public acceptance and plans have been put in place to reach out to local communities before projects get underway to minimize backlash and maximize cooperation. In addition, measures have been put in place to promote cooperation between National Contact Points (NCPs) in charge of licensing among member states. The EU Commission is operating a dedicated platform and TEN-E regional groups to coordinate licensing procedures in each country and share best practices among member states to help make the licensing process more efficient.

Improving the efficiency of the permitting process through the revised Renewable Energy Directive (RED)

To speed up the permitting process for offshore wind and other renewable energy projects, the EU has revised the Renewable Energy Directive (RED) to enhance the efficiency and accelerate the permitting process. Under the revised RED, certain areas can be designated as Renewables Acceleration Areas (RAA). This is a system that shortens administrative procedures by setting in advance areas where renewable energy projects can be quickly approved. However, protected areas are excluded. In addition, infrastructure such as power grids and energy storage facilities can be designated as separate dedicated areas to enable a faster permitting process. Offshore wind projects are larger than onshore renewable energy projects, and environmental impact assessments (EIA) are often more

complex as a result. In addition, the EU Commission founded the Energy and Geographic Industry Lab (EIGL) to provide data to support member states in designation RAAs. This helps each country to more quickly and accurately determine the optimal location for offshore wind projects.

EU-wide cooperation and technical support to accelerate the permitting process

The EU operates various cooperation and technical assistance programs at the EU level to improve efficiency and accelerate the permitting process for offshore wind and renewable energy projects. The Concerted Action on the Renewable Energy Directive (CA RES) is a cooperative initiative jointly operated by EU member states and the European Commission, which supports information sharing and policy coordination to help countries implement renewable energy permitting procedures more effectively. In addition, the EU Recovery and Resilience Plans (RRP) also include improvements to the offshore wind permit process. The plan is a strategy to achieve both economic recovery and a sustainable energy transition in the EU, and improving the efficiency of administrative procedures for offshore wind projects has been set as one of the main tasks. It is supporting the development of power grids for renewable energy integration through technical assistance and the Single Market Enforcement Taskforce (SMET). SMET is an organization that aims to efficiently implement energy policies for the single market at the EU level, and it is helping to resolve technical and administrative issues that arise during the grid integration of renewable energy projects.

D) Integrated Maritime Spatial Planning (MSP)

The need for Maritime Spatial Planning (MSP)

Maritime Spatial Planning (MSP) is an essential policy tool for systematically coordinating various maritime activities with the long-term protection of marine ecosystems. The EU Commission has established the MSP platform to better manage the use of marine space and provides guidelines to help countries rationally allocate and use marine space. MSP goes beyond simple marine use planning and plays a role in strengthening cross-border cooperation, resolving conflicts between stakeholders, and promoting best practices for shared of space. In particular, as offshore renewable energy projects expand, it is becoming an essential task to harmonize MSP with existing industrial and marine protection policies.

Coexistence of offshore renewable energy and marine activities

As marine space is utilized by various stakeholders, offshore renewable energy needs to be promoted in a way that allows it to function in operate in harmony with existing marine industries while complying with environmental protection policies. Offshore renewable energy projects, including

offshore wind power, must coexist with fisheries, shipping, tourism, and marine protected areas, and development must be carried out in a way that minimizes environmental impact. In this context, MSP policies that take into account environmental protection, the restoration of marine ecosystems, and the safety of maritime traffic are needed. Systematic coordination of marine space can help offshore renewable energy development form a mutually complementary relationship existing marine industries, rather than compete with them for space. The EU launched the European Blue Forum in May 2023 to facilitate dialogue among maritime stakeholders. The forum is a platform for various stakeholders, including the scientific community, the energy industry, the shipping industry, the fishing industry, and the tourism industry, to exchange opinions on MSP policies and support the development of offshore renewable energy projects in a more balanced manner.

MSP adoption in member states and future actions

EU member states are managing their marine spaces more effectively through MSPs, and most countries are continuously refining their plans to reconcile renewable energy development with environmental protection. Currently, 17 of the EU's 22 coastal countries have formally adopted MSPs, and some countries are in the process of revising their MSPs to reflect their goals of expanding offshore renewable energy and protecting the environment. The EU is calling for the continuous improvement of MSP through the EU 2030 Biodiversity Strategy, and it emphasizes that each member state should adjust its MSP to create synergies between renewable energy, fisheries, and economic activities. Countries that have not yet introduced MSP need to establish strategic and integrated plans to comply with their legal obligations, and the EU is also preparing technical and administrative guidelines to support this. MSPs are also an important means of strengthening cooperation between countries in a way that goes beyond. As offshore renewable energy not only contributes to the economic interests of a country but also to the achievement of energy security and carbon neutrality targets across Europe, EU member states are considering establishing joint MSP oversight and operational bodies.

The EU Marine Spatial Strategy and international cooperation

The EU has set the goal of protecting the marine environment and biodiversity through the Marine Strategy Framework Directive (MSFD), and is calling for the establishment of policies that take into account environmental impact for the sustainable use of the oceans. The EU is also strengthening international cooperation systems to protect the oceans. Notably, the OSPAR Convention (Protection of the North-East Atlantic) and the HELCOM Convention (Protection of the Baltic Sea) are conducting research on the impact of offshore renewable energy on marine ecosystems and working to develop appropriate environmental protection measures. In the Baltic Sea region, a joint working group has

convened to coordinate MSP between countries and is seeking ways to balance offshore wind development and environmental protection. In the future, the EU will expand MSPs support research, and strengthen links between offshore renewable energy and marine strategies.

E) Research and innovation (R&I) to support offshore renewable energy

Floating offshore wind development priorities

Floating offshore wind power is essential to generating electricity farther offshore in deep waters where it is difficult to install traditional fixed windmills. Currently, various floating wind technologies are being developed, but no specific, standardized technology has yet been established. In response, the EU is investing in R&D and demonstration projects to promote the commercialization of floating wind technology. Several countries, including Ireland, Portugal, Spain, Italy, Malta, and Greece, have selected sites for floating wind farms, and France is in the process of bidding for the first commercial floating wind farm. These and other national floating wind projects demonstrate the economic feasibility of the technology and illustrate its advantages over traditional wind power.

Support for marine energy technology (tidal and wave power generation) and innovation

In addition to offshore wind power, the EU is also researching and developing various marine renewable energy technologies, including tidal energy, wave energy, floating solar power, and offshore hydrogen production. The EU aims to diversify its renewable energy portfolio and achieve a sustainable energy transition through these new technologies. The European Commission operates an online funding overview website to facilitate the financing of offshore renewable energy projects, helping companies and research institutions throughout the bloc secure necessary funding. In particular, from 2009 to 2022, maritime technology received the most funding from EU research and innovation (R&I) funds, suggesting that maritime renewable energy is an important pillar of EU energy policy. The EU is actively supporting maritime renewable energy research and development through the Horizon Europe (HE) program, and the following studies are being now underway:

- InterOPERA Project: Promotion of the HVDC (High Voltage Direct Current) power grid demonstration project
- Integration of the concept of circularity by design: Minimization of resource waste by considering the possibility of reuse and recycling from the design stage of energy facilities
- Mission Restore Our Ocean and Waters: Research on integrating offshore wind power and aquaculture

In addition, various funds exist to support offshore wind and marine energy. The main support programs are as follows:

- European Regional Development Fund (ERDF): Support for the development of high-performance high-voltage cables and the establishment of the Offshore Wind Innovation Center in the Netherlands.
- Recovery and Restoration Fund (RRF): Support for the deployment of 1,500 MW of offshore wind capacity and 100 MW of floating wind and solar power generation capacity, and the construction of offshore "energy islands"
- Innovation Fund: Support for offshore energy technology and hydrogen-linked projects (additional funding of EUR 4 billion is planned for 2024)
- InvestEU program: Support for private investment and co-financing for the construction of Poland's first offshore wind farm (EUR 610 million loan from the European Investment Bank, EIB)

Research and innovation goals and future tasks (post-2024)

The EU is continuously refining its research and innovation (R&I) goals for offshore renewable energy and is specifying the direction of future research and development. It is supporting the European Technology and Innovation Platform (ETIP) and plans to revise the Strategic Research and Innovation Agenda (SRIA) for wind and marine energy. In addition, the Strategic Energy Technology (SET) plan will be reviewed to revise the offshore wind and marine energy targets and action plans and strengthen cooperation between countries. Through this, R&I priorities are being set for the development of offshore renewable energy technologies, manufacturing, circular economy initiatives material research, and human capital development. The EU's R&I focus areas after 2024 are as follows:

- Research on new materials to reduce the dependence on rare earths used in permanent magnets for wind turbines
- Promote a project to assess offshore wind farms' environmental and social impact on marine ecosystems.
- Improve offshore wind manufacturing technology and increase production efficiency by incorporating IoT-based digital technology.
- Full-scale floating offshore wind demonstration project (2024)

As a goal for ocean energy, the EU plans to expand the capacity of ocean energy generation to 100 MW by 2027 and 1 GW by 2030. To this end, it aims to create synergies between tidal and wave power generation projects and national and regional funding programs. The EU also aims to mitigate the risk of developing new technologies and maintain Europe's leadership in offshore renewable energy technologies by utilizing its Innovative Procurement strategy.

F) Supply chain and human resource development

Supply chain-related issues

Establishing a stable supply chain is essential for the continued growth of the offshore wind power industry. However, external factors such as the war in Ukraine, global supply chain instability, and intensifying technological competition with China and the U.S. have raised concerns about the EU's competitiveness. The the offshore wind supply chain, which includes turbines, substations, cables, ports, and installation equipment, remains unstable, and non-EU countries (especially China) are rapidly advancing their manufacturing capabilities. As a result, the EU must strengthen its own manufacturing capacity and expand the overall supply chain. A particular challenge is the lack of adequate port infrastructure. Many European port facilities lack the logistics capacity to handle the very large turbines used in offshore wind platforms. The EU also remains heavily dependent on foreign vessels capable of installing and operating offshore wind farms, and this poses a risk to EU goals of upscaling offshore wind power.

The EU's supply chain strengthening strategy

The EU is expanding various policies and financial support to establish a smooth and stable supply chain for the offshore wind power industry. It lays the foundation for implementing large-scale projects by increasing investment in port infrastructure. To this end, the EU is utilizing cooperation systems such as the North Sea Energy Cooperation (NSEC), the Trans-European Transport Network (TEN-T), and the Trans-European Energy Network (TEN-E) to support research and planning for port expansion and modernization and improvement to logistics systems. As part of this effort, the Port Electricity Commercial Model pilot project was launched in the first half of 2024 to introduce electrification and modernization strategies for key ports. These efforts aim to systematically enhance port facilities needed for offshore wind turbines' transportation, installation, and maintenance. To further strengthen supply chain resilience and industrial competitiveness, the EU is promoting clean technology manufacturing and securing access to rare earth elements (REE) and other strategic materials through the net-zero Industry Act (NZIA) and the Critical Raw Materials Act (CRM). In parallel, financial support is being expanded through mechanisms such as InvestEU and the Innovation Fund, while the European Investment Bank (EIB) plays a central role in offering loans and co-financing for new offshore wind projects.

Offshore renewable energy workforce development strategy

As the offshore wind industry grows, a shortage of skilled workers has emerged as a major stumbling block, but there is a shortage of skilled engineers, technicians, and managers to fill these positions. To address this, the EU is strengthening training in digital, ICT, robotics, and health and safety-related

technologies, and expanding support programs for workers. It is also increasing the participation of women and young people through its Diversity & Inclusion policy and supporting workers transitioning from existing industries to offshore wind. The EU is actively utilizing the Erasmus+ and net-zero Industry Academies programs to develop such talent, aiming to secure the workforce needed for continued offshore wind growth through expanded training and education (Table 13).

Table 13 Main content of the EU's offshore renewable energy strategy

Category	Content
Cross-border Offshore Grid Development	• Offshore wind requires both offshore and onshore grid expansion • Revised TEN-E Regulation promotes multinational grid cooperation • MSP integrated with grid development via NSEC and BEMIP • RED encourages joint offshore renewable energy projects • ONDP established to provide roadmap for offshore grid development by 2050 • EU working on fair cost-sharing mechanisms for offshore infrastructure • EMD reform to ensure market stability and investment for offshore projects
Acceleration and Efficiency of the Licensing Process	• Fast-track permitting needed to meet 2030 (60 GW) and 2050 (300 GW) targets • Revised TEN-E Regulation introduces one-stop-shop and cooperation among NCPs • Revised RED introduces 'Renewables Acceleration Areas' (RAAs) and improved EIA timelines • EU platforms like EIGL support site selection • Technical support via CA RES, RRP, SMET to streamline and support permitting
Integrated Maritime Spatial Planning (MSP)	• MSP helps coordinate marine use with offshore renewable development • Offshore projects must coexist with fisheries, shipping, tourism, and MPAs • EU supports MSP through platforms, guidance, and stakeholder forums (e.g., European Blue Forum) • 17 out of 22 coastal countries have MSPs; EU urges continuous updates • MSP integrated with biodiversity, fisheries, and economic strategies (MSFD, OSPAR, HELCOM)
Research and Innovation (R&I)	• Floating wind tech prioritized for deep waters (e.g., Atlantic, Mediterranean) • R&D support for tidal, wave, solar, hydrogen energy • Key EU programs: Horizon Europe, ERDF, RRF, Innovation Fund, InvestEU • Major projects: InterOPERA (HVDC), circularity design, aquaculture integration • Post-2024 R&I goals: new materials, ecosystem impact, manufacturing efficiency, floating wind demo • Ocean energy capacity targets: 100 MW (2027), 1 GW (2030)

Table 13 (continued)

Category	Content
Supply Chain and Human Resource Development	• Offshore wind supply chain faces port, cable, ship shortages and geopolitical risks • EU invests in port infrastructure and clean tech via NZIA and CRM Acts • Projects like Port Electricity Commercial Model aim to modernize ports • InvestEU, EIB, Innovation Fund used for financial support • Workforce strategy targets 20,000??0,000 jobs; training in digital, ICT, safety • Programs: Erasmus+, net-zero Industry Academies, Diversity & Inclusion policies

Source European Union, "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Delivering on the European Green Deal through climate action in the EU and internationally (COM(2023) 668, final)", accessed on February 17, 2025.

(3) European Wind Power Action Plan (WPAP)[7)]

A) Introduction

The growth of the European wind power industry has slowed down recently due to intensifying competition in the international market, supply chain instability, financing difficulties, and delays in permitting procedures. In response, the European Union recently announced the European Wind Power Action Plan (WPAP). The WPAP presents a comprehensive roadmap for developing the EU's offshore wind power industry and features comprehensive strategies for accelerating the deployment of wind energy, stimulating investment, and strengthening international competitiveness.

Through this, the WPAP is expected to play an essential role in achieving the EU's energy transition goals by increasing offshore wind power generation capacity, strengthening supply chains, and improving the efficiency of licensing procedures. It is also expected to further strengthen the competitiveness of the EU's offshore wind power industry by enhancing maritime security, promoting regional cooperation, and attracting investment. The WPAP is a concrete plan of action with specific goals designed to facilitate the continuous development of the EU wind power industry and preserve the EU's leading position in the global market.

7) European Union, "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – European Wind Power Action Plan (COM(2023) 669 final)", accessed on February 17, 2025.

B) Key action plans

Accelerate wind power deployment and streamline permitting

One of the main goals of the WPAP is to accelerate the deployment of wind power projects. To this end, the European Commission and member states will streamline the permitting process for wind power projects and quickly implement the proposed amendments to the Renewable Energy Directive (RED) through the Accele-RES program. Member states will also make plans for promoting national-level win power projects more transparently and long-term renewable energy deployment plans to increase predictability.

Improving auction design and expanding the power grid infrastructure

The EU wants to improve the bidding process for wind power projects to ensure the stability of project implementation. To this end, it will include criteria that take into account environmental and social impacts in the auction process and improve the design to maximize the project implementation rate. It is also working on ways to address cyber security and data protection issues and strengthen the Global Gateway for the wind energy sector.

Financial support and investment promotion

The European Commission will develop with measures to help wind energy companies receive financial support. The European Investment Bank (EIB) will provide risk mitigation tools and guarantee systems for EU wind companies to reduce investment risk, and member states will take measures to make the most of the flexibility of the State Aid rules to protect the EU wind industry value chain. This will expand the attraction of public and private investment and promote the development of key infrastructure such as wind turbines, substations, and transmission networks.

Creating a fair and competitive international environment

The EU aims to strengthen the competitiveness of wind energy companies in the international market. To this end, it will implement support policies to attract investors and increase the accessibility of EU wind energy companies to overseas investment markets. It will also strengthen measures to protect the EU internal market from trade distortions, protect national security and public order, and promote standardization in the wind energy sector to further strengthen industrial competitiveness.

Strengthening technological innovation and research and development (R&D)

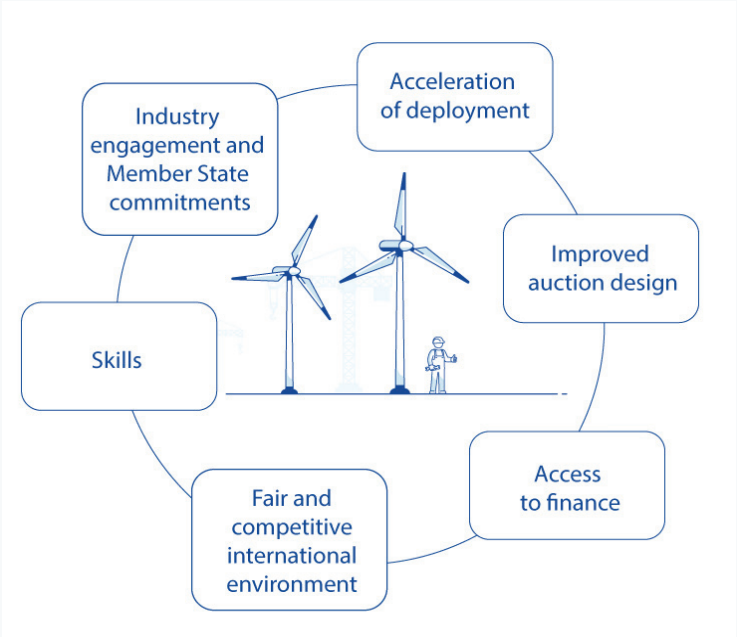
As the wind power industry continues to grow, the EU plans to establish large-scale technology partnerships to train technical personnel and secure the specialized workforce needed in the renewable energy sector. This will expand the size of the skilled workforce in the wind power industry

and maximize the job creation opportunities in the renewable energy sector. The EU also introduced the EU Wind Charter by December 2023 to promote cooperation between the industry and member states.

Strengthening industry participation and member state cooperation

The WPAP aims to promote cooperation between the EU Commission, member state governments, and wind energy companies to develop the wind power industry. The industrial structure of the wind energy is characterized by a high degree of internationalism; policies implemented by any single country may often fail to significantly impact the growth prospects of the industry. This makes it is essential to strengthen cooperation between member states in areas such as joint project development, grid connection, and technology sharing (See Figure 13 and Table 14).

Figure 13 Six main pillars of the European Wind Power Action Plan



Note The European Wind Power Action Plan focuses on six key pillars to accelerate wind energy deployment: (i) acceleration of deployment through increased predictability and faster permitting; (ii) improved auction design; (iii) access to finance; (iv) creating a fair and competitive international environment; (v) skills; and (vi) industry engagement and member state commitments. These actions also support other renewable energy sectors.

Source European Union, "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – European Wind Power Action Plan (COM(2023) 669 final)", accessed on February 17, 2025.

Table 14 **The European Wind Power Action Plan in a nutshell**

Category	Actions/instruments	Timeline
Acceleration of deployment through increased predictability and faster permitting	• Commission and member states to work together in order to accelerate permitting. 'Accele-RES' focuses on frontloading transposition and implementation of the revised RED. Temporary emergency regime	Starting Nov. 2023
	• Member states to increase visibility of the wind projects pipeline through wind pledges, publication of mid-term auction schedules, long-term plans for renewables deployment	Starting Nov. 2023
	• Commission to adopt an action plan to facilitate grids build-out	Nov. 2023
Improved auction design	• Member states to include in their auctions objective, transparent and non-discriminatory qualitative criteria and measures to maximize the execution rate of the projects, supported by Commission recommendation and guidance	as soon as possible
	• Tackling cybersecurity risks and addressing data protection aspects	Beginning in 2024
	• Commission to increase the use of strategic procurement in the context of the Global Gateway	As of adoption
Access to finance	• Commission to facilitate access to EU financing	By the end of 2023
	• EIB to provide de-risking tools and guarantees for EU wind companies	Apr. 2023
	• Member states to make full use of flexibility provided under State aid rules for EU wind value chain	As of adoption
Creating a fair and competitive international environment	• Commission to strengthen the dialogue with investors to foster the attractiveness of investment in the EU's wind sector	By the end of 2023
	• Commission to facilitate EU manufacturers' access to foreign markets	As of adoption
	• Protect the internal market against trade distortions and threat to security and public order	As of adoption
	• Enhancing standardization in the wind energy sector	By the end of 2023
Skills	• Large Scale Skills Partnerships for Renewable Energy to design projects that support skills development for the renewable energy sector, including wind	By mid-2024
Industry engagement and member states commitments	• EU Wind Charter	Dec. 2023

Source European Union, "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – European Wind Power Action Plan (COM(2023) 669 final)", accessed on February 17, 2025.

(4) Renewables Acceleration Area (RAA)[8)]

A) Introduction

The Renewables Acceleration Area (RAA) is a policy concept introduced by the European Union (EU) to contribute to its goal of expanding renewable energy. It is designed to accelerate the permitting process for offshore and onshore renewable energy projects and reduce administrative barriers to enable rapid construction of power plants. By February 21, 2026, member states must designate at least one renewable energy technology for use in an RAA.

The RAA framework allows member states to select environmentally suitable areas and provides regulatory support to minimize environmental impacts through strategic environmental assessments (SEA) and other means. It is also based on the EU Renewable Energy Directive (RED) amendment and is linked to Maritime Spatial Plans (MSP) and existing renewable energy policies. In particular, it aims to promote the development of wind and solar power projects through a rapid permitting process and to build an efficient power supply system in conjunction with energy storage infrastructure.

B) Key features

Environmental and biodiversity considerations

The RAA framework ensures the rapid progress of renewable energy projects. As with all large-scale development projects, renewable energy projects require an environmental impact assessment (EIA) before breaking ground on construction. The RAA policy directs developers to avoid environmentally sensitive areas and ensures that development aligns with existing ecological conservation and restoration measures when applicable. The RAA framework also directs member states to apply a so-called "mitigation rulebook" to ensure that the project does not disrupt the local ecological balance and continuously monitors for environmental impacts.

Integration of energy storage systems

Not only can RAAs can be designated to fast-track permitting processes for power generation facilities promote the concurrent use of renewable energy with advanced energy storage systems (ESS). Since renewable energy is intermittent, the policy encourages battery storage technology, hydrogen storage infrastructure, and smart grids to be used in RAAs of an integrated utilization platform. This allows for the efficient storage and distribution of generated power, and also contributes to securing the stability of the power grid.

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8) European Union (2024).

Streamlined licensing procedures

The RAA policy's main focus is to streamline licensing to expedite the progress of renewable energy projects. To this end, the policy calls for the establishment of an independent Energy Landscape to support each member state in expediting designation of RAAs. Administrative efficiency is maximized by reducing the existing licensing procedures and operating a one-stop service system.

Strengthening cooperation between countries and linking maritime spatial planning

The RAA designation process is designed to strengthen cooperation between countries and ensure consistent development in connection with maritime spatial planning (MSP). Optimal RAA locations will be determined through cross-border cooperation and coordinated to ensure functional linkages with maritime and terrestrial power grids. It also encourages sharing of best practices and collaboration among member states.

C) RAA designation procedure and implementation plan

RAA planning and area selection

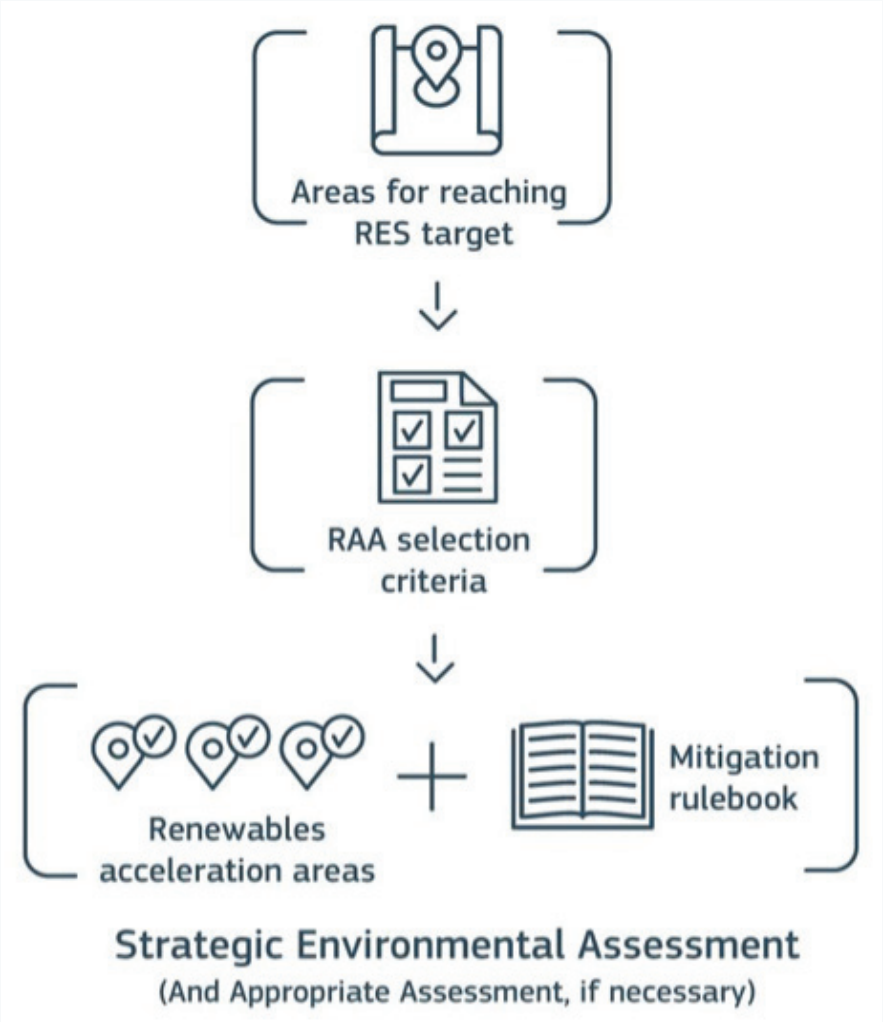
To designate an RAA, member states must first identify areas suitable for renewable energy project development. To do this, they use digital tools and environmental data analysis to assess the ecological characteristics, social acceptability, and infrastructure of a candidate area. The areas selected must be suitable for achieving the renewable energy targets, thereby maximizing the effectiveness of renewable energy projects. Member states are asked to supply a rulebook for use in all designated RAAs to mitigate the environmental impact of renewable energy facilities, which will enable projects to proceed quickly while complying with environmental laws. RAAs should avoid environmentally high-risk areas or ecologically sensitive zones, and ensure balanced development that takes into account existing infrastructure and social impacts. In this process, cooperation between member states and EU-wide guidelines play an important role, and optimal locations for RAAs should be determined in full reflection of regional characteristics and policy priorities.

Strategic environmental assessments (SEAs)

Once the RAA plan is established, a strategic environmental assessment (SEA) must be conducted to examine whether the development area is environmentally suitable. SEAs evaluate the long-term environmental impacts of a project and, if necessary, propose additional environmental protection measures. Even in areas designated as RAAs, separate environmental assessment procedures are required in areas adjacent to Natura 2000 protected areas, and detailed adjustments are made to minimize the impact on the ecosystem. If necessary, the boundaries of the RAA can be adjusted

through inter-country cooperation during the SEA process, and supplementary measures should be taken if environmental impacts are expected. Projects implemented under the RAA can proceed quickly through the licensing process after undergoing a preliminary environmental review through the SEA. The overall effect should result in a simplified administrative process and faster project implementation (See Figure 14).

Figure 14 **Renewable Energy Acceleration Areas (RAAs) and the strategic environmental assessment process**



Source European Union (2024), p. 9.

D) Expected effects

The Renewable Energy Acceleration Area (RAA) is a policy tool that plays a key role in helping the EU achieve its renewable energy targets for 2030 and 2050. It should help shorten administrative procedures, speed up the promotion of renewable energy projects, and support the construction of

power plants more quickly. In particular, it is expected that the construction of renewable energy power plants and related infrastructure will be accelerated as the existing complex licensing process is streamlined.

It also contributes to a sustainable energy transition by balancing environmental protection and the development of new and renewable energy. RAA projects are to be carried out in a way that minimizes their environmental impact which will contribute to achieving the two goals of expanding renewable energy and protecting the ecosystem at the same time.

In addition, cooperation between countries can efficiently expand the power grid and energy storage infrastructure, which will play an important role in increasing the energy independence of the whole of Europe. The RAA promotes cross-border cooperation and lays the foundation for more systematic construction of energy infrastructure in connection with the interconnection of power grids between member states and Marine Spatial Planning (MSP).

The RAA policy is expected to encourage the growth of the renewable energy industry and private investment by providing a predictable policy environment for companies and investors. Clear regulations and fast licensing procedures will help companies participate in renewable energy projects more reliably and provide long-term investment incentives.

As a result, RAA is expected to become an essential policy tool for accelerating the transition to renewable energy in Europe, and will play an important role in achieving both rapid project implementation and environmental sustainability.

3.1.2 Electricity Network Act and related policies

(1) Trans-European Networks for Energy (TNE-E) Regulation[9)]

A) Introduction

The Trans-European Networks for Energy (TEN-E) Regulation is a key piece of legislation for modernizing the EU's energy infrastructure and transforming it towards a renewable energy- based system. It aims to strengthen the interconnectivity of energy networks in Europe and serves to promote the interconnection of national electricity grids and the development of smart grids. A 2022 revision to the policy revoked support for natural gas-based infrastructure, thereby laying the foundation for the EU to effectively achieve its 2050 net-zero carbon target. The main objectives of the

9) European Union, "Regulation (EU) 2022/869 of the European Parliament and of the Council of 30 May 2022 on guidelines for trans-European energy infrastructure and repealing Regulation (EU) No 347/2013", accessed on February 17, 2025.

TEN-E Regulation are as follows:

- Promote the development of energy infrastructure in Europe
- Strengthen cross-border energy connectivity
- Modernize the power grid to integrate renewable energy
- Strengthen energy security and market integration

Essential concepts in this regulation include Projects of Common Interest (PCI), Cross-Border Renewable Energy Projects (CB RES), and Cross-Border Interconnectors (CBI). These projects contribute to increasing the stability of the energy supply by efficiently connecting the European power grid and renewable energy systems.

B) Main content

Strengthening the interconnection of power grids between EU member states

One of the core objectives of the TEN-E Regulation is to ensure a stable continental supply by connecting the power grids of the various EU member states. The New cross-border energy infrastructure will help to solve power shortages that may occur in certain regions and facilitate the sharing of energy between member states. The TEN-E Regulation also calls on member states to build an offshore energy grid to effectively utilize the power generated by offshore wind farms. This will enable the stable supply of renewable energy generated at sea by connecting it to the onshore power grid, and will maximize the efficiency of large-scale offshore wind power projects.

Promoting renewable energy and power grid modernization

The EU is promoting the modernization of the power grid and the development of smart grids to support the expansion of renewable energy. The existing power grid is optimized for fossil fuel-based power plants, which limits its ability to handle the variability of renewable energy. To solve this problem, energy stakeholders are adopting digital power grid and smart grid technologies to optimize power flow and effectively manage renewable energy. Power generation and distribution systems are also being linked with energy storage systems to compensate for the intermittent variability of renewable energy and increase the overall stability of power supply. For example, battery storage systems can help solve the problem of intermittent power production from solar and wind power generation, and a system will be built to automatically adjust to meet power demand.

Designated of Projects of Common Interest (PCI) that transcend national borders

The EU designates major infrastructure projects that connect energy networks between member states and support the expansion of renewable energy as Projects of Common Interest (PCI). Projects designated as PCI can benefit from expedited permitting procedures, and policy and financial support from the EU. The PCI list is updated every two years in accordance with the TEN-E Regulation, and major projects that increase the efficiency of the European energy system and promote the transition to renewable energy are selected. This provides administrative and financial support to ensure the smooth progress of renewable energy projects in the EU.

Regulation and financial support

The TEN-E Regulation provides financing for PCI projects through the Connecting Europe Facility (CEF). The CEF is the main financial support program for European energy infrastructure projects and plays an important role in promoting strategic energy projects at the EU level. It also includes measures to prevent double regulation in cross-border projects. In general, large-scale energy projects that span multiple countries are likely to experience significant delays due to the need to go through redundant regulatory and administrative procedures in each country. To address this, measures are being developed to reduce unnecessary regulations and streamline licensing procedures through cooperation between countries.

Support for the construction of offshore power grids

To expand offshore wind power generation, the law calls for the construction of submarine transmission lines connecting offshore wind farms to the onshore power grid. Technologies such as high-voltage direct current (HVDC) transmission lines are actively used to reliably transmit power generated at sea to the mainland, thereby minimizing power loss and enabling efficient power transmission. In addition, legal and financial support is provided to support the expansion of offshore wind farms. As offshore wind projects require large-scale investments, financial support and legal stability at the EU level must be secured. Accordingly, the TEN-E Regulation provides incentives for member states and private investors to actively participate in offshore wind projects and lays the legal foundation for streamlining administrative procedures.

C) Policy instruments supporting offshore renewable energy, grid integration, and marine planning

This section explains the key provisions related to offshore wind and renewable energy, the connection of offshore wind farms to the electricity grid, and maritime spatial planning, as part of the policy instruments supporting offshore renewable energy, grid integration, and marine planning (See Table 15, Table 16, and Table 17).

Table 15 Key provisions related to offshore wind and renewable energy

Category	Actions/instruments
Article 4: Selection criteria for renewable energy-based projects	• The electricity generated by offshore wind farms shall be efficiently transmitted to land • It shall enhance connectivity with existing power grids and contribute to the expansion of renewable energy • The impact of the project on market integration and energy security shall be assessed
Article 5: Monitoring the progress of offshore wind and transmission network projects	• Check whether offshore wind farms are being built according to the planned schedule. • Evaluate whether the connection to the power grid is being carried out smoothly.
Article 11: Energy system wide cost-benefit analysis	• The EU Network of Transmission System Operators for Electricity (ENTSO-E) and Gas (ENTSO-G) shall develop a cost-benefit analysis methodology for renewable energy and offshore wind power, which shall be consistent with the EU's 2030 energy and climate targets and 2050 carbon neutrality targets. • Scenario analyses should be carried out taking into account offshore wind and renewable energy, and the environmental, social and economic impacts of the relevant infrastructure should be reflected.
Article 12: Scenarios for the ten-year network development plans	• ENTSO-E and ENTSO-G should establish joint scenarios including offshore wind for the EU ten-year electricity network development plan. • The energy efficiency first principle and the National Energy and Climate Plan (NECP) should be reflected.
Annex Ⅰ: Trans-European Energy Infrastructure Priorities	• Provides a list of priority infrastructure, including offshore wind and grid-connection projects. • Sets the development of renewable energy-based grids in the ocean as a key objective.

Source European Union, "Regulation (EU) 2022/869 of the European Parliament and of the Council of 30 May 2022 on guidelines for trans-European energy infrastructure and repealing Regulation (EU) No 347/2013", accessed on February 17, 2025.

Table 16 **Key provisions related to the connection of offshore wind farms to the electricity grid**

Category	Actions/instruments
Article 1: Subject matter, objectives and scope	• The key objective is to develop the European electricity grid infrastructure so that the EU's electricity grid can be connected to offshore wind farms • Ensure that the electricity generated by offshore wind farms can be efficiently distributed across Europe through the expansion of the electricity grid
Article 3: Union list of projects of common interest and projects of mutual interest	• Offshore wind power-related power grid projects are included in the list of "Projects of Common Interest (PCI)" and given priority support • PCI projects are designated as priority projects eligible for EU funding
Article 14: Offshore grid planning	• By January 24, 2023, EU member states must conclude a non-binding agreement setting targets for offshore wind development (2030, 2040, 2050) • The agreement will be linked to national energy and climate plans (NECP) and must take into account the renewable energy potential of each sea basin • By January 24, 2024, ENTSO-E (European Network of Transmission System Operators for Electricity) shall establish a strategy for the development of offshore networks, integrate it with the development plan for the electricity network for the next ten years, and reflect the results of the cost-benefit analysis
Article 15: Offshore grids for renewable energy cross-border cost sharing	• By June 24, 2024, the EU Commission must develop a cost-benefit and cost-sharing guideline for offshore wind and the offshore grid, and ENTSO-E must announce a cost-sharing model for the offshore wind grid
Article 23: Information and publicity	• Emphasizes the need to build an undersea power grid that can transmit offshore wind power to land. • Support cross-border grid-connection projects to promote the exchange of offshore wind power between countries
Annex Ⅱ: Energy Infrastructure Categories	• Define infrastructure categories that connect the power grid and offshore wind power • Include high-voltage direct current (HVDC) transmission networks that connect offshore wind farms to land

Source European Union, "Regulation (EU) 2022/869 of the European Parliament and of the Council of 30 May 2022 on guidelines for trans-European energy infrastructure and repealing Regulation (EU) No 347/2013", accessed on February 17, 2025.

Table 17 Key provisions related to maritime spatial planning

Category	Actions/instruments
Article 7: Priority status of projects on the Union list	• Ensuring that offshore wind and related power grid projects are linked to maritime spatial planning (MSP) • Ensuring that the construction of energy infrastructure in the sea is harmonized with other maritime activities (fishing, ship navigation, marine protected areas, etc.)
Article 8: Organization of the permit granting process	• Adjusting the permitting process for each country to ensure that offshore wind and marine power grid projects can be quickly approved • Integrating the project approval process to harmonize with the Marine Spatial Planning Act

Source European Union, "Regulation (EU) 2022/869 of the European Parliament and of the Council of 30 May 2022 on guidelines for trans-European energy infrastructure and repealing Regulation (EU) No 347/2013", accessed on February 17, 2025.

(2) EU Action Plan for Grids[10)]

A) Introduction

The European Union (EU) is developing a strategic plan to strengthen and modernize its power grids to help its net-zero carbon emissions goal and accelerate the energy transition. The EU Action Plan for Grids is designed to increase the utilization of renewable energy and ensure the stability of the power system by expanding the power grid infrastructure in Europe, introducing innovative grid technology, and streamlining licensing procedures.

The plan accelerates the implementation of the Trans-European Networks for Energy (TEN-E) policy, improves the efficiency of existing power grids, and presents practical implementation measures to respond to future increases in energy demand. Through this, the EU aims to build a renewable energy-based power grid, smoothly coordinate power flows between member states, and strengthen its competitiveness in the global energy market.

B) Key strategies

Accelerating projects

The EU has set the expansion of power grid infrastructure as a top priority and is accelerating the implementation of Projects of Common Interest (PCI) and Projects of Mutual Interest (PMI) to this end.

10) European Union (2023).

Strengthening long-term planning

The EU is developing a long-term plan for the expansion of the electricity grid as renewable power plants come online and has demand for electricity grows.

Providing regulatory incentives

The EU is pursuing a strategy to stimulate private and public sector investment by introducing financial and institutional incentives to promote the construction of power grids and the promotion of offshore wind power projects. In particular, the EU plans to introduce regulatory incentives to encourage private companies to participate in the development of power grids in order to encourage future-oriented power grid investment.

Improving the utilization of power grids

The EU is planning to introduce smart grid technology and build a digital power grid operating system to maximize the utilization of existing power grids and achieve efficient power distribution. At the same time, it plans to reduce the cost of operating the power grid by improving the network fee system, and provide a more rational power grid operating environment for both consumers and businesses by enhancing the transparency of power consumption and distribution.

Improving access to financial support

Large-scale financial support is essential for the modernization of the electricity grid, and the EU is therefore increasing access to financial support for smart grid and distribution network upgrade projects and expanding relevant EU funding programs. To this end, the EU funding programs for building and upgrading the electricity grid will be clearly organized and the EU is offering member states and private firms support in securing financing.

Streamlining the licensing process

One of the EU's main goals is to minimize project delays by improving the complex administrative procedures related to building power grids and taking measures to streamline the licensing process. To this end, the EU plans to provide technical support to authorities in each country and accelerate the progress of projects by establishing guidelines to streamline the licensing process. In addition, it will promote the participation of local communities and stakeholders to increase social acceptance of the expansion of the power grid and ensure that that projects proceed smoothly. In particular, the key strategy is to speed up the development of the power grid through a rapid permitting process and effectively support the EU's renewable energy transition goals.

Strengthening the supply chain

The EU is pursuing a strategy to secure a stable supply chain of key components for building power grids and to strengthen production capacity. To this end, it is essential to coordinate industrial manufacturing requirements for the development of power grid infrastructure and to secure a stable supply chain for key equipment. It is also an important optimize connections between power plants and regions with power demand through cooperation between countries and to build a network for stable power supply (See Table 18).

Table 18 Key strategies of the EU Action Plan for Grids

Category	Actions/instruments
Accelerating projects	• Prioritizing power grid expansion and accelerating Projects of Common Interest (PCI) and Projects of Mutual Interest (PMI) to support renewable energy and stable power supply
Strengthening long-term planning	• Developing long-term plans for electricity grid expansion in response to growing renewable energy generation and electricity demand, including hydrogen usage
Providing regulatory incentives	• Stimulating private and public investment by introducing financial and institutional incentives, especially to encourage private sector participation in power grid development
Improving the utilization of power grids	• Implementing innovative grid technology and a digitized operating system to enhance grid efficiency, reduce operation costs, and improve transparency in power consumption and distribution
Improving access to financial support	• Increasing financial support for grid modernization projects, organizing EU funding programs, and helping member states and private companies secure necessary funds
Streamlining the licensing process	• Minimizing delays by simplifying administrative procedures, providing technical support, establishing guidelines, and engaging local communities to enhance project acceptance
Strengthening the supply chain	• Securing a stable supply of key components, enhancing production capacity, coordinating industrial requirements, and optimizing connections between power plants and demand regions

Source European Union (2023), p. 20.

3.1.3 Policies related to marine spatial planning

(1) Maritime Spatial Planning Directive[11)]

A) Introduction

The European Union (EU) has introduced the Marine Spatial Planning Directive (MSPD) to ensure the sustainable and systematic use of marine space. This directive aims to provide a legal framework for EU member states to efficiently manage marine space and balance various marine activities (renewable energy, shipping, fishing, tourism, etc.). Through this Directive, the EU aims to lay the policy foundation for more planned and systematic use of marine space while simultaneously considering the expansion of renewable energy and protecting aquatic ecosystems. The MSPD has the following main objectives:

- Systematic management of the marine space: Prevent spatial conflicts between various activities such as offshore wind power, shipping, and fishing, and enable efficient use of marine resources.
- Support for renewable energy and offshore wind: Promote the development of renewable energy at sea by locating offshore wind farms and connecting them to the electricity grid.
- Balance environmental protection and economic development: Promote sustainable use of the sea while protecting and preserving marine ecosystems.
- Promote cooperation among member states: Encourage the efficient use of maritime resources across national borders and establish a comprehensive marine spatial plan at the EU level.

B) Key provisions on offshore energy development and grid infrastructure

Offshore wind energy development and its integration with the electricity grid require a coordinated legal and policy framework within the European Union. The MSPD contains several provisions that serve as a foundation for aligning renewable energy goals with spatial planning and infrastructure development. These provisions highlight the importance of marine spatial planning in facilitating offshore renewable energy and emphasize the need for harmonized connections to onshore power grids and cross-border cooperation.

The following table summarizes the key provisions in the MSPD, categorized by their relevance to (1) offshore wind and renewable energy, (2) the electricity grid and transmission infrastructure, and (3) coordination and cooperation between offshore wind power and the grid (See Table 19).

11) European Union, "Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning", accessed on February 17, 2025.

Table 19 **Key provisions on offshore energy development and grid infrastructure**

Category	Actions/instruments
Provisions related to offshore wind and renewable energy	• Recital 1 It clearly states that marine spatial planning is a tool for coordinating various marine activities, including renewable energy. • Recitals 8 and 9 It emphasizes that marine spatial planning can increase the efficiency of offshore wind power generation and thereby ensure sustainable use of the marine environment. • Recital 22 It specifies that marine spatial planning should be linked to the goal of expanding renewable energy (Directive 2009/28/EC), thereby ensuring that the development of renewable energy at the EU level is carried out in a systematic manner. • Preamble (Recital 25) Each country is required to submit its marine spatial plan to the European Commission for evaluation of its implementation, which allows the Commission to check whether the member states are faithfully implementing their marine spatial plans.
Provisions on the electricity grid and transmission infrastructure	• Article 5(2): Objectives of the marine spatial plan It stipulates that the energy sector's sustainability at sea should be considered, which means that facilities such as offshore wind farms should be reflected in marine spatial planning. It also suggests the need to consider the connection between power grid infrastructure and offshore wind farms. • Article 8(2): List of activities and infrastructure to be considered in the marine space It states that renewable energy generation facilities and infrastructure, undersea power grids, and transmission routes must be included in the marine spatial plan. This is a provision that emphasizes that offshore wind farms should not be installed independently, but should be connected to the transmission infrastructure to establish an efficient energy supply system.
Provisions on coordination and cooperation between offshore wind power and the power grid	• Article 6(2)(c): Minimum requirements for marine spatial planning It stipulates harmonizing marine spatial planning, land-based power grid connection, and integrated coastal management. This means that offshore wind power generation should not only be operated in the ocean but also be closely connected to the land-based power grid, enabling a stable supply and efficient distribution of electricity. • Article 12: Cooperation with third countries It encourages cooperation not only with EU member states but also with countries outside Europe for offshore wind power and grid connection. This is a provision that encourages offshore wind power generation to enable more efficient grid operation through international cooperation, rather than at the level of a single country.

Source European Union "Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning", accessed on February 17, 2025.

(2) Offshore Network Development Plans (ONDP) of the European Union of Transmission System Operators for Electricity (ENTSO-E)[12)]

A) Overview of ENTSO-E and ONDP

The European Network of Transmission System Operators for Electricity (ENTSO-E) is an organization that coordinates grid management and policies among transmission system operators (TSOs) in 35 European countries. It monitors and analyzes the flow of electricity, transmission infrastructure, and the connection status of renewable energy plants in Europe.

ENTSO-E aims to integrate and optimize the European electricity network and develops strategic plans for the effective integration of renewable energy. Among these are the Offshore Network Development Plans (ONDP), which are included as part of the Ten-Year Network Development Plan (TYNDP).

ONDPs are strategic plans aimed at building transmission infrastructure that integrates electricity generated by offshore renewable plants, and are mandated by the TEN-E Regulation (EU Reg. No. 2022/869 Art. 14.2). These plants support the more systematic and efficient connection of offshore wind power generation in Europe to the onshore power grid.

B) Main content of the ONDP policy

Evaluation of the capacity potential and infrastructure requirements of offshore wind power generation

ONDPs evaluates the potential of offshore wind power generation in Europe and analyze the infrastructure requirements for effectively connecting offshore wind facilities to the onshore power grid. They must include an optimal network construction plan that comprehensively considers the location of offshore wind power plants, their generation capacity, and the best method the transmission network. In addition, they must outline plans to expand the power grid so that the electricity generated by offshore wind farms can be smoothly supplied to the whole of Europe, and must consider ways to strengthen transmission connections between countries. The results of these assessments will be used as basic data for formulating policies to achieve the renewable energy targets in Europe and will contribute to accelerating the growth of offshore wind power generation.

12) ENTSO-E (2024).

Research on offshore power grid connection methods

The Offshore Network Development Plans (ONDP) initiative in the EU explores a range of network configurations to effectively connect offshore wind farms, focusing on assessing each approach's technical and economic feasibility. Among these configurations are Hybrid Projects, which involve constructing an offshore power grid that links multiple countries, facilitating the cross-border exchange of electricity and enhancing the efficient use of renewable energy resources. Another method under consideration is Radial Connections, where individual offshore wind farms are directly connected to the onshore transmission grid, strengthening grid stability within specific countries. ONDP is also examining Reinforcements, which entail building additional infrastructure to support existing offshore and onshore grids, helping to mitigate the intermittency of renewable energy and ensure a reliable power supply. Finally, the integration of Hydrogen Infrastructure is being studied, focusing on converting offshore wind-generated electricity into hydrogen via water electrolysis, with subsequent storage and transportation options being evaluated.

Linkage and coordination with marine spatial planning

ONDPs are also meant to strengthen linkages with marine spatial planning (MSP) to ensure that offshore wind farms and related infrastructure can operate in harmony with other activities in the marine space. ONDPs also consider ways to coordinate offshore wind farms and marine protected areas to enable energy development while minimizing environmental impact. They also take into account the shared use of marine space by various stakeholders in the fishing, shipping, and other industries, and are designed to minimize conflicts.

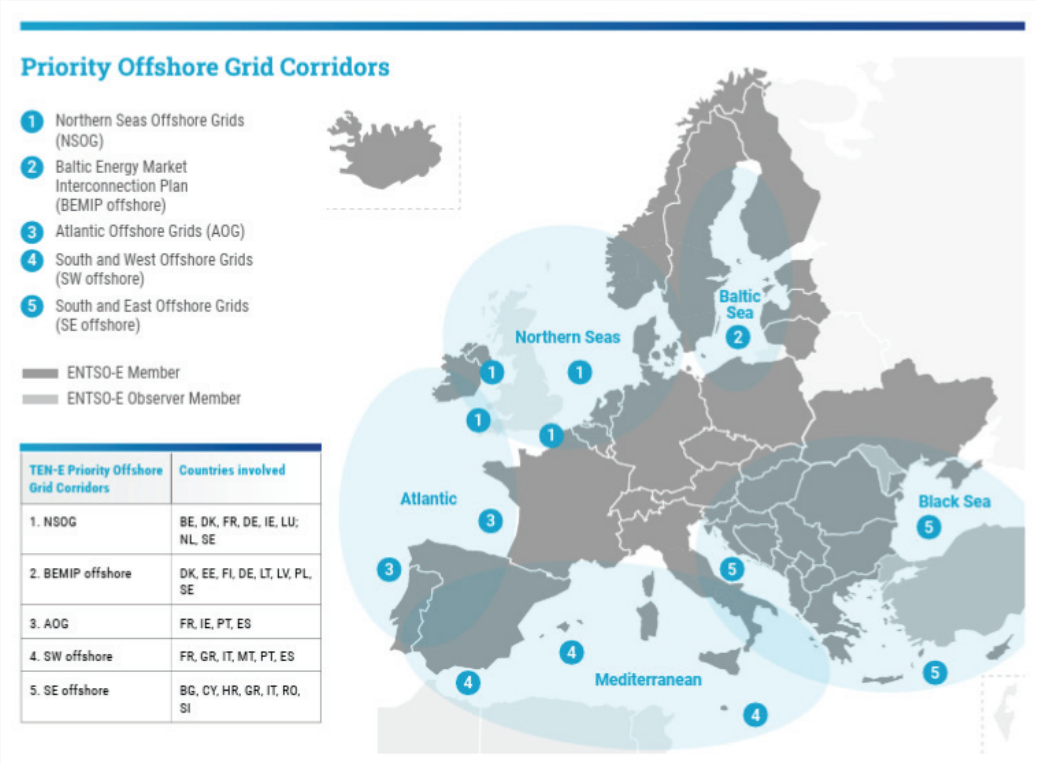
Setting the long-term development direction for offshore network infrastructure

ONDPs are essential to a larger strategy for the development of the power grid to ensure that offshore wind power generation in Europe continues to grow in line with long-term targets for 2030, 2040 and 2050. It will develop a step-by-step action plans for building an offshore network and promoting the sustainable expansion of the power grid They also include short-term (2030), mid-term (2040), and long-term (2050) goals. They also set directions for technological innovation and investment in R&D.

Supporting the transition of the European energy system

The ONDPs are key to Europe's strategy for building power grid infrastructure that supports its net-zero targets, by enabling offshore wind power to play a pivotal role in the transition to renewable energy. By building offshore power grid infrastructure, the EU hopes that ONDPs will contribute to efforts to power generated by offshore wind farms and replace fossil fuel-based power generation (See Figure 15).

Figure 15 TEN-E Priority Offshore Grid Corridors as described in Regulation (EU) 2022/869



TEN-E Priority Offshore Grid Corridors	Countries involved
1. NSOG	BE, DK, FR, DE, IE, LU; NL, SE
2. BEMIP offshore	DK, EE, FI, DE, LT, LV, PL, SE
3. AOG	FR, IE, PT, ES
4. SW offshore	FR, GR, IT, MT, PT, ES
5. SE offshore	BG, CY, HR, GR, IT, RO, SI

Note This is a map showing the TEN-E (Trans-European Networks for Energy) Priority Offshore Grid Corridors, as defined by the TEN-E Regulation (2022/869 EU). The European Union (EU) is establishing plans for the construction of important offshore power grids in each region to expand offshore wind power generation, and this map visually represents the main areas of these networks.

Source EENTSO-E (2024), p. 7.

C) ENTSO-E's transmission system map

Providing real-time data on the European power grid

The ENTSO-E data map offers real-time information on the status and connectivity of each EU country's transmission system operator (TSO). This enables intuitive monitoring of electricity flows across Europe, including cross-border imports and exports. In addition the map visually shows the location and operational status of renewable energy facilities, helping users understand how renewables are distributed and how power generation capacity is balanced across the continent.

Checking the status of offshore wind and onshore power grids

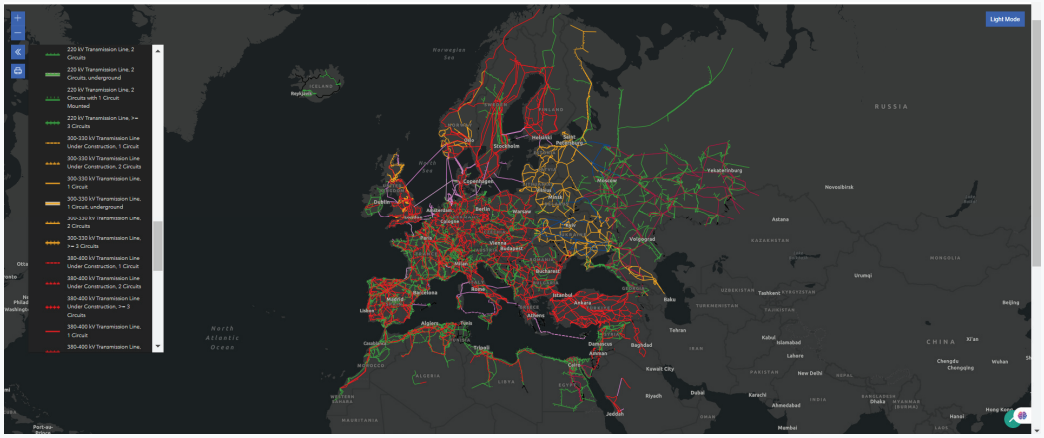
The ENTSO-E map allows users to easily identify how offshore wind farms are connected to onshore transmission networks across European countries. It provides insights into which regions are actively

expanding grid infrastructure to accommodating the growing supply of renewable energy. The map also includes information on HVDC (High Voltage Direct Current) projects and long-term expansion plans, showing the direction of future grid development.

Power flow analysis and forecasting

Through real-time data on electricity generation and consumption, the ENTSO-E data map enables detailed analysis of the supply and demand of energy each country. Users can assess how much electricity is being produced, where it is being consumed, and whether there is a balance or deficit. The map also provides information on cross-border electricity trading and interconnection capacities, which is essential for evaluating grid stability and forecasting future power flows (See Figure 16).

Figure 16 ENTSO-E's transmission system map



Note This map shows the transmission network run by ENTSO-E members.
Source ENTSO-E (2025), "ENTSO-E Transmission System Map", accessed on February 27, 2025.

3.1.4 Improving the efficiency of the implementation of environmental impact assessments (EIA)[13)]

(1) Principles and background

The EU is building an institutional foundation to streamline and coordinate environmental impact assessment (EIA) procedures to expand renewable energy and related infrastructure projects. The legal authority of the TEN-E Regulation (EU 2022/869), the Renewable Energy Directive (EU 2023/2413), RED, and the EIA/SEA Directive (2011/92/EU, 2001/42/EC) is what constitutes this foundation, and more streamlined EIAs are especially important for major renewable energy projects,

13) European Commission (2013; 2018).

which are often Projects of Common Interest (PCI) or Projects of Mutual Interest (PMI). The EU has set out a clear framework for energy and climate policy up to 2020 with its 2009 Climate and Energy Package, which emphasizes that optimization of network development should comply with EU environmental policy and legal requirements.

Streamlining in this case is defined as improving and better coordinating EIA procedures, with a view to reducing the administrative burden creating synergies, and speeding up the EIA process while at the same time ensuring a maximum level of environmental protection through comprehensive environmental assessments, in accordance with EU environmental goals. Hence, streamlining does not imply any weakening of environmental protection requirements under EU law. On the contrary, the recommendations set out in the guidance serve to improve the quality of the EIA process for energy infrastructure projects. From an energy policy perspective, it is important to put public interest first.

(2) Early plan establishment and evaluation roadmap development

In view of the complexity of EIAs and the application requirements of various environmental laws, especially for PCIs, planning at an early stage and preparing a roadmap for the assessment procedure are essential to streamlining efforts. This is not just a means of administrative streamlining, but a key strategy for complying with the licensing deadlines set by the TEN-E Regulation and at the same time ensuring environmental accountability.

Such planning should start as early as possible, at the project conceptualization stage (e.g., setting up connection points), and be formalized as an assessment roadmap that clearly presents the types of assessments to be carried out environmental requirements to be satisfied for each stage of the project. This roadmap should be led by the project promoter, but should be drawn up in close cooperation with coordinating authorities.

If staged assessment is required, the roadmap can be used to clarify which assessment elements should be addressed at which point, thereby increasing the complementarity between assessments and reducing the risk of missing or duplicating assessments. The roadmap should also include plans for other environmental legal requirements related to the project (e.g., species protection provisions in the habitat guidance).

Scoping plays a crucial role in the effective development of an evaluation roadmap. It serves to identify all potential environmental impacts of a project during the conceptual stage and to deepen understanding of these impacts as the project moves into more detailed phases, such as the pre-application process or the EIA and Appropriate Assessment (AA) stages. In addition to its role in impact identification, scoping provides several key benefits. It facilitates the early identification of

relevant legislation, assessment criteria, and regulatory requirements; helps to pinpoint potential impacts on Natura 2000 protected areas; and determines the appropriate methods for data collection, alternative routing, scope of analysis, and required level of detail. Moreover, scoping enables early recognition of the issues most important to stakeholders and the general public. Most importantly, by reaching an early agreement with the relevant authorities on the expected level of assessment, project promoters can proactively prepare for the systematic collection of environmental data. This, in turn, contributes to higher-quality assessments, reduced procedural timelines, and greater public acceptance.

In conclusion, early roadmap setting and scoping are the most fundamental and essential steps that reduce duplications and delay in EIA process and enable a strategic and integrated approach. As the TEN-E Regulation emphasizes, this is especially important for complex and sensitive PCIs, such as energy infrastructure projects (See Table 20).

Table 20 **Early planning and roadmapping: Examples from EU member states**

State	Actions/instruments
Germany	• The early scoping process for electricity grid planning (Bundesfachplanung – Federal specialist planning) and the following detailed scoping process for specific electricity grid projects with cross-regional or cross-border impacts are set out in the Grid Expansion Acceleration Act of 2011 known as the NABEG. • This law provides for 'application conferences' that have to take place after the initial application is submitted to the competent authority. • At the conference, which is open to the public, scoping of assessments required including SEA/EIA and siting alternatives are discussed. The authority determines the final scope for the final application and the level of detail of information to be included based on the input at the conference.
Hungary	• It is a common practice that before the initiation of a large authorization procedure, the investors, their experts and legal representatives meet together with the competent authority to discuss the further details of the given procedure, the necessary requirements, etc. • Additional meetings often take place throughout the procedure, and the various parties also keep in contact via email.

Source European Commission (2013), p. 16.

(3) Early integration and tiering of environmental impact assessment and environmental requirements

Strategically integrating environmental requirements as early as possible into project planning is essential to meet EIA, SEA, and AA requirements in energy infrastructure development. In particular, for projects of common interest (PCIs), early integration and inter-procedural coordination are very important in order to meet the licensing deadlines set by the TEN-E Regulation while fulfilling environmental responsibilities.

This integration should be systematized based on the principle of tiering between assessments, so that the results of assessments at the higher level of planning or policy are reflected in the lower level assessments. This allows individual assessments to work in a complementary manner without duplication and to increase the efficiency of assessments at the detailed project stage. In fact, the EU's SEA Directive (Article 4(3)) recommends avoiding duplicate assessments between plans and programs and provides the institutional basis for project-level EIA to be conducted based on the results of SEAs.

Integration of environmental requirements does not stop at the EIA itself. For example, species protection in accordance with the Habitats Directive, impact assessments of water systems in accordance with the Water Framework Directive (WFD), and consideration of aspects of climate change adaptation (e.g., flooding, forest fires, sea-level rise, etc.) should also be included in the assessment from the beginning of the project planning stage. This will ensure that the infrastructure has the resilience to respond to future environmental changes and prevent conflicts or delays at the permitting stage.

In addition, various factors such as the impact on Natura 2000 protected areas, baseline verification of water quality status, and whether the Industrial Emissions Directive (IED) applies should be integrally and timely reviewed within a single comprehensive assessment system, and this approach can be more effectively implemented through early collaboration with relevant experts, institutions, and stakeholders.

This integrated approach can be further strengthened by making SEA or AA mandatory from the planning stage for national energy plans (e.g., transmission network development plans), which provides a basis for strategically assessing energy sources' environmental suitability and locational feasibility. This effectively prevents a fait accompli of post-permit approval and ensures that the level of assessment is commensurate with the level of decision-making.

In conclusion, the early integration and hierarchical linkage of environmental assessment not only

streamline the assessment process, but also serve as a key policy tools that contribute to strategic spatial planning, the minimization of environmental risks, enhancing public acceptance, and ultimately achieving a sustainable energy transition. These principles should be established as a universal strategy applicable to all energy infrastructure developments, not just PCIs and other large-scale infrastructure projects (See Table 21).

Table 21 **National grid investment plan SEA in Portugal**

Actions/instruments

- Period and integration: NTG planning and SEA were conducted simultaneously for 11 months from 2007 to 2008.
- Objective: Compare strategic investment alternatives, derive optimal solution in terms of environment and development
- Core Consideration Factors (CDFs): Energy, biodiversity (wildlife), land use
- Analysis of strategic options: Initial four alternatives → Derive alternative S5, minimize damage to ecosystems and densely populated areas
- Effects: Reduced time, avoidance of redundant procedures, contribution to the preparation of future EIA guidelines

CFD	Criteria	S1	S2	S3	S4	S5
Energy	Effective transmission of energy including from the Special Production Regime (renewable sources)	++	+	+	-	++
	Energy efficiency (management and reduction of losses in the network)	+	-	-	+	+
Fauna	Crossing/fragmentation of protected areas	--	--	--	-	-
	Crossing of sensitive areas for fauna species	--	--	-	--	-
	Crossing of critical areas for bird species with unfavourable conservation status and higher risk of collision	--	--	-	-	-
	Proximity to shelter of bats of national importance	--	--	--	--	-
	Minimising cumulative impacts	-	-	+	+	+
Land use	Interference with sensitive areas (including landscape) or conditioned by natural and heritage protection status	--	--	-	-	-
	Interference with current and potential areas of strong human presence and infrastructure	--	--	--	-	+
	Opportunities for synergies between energy production needs, development in remote regions; improvement in efficiency of energy transmission and reductions in the overall need for transmission lines or corridors	+	+	-	-	++

Key: ++ very significant opportunity; + opportunity; 0 neutral; - risks; -- very significant risks

Source Partidario et al. (2010), as cited in European Commission (2013), p. 19.

(4) Adjusting licensing procedures and setting time limits

The TEN-E Regulation requires each member state to select one of three licensing schemes (integrated, coordinated, or cooperative) and introduce a "one-stop-shop" approach in order to further streamline and coordinate the licensing framework for (PCIs) serve as the basis for maximizing the streamlining effect of the EIA process.

EU Member States are required to designate a competent authority—or delegate the overall licensing process to another body—with the mandate to coordinate environmental impact assessments. This designated body may be granted several key powers, including the authority to require the integration or joint conduct of assessment procedures, to determine and coordinate the scope of the assessment (such as by incorporating findings from previous assessments), to organize joint consultations, and to set time limits for decisions made by each involved institution. In addition to procedural adjustments, the establishment of time limits is viewed as an effective tool for streamlining the licensing process. Time limits enhance legal certainty, accelerate decision-making, and help ensure that assessments are completed within the overall authorization timeframe established by the TEN-E Regulation. These limits may be applied universally or tailored to individual cases based on specific project characteristics. However, the integrity and quality of the assessment process must not be compromised, and the legal implications of missing deadlines, along with procedures for extending timeframes on justified grounds, must be clearly defined.

In particular, when scientific and field investigations are required (such as AA) according to the format guidelines, the time limit should be set flexibly according to the nature of the investigation and sufficient time should be guaranteed for collecting environmental information. For example, EU general practices and the recommendations of the Aarhus Convention set a minimum of 30 days and a maximum of 60 days for public hearings on EIA reports, with a one-month extension available upon request.

Finally, flexible time extension options should be allowed depending on the location, scale, complexity, and environmental impact of the project in question and these adjustments and time management should be considered holistically at the initial roadmap stage. This will ensure both consistency in the overall licensing process and effectiveness in environmental assessment.

(5) Data collection, sharing, and report quality control

Securing reliable data and ensuring the quality of assessment reports are key factors in the validity and speed of environmental impact assessment procedures for energy infrastructure projects, especially PCIs. Time-dependent data collection can cause delays in permitting, so the necessary data should be

identified early in the roadmap phase and collection begun.

Member states should provide project promoters access to national environmental data, which is particularly important in the context of AA for Natura 2000 sites. The Natura 2000 Viewer, regional management plans, and national biodiversity monitoring data are valuable sources of information.

Data should be systematically managed at the national or regional level, and information collected in EIAs should be stored in a public database. This reduces the time required to prepare assessments and enables tiered assessments. In particular, data sharing and the consistent use of research methodology among member states contribute to improving the efficiency of assessments in cross-border projects.

In addition, evaluating the actual environmental impact and the implementation of measures through an ex-post monitoring system would improve the predictive accuracy and reliability of the assessment of similar projects in the future. Monitoring should be operated integrally at the national or EU level, rather than at the project level, which would reduce redundant investigations and procedural delays.

Ensuring the quality of the final is also an important task. Project managers should prepare the environmental report themselves and use the technical capabilities of internal or external experts to prepare the report. The involvement of qualified external experts can improve the data's appropriateness, the impact analysis's validity, and the assessment's objectivity. This is especially important in AAs and similar assessments that require scientific evidence of ecological impact.

EU guidelines, technical toolkits, training and case sharing support these procedures, and ERDF, ESF and other EU funds can be used to strengthen the capacity of institutions and experts.

In conclusion, early data collection, systematic sharing, quality control of reports, and the establishment of an independent review system are the key foundations for reducing delays in the assessment process and increasing reliability and acceptability, which will greatly contribute to the development of sustainable energy infrastructure and the promotion of PCIs in the future.

(6) Cross-border cooperation

In the case of cross-border infrastructure projects and other types of PCI, cooperation and coordination between the relevant member states is an essential element. In particular, it is important to establish joint procedures at an early stage to coordinate the licensing schedule and the scope and level of detail of the information that project promoters must submit to relevant authorities.

Such coordination can be achieved through direct cooperation between the relevant authorities in the

member states or through a third-party arbitrator, and can be institutionalized in the form of bilateral or multilateral agreements or on an ad hoc basis for specific types of projects (e.g., energy infrastructure). Several member states already collaborate in this manner, in accordance with the Espoo Convention and the strategic environmental assessment Protocol (SEA Protocol), which the European Union has institutionalized.

In 2013, the European Union published additional guidance on the application of EIA procedures for large transboundary projects. This guidance provides specific methods for practical coordination and integration of assessments. The directive is designed to streamline the approval process and increase transparency for cross-border cooperation projects.

The TEN-E Regulation also provides institutional provisions for such cross-border cooperation, and by Articles 8 (3) and (5), collaboration between member states is mandatory for cross-border PCIs. In addition, if serious implementation issues arise during the project, the European Commission may designate a European Coordinator (Article 6) by agreement of the member states, and this Coordinator will provide practical support in various areas, including public hearings, licensing procedures, and inter-agency coordination. Such a Coordinator may also be designated by any member state of its own accord, thereby preventing potential problems in advance.

In conclusion, initial coordination, a common assessment framework, and a European-level coordination mechanism are key strategies for increasing the feasibility of project approval and implementation in cross-border energy infrastructure development. This is a governance approach that integrates not only administrative cooperation, but also environmental conservation, legal certainty, and public acceptance.

(7) Early and effective public participation

Public participation in environmental assessment procedures has become a key element of EU environmental law.

The environmental impact assessment (EIA) Guidelines, strategic environmental assessment (SEA) Guidelines, and the Aarhus Convention guarantee the public's right to access information, participation, and access to justice and are especially essential for the approval process of projects for the public interest (PCIs).

The TEN-E Regulation and related guidelines emphasize that public participation plans should be designed together in the roadmap stage of the environmental impact assessment process. In particular, it is recommended to identify not only environmental impacts but any other sensitive

factors that could impact public acceptance through early scoping in the early stages of project conceptualization. In this process, public scoping events can be an effective means of informing residents and gathering feedback.

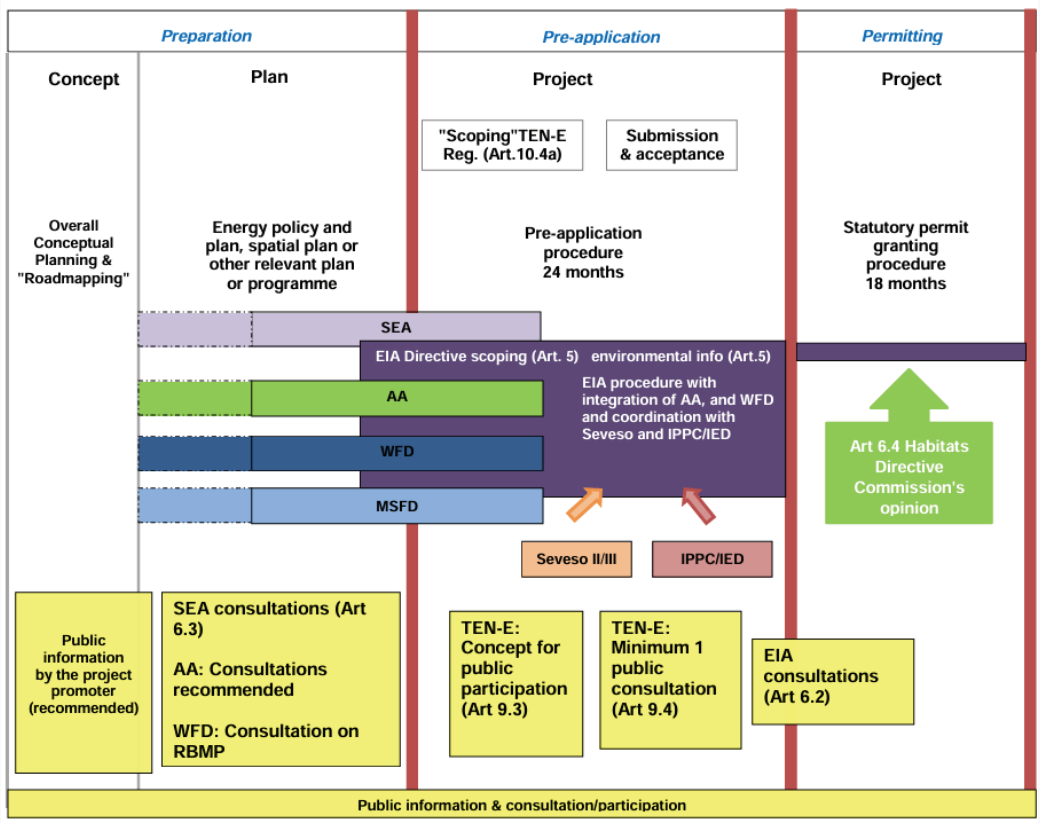
Such participation should go beyond a mere formal procedure and be implemented within a tiering system that is structured in stages according to a multi-layered assessment procedure, and should be reflected integrally throughout the environmental assessment. For example, although public hearings are not legally required for AAs, it is strongly recommended that stakeholders and local residents have the the opportunity to have their opinions heard (and listen to the opinions of others) on the potential impacts of development projects on Natura 2000 protected areas. In this case, it is desirable to conduct public hearings efficiently in a way that avoids parallel or redundant hearings.

In addition, provisions for public participation are required in River Basin Management Plans (RBMPs) prepared in accordance with the Water Framework Directive (WFD) or in the marine programs under the Marine Strategy Framework Directive (MSFD). For example, when the RBMP is revised, a six-month public hearing period is set, and any PCI that may adversely affect water bodies must be included in the plan. Public comments must be sought, and the project developers and related authorities must explain how the proposed project satisfies all legal requirements (e.g., WFD Article 4(7)).

Ease of access to information must also be guaranteed for effective participation. According to Article 9(7) of the TEN-E Regulation, the project promoter or the competent authority shall set up a website that provides relevant information and update it regularly, and in the case of transboundary projects, it is recommended to provide information in the official languages of the relevant countries.

In summary, early and systematic public engagement goes beyond environmental feasibility review, contributing to social acceptability of the project, policy transparency, and qualitatively improving the EIA process. Accordingly, public engagement should be integrated throughout the entire process, rather than made a mere formality, and this especially important in complex and influential projects, such as PCIs (See Figure 17).

Figure 17 Streamlining environmental assessments for energy PCIs: The overall procedure



Source European Commission (2013), p. 15.

(8) The Appropriate Assessment (AA) procedure for Natura 2000 protection

The EU Nature Conservation Act does not prohibit development within Natura 2000 protected areas in principle, but requires developers to conduct Appropriate Assessment (AA) in accordance with Article 6, Paragraph 3 of the Habitats Directive if a significant impact on the protected area is expected. An AA is essentially a process of scientifically reviewing the impact of development on the conservation goals of the area, and AAs are often applied to large-scale projects such as energy transmission infrastructure.

AAs differ from EIAs or SEAs in terms of purpose and force of law. While EIAs and SEAs are subject to interpretation, AAs must objectively and scientifically demonstrate that there will be no negative impact on the integrity of the protected area. If this high standard is not met, approvals may be withheld.

AAs must consider potential impacts on protected species and habitats, and in some cases are required even if projected impacts fall outside Natura 2000 zones. This includes cross-border impacts, which is also consistent with the Espoo Convention and the SEA Protocol.

Ultimately, AAs are essential to preserving the ecological value of protected areas and are a key means of balancing development and conservation through early diagnosis and scientific review.

The Appropriate Assessment (AA) procedure, as outlined in Article 6(3) of the Habitats Directive, is conducted in a series of stages, with progression to each subsequent stage determined by the results of the previous one. The process begins with Step 1: Screening, which evaluates whether a given plan or project is likely to impact a Natura 2000 site significantly. If such a likelihood exists, the procedure advances to Step 2: Appropriate Assessment, in which a detailed examination is carried out to assess potential impacts on the integrity and conservation objectives of the protected area. This stage also takes into account cumulative effects from other plans or projects. Following this, Step 3: Decision Making determines whether the project may proceed; if the assessment identifies negative impacts that cannot be mitigated, the competent authority must withhold approval. However, Article 6(4) allows for exceptions in exceptional cases—such as when overriding public interest is demonstrated—even if negative impacts are present. The AA procedure is grounded in the precautionary principle, and its core requirement is the demonstration, through objective and reliable data, that the proposed plan or project will not adversely affect the protected site.

3.1.5 Key legislation and interlinkages

(1) The role of each law and policy

Renewable Energy Directive (RED): This law serves to set EU targets for expanding offshore wind power generation. It gives countries the legal authority to increase the proportion of renewable energy and expand the construction of offshore wind power plants. However, in practice, power generation targets are difficult to meet, and it is necessary to build infrastructure to accomplish such goals.

Trans-European Energy Network (TEN-E): This law governs the construction of power grid infrastructure needed to achieve the offshore wind power generation targets set by RED. To reliably transmit the power generated by offshore wind farms to land, it is essential to connect the offshore and onshore power grids, and to this end, TEN-E supports cross-border power grid connection projects and the development of major transmission infrastructure.

Marine Spatial Planning Guidelines (MSP): These guidelines determine where offshore wind farms are allowed. MSP coordinates the spatial arrangement of offshore wind farms, power grids, shipping,

fisheries, and environmental protection zones in the marine space to designate appropriate areas for wind farms. It also performs orchestrates use of the marine space between offshore wind and other marine activities.

The Offshore Network Development Plan (ONDP): The ONDP specifies how developers are to design plans for transmitting power from offshore wind farms to the onshore power grid. It specifically targets offshore power grids and transmission infrastructure, and describes how plans for interconnecting power grids between countries and expanding transmission capacity should be drawn up to ensure the effective distribution of offshore wind power.

(2) Interlinkages among laws

When the Renewable Energy Directive (RED) sets targets for offshore wind power generation, the supporting infrastructure is developed through the Trans-European Networks for Energy (TEN-E). RED outlines specific goals for expanding offshore wind capacity across the EU by 2030 and 2050. However, these targets cannot be achieved without adequate infrastructure to transmit the generated electricity to shore and to connect power grids across national borders. TEN-E is therefore tasked with building the necessary transmission infrastructure and promoting cross-border grid interconnection. Complementing these efforts, the Action Plan for Grids encourages investment and supports the development of infrastructure for effective grid integration.

While RED drives offshore wind energy expansion, Maritime Spatial Planning (MSP) determines where offshore wind farms will actually be located. MSP provides a legal and spatial framework for siting power plants within marine areas, balancing various interests such as shipping, fishing, and environmental conservation to allocate optimal locations. Once the sites have been designated, the Offshore Network Development Plans (ONDP) are responsible for designing the offshore transmission network. ONDP identifies optimal routes for power cables, selects appropriate transmission technologies, and facilitates coordination among national grids to enable efficient cross-border electricity flows.

TEN-E, MSP, and ONDP work in tandem to effectively integrate offshore wind power into the wider energy system. TEN-E builds the core transmission infrastructure, particularly for projects that connect offshore wind farms with national and cross-border grids. MSP and ONDP, meanwhile, coordinate to ensure that this infrastructure is appropriately deployed within marine spaces, minimizing conflicts with other uses such as shipping lanes and fishing zones and providing a harmonized and efficient rollout of the offshore grid (See Table 22).

Table 22 **Key EU legislation and interlinkages**

Legislation	Purpose	Related policies	Interconnection
Renewable Energy Directive (RED)	Expansion of renewable energy and setting of mandatory targets	Fit for 55, REPowerEU, EU Green Deal	• Increase the production of offshore wind power → Expand the power grid (TEN-E required) • Determine the location of offshore wind power plants → Plan marine space (MSP required)
Electricity grid law (TEN-E regulations & EU Action Plan for Grids)	Building cross-border energy infrastructure and modernizing power grids	TEN-E, EU Action Plan for Grids, net-zero Industry Act	• Support for offshore wind power transmission → Essential for achieving renewable energy targets (RED) • Locating offshore transmission networks → Maritime Spatial Planning (MSP & ONDP required)
Maritime Spatial Planning Directive (MSP & ONDP)	Offshore Wind and Maritime Spatial Optimization	Maritime Spatial Planning Directive (MSP), ONDP, TEN-E	• Expansion of offshore wind power → Coordination with the Renewable Energy Directive (RED) • Establishment of an offshore transmission network → Coordination with the Electricity Network Law (TEN-E)

Source The authors.

Through the coordination of these measures, the EU can effectively expand offshore wind power generation and promote a sustainable energy transition. This suggests that a comprehensive policy approach that goes beyond simply setting individual targets or building infrastructure is needed, encompassing cooperation between countries, efficient use of maritime space, expansion of transmission infrastructure, and integration of renewable energy (See Note 1 and Note 2).

Note 1 **Examples of Offshore and Onshore Grid Consideration in Renewables Grid Initiative's activities**

Comprehensive Consideration of Offshore and Onshore Energy Systems
The Renewables Grid Initiative (RGI) is a unique collaboration of NGOs and transmission system operators (TSOs) from across Europe, working together as part of an energy transition "ecosystem of actors." Since 2009, RGI has promoted fair, transparent, and sustainable grid development to enable the growth of renewables and achieve full decarbonisation in line with the Paris Agreement. The Renewable Grid Initiative (RGI) considers both offshore and onshore energy systems in its research and policy activities. Rather than addressing them as separate elements, RGI emphasizes the importance of a well-coordinated approach to ensure that offshore renewable energy development is effectively connected to onshore grid infrastructure. RGI recognizes that offshore renewable energy, particularly offshore wind, requires a well-planned transmission network at both sea and land. RGI advocates for a balanced approach that integrates offshore energy planning, marine spatial considerations, and onshore grid reinforcement to support this. This helps to enhance grid connectivity, optimize resource utilization, and minimize potential environmental and social impacts.

Note 1 **(continued)**

Comprehensive Consideration of Offshore and Onshore Energy Systems

As part of its commitment to responsible energy development, RGI has published both the **European Grid Declaration**[14] and **the Marine Grid Declaration**[15]: The European Grid Declaration highlights the importance of onshore transmission infrastructure, ensuring that grid expansion supports the energy transition while considering environmental and social factors. The Marine Grid Declaration focuses on the sustainable development of offshore grid infrastructure, promoting environmental protection, cross-border and cross-sector collaborations, and efficient and effective offshore energy planning processes. Both declarations have been signed by RGI members and its extended network, committing to apply those principles in their operations, in line with each signatory's specific role in the energy transition. The Marine Grid Declaration led to the establishment of the **Offshore Coalition for Energy and Nature (OCEaN)**,[16] which brings together wind industry representatives, TSOs and NGOs from across all EU sea basins. OCEaN works to further define and operationalize the principles set out in the declaration by translating them into concrete actions, joint recommendations, and collaborative approaches to planning and deploying offshore energy and grid infrastructure. Through OCEaN, stakeholders co-develop solutions that balance the urgent need for offshore wind expansion with the protection and restoration of marine ecosystems, aiming for a truly sustainable energy transition at sea.

By incorporating perspectives from both offshore and onshore energy planning, RGI contributes to a more sustainable and efficient energy transition, ensuring that renewable energy deployment aligns with long-term grid infrastructure strategies.

Comparison of the European Grid Declaration (EGD) and the Marine Grid Declaration (MGD) in Renewables Grid Initiative

Category	European Grid Declaration (EGD)	Marine Grid Declaration (MGD)
Primary Objective	• Ensuring that electricity grid expansion aligns with climate goals while minimizing environmental impacts and improving public acceptance.	• Ensuring that offshore grid infrastructure is developed sustainably, integrating marine spatial planning, biodiversity protection, and climate objectives.
Environmental Protection	• Emphasizes nature conservation in grid development to minimize biodiversity impacts.	• Strong focus on marine biodiversity conservation, ensuring that offshore grid expansion does not harm marine ecosystems.
Spatial Planning	• Encourages strategic spatial planning at the European, national, and regional levels to optimize grid expansion.	• Calls for marine spatial planning (MSP) in line with the EU Marine Strategy Framework Directive and Maritime Spatial Planning Directive.
Public and Stakeholder Engagement	• Promotes public participation, transparency, and social acceptance to facilitate grid expansion projects.	• Advocates for inclusive decision-making involving marine stakeholders, coastal communities, and environmental organizations.

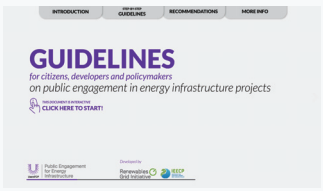
Source Written by the authors from the information on Renewables Grid Initiative, "Renewables Grid Initiative", accessed on March 22, 2025.

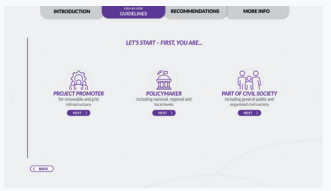
Note 2 Best Practice and Public Acceptance Consideration in Renewables Grid Initiative

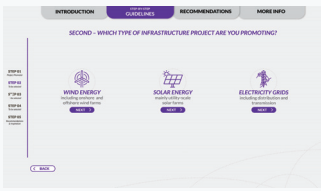
Renewables Grid Initiative also presented a declaration on transparency and public participation and sought to develop best practices to improve public acceptance. Through the **RGI Grid Award**,[17] successful cases of grid development that promote the integration of renewable energy are continuously being identified and divided into the following categories: technological innovation and system integration, communication & participation, and environmental protection. The **Engage4Energy**[18] project also created guidelines to promote public participation in the construction of renewable energy and grid infrastructure. These guidelines are based on four principles: early engagement, transparency, inclusiveness, and trust development, and they present three levels of meaningful engagement: information sharing, consultation, and empowerment.

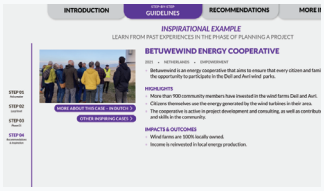
Good Practice of The Year 2024

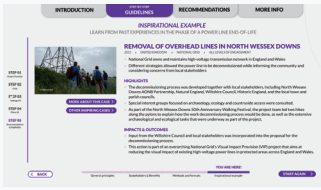
Guidelines for citizens, developers and policymakers on meaningful engagement in energy infrastructure projects











source Written by the authors from the information on Renewables Grid Initiative, "Renewables Grid Initiative", accessed on March 22, 2025.

14) Renewables Grid Initiative, "European Grid Declaration", accessed on March 22, 2025.
15) Renewables Grid Initiative, "Marine Grid Declaration", accessed on March 22, 2025.
16) Offshore Coalition for Energy and Nature, "About OCEaN", accessed on March 22, 2025.
17) Renewables Grid Initiative, "RGI Grid Awards", accessed on March 22, 2025.
18) Renewables Grid Initiative, "Public Engagement for Energy Infrastructure", accessed on March 22, 2025.

3.2 The United Kingdom (UK)

3.2.1 Renewable Energy Act and Offshore Wind Policy

(1) Climate Change Act

The United Kingdom was the first country in the world to enact climate change legislation, when in 2008 Parliament passed the Climate Change Act, which laid the legal foundation for decarbonization policy by legally specifying greenhouse gas reduction targets. Since then, the country has pledged to reach net-zero carbon emissions by 2050 (following a revision in 2019), and has established itself as one of the most active promoters of decarbonization in Europe.

Central to the Act is expanding offshore wind power and clean energy, with offshore wind identified as a primary energy source for meeting the UK's carbon neutrality goals. As a result, investment in this sector continues to grow steadily. The Act also includes provisions for strengthening compliance with the carbon budget, requiring governments and businesses to meet phased carbon reduction targets. Regulatory measures and policy incentives have been implemented to support this. Furthermore, the UK is leveraging the Climate Change Act to enhance its international leadership in climate action, positioning itself as a key player in Europe and beyond while actively promoting the clean energy sector through global cooperation and partnerships.

(2) Energy White Paper 2020: Powering Our net-zero Future

In 2020 the UK published a white paper on energy (Powering Our net-zero Future). This paper focuses on:

- Promoting the growth of the offshore wind power market: The government aims to become the world's largest offshore wind power producer by increasing investment in government-led offshore wind power generation.
- Reorganizing the power grid and expanding transmission infrastructure: The government will expand the offshore wind power grid in line with its carbon neutrality goals and strengthen its network integration policy to build a stable transmission infrastructure.
- Development of the offshore wind power industry linked to hydrogen: The company is expanding the production of green hydrogen using the power generated by offshore wind power and promoting new projects to revitalize the hydrogen economy.

(3) Clean Power 2030 Action Plan

The Clean Power 2030 Action Plan, released in December 2024, outlines the UK's strategic roadmap for transforming its power grid into a net-zero power system by 2030. The plan sets out a range of measures focused on expanding renewable energy sources, including offshore wind, solar, hydrogen, and nuclear power, to achieve this goal. A central pillar of the plan is strengthening renewable energy policies with a focus on offshore wind, aiming to decarbonize the power grid by significantly increasing offshore wind capacity. The plan also calls for reorganizing the power grid and enhanced European power interconnection, with continued promotion of the Offshore Transmission Network Review (OTNR) to improve the efficiency of connections between offshore wind farms and the onshore grid. Additionally, the Action Plan supports the expansion of the clean energy industry, including scaling up green hydrogen production powered by offshore wind, advancing nuclear energy, and introducing carbon capture and storage (CCS) technologies to reduce emissions further and support the transition to a clean energy system.

3.2.2 Power grid reinforcement and spatial planning policies

(1) Offshore Transmission Network Review (OTNR)[19)]

A) Overview

The Offshore Transmission Network Review (OTNR) is a strategic review platform used by the UK government to optimize the connection of offshore wind farms to the electricity grid. The plan was developed in collaboration with National Grid ESO (the UK's electricity grid operator), the Crown Estate, and Ofgem (the energy regulator) and includes a strategy for the expansion and optimization of the grid to meet the UK's offshore wind power targets by 2030.

Through OTNR, the government evaluates the current status of existing offshore wind farms and transmission networks and suggests future directions for transmission network expansion to help offshore wind power connect more efficiently to the onshore power grid. The aim is to increase the utilization of offshore wind resources in the UK and strengthen the stability of the national power grid.

B) Main role

Analysis of the current status of offshore wind farms in the UK

OTNR provides a systematic overview of the locations and power generation capacities of existing and planned offshore wind power projects in the UK. Major offshore wind power projects are being

19) UK Government, "Offshore Transmission Network Review (OTNR)", accessed on February 27, 2025.

undertaken by large operators such as Seagreen Wind Energy and Moray Offshore, and by analyzing the scale and characteristics of each power plant, OTNR is laying the foundation for the construction of an efficient transmission network.

Connection and expansion plans for offshore wind farms

The Offshore Transmission Network Review (OTNR) is a key initiative focused on optimizing how offshore wind farms are connected to the onshore power grid to support the expansion of transmission infrastructure through 2030. By examining current connection methods and future needs, OTNR aims to develop a comprehensive plan for an efficient and integrated offshore transmission network. Central to this effort is the analysis of connection methods, which includes strengthening links between new offshore wind projects and the existing grid infrastructure. The review also involves the development of a detailed grid expansion schedule, outlining how transmission capacity will be scaled up to meet growing demand by 2030. In addition, OTNR emphasizes the application of advanced technologies to minimize power losses and enhance transmission efficiency, ensuring that the offshore grid operates at optimal performance as part of the UK's broader clean energy transition.

Technology innovation and pilot projects.

Through the OTNR, the UK government is actively promoting innovation and research to advance offshore wind technology, focusing on next-generation solutions such as floating wind power. As part of this effort, the UK is supporting pilot projects to explore the commercial viability of floating offshore wind, including notable initiatives like Hywind and Kincardine. These projects serve as testbeds for assessing floating wind technology's scalability and economic feasibility in real-world conditions. In parallel, the UK is (through OTNR) investing in research on high- voltage direct current (HVDC) technology, which plays a critical role in efficiently integrating offshore wind farms into the broader transmission network. To further accelerate progress, the government provides regulatory support and financial incentives, creating a favorable environment for developing and deploying cutting-edge offshore wind technologies.

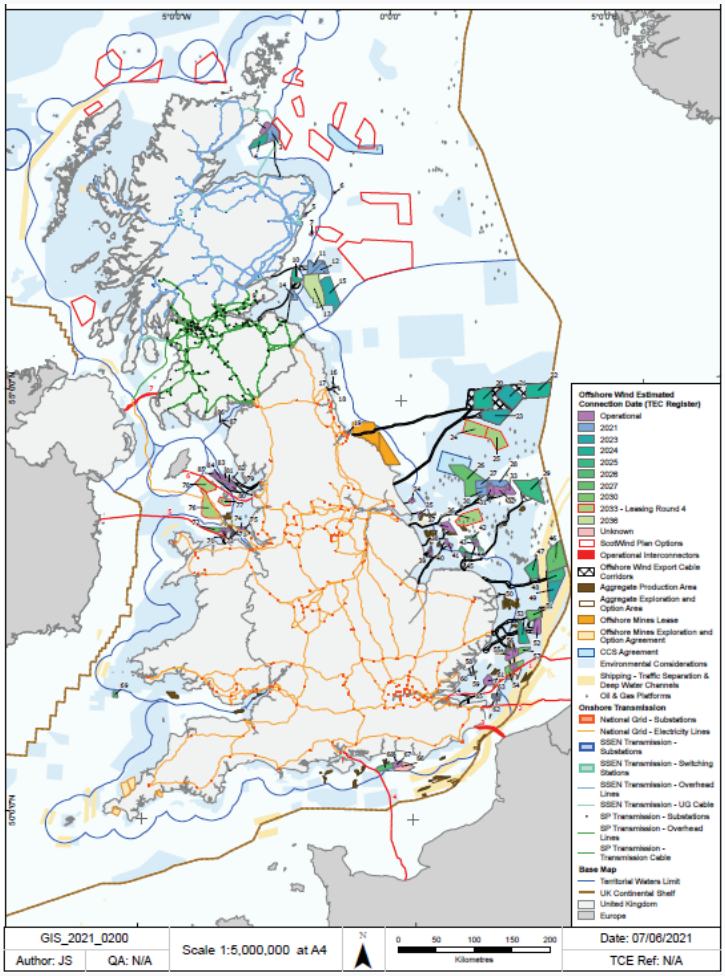
C) OTNR Generation Map

The OTNR Generation Map is a visual representation of the status of offshore wind farms and their connection to the transmission grid in the UK. This map highlights the importance of investing in and expanding the power grid infrastructure and helps to intuitively understand the strategy for building an offshore wind power grid by 2030. The OTNR Generation Map is an essential tool for understanding the overall progress of offshore wind power generation and transmission grid construction in the UK

and visually analyzing key strategies for optimizing and efficiently operating the power grid.

It provides detailed information on the locations of offshore wind farms, categorizing them by their expected year of completion to give a clear picture of the sector's timeline and growth. The map also highlights the main routes of the offshore transmission network and outlines future grid expansion plans, supporting the efficient integration of offshore wind into the national grid. Additionally, it presents the UK's offshore wind generation targets alongside the infrastructure strategies planned through 2030, offering a coordinated view of how generation capacity and transmission development will progress in tandem (See Figure 18).

Figure 18 **The OTNR Generation Map**



Notes Orange indicates the existing power grid, while black and red represent newly planned undersea infrastructure.

Source The Crown Estate (2021), p. 1.

(2) Holistic Network Design (HND)[20)]

A) Overview

Holistic Network Design (HND) is a plan to comprehensively design the UK's offshore and onshore transmission infrastructure to help achieve national wind power generation targets by 2030, and to present a plan for building out the network. The lead on this project is Ofgem, the UK's gas and electricity market regulator. It has issued a number of minded-to decisions as part of the larger OTNR Pathway to 2030 project.

While through the OTNR, the UK government performs a macro-level review of the entire offshore transmission grid, it is through the HND plan that the government is to propose how to achieve 50 GW in offshore wind power generation by 2030. A major goal of HND is to optimize the design of offshore wind farm transmission networks to maximize cost-effectiveness and technical feasibility and minimize environmental and social impacts in the process of transmitting power from offshore wind farms to the onshore power grid.

B) Key objectives of HND

Maximizing cost efficiency

HND aims to provide consumers with the maximum economic value. To this end, it uses economic assessment tools to prepare a transmission network design with the most efficient cost structure and presents a plan to maximize cost savings.

Ensuring feasibility and operational stability

To help the UK achieve its offshore wind power generation targets by 2030, HND proposes using a framework that comprehensively considers offshore transmission networks' feasibility and operational safety. This includes analyzing potential risks in advance and minimizing technical obstacles to ensure the power grid operates smoothly.

Minimizing environmental impact

The UK government ensures that HND considers environmental protection a top priority, and it is designed to ensure that offshore transmission networks have a minimal impact on marine and terrestrial ecosystems. It establishes cable routes and infrastructure deployment strategies considering environmental protection zones and ecologically sensitive areas and conducts ongoing environmental assessments to investigate any negative impacts on marine ecosystems thoroughly.

20) National Grid ESO (2022).

Harmony with the local community

The HDN approach also aims to address community concerns that may arise from the expansion of the transmission network and build close partnerships with local residents. To this end, the HND encourages developers to communicate with local residents and coordinate with local communities to maximize the positive effects and minimize the negative effects of major transmission infrastructure projects on local economies.

C) The HND approach

Central Design Group (CDG)

HND plans are devised in collaboration between Electricity System Operators (ESOs) and the Central Design Group (CDG). The CDG is composed of Transmission Owners (TOs) and other key stakeholders and its role is to derive the optimal network design plan by considering technical and economic aspects.

The Building Blocks approach

The HND approach is a six-stage method. These stages are called Building Blocks, and are as follows:

- Stakeholder engagement – Key energy companies and government agencies are involved to reflect their opinions
- Initial strategy assessment – Review the basic design direction and feasibility
- Economic assessment – Analyze cost-effectiveness to derive the optimal design
- Final strategy assessment – Evaluate technical and operational feasibility
- Network Options Assessment (NOA) update – Update the assessment in consideration of the connectivity with the existing transmission network
- Final HND construction – Confirm the implementation strategy based on the final design plan

BRAG assessment system application

The HND analyzes the feasibility of the project by applying the BRAG (Black, Red, Amber, Green) system to assess environmental and community constraints. BRAG is assigned and evaluated based on the constraints and risk level of the cable route or infrastructure site selection. BRAG evaluation plays an important role in identifying feasible cable routes from the electrical to the interface point, providing an initial assessment of environmental and community impacts, and supporting decision-making for sustainable network design (See Figure 19 and Figure 20). The BRAG rubric is as follows:

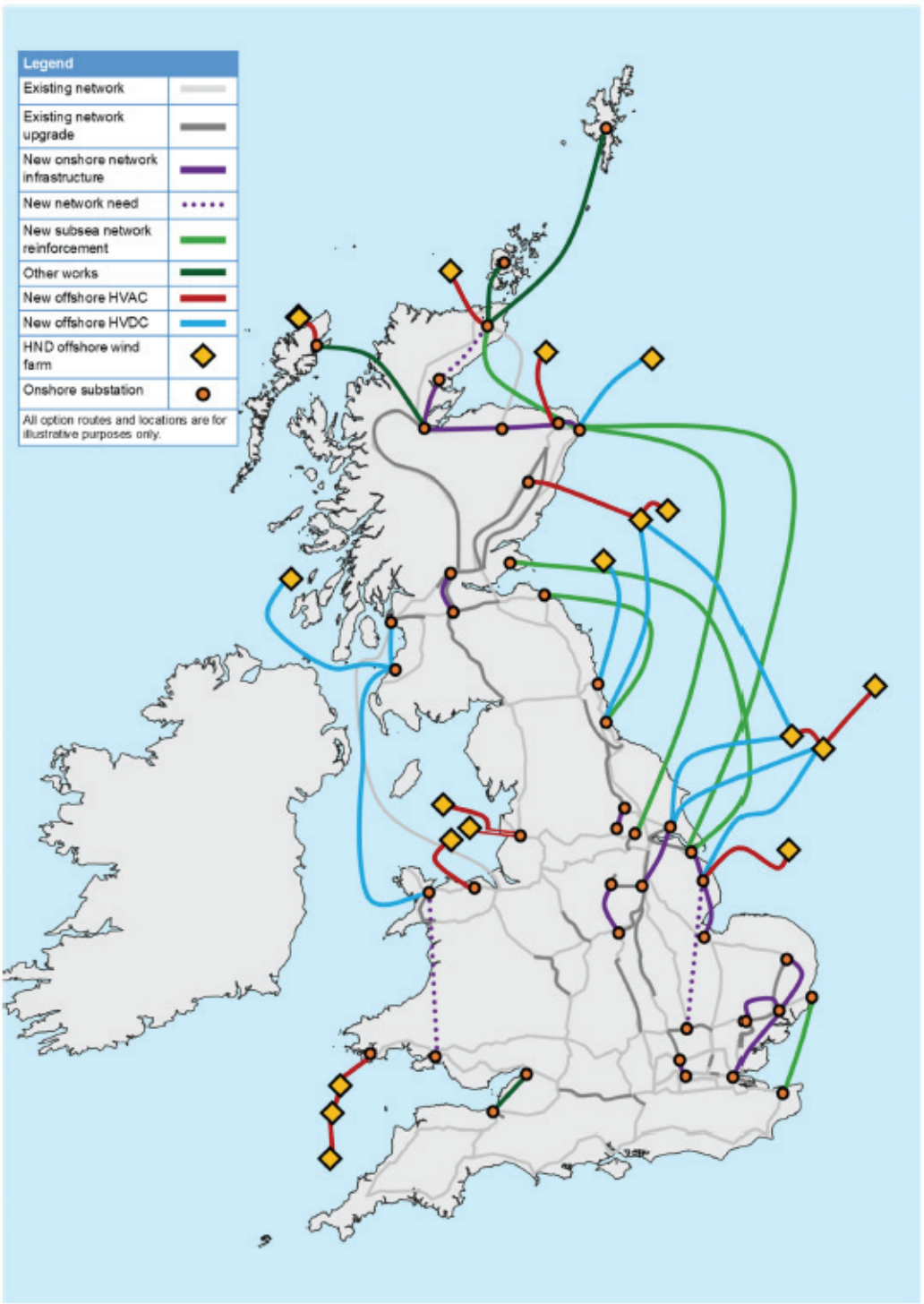
- Black (impossible): When environmental and technical factors are so severe that implementation is impossible.
- Red (high risk): When there is a high probability of causing environmental and social impacts.
- Amber (medium risk): When there is a possibility of some impact, but it can be adjusted.
- Green (low risk): When the impact on the environment and society can be minimized.

Figure 19 **Environmental and community appraisal data and rankings (partial)**

Theme	Data displaying	Offshore cables	Offshore platforms	Landfall	Onshore cables	Onshore stations
Offshore Infrastructure	Offshore Telecom Cables	A	A	A	N/A	N/A
	Offshore Power Cables	A	A	A	N/A	N/A
	Offshore Pipelines	A	A	A	N/A	N/A
	UK Oil and Gas Wells & Diffusers	R	R	N/A	N/A	N/A
	UK Offshore Oil and Gas Installations	R	R	R	N/A	N/A
	UK Offshore Carbon Capture and Storage Site Agreements	A	A	N/A	N/A	N/A
	UK Offshore Meteorological and Oceanographic Equipment Agreements	A	A	N/A	N/A	N/A
Other planned infrastructure (e.g. coastal development near potential landfall areas)	-	A	A	A	A	A
Traffic separation zone	Traffic Separation Zones	A	B	N/A	N/A	N/A
Shipping lanes	Shipping lanes	A	B	A	N/A	N/A
AIS Vessel Density Grid	UK AIS Vessel Density grid - High density shipping areas	A	A	A	N/A	N/A
Designated anchorage areas	Designated anchorage areas	R	R	R	N/A	N/A
Bathing waters	Bathing Water	G	R	G	N/A	N/A
Shellfish waters	Shellfish Waters	G	A	G	N/A	N/A
Fishing activity	UK Fishing Activity - Areas of high intensity fishing effort	G	G	G	N/A	N/A
Marine Fish Farms	UK Marine Finfish	A	R	A	N/A	N/A

Source National Grid ESO (2022), p. 149.

Figure 20 Major onshore and offshore recommendations through HND



Notes This map combines the existing and recommended transmission as part of the HND. It highlights the major land-based transmission system upgrades and the recommended sea design.

Source National Grid ESO (2022), p. 32.

3.2.3 Environmental Impact Assessment (EIA) and licensing procedures

The UK is actively promoting streamlining the environmental impact assessment (EIA) process to facilitate the development of more large-scale low-carbon infrastructure projects, including renewable energy, power grids, and offshore wind power. This is part of a multi-layered policy and legislative improvement introduced to facilitate infrastructure supply to achieve the UK's 2050 carbon targets.

The UK is seeking to substantially streamline the EIA process through early stage planning coordination, data-driven site selection, integrated permitting, timed screening, and use of digital information-sharing platforms, while respecting existing environmental protection legislation.

This structure is considered an important example of balancing environmental performance and procedural expediency in complex large-scale infrastructure projects such as offshore wind, power grid expansion, and hydrogen and storage infrastructure.

(1) Development Consent Order (DCO) system

The Development Consent Order (DCO) system was introduced under the Planning Act 2008 and allows large-scale renewable energy and electricity grid projects that fall under Nationally Significant Infrastructure Projects (NSIPs) to be approved through a single, integrated process.

In this procedure, a central agency called the Planning Inspectorate (PI) organizes and handles the EIA, public consultation, technical review, and approval recommendation processes instead of local governments.

EIAs are mandatory elements of the DCO procedure, and developers submit an EIA Scoping Report at the initial stage and conduct an assessment within the specified period within the scope.

(2) Strategic spatial planning and identification of suitable locations

In particular, projects related to power grids and offshore wind power are strategically selected in advance in connection with the FES (ETYS, etc.) of the National Grid ESO (power grid operator).

This is to encourage developers and authorities to avoid environmentally sensitive areas (e.g., protected species habitats, national parks, etc.) in advance and reduce the possibility of conflicts during the EIA stage.

(3) Establishment of the Offshore Wind Environmental Evidence Register (OWEER)

To reduce the cost and time of - of which several are typically performed over the course of an offshore wind power project - the government has established a data-sharing platform called the Offshore Wind Environmental Evidence Register (OWEER).

This database is designed to help developers and project proponents to shorten the scope and duration of individual projects by eliminating redundancies and encourage the use of data collected from previous surveys.

(4) Integration with Marine Spatial Planning (MSP)

Proposed locations for offshore wind projects are reviewed in advance for compliance with the existing marine spatial plan (MSP) promulgated by the UK's Marine Management Organization (MMO).

As part of this process, strategic environmental assessments (SEAs) are conducted in advance, narrowing the scope of EIAs to the individual project level and increasing overall efficiency.

(5) Environmental regulation reform and Environmental Outcome Report (EOR)

The Levelling Up and Regeneration Act, which was announced in 2023, will combine EIAs and SEAs into an integrated report, the Environmental Outcome Report (EOR).

The goal is to enable decisions based on outcome-oriented environmental protection performance rather than preliminary assessments, and to reduce procedural complexity while maintaining substantial environmental protection effects.

(6) Discussion on acceleration zones

To expedite the development of offshore wind and grid-connected facilities, discussions are underway to designate areas that have already been subject to SEAs and other sensitivity assessments as "priority development areas."

Projects within these areas may be subject to streamlined EIA or rapid assessment procedures.

3.2.4 Key legislation and interlinkages

(1) The role of each law and policy

Climate Change Act (2008): The UK was the first country in the world to legally specify a goal of net-zero carbon emissions by 2050. The Climate Change Act of 2008 sets national carbon reduction targets and provides policy directions for their implementation. The ultimate goal is to reduce greenhouse gas emissions by 100%, and to achieve this, it is essential to expand renewable energy sources such as offshore wind power.

The Electricity Network Directive (TEN-E Regulation & EU Action Plan for Grids): The TEN-E Regulation and the EU Action Plan for Grids are the legal and policy frameworks the UK uses for accelerating the energy transition with a focus on renewable energy. The bill aims to secure 50 GW of offshore wind power, expand the power grid, and revitalize the hydrogen economy by 2030, and in particular emphasizes the need for marine spatial planning (MSP) and expansion of the power grid (OTNR, HND) to expand offshore wind power.

Clean Power 2030 Action Plan (2024): This policy aims to convert more than 95% of the UK's electricity supply to clean energy by 2030, and includes plans to expand offshore wind power capacity to 43-50 GW.

Offshore Transmission Network Review (OTNR): The OTNR is a policy tool used to optimize the integration of the power grids between offshore wind farms. Its purpose is to gradually shift from connecting each individual offshore wind farm to the grid separately to connecting them to a shared submarine transmission network. This will enable the optimization of the power grid between offshore wind farms in connection with the 2030 Clean Power Plan and will also facilitate the connection to transnational, cross-border multi-purpose interconnectors (MPIs).

Holistic Network Design (HND): HND is a comprehensive plan for designing transmission networks that optimizes and connects offshore wind farms with the onshore power grid and lays out best practices for building new power grids. Together with the OTNR, it is crafted to optimize the offshore wind power grid.

Marine Spatial Planning (MSP): MSP is a policy instrument for offshore wind farms in a way that minimizes their environmental impact. MSP plays a key role in organically coordinating the construction of offshore wind farms and the construction of power grids.

(2) Interlinkages among laws

The various laws and policies introduced to achieve the UK's net-zero target are closely linked and are being coordinated to enable the expansion of offshore wind power generation and the construction of power grid infrastructure. Each law and policy play a specific role in setting carbon reduction targets, expanding offshore wind power generation, constructing and optimizing power grid infrastructure, and promoting a long-term energy transition.

The Climate Change Act (2008)[21], which obligates the UK government to pursue carbon neutrality, stipulates a need for offshore wind power generation, and the 2030 Clean Power Action Plan (2024)[22] sets quantitative targets for wind power (43-50GW). In addition, the Energy White Paper (2020)[23] provides detailed implementation strategies to achieve these targets and lays out a key policy framework for the UK's clean energy transition.

Effective Spatial Planning (MSP) is essential for the expansion of offshore wind power plants. After determining the optimal location for offshore wind power plants through MSP, the Offshore Transmission Network Review (OTNR) and Holistic Network Design (HND) policy tools support the construction of offshore and onshore power grids. In other words, these laws work together to ensure that power grid is developed in a way that guarantees offshore wind farms are efficiently located and that their impact on the environment is minimized.

The UK's offshore wind and power grid construction policies are closely related to the EU's power grid regulations and support policies. The TEN-E Regulation emphasizes the construction of power grid infrastructure to expand offshore wind power, and the EU Action Plan for Grids is being promoted in a direction that calls for the expansion of transmission infrastructure and the activation of the hydrogen economy. In other words, the UK is developing a plan to optimize its power grid while considering energy cooperation with the EU and strengthening its connections to Europe via submarine power grids (Multi-Purpose Interconnectors: MPI) (See Table 23).

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21) UK Government, "Climate Change Act 2008", accessed on February 27, 2025.
22) UK Government (2024), Clean Power 2030: Action plan – A new era of clean electricity.
23) UK Government (2020), Energy white paper: Powering our net zero future (CP 337).

Table 23 **Key UK legislation and interlinkages**

Legislation/ Policy	Purpose	Related policies	Interconnection
Climate Change Act (2008)	Legislation of net-zero Targets	2030 Clean Power Implementation Plan, Energy White Paper (2020)	• Expansion of offshore wind power generation is necessary to achieve the carbon neutrality goal → Linkage with offshore wind power generation (Energy White Paper, 2030 Action Plan) • Need to build a power grid to expand renewable energy (OTNR, HND)
Electricity Network Act (TEN-E & EU Action Plan for Grids)	Energy transition centered on renewable energy, Expand the power grid	2030 Clean Power Implementation Plan, HND, OTNR	• Goal for offshore wind expansion (50GW) → Marine Spatial Planning (MSP) required • Expansion of the power grid (OTNR, HND) required
Clean Power 2030 Action Plan (2024)	Clean energy power grid construction	Energy White Paper, HND, OTNR	• Expansion of offshore wind power to 50GW → Need for Marine Spatial Planning (MSP) • Need for Offshore Transmission Network Review (OTNR)
Offshore Transmission Network Review (OTNR)	Optimization of power grid integration between offshore wind farms	HND, Offshore Wind Power Policy	• Optimizing the offshore wind farm power grid → Connecting with the 2030 Clean Power Implementation Plan • Connecting with the Multinational Submarine Power Grid (MPI)
Holistic Network Design (HND)	Optimizing the power grid and connecting offshore wind farms	OTNR, Energy White Paper	• OTNR-linked offshore wind power transmission network optimization • Linked to the offshore wind power expansion policy (2030 Action Plan)
Marine Spatial Planning (MSP)	Designating offshore wind farm sites and minimizing environmental impact	The Crown Estate, OTNR	• In connection with the expansion of offshore wind power (2030 Action Plan, Energy White Paper) • After the offshore wind farm site is confirmed, the power grid must be built (OTNR, HND)

Source The authors.

3.3 Germany

3.3.1 Renewable Energy Act (Erneuerbare-Energien-Gesetz: EEG)[24)]

(1) Overview

Germany's Renewable Energy Act (EEG, Erneuerbare-Energien-Gesetz) is a key piece of legislation for expanding renewable energy and achieving carbon neutrality and an important legal framework that supports Germany's energy transition strategy. The main goal of the law is to respond to climate change by increasing consumption of electricity generated by renewable sources, and includes various support and regulatory measures to promote renewable energy generation such as solar, wind, and biogas. The German government hopes that 80% of all electricity used in the country will be produced by renewable sources by 2030, and to achieve carbon neutrality in the electricity sector by 2050 through the EEG.

(2) Key points

Expanding renewable energy

The EEG aims to promote the decarbonization of the energy system by gradually increasing the share of renewable energy in Germany. By 2030. The German government wants to see 80% of electricity demand supplied by renewable sources, and to see this come to pass has pledged to intensively promote solar, wind, biogas, and other forms of renewable energy. The ultimate goal is to achieve carbon neutrality in the German electricity sector by 2050, completely eliminating dependence on fossil fuels. To this end, the EEG has been continuously revised and developed in a way that expands renewable energy generation and increases the competitiveness of renewable energy in the electricity market.

Support for renewable energy production

The EEG operates a support system through a feed-in tariff (FiT) and a bidding system to encourage renewable energy production. Small-scale renewable energy producers are guaranteed a fixed feed-in tariff (FiT) for a specific period, allowing them to continue generating electricity while maintaining economic stability. The EEG also features a support system to ensure the financial viability of large-scale renewable energy power plants, including offshore wind, onshore wind, and solar power.

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24) German Federal Ministry of Justice and Consumer Protection (2023).

Grid integration

The law also stipulates technical requirements and procedures to ensure that renewable energy can be stably integrated into the existing power grid. Germany is promoting the establishment of a system that efficiently connects large-scale offshore and onshore wind farms to the power grid, and is taking measures to clarify the obligation of power grid operators to integrate renewable energy so that the transmission and distribution networks can be seamlessly connected to renewable energy generation. As the share of renewable energy generation increases, it is essential to expand investment in transmission and distribution networks, introduce smart grids, and build energy storage systems.

Cost distribution

The EEG stipulates that electricity consumers and power grid operators should share the costs associated with the expansion of renewable energy. Electricity consumers bear a particular portion of the costs of supporting renewable energy through EEG surcharges (EEG-Umlage), and a system is in place to subsidize these surcharges for large firms and primary industries to ensure that the energy transition does not significantly impact German industrial competitiveness. The power grid operator bears the cost of building infrastructure for renewable energy generation, ensuring continuous transmission and distribution network expansion.

Introduction of a bidding system and market competition

The EEG has introduced a bidding system to increase the efficiency of the renewable energy market and is promoting the expansion of renewable energy through competition. Large-scale solar and wind power generation projects select operators through an auction system, and the operators offering the lowest power purchase price are selected first. This system is expected to lower the unit price of renewable energy generation and enhance market competitiveness. This bidding system plays an important role in maximizing the efficiency of renewable energy production while ensuring long-term power supply stability.

(3) Linking the Renewable Energy Act (EEG) with other laws

Germany's Renewable Energy Act (EEG) is a key piece of legislation that provides the legal foundation for expanding renewable energy, establishing a system encompassing technical standards, market mechanisms, grid connection, and subsidy systems. This law is particularly notable for the way that it links the Renewable Energy Enforcement Ordinance (EEV), the Accelerated Expansion of the Power Grid Act (NABEG), and the Offshore Wind Energy Act (WindSeeG). Each of these laws complements the implementation of the EEG and contributes to the practical expansion of renewable energy and

power grid integration.

First, regarding the relationship between EEG and EEV, the EEV enhances the enforcement power of EEG by specifying technical standards and operational requirements. For example, the technical standards for renewable energy facilities (Section 3), the subsidy system based on bidding (Section 22), the annual adjustment of the bidding price for photovoltaic facilities (Section 37b), and the obligation of power grid operators to prioritize the transmission of renewable energy (Section 11) are all carried out in accordance with EEV standards. In addition, the requirements for the certification and subsidy payment of renewable energy (§21, §79a), the obligation to submit data (§70), and the EEG financing adjustment method (§91) are also specified in detail through the EEV.

Next, linkages NABEG constitute the basis for efficiently transmitting and integrating electricity produced by renewable sources into the national power grid. The NABEG aims to rapidly expand and optimize the electricity grid, by rapidly incorporating renewable sources into the national grid, facilitate the performance economic and technical feasibility studies (§8), mandating cooperation with transmission grid operators (§11), and establishing subsidies and a bidding system for grid investments (§21, §22). This shows that the expansion of renewable energy in the EEG is linked to the systematic expansion of the transmission infrastructure, and goes well beyond the simple distribution of equipment.

Finally, WindSeeG is a special law that supplements EEG provisions for the offshore wind sector and governs the development and transmission of offshore wind farms in the North and Baltic Seas. WindSeeG regulates the capacity setting of offshore wind power (§4), its connection to EU energy targets (§5), technical requirements such as night lighting (§9), and installation permits and transmission line construction on public lands (§11a). It ALSO includes provisions on the integration of the electricity grid (§11b), the grid code (§12), the application of EEG subsidies for offshore wind power (§21), the competitive bidding system (§22, §32), the exemption from subsidies in the event of a decline in market prices (§51), the granting of legal protection and the authorization to use (§83a, §84), and the federal government's periodic evaluation and reporting system (§99) (See Table 24, Table 25, and Table 26).

Table 24 **Provisions related to the EEV**

EEV-related content in EEG
Purpose and definition of the law
• **§ 1(3) Purpose of the law:** The expansion of renewable energy sources must be carried out with consideration of environmental sustainability, cost-effectiveness, and grid compatibility.
• **§ 3(1) Definition:** "Installation" means any facility that generates electricity from renewable energy or certain fuels (e.g. biogas), which is used to set technical standards in the EEV.
Expansion and market mechanisms
• **§ 4 Path for expansion:** The goal of expanding renewable energy is set by the technical guidelines, which are specified by the EEV.
• **§ 22 Competitive calculation of market subsidies:** The recipients and the amount of market subsidies are determined through a public bidding process, and they are intended for renewable energy power plants such as wind, solar, and biomass
• **§ 37b Maximum bid for solar installations:** The bid price for solar installations is reduced annually by the EEV.
Power grid and data management
• **§ 11 Reception, transmission and distribution:** Network operators should prioritize the reception, transmission and distribution of power generated from renewable energy or biogas.
• **§ 12 Expanding network capacity:** Power grid operators must optimize, strengthen and expand the power grid to safely accommodate renewable energy power, and these procedures are stipulated in the EEV.
• **§ 70 Obligation to provide data:** Facility and network operators must immediately provide the data required for energy balancing in accordance with the EEV.
Subsidies and certification
• § 21 Support for the difference in generation and subsidies for leased power: If the power is generated from renewable energy or biogas and meets certain requirements, you can receive subsidies when you supply the power to the transmission network. The subsidies are applicable to various situations, including the use of power in small-scale power generation facilities, commercial facilities, and residential areas.
• **§ 79a Regional certificates:** The Federal Environmental Agency is responsible for electronically issuing, transferring, and extinguishing regional certificates of renewable energy in accordance with the EEV (certificates prove that electricity is consumed within a specific region, and the Agency must take appropriate measures to prevent abuse of such certificates).
Compensation and regulations
• § 31 Collateral: The bidder must provide a bid bond to the Federal Network Agency by the respective bid deadline, which is used to guarantee the fine claims of the grid operator.
• **§ 91 Regulations on compensation mechanisms Issuance authority:** stipulates disclosure, transparency obligations and deadlines for implementation for the adjustment of EEG financial requirements pursuant to Section 1 of Parts Ⅲ and Ⅳ of the EEV

Source German Federal Ministry of Justice and Consumer Protection (2023).

Table 25 **Provisions related to the NABEG**

NABEG-related content in EEG
Purpose and definition of the law
• **§ 1(3) Purpose of the Act:** To ensure the compatibility and sustainability of the power grid, the expansion of renewable energy facilities must be harmonized with the power grid
Grid connection and expansion
• **§ 8 Connection: The grid operator** must ensure the rapid connection of renewable energy facilities, taking into account the most technically and economically appropriate connection point, and this regulation is linked to the optimization of the grid emphasized by the NABEG. • **§ 11 Reception, transmission and distribution:** The network operator must ensure the priority transmission of renewable energy power, and the higher-level transmission network operator must cooperate to achieve this. • **§ 12 Expanding the capacity of the network:** The power grid operator must strengthen and expand the power grid if necessary, and these costs are borne by the network operator. → Expanding, strengthening, and optimizing the power grid for the connection of renewable energy facilities is in line with the main purpose of the NABEG, and the EEG also recognizes this.
Subsidies and market mechanisms
• § 21 Support for generation difference and subsidies for leased power: Subsidies are paid for the connection of power generated by renewable energy to the local network or for the direct supply of power to nearby consumers, including the transmission of power through the transmission network. • **§ 22 Competitive calculation of market subsidies:** In connection with the expansion of the power grid, which is a major focus of the NABEG, a competitive bidding system is introduced to meet the additional transmission requirements arising from the market.
Role of the transmission grid operator
• **§ 73 Transmission network operators:** Transmission network operators must transparently disclose the amount of electricity and related data in accordance with the NABEG standards.

Source German Federal Ministry of Justice and Consumer Protection (2023).

Table 26 **Provisions related to the WindSeeG**

WindSeeG-related content in EEG
Equipment and expansion of offshore wind farms
• **§ 4(2) Expansion Path:** The capacity of offshore wind farms in the North Sea and the Baltic Sea economic zones is to be increased in accordance with WindSeeG
• **§ 5(6) Domestic and international expansion:** Offshore wind farms can be designed to contribute up to 20% of their installed capacity per year to the energy targets of other EU member states.
• **§ 9(8) Technical specifications:** Additional technical requirements, such as night lighting systems, are specified for offshore wind farms
Connection to and expansion of the power grid
• **§ 11a Right to install power lines:** Permitting the installation and maintenance of offshore wind power lines on public land.
• **§ 11b Right of way during installation and removal:** Regulating the procedures for using land for construction and demolition
• **§ 12 Network capacity expansion:** The power grid must be optimized, strengthened, and expanded to ensure that the power generated by offshore wind farms is transmitted reliably
Subsidies and bidding system
• **§ 21 Support for the difference in power generation and subsidies for leased power:** Power generated by offshore wind farms is also subject to the subsidy system, and is intended for power supplied directly to the power grid or to local consumers
• **§ 22 Competitive calculation of market subsidies:** Additional capacity of offshore wind farms is selected for support through competitive bidding
• **§ 32 Bidding Procedure:** Federal network agencies shall conduct approval procedures for licensed bidders according to the bidding ranking and criteria in the bidding for each energy source
• **§ 51 Abs. 2 Nr. 3 Reduction of the right to payment in the event of negative prices:** In the event of a negative market price, the offshore wind pilot plant defined in WindSeeG is exempt from subsidy reduction
Regulation and Legal Protection
• **§ 55 Penalties:** In accordance with § 15 of the WindSeeG, the provisions on penalties arising from the bidding process for offshore wind farms apply.
• **§ 83a Legal protection in connection with tenders:** According to the WindSeeG, the Federal Network Agency must provide legal protection in the tendering process.
• **§ 84 Maritime right of way:** Operators of offshore wind farms receiving subsidies under the WindSeeG are entitled to free use of the exclusive economic zone and the territorial sea of Germany.
Monitoring and evaluation
• **§ 97 Cooperation Committee:** The main coordination role associated with the WindSeeG includes 1) monitoring the development status of onshore and offshore wind power generation and 2) checking the progress of land designation.
• **§ 99 Result report:** The federal government evaluates the EEG and WindSeeG every four years and reports on the achievements of offshore wind power

Source German Federal Ministry of Justice and Consumer Protection (2023).

(4) Relationship with other laws

The table below summarizes the relationship between EEG and other laws (See Table 27).

Table 27 Relationship between the EEG and other laws

Law	Relationship with the EEG	Main content
EEV	• The expansion of renewable energy is considered in terms of environmental sustainability, cost-effectiveness, and grid compatibility in accordance with EEV standards. • The EEV regulates the technical standards for renewable energy and biogas facilities.	• The renewable energy target is set in accordance with the EEV technical guidelines, and subsidies are determined through competitive bidding. • The power grid network operator prioritizes power and provides data in accordance with EEV requirements. • Facilities are subsidized and certified if they meet EEV standards.
NABEG	• Renewable energy facilities are expanded in harmony with NABEG's power grid optimization principles. • Power grid connections and expansion are managed in accordance with NABEG standards.	• Facilities are connected quickly and the power grid is strengthened in accordance with NABEG principles. • Subsidies and competitive bidding are introduced to ensure grid stability. • The amount of power and data is transparently disclosed in accordance with NABEG standards (role of the transmission grid operator).
WindSeeG	• The installation and expansion of offshore wind power facilities is carried out in accordance with WindSeeG regulations. • WindSeeG links offshore wind power and EEG subsidy policies.	• WindSeeG specifies the installation of offshore wind power facilities and additional technical requirements. • Allow installation and maintenance of offshore wind power cables • Include offshore wind power cables in the subsidy and set bidding criteria • Specify penalties and legal dispute resolution in case of delay in operation

Source The authors.

3.3.2 Renewable Energy Sources Ordinance (EEV: Erneuerbare-Energien-Verordnung)[25)]

(1) Overview

The Renewable Energy Sources Ordinance (EEV, Erneuerbare-Energien-Verordnung) is a legal framework that supplements Germany's Renewable Energy Sources Act (EEG, Erneuerbare-Energien-Gesetz) and provides detailed regulations and operational methods to practically implement renewable energy expansion policy.

The EEV specifies detailed regulations on the installation and operation requirements of renewable energy facilities, grid integration standards, subsidy payment methods, environmental protection, and streamlines administrative procedures to implement the renewable energy targets set by the EEG. It plays a role in reliably connecting renewable energy power plants (solar, wind, biogas, etc.) to the power grid and ensuring the efficient transmission of electricity generated by renewable sources.

(2) Key points

Specifying the objectives of the EEG and setting technical standards

The EEV specifies the operational methods and technical standards for achieving the German Renewable Energy Act (EEG) objectives in practice. Different technical standards and requirements are applied depending on the energy source to reflect better the unique characteristics of solar, wind, and biogas power. It also clarifies the technical standards and requirements for power plants to connect to the power grid to facilitate the integration of offshore and onshore wind power plants into the power grid.

Power grid operation and renewable energy integration

The EEV establishes technical standards to ensure that renewable energy plants can be seamlessly connected to the existing power grid and supports the operation of the transmission network. It also improves the stability of large-scale offshore wind power projects by clearly presenting the requirements for connecting to the power grid and installation standards for offshore wind power plants. It strengthens connections with the NABEG (Netzausbaubeschleunigungsgesetz) to ensure that new renewable energy facilities can be quickly connected to the power grid. In conjunction with the WindSeeG (law on offshore wind power), it effectively supports the integration and optimization of offshore wind farms into the onshore power grid.

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25) German Federal Ministry of Justice and Consumer Protection (2025).

Support and subsidy system

The EEV plays a role in the practical operation of the renewable energy subsidy system specified in the EEG. It ensures fair competition in the electricity market by setting clear standards for subsidies for renewable energy plants. It provides a guaranteed feed-in tariff (FiT) and a specific framework for operating a bidding system so that small-scale power plants and large-scale projects can secure stable returns. It also helps to manage government-supported renewable energy facilities to ensure compliance with regulations and systematize the subsidy payment process.

Environmental protection and streamlined procedures

The EEV includes regulations designed to mitigate the environmental impact of renewable energy plants and encourage rapid development by streamlining administrative procedures. Regulations are in place to guarantee that environmental protection standards are met to minimize the impact of renewable power generation facilities on the natural ecosystem. In addition, administrative procedures are streamlined to shorten the permitting period for renewable energy projects and support the rapid construction of power plants.

(3) Linking the Renewable Energy Sources Ordinance (EEV) with other laws

The Renewable Energy Enforcement Ordinance (EEV) sets detailed standards for implementing Germany's renewable energy legislation practically. It is closely linked to the Renewable Energy Act (EEG), the Network Expansion Acceleration Act (NABEG), and the Offshore Wind Act (WindSeeG). The EEV is responsible for specifying and implementing each law's normative and legal provisions and forms an organic structure between laws in various areas, including electricity trading, certification systems, transmission network design and connection, and offshore infrastructure installation.

First, in connection with EEG, the EEV specifies provisions on compensation and balance settlement (§19, §57), the electricity trading process and market sales procedures (§19), disclosure standards for transaction data (§72), standards for operating the renewable energy certificate system (§79), and the standards for registering regional certificates (§79a). It also provides the core implementation basis for the EEG by delegating the authority to manage data and perform certifications to the Umweltbundesamt, the German environmental authority (UBA) (§79, §79a). The link with NABEG focuses on grid efficiency and submarine cable design standards. The EEV stipulates submarine cable installation standards that take into account the marine environment and the public interest in accordance with the principles of the NABEG (§5) and ensures that transmission capacity and the grid stability match bidding volumes (§33). In addition, the details of the transmission-related cost reflection and special rate setting are delegated to the Federal Maritime and Hydrographic Agency (BSH) (§15).

Finally, the link with WindSeeG focuses on the rules for the trading and transmission of offshore wind power. EEV specifies that offshore wind power must be sold on the market through the grid operator (§2) and stipulates that the laying and design of submarine cables must comply with the standards for the marine environment (§5). In addition, the detailed operational authority under WindSeeG §12, including the review of the suitability of a specific site, the calculation of the capacity of the facility, and the provision of technical guidelines, is delegated to the Federal Maritime and Hydrographic Agency (§15).

In this way, the EEV, through structural linkages with NABEG and WindSeeG, systematically regulates the entire process of installing, producing, and delivering renewable energy, and thus plays a key role in contributing to Germany's renewable energy goals (See Table 28, Table 29, and Table 30).

Table 28 **Provisions related to the EEG**

EEG-related content in EEV
• **§ 1 Scope of application:** In accordance with § 19(1) and § 57 of the EEG, the EEV specifies the regulations relating to the compensation and balancing of renewable energy power as stipulated in the EEG. • **§ 2 Sales by the grid operator:** Sales of renewable energy electricity must be made in accordance with §19(1) of the EEG, and the grid operator must sell it on the market. In accordance with §57 of the EEG, the balancing and trading of renewable energy electricity must be carried out in an optimized manner on the market. • **§ 3 Transparency of sales activities:** The renewable energy power trading data must be disclosed in accordance with §72(1)(2) of the EEG, and the trading data must be disclosed by technology group on an hourly and monthly basis in accordance with §19 of the EEG. • **§ 7 Registration of the certification of origin:** The criteria for operating the certification of origin system are stipulated in accordance with §79 of the EEG, and the transparency and security requirements of the certification data must be met. • **§ 8 Registration of regional certifications:** Regulates the operation and data management standards of regional certifications in accordance with EEG §79a. • **§ 14 Delegation to the Federal Environment Agency:** Establishes additional regulations on data management and procedures of the certification system in accordance with EEG §79 and §79a.

Source German Federal Ministry of Justice and Consumer Protection (2025).

Table 29 **Provisions related to the NABEG**

NABEG-related content in EEV
• **§ 5 Cable Laying and Design:** The laying of submarine cables must meet the marine environment and public interest in accordance with the NABEG's grid efficiency and optimization standards, and ensure stable and efficient power transmission. • **§ 33 Connection to the power grid:** The power supply must not exceed the volume of bidding specified by NABEG and must ensure the stability and efficiency of the power grid. • **§ 15 Delegation to the Federal Maritime and Hydrographic Agency:** Setting special tariff provisions to take into account the costs associated with the expansion of the power grid and the installation of cables in connection with NABEG.

Source German Federal Ministry of Justice and Consumer Protection (2025).

Table 30 **Provisions related to the WindSeeG**

WindSeeG-related content in EEV
• **§ 2 Sales by the grid operator:** The regulations related to WindSeeG stipulate that the power generated by offshore wind farms be sold by the grid operator on the market. • **§ 5 5 Cable layout and design:** The cable system connected to the offshore wind farm must be installed in accordance with WindSeeG §12(5) and must comply with the marine environment and safety standards. • **§ 15 Delegation to the Federal Maritime and Hydrographic Office:** The regulations on the suitability and installed capacity of offshore wind farms are delegated to the Federal Maritime and Hydrographic Office in accordance with WindSeeG §12 (reviewing the suitability of a specific site and determining the installed capacity of the power plant, and providing technical guidelines during the installation of the power plant).

Source German Federal Ministry of Justice and Consumer Protection (2025).

(4) Relationship with other laws

The table below summarizes the relationship between EEV and other laws (See Table 31).

Table 31 **Relationship between EEV and other laws**

Law	Relationship with the EEV	Main content
EEG	• The EEV is devised in such a way to support the implementation of regulations in the EEG.	• Establishes market sales and transparency standards for renewable energy power. • Regulates power grid operators to optimize the sale of renewable energy power in the market. • Specifies requirements for data disclosure and transparent management of power. • Supports EEG-based certification systems (specify standards for operating regional certification systems and certifying the origin of power).

Table 31 (continued)

Law	Relationship with the EEV	Main content
NABEG	• Technically specifies the design and installation of submarine cables in EEVs in consideration of the power grid efficiency and expansion specified by NABEG.	• Sets power supply conditions at the power grid connection point. • Minimizes public opposition and environmental impact and maximizes power grid efficiency through the arrangement and design of submarine cable systems.
WindSeeG	• Supports the standards for the development of offshore wind farms and the technical conformity verification procedures of WindSeeG, and manages and standardizes relevant data through EEV.	• Evaluates sites and installed capacity suitable for offshore wind farms in accordance with WindSeeG §12. • Requires a comprehensive review of environmental, technical, and grid conditions related to offshore wind power generation.

Source The authors.

3.3.3 Wind Energy on Sea Act (WindSeeG: Windenergie-auf-See-Gesetz)[26]

(1) Overview

The WindSeeG (Windenergie-auf-See-Gesetz) law was enacted to systematically manage offshore wind power generation in Germany. It regulates the selection of locations for offshore wind power plants, construction, operation, licensing procedures, and grid connection, and supports Germany's renewable energy expansion and carbon neutrality goals.

As part of its strategy for a transition to renewable energy (Energiewende), Germany is fostering offshore wind power as one of its main energy sources, and is implementing WindSeeG as the legal basis for effectively operating it. WindSeeG's main objectives are to ensure the efficient operation of offshore wind farms and offshore grid infrastructure, protect the marine ecosystem, and strengthen market competitiveness. It provides an important legal framework for the sustainable and economic operation of offshore wind power in Germany.

(2) Key points

Site selection and preliminary assessment of offshore wind farms

WindSeeG stipulates that site selection and environmental impact assessment (EIA) processes for offshore wind farms be carried out in a systematic manner. The Federal Maritime Administration

26) German Federal Ministry of Justice and Consumer Protection, "Gesetz zur Entwicklung und Förderung der Windenergie auf See(Windenergie-auf-See-Gesetz - WindSeeG)", accessed on January 10, 2025.

(BSH, Bundesamt für Seeschifffahrt und Hydrographie) selects suitable sites for offshore wind farms and carries out an EIA for the relevant area. It provides legal guidelines to systematically manage maritime space and comply with environmental protection standards. It coordinates to ensure that offshore wind farms do not conflict with marine protected areas or major marine use activities (navigation, fishing, military operations, etc.), and plans the development of power plants in conjunction with maritime spatial planning (MSP) to achieve this.

Marine environmental protection and spatial planning

WindSeeG is designed to ensure that offshore wind power generation has a minimal impact on the marine environment and does not create conflicts with other users of marine space. It requires environmental protection measures to minimize the impact of the installation and operation of offshore wind farms on marine ecosystems. It balances offshore wind power with other marine activities by locating power plants using MSP to prevent spatial conflicts with fisheries, maritime transportation, tourism, and other activities. When constructing offshore wind farms in environmentally sensitive waters, it is stipulated that a separate environmental impact assessment (EIA) be conducted and measures for environmental conservation be put in place.

Phased offshore wind power generation and grid connection optimization

WindSeeG maximizes grid expansion and connectivity through a phased approach to development by integrating offshore wind farms and grid expansion planning. In cooperation with Germany's Network Expansion Acceleration Act (NABEG), the national grid is to build transmission infrastructure and develop an efficient transmission system for offshore wind power. It will also work with NABEG to carry out integrated planning of power plants and transmission networks and optimize connections to new power grids. This step-by-step development plan will gradually expand Germany's offshore wind power generation capacity and ensure the stability of the power supply.

Connecting offshore wind power to the grid and building transmission infrastructure

WindSeeG stipulates the construction of transmission infrastructure and submarine cables to reliably and efficiently deliver electricity generated by offshore wind farms to the power grid inland. The national network operator is responsible for connecting the offshore wind farms to the grid, and the developer is required to share the costs. In this way, WindSeeg offers synergies with the German Network Expansion Act (NABAG) to quickly expand grid infrastructure and prevent development bottlenecks.

Economic support and market competition adjustment

WindSeeG includes provisions for support and a tender system to promote the development of offshore wind farms and ensure fair competition in the market. It calls for the operation of an open bidding process for the development of offshore wind farms, and selects the most cost-effect and efficient projects through public competition. Bidding criteria include economic feasibility, environmental protection, and technical efficiency, and the bidding process is designed to ensure fair competition. In this way it provides developers with opportunities to enter the market with a bidding system technically superior projects are selected.

(3) Linking the Wind Energy on Sea Act (WindSeeG) with other laws

WindSeeG is a special law written to systematically regulate offshore wind power generation in Germany, and comprehensively covers the selection of offshore facility locations, design standards, connections to transmission infrastructure, environmental protection, and technical standards. The law is closely linked to the Renewable Energy Act (EEG), the Renewable Energy Enforcement Decree (EEV), and the Acceleration of the Expansion of the Power Grid Act (NABEG), and is implemented in conjunction with other laws, and together, these laws constitute the legal backdrop against which every stage of the offshore wind power industry operates.

First, in terms of linkages with EEG, WindSeeG has its legislative basis in EEG §15, which has been gradually expanded since its enactment on February 17, 2015 through amendments on May 25, 2020, December 20, 2022, and February 2, 2024. WindSeeG requires continuous monitoring of the impact of offshore wind farms on the marine environment during construction and for the first three years of operation based on the provisions of EEG §48 and §57, thereby balancing environmental protection and facility operation. In addition, the suitability of specific waters (N-6.6, N-6.7) for location is defined in terms of public interest and public safety, and the development capacity of each zone is clearly set, which is directly linked to the EEG's subsidy system and bidding structure.

Connections with EEV are reflected in offshore wind power's technical standards and design methods. The Federal Maritime and Hydrographic Agency (BSH) establishes separate standards for the design and location of submarine cables based on technical guidance specified in the EEV. In particular, the amount of power supplied at the point of connection to the transmission network must not exceed the amount of power allocated by EEV, which is set at a value that ensures the stability and predictability of offshore power transmission.

NABEG's linkages focus on the harmonious integration of transmission infrastructure and offshore facilities. According to NABEG's power grid optimization principles, submarine cable design prioritize transmission efficiency and directs developers to maintain a stable depth of at least 1.5 meters, as

well as proper sheathe standards. It also includes environmental protection provisions for monitoring the level of contamination in the drainage system and prohibiting oceanic discharge when the level of contamination exceeds the standard. In addition, it strengthens the consistency of spatial planning by establishing a minimum 500-meter protection zone in consideration of existing or planned cables and pipelines, and by requiring a distance of 500 meters or more separate substations and offshore wind farms.

As such, WindSeeG is closely linked to the EEG support system, the EEV technical standards, and the NABEG transmission infrastructure expansion principles, and functions as an integrated legal and technical framework for promoting offshore wind power in Germany (See Table 32, Table 33 and Table 34).

Table 32 **Provisions related to the EEG**

EEG-related content in WindSeeG
• **Foreword:** The Offshore Wind Act is based on Article 15 of the Renewable Energy Act (EEG) of February 17, 2015, and was added by laws of May 25, 2020 and December 20, 2022, and was finally amended by law of February 2, 2024. • **§ 1 Scope of Application and Purpose of Regulation:** Pursuant to this regulation, the N-6.6 and N-6.7 zones have been identified as suitable for offshore wind farms in accordance with Section 12, Paragraph 5 of the Windenergie-auf-See-Gesetz (Wind Energy on Sea Act), and the installation of offshore wind farms in these areas is deemed necessary for reasons of public interest and public safety. • **§ 4 Monitoring:** During the construction phase and the first three years of operation, monitoring of the impact of the facility must be carried out in accordance with EEG § 48(4) and § 57(2, 3, 5) in order to determine the measures necessary to protect the marine environment. • **§ 6 Verification of installed capacity:** The installed capacity is set as follows (Zone N-9.1: 2,000 megawatts, Zone N-9.2: 2,000 megawatts, Zone N-9.3: 1,500 megawatts)

Source German Federal Ministry of Justice and Consumer Protection, “Gesetz zur Entwicklung und Förderung der Windenergie auf See(Windenergie-auf-See-Gesetz - WindSeeG)”, accessed on January 10, 2025.

Table 33 **Provisions related to the EEV**

EEV-related content in WindSeeG
• **Foreword:** The Federal Maritime and Waterways Agency has issued this regulation in accordance with the Renewable Energy Regulations (EEV) by applying the technical standards of the Act. • **§ 33 Power Supply at the Point of Connection to the Power Grid:** The power input at the point of connection to the network may not exceed the allocated bid volume, which is to comply with the power supply conditions stipulated in the EEV. • **§ 5 Submarine Cable System Layout and Design:** Cable layout and design shall follow the standards required by the EEV, minimize the impact on the marine environment, and the location and depth of the cable system shall meet public interest purposes and environmental standards.

Source German Federal Ministry of Justice and Consumer Protection, "Gesetz zur Entwicklung und Förderung der Windenergie auf See(Windenergie-auf-See-Gesetz - WindSeeG)", accessed on January 10, 2025.

Table 34 **Provisions related to the NABEG**

NABEG-related content in WindSeeG
• **§ 1 Scope of application:** In cooperation with NABEG, the conformity and regulation of the expansion of offshore wind farm facilities in the North Sea and Baltic Sea Economic Zones in Germany. • **§ 5 Deployment and design of submarine cable systems:** The design of submarine cable systems shall be based on the principles of grid efficiency and optimization required by NABEG. • **§ 12 Drainage system:** In accordance with the standards of NABEG, the level of pollution of drainage water must be monitored to protect the marine environment, and discharge into the sea must be prevented if the standards are exceeded. • **§ 23 Depth and cover of cables inside the park:** In accordance with the standards specified in NABEG, cables in the priority navigation area must maintain a stable depth and a cover of at least 1.5m. • **§ 32 Harmonization with existing and planned cables, pipelines and installations:** In accordance with the requirements of NABEG, the installation of submarine cables inside the park must be carried out taking into account existing and planned cables and pipelines, and a protective zone of at least 500 m must be maintained to protect pipelines and cables. • **§ 46 Special provisions for harmonization with substations:** In accordance with NABEG's plans for expanding the power grid, wind farms must maintain a minimum distance of 500 meters from substations.

Source German Federal Ministry of Justice and Consumer Protection, "Gesetz zur Entwicklung und Förderung der Windenergie auf See(Windenergie-auf-See-Gesetz - WindSeeG)", accessed on January 10, 2025.

(4) Relationship between other laws

The table below summarizes the relationship between WindSeeG and other laws (See Table 35).

Table 35 Relationship between WindSeeG and other laws

Law	Relationship with the EEV	Main content
EEG	• WindSeeG sets policy direction and public interest based on EEG.	• Regulations on the suitability and necessity of offshore wind farms. • Emphasis on public interest and public safety. • Setting monitoring requirements for marine environmental protection.
EEV	• WindSeeG applies the technical standards of EEV to ensure compliance with the design and operation standards of offshore wind farms.	• Compliance with submarine cable deployment and design standards. • Setting conditions for connecting to the power grid • Meeting public interest while minimizing environmental impact
NABEG	• WindSeeG follows the principles of NABEG's grid efficiency and optimization, emphasizing integrated operation with infrastructure.	• Planning wind farms with expansion in mind for the power grid • Setting a minimum protection zone (500m) when installing cables • Maintaining a minimum distance (500m) from substations • Drainage management for the protection of the marine environment

Source The authors.

3.3.4 Network Expansion Acceleration Act (NABEG: Netzausbaubeschleunigungsgesetz)[27)]

(1) Overview

The German Network Expa129nsion Acceleration Act (NABEG, Netzausbaubeschleunigungsgesetz) is federal law meant to expedite the expansion of the power grid and efficiently build transmission infrastructure to accommodate expansion of renewable energy. The main purpose of this law is to eliminate bottlenecks in the German power grid and to support the reliable transmission of power generated by renewable source (especially offshore wind power).

NABEG is also a key part of Germany's strategy to achieve net-zero emissions and completely decarbonize Germany's power system by 2050. The law supports integrating large-scale renewable

27) German Federal Ministry of Justice and Consumer Protection, "Netzausbaubeschleunigungsgesetz Übertragungsnetz (NABEG)", accessed on January 10, 2025.

energy generation projects, such as offshore wind farms, into the existing power grid. It includes measures to streamline permitting procedures, connect to the broader European power grid, and protect the environment.

(2) Key points

National planning and coordination

NABEG stipulates that the federal government must designate key transmission projects as national priorities in order to systematically promote the expansion of the German power grid. The German federal government directly manages large-scale transmission projects and comprehensively coordinates the expansion of the national power grid and transnational power grids between European countries, which will promote energy integration and renewable energy-based power trading at the EU level. It supports the rapid implementation of major power grid projects to resolve existing transmission bottlenecks and accelerate the transition to renewable energy.

Streamlined licensing procedures and administrative support

NABEG includes various legal measures to streamline administrative procedures related to the expansion of the transmission network and expedite the licensing process. The administrative procedures required for the licensing of power grid expansion projects are processed in a single window, which speeds up the project process. This shortens the evaluation and deliberation processes in the construction of the transmission network and eliminates administrative inefficiencies. In addition, since the expansion of the power grid is a matter that requires cooperation between the German states and the federal government, the NABEG stipulates that the federal government should work closely with state governments to resolve jurisdictional issues and strengthen administrative coordination. This will speed up the progress of transmission projects and minimize administrative obstacles to the expansion of the power grid.

Building a power grid in connection with offshore wind power generation

NABEG includes provisions for the construction of submarine cables and transmission infrastructure to enable the reliable delivery of electricity from offshore wind farms to the onshore grid. It emphasizes the integrated connection of offshore wind farms with the national power grid, and legally stipulates the construction of submarine transmission lines for the stable transmission of offshore wind power. In conjunction with the WindSeeG law, it optimizes coordination between offshore wind farms and the onshore transmission grid. In addition, NABEG actively supports the construction of an offshore transmission grid to effectively transmit power generated by offshore wind farms to the mainland.

Consideration of environmental protection

NABEG includes measures that consider environmental protection and promote public participation in the process of expanding the power grid. It calls for environmental impact assessments (EIAs) to evaluate the impact of the construction of the transmission network on the ecosystem and stipulates that environmental protection measures be taken in parallel. It prioritizes undergrounding (the installation of underground cables) to minimize the impact of the expansion of the power grid on the natural environment.

(3) Linking the Network Expansion Acceleration Act (NABEG) with other laws

NABEG aims to quickly and efficiently build the power grid infrastructure needed to expand renewable energy, and to this end, it features organic linkages with the EEG (Renewable Energy Act), EEV (Renewable Energy Ordinance), and WindSeeG (Offshore Wind Act).

First, according to the EEG (Renewable Energy Act) (§1), the integration and expansion of renewable energy into the power grid must be safe, environmentally sustainable, and in the public interest. Furthermore, §5 stipulates that the planning of extra-high voltage transmission grids and renewable energy supply infrastructure must be carried out efficiently and economically at national and transnational levels. This closely tracks with NABEG's stated goals of expanding the national power grid, strengthening international connectivity, and developing an environmentally friendly power grid.

Next, the EEV (Renewable Energy Act) provides detailed technical and operational guidelines to support the implementation of NABEG. §1 states that power grid operators must transparently sell renewable energy to the market, and §5 defines efficient power trading and grid integration of renewable energy as being at the core of the basic plan. This is a practical means of implementing the NABEG's goals of ensuring transparency in the electricity market, efficiently distributing resources, and integrating renewable energy into the national grid.

In addition, the WindSeeG (Offshore Wind Act) ensures spatial consistency with NABEG's grid expansion plans. §5 requires that the Federal Base Plan must reflect the stipulations of the Spatial Development Plan, which concerns high-voltage transmission lines and offshore connection lines, and §17 states that the offshore connection routes and zones designated under WindSeeG must be included in the Federal Grid Plan. This institutionally ensures that the location selection of offshore wind farms and the expansion of transmission infrastructure must be integrated.

In summary, NABEG conforms with the EEG by mandating compliance with legal principles and environmental practices and by promoting public participation, supports transparency of market transactions and the effectiveness of grid integration through EEV, and realizes structural consistency

and harmony between spatial planning and power planning through WindSeeG. These multi-layered linkages form a strong legal and institutional foundation that enables Germany to steadily promote the expansion of renewable energy and the energy transition (Energiewende) (See Table 36, Table 37, and Table 38).

Table 36 **Provisions related to the EEG**

EEG-related content in NABEG
• **§ 1 Principle:** According to the EEG, the integration and expansion of renewable energy into the electricity grid must be legally safe and environmentally friendly, and the projects must serve the public interest. • **§ 5 Contents of the Federal Basic Plan:** According to EEG §12e, high-voltage transmission grids and renewable energy supply infrastructure between countries and across borders must be planned in an efficient and economical manner.

Source German Federal Ministry of Justice and Consumer Protection, "Netzausbaubeschleunigungsgesetz Übertragungsnetz (NABEG)", accessed on January 10, 2025.

Table 37 **Provisions related to the EEV**

EEV-related content in NABEG
• **§ 1 Principle:** In accordance with EEV §19 and §57, the grid operator is obliged to sell renewable energy power on the market, and the sale of power must be done transparently. • **§ 5 Contents of the Federal Basic Plan:** In accordance with the EEV, efficient power trading of renewable energy and the integration of the grid must be the focus.

Source German Federal Ministry of Justice and Consumer Protection, "Netzausbaubeschleunigungsgesetz Übertragungsnetz (NABEG)", accessed on January 10, 2025.

Table 38 **Provisions related to WindSeeG**

WindSeeG-related content in NABEG
• **§ 5 Contents of the Federal Basic Plan:** When establishing the basic plan for high-voltage transmission lines, including offshore-connection lines, the spatial development plan pursuant to § 5 of the WindSeeG must be taken into account. • **§ 17 Federal Grid Plan:** The routes and areas associated with the offshore-connection lines specified in accordance with § 5 of the WindSeeG are included in the Federal Grid Plan.

Source German Federal Ministry of Justice and Consumer Protection, "Netzausbaubeschleunigungsgesetz Übertragungsnetz (NABEG)", accessed on January 10, 2025.

(4) Relationship with other laws

The table below summarizes the relationship between NABEG and other laws (See Table 39).

Table 39 Relationship between NABEG and other laws

Law	Relationship with the EEV	Main content
EEG	• NABEG provides the legal basis for the expansion of national transmission grids and the integration of renewable energy in accordance with the EEG.	• In conjunction with EEG §12e, it regulates the procedures for the cross-border planning and construction of high-voltage transmission grids. • It emphasizes the integration of renewable energy grids and compliance with environmentally friendly methods.
EEV	• NABEG supplements the procedures related to the sale of renewable energy by EEVs and the obligations of transmission grid operators.	• Support for transparent trading of renewable energy power (EEV §19, §57) • Connection regulations with the transmission grid operator
WindSeeG	• NABEG focuses on the integration of the offshore wind power connection network of WindSeeG and the Federal Grid Plan	• Integration of the spatial development plan of WindSeeG §5 into the Federal Basic Plan • Including the designation of offshore wind power areas and routes

Source The authors.

3.3.5 Marine Spatial Planning (MSP)

(1) Overview

Germany's Maritime Spatial Planning (MSP) is a legal and spatial planning system implemented to efficiently utilize maritime space and systematically develop offshore wind power generation and power grid infrastructure. Germany has implemented MSP in accordance with the EU's Marine Spatial Planning Directive (MSP Directive, 2014/89/EU), and through this, it is promoting a strategy to continuously expand the development of oceanic renewable energy while protecting the marine ecosystem. Offshore wind farms and the associated transmission grid infrastructure are coordinated around the Network Development Plan (NEP) and the Regional Development Plan (FEP), and the two plans are linked to support the continued expansion of the German offshore wind industry (See Table 40).

Table 40 Major plans related to the MSP in Germany

Key concepts	Developer	Main role
Network development plan (NEP)	Developed in cooperation between the Federal Network Agency (BNetzA) and the transmission system operator (TSO)	• Propose a plan for transmitting power from offshore wind farms to land • Identify the network voltage point (NVP) • Establish a technical concept for connecting offshore power grids • Review expansion scenarios and alternative connection points
Regional development plan (FEP)	Developed by the Federal Maritime and Hydrographic Agency (BSH)	• Establish a spatial and temporal plan for connecting offshore wind farms to the power grid • Determine the location and power capacity of the offshore wind farms to be installed Coordinate the installation year and the schedule for connecting offshore wind farms to the power grid
WindSeeG (German: WindSeeG)	• Legal basis and target setting for offshore wind power generation • Decide on the location and development method of offshore wind power plants in cooperation with MSP	

Source Prepared by the authors based on the data from Netzentwicklungsplanstrom, "Offshore-Netzentwicklung", accessed on March 6, 2025.

(2) Case study on spatial planning

1) The N-13 offshore wind power transmission project

Currently, a project is underway to build a more efficient transmission network for connecting the N-13 offshore wind farm to the national grid. The goal of the project is to reduce costs and increase the reliability of electricity supply. The new transmission network will utilize direct current (DC) technology and select an optimal network voltage point.

Project overview

The primary objective of this project is to transmit electricity generated by the N-13 offshore wind power complex to the mainland. The planned transmission capacity is 2,000 MW, and the project will utilize a direct current (DC) transmission method. This DC approach has been adopted to optimize the use of transmission line space and to minimize losses associated with long-distance power transmission. In addition it offers the flexibility to expand the offshore grid in the future to accommodate increasing power demand.

Transmission routes and connection points

The transmission route has been planned to land in the northwestern part of Lower Saxony, following the border corridor N-III as specified in the regional development plan (FEP). The most suitable network voltage point (NVP) has been identified as Sensenbusch. With the closure of existing power plants A and B, it is now possible to connect the new infrastructure in parallel with existing power grid lines. However, to facilitate this connection, the installation of new switchgear will be required to link the offshore-generated electricity to the 380kV power grid.

The necessity and justification of connecting to the power grid

Connecting this offshore wind project to the power grid is essential to meet the rising industrial electricity consumption in the Rhine-Ruhr and Rhine-Main regions, especially in light of the planned shutdown of coal-fired power plants. The project can supplement generation capacity without additional grid expansion by linking the transmission infrastructure to a network voltage point near major consumption areas. Furthermore, the new connection will help alleviate transmission bottlenecks, thereby contributing to the stable and efficient operation of the power grid.

The role of the NOR-13-1 grid-connection system

The NOR-13-1 system is a key piece of infrastructure responding to the increase in power flowing from offshore wind farms in the North Sea region of Germany. In line with Germany's goal of expanding offshore wind power generation, the system plays a vital role in reliably supplying renewable energy to the mainland of Germany and the European power grid. It improves the overall efficiency of the transmission network while ensuring its stability. By increasing transmission capacity and strengthening system reliability, the NOR-13-1 system supports the stable operation of the German power grid. Additionally, it optimizes electricity transmission from offshore wind farms to the mainland, thereby reducing the costs associated with long-distance transmission.

2) Marine Grid Development Map (OpenStreetMap-based transmission infrastructure)

The German Maritime Spatial Plan (MSP) includes the latest land and sea transmission projects based on the second draft of the NDP 2037/2045 (2023). It provides information on major transmission projects currently in operation or scheduled to be operational by 2037-2045. This allows interested parties visually check the status of the infrastructure for connecting offshore wind farms to the power grid.

Method of transmitting offshore wind power

The power generated by offshore wind turbines is connected to the mainland power grid by the transmission system operator (TSO), and some of the power is further distributed through long-distance transmission networks. In the North Sea, high-voltage direct current (DC) transmission is used. This method is effective in minimizing power loss during long-distance transmission and increasing transmission efficiency.

The transmission process begins with the generation of power offshore in the form of alternating current (AC). This AC power is then converted to direct current (DC) on the central converter platform operated by the transmission system operator (TSO). The converted DC power is transmitted to the mainland, where it is once again converted back into alternating current (AC) before being supplied to the extra-high voltage transmission network. In addition to local distribution, a portion of this power is also transmitted to southern regions via a long- distance DC transmission network.

In the Baltic Sea region, alternating current (AC) transmission is mainly used. The short distance between the Baltic Sea offshore wind farms and the land connection point eliminates the need for direct current (DC) conversion, making AC transmission more economical.

3.3.6 Key German legislation and interlinkages

(1) The role of each law and policy

Renewable Energy Act (EEG: Erneuerbare-Energien-Gesetz): The EEG governs Germany's renewable energy policies and provides basic legal framework for expanding renewable energy. The law lays the foundation for pursuing Germany's energy transition strategy and aims to expand various renewable energy sources, including solar, wind, and biogas. In addition, the EEG sets long-term targets for renewable energy generation in Germany by lighting the path through which the power sector can achieve the goal of net-zero carbon emissions by 2050. This law plays a key role in leading the construction of a sustainable energy system in Germany, in conjunction with the expansion of the power grid, offshore wind power generation, and support policies.

Renewable Energy Sources Ordinance (EEV: Erneuerbare-Energien-Verordnung): The EEV provides implementation guidelines to effectively realize Germany's energy transition. In particular, it specifies how to implement the renewable energy promotion policies defined by the EEG, and sets practical operating standards for each sector in conjunction with the NABEG (Accelerated Expansion of the Electricity Grid Act) and WindSeeG (Offshore Wind Act). The EEV sets the technical standards required for operating the power grid and helps ensure that renewable energy is reliably integrated into the existing power grid. It also provides economic stability to renewable energy plant operators by

establishing specific implementation guidelines for the feed-in tariff and bidding system as stipulated by the EEG.

Network Expansion Acceleration Act (NABEG: Netzausbaubeschleunigungsgesetz): The NABEG accelerates the expansion of the power grid to ensure the smooth supply of electricity generated by renewable energy plants in Germany to consumers. This law provides the legal basis for upgrading and building new transmission networks and serves to increase the stability of the renewable energy supply by eliminating bottlenecks in the power grid. NABEG supports the construction of submarine transmission networks to facilitate the transmission of electricity from offshore wind farms to land, and in this process, it works closely with WindSeeG (the Offshore Wind Act) to optimize the connection of offshore wind power grids. NABEG also prioritizes major power grid expansion projects at the national level and supports rapid project progress by introducing a one-stop shop that streamline the permitting process.

Wind Energy on Sea Act (WindSeeG: Windenergie-auf-See-Gesetz): WindSeeG is a special law enacted to systematically develop and operate offshore wind power generation facilities in Germany. It regulates the selection of locations for offshore wind power plants, the permitting process, and operating standards within the German economic zone in the North Sea and Baltic Sea. This law provides the legal basis for implementing the offshore wind power generation targets set by EEG, establishes technical standards for connecting offshore wind farms to the power grid, and supports the construction of efficient transmission networks in cooperation with NABEG and EEV. WindSeeG also plays a role in coordinating with the Maritime Spatial Plan (MSP) to ensure that offshore wind farms can operate effectively while protecting the marine environment.

(2) Interlinkages among laws

Germany's renewable energy laws play their respective roles while organically linking them to build a systematic system toward the 2050 net-zero goal.

The process begins with the Renewable Energy Act (EEG), which sets the overall targets for expanding renewable energy. The Renewable Energy Sources Ordinance (EEV) establishes detailed standards for implementing the objectives outlined in the EEG. To support the necessary infrastructure, the Act on Accelerating the Expansion of Electric Power Grids (NABEG) facilitates the development of renewable energy transmission systems and streamlines the permitting process. Finally, the Maritime Wind Energy Act (WindSeeG) governs offshore wind farms' development, operation, and management.

This allows Germany to effectively expand its offshore wind farms and build a stable power grid

infrastructure. Through linkages among the laws, a comprehensive policy framework is in place that efficiently coordinates the construction of offshore wind power generation and transmission infrastructure. As a result, Germany's system of organically connected laws and policies are both contributing to its net-zero goals as well as the energy transition. Together, they provide the legal and institutional foundation for Germany to become a leading country in the global energy transition through support for expanding renewable energy and developing offshore wind power plants.

3.3.7 The NOVA (Netz-Optimierung vor Verstärkung vor Ausbau) principle for efficient power grid operation[28)]

(1) Overview

As part of its energy transition (Energiewende), Germany aims to shift away from the existing nuclear and fossil fuel-based energy system toward one centered on renewable sources of energy, such as wind and solar power. However, renewable energy tends to fluctuate depending on weather conditions. It is often only viable in specific regions (e.g., offshore wind farms in the seas off the northern coast of the country. This necessitates structural measures that ensure the stability of the power supply.

TransnetBW, the operator of the power grid in Baden-Württemberg, a state in southwestern Germany, has adopted the NOVA principle as its core operational strategy. NOVA, which stands for Netz-Optimierung vor Verstärkung vor Ausbau—meaning "optimization before reinforcement before expansion"—is a stepwise approach that prioritizes making the most efficient use of existing grid infrastructure. Only after optimizing the current system does the strategy call for strengthening it, and ultimately, if necessary, constructing new grid capacity.

This principle aims to minimize the construction of new power grid infrastructure, minimize social conflicts and environmental damage, and realize a stable and economical power supply, based on a responsible attitude toward people, nature, and the environment. Based on this principle, the four transmission system operators (TSOs) in Germany jointly establish a network development plan (NEP) every two years, which reflects all necessary technical measures. At this time, all measures must be prioritized according to the NOVA principle, and new transmission lines can only be planned when all possibilities of the existing network have been exhausted (See Figure 21).

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28) TransnetBW, "NOVA principle. Responsibility in network construction", accessed on March 23, 2025.

Figure 21 Three energy transition scenarios for Berlin and Bayern

Source TransnetBW, "NOVA principle. Responsibility in network construction", accessed on March 23, 2025.

(2) Grid optimization: Improving equipment operation by taking advantage of climate conditions

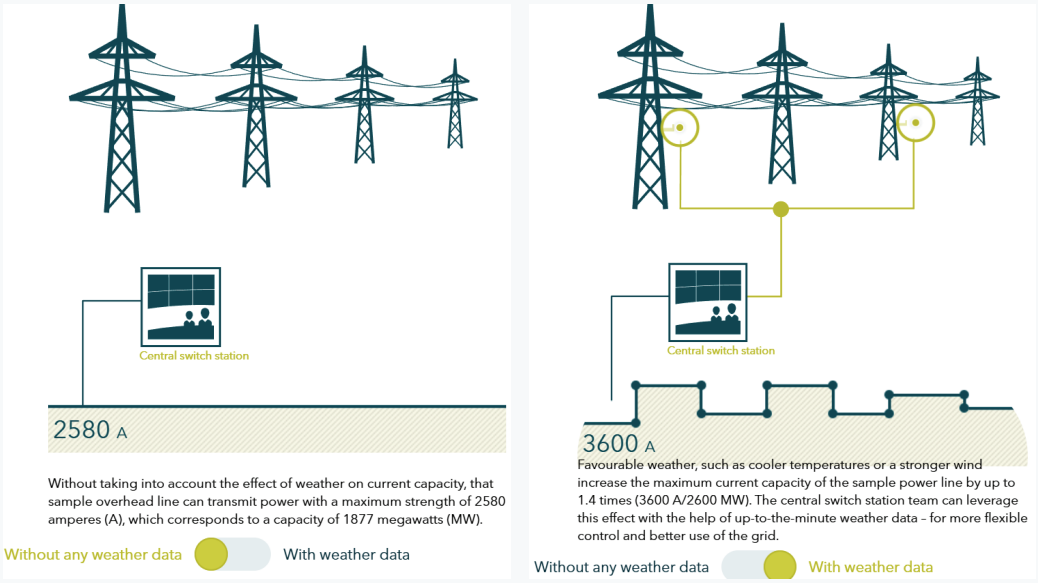
The first step in the NOVA principle, Grid Optimization, is a strategy that maximizes the operational efficiency of existing transmission networks without building new infrastructure. By improving operational efficiency without making structural changes, the two goals of reducing costs and minimizing environmental impact can be achieved simultaneously.

This strategy is realized through digitalization, artificial intelligence (AI), data-based forecasting and the integration of meteorological science. In particular, optimizing the operation of transmission lines in consideration of weather conditions is key. For example, the current capacity of transmission lines is generally set based on a worst-case scenario, which is a "a hot, dry summer day with a temperature of 35°C and a wind speed of 0.6 m/s." It has been scientifically proven that in reality, the cooling effect of transmission lines increases when the temperature is low or the wind speed is strong, which can increase the transmission capacity.

In light of this possibility, TransnetBW has installed its own weather station and collects real-time weather data to dynamically adjust the transmission capacity. This will allow the company to establish optimal transmission strategies under all weather conditions and plan to fully introduce Meteorology-based Dynamic Line Rating (DLR) in the future. Such optimization measures can

significantly improve transmission capacity without building new lines, making them a very effective means in the early stages of energy transition (See Figure 22).

Figure 22 **Optimizing transmission capacity using weather data**



Source TransnetBW, "NOVA principle. Responsibility in network construction", accessed on March 23, 2025.

(3) Grid reinforcement: Achieving maximum performance with minimal changes

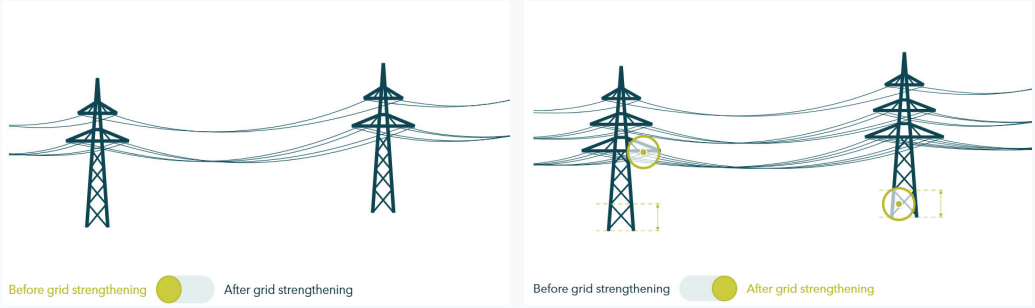
When it is difficult to meet the demand for power transmission by optimizing the power grid alone, the next step is to apply reinforce the grid. This strategy involves increasing the transmission capacity of the existing transmission network by partially supplementing its physical infrastructure. It is used as a practical solution because it can achieve a significant increase in network capacity while incurring less time, costs, and inciting fewer social conflicts than the construction of new lines.

There are two main reinforcement methods. The first is to increase the voltage level of existing transmission lines from 220kV to 380kV to increase energy transfer efficiency, and the second is to add wires in parallel to existing transmission towers. This is a strategy that substantially increases transmission capacity while minimizing structural changes by adding or replacing cables while leaving the structure of the transmission tower intact.

The Ultranet project that TransnetBW is carrying out is a prime example of power grid reinforcement. Ultranet is designed to reliably transport large amounts of renewable energy, such as offshore wind power in the north, to the southern industrial zone by installing a DC transmission network in parallel with the existing AC transmission route. This is also effective in terms of space efficiency and

economy, and is highly likely to upgraded to a ultra-high voltage transmission system in the future (See Figure 23).

Figure 23 **Strengthening the power grid by reinforcing the existing transmission infrastructure**



Source TransnetBW, "NOVA principle. Responsibility in network construction", accessed on March 23, 2025.

(4) Grid reinforcement: Achieving maximum performance with minimal changes

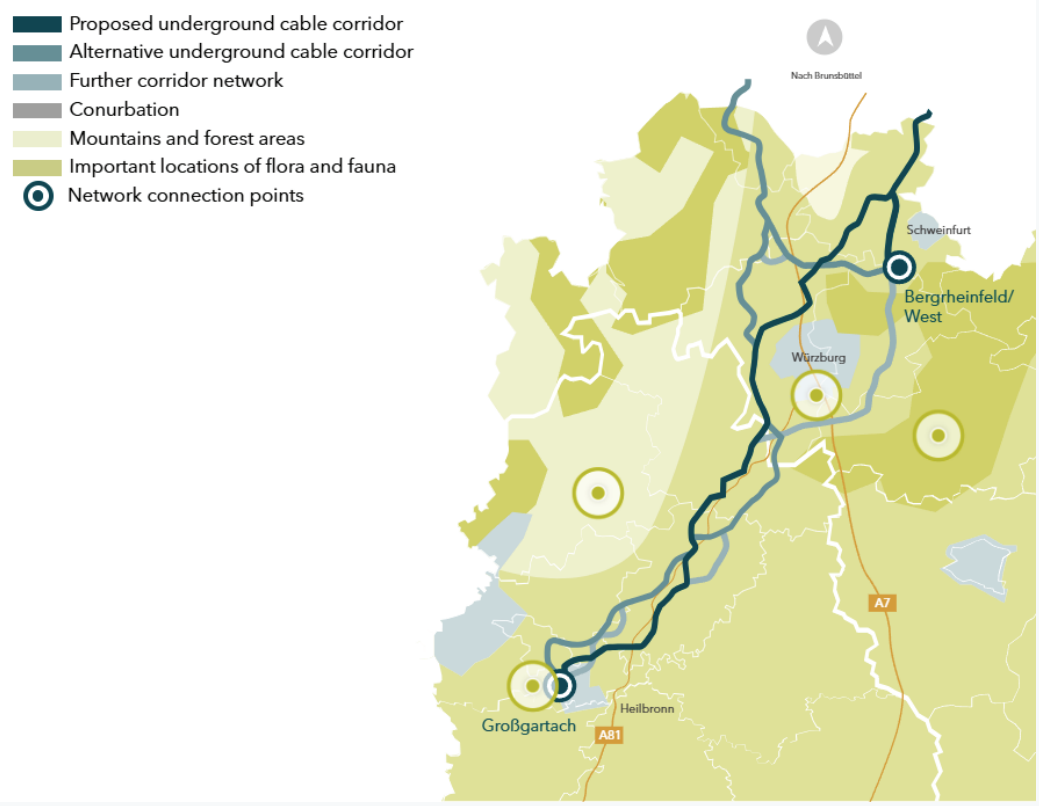
Suppose all means of optimizing and strengthening the transmission infrastructure have been exhausted, and the demand for power transmission still cannot be met. In that case, grid expansion is considered as a last resort. This stage involves building a new transmission network, which takes a long time from planning to construction and involves a complex web of interests, including environmental impact, land use, and community acceptance.

While expanding the power grid is is often inevitable to address the growing demand for electricity and the physical distance from renewable energy generation centers, it must be accompanied by extensive public participation and transparent procedures. A prime example is SuedLink, a key project in Germany's energy transition. This project is intended to transmit large amounts of electricity generated by offshore wind farms in the north to high-demand industrial areas in the south. It is a large-scale infrastructure plan to build a 700-kilometer ultra-long- distance underground direct current transmission network. The route crosses five states and is considered the largest power grid project in German history.

SuedLink is attracting attention for using a citizen-participation infrastructure planning model. TransnetBW (and its joint operator, TenneT) are continuously communicating with various stakeholders, including local governments, residents, and civic groups, to adjust the design, and have innovatively raised the level of public communication by collecting real-time opinions through online participation tools. The project's participatory approach and high level of transparency have been praised across the globe, with the SuedLink project winning three international communication awards.

The grid expansion phase involves more than just physical construction, and includes multi-layered objectives of social acceptance, environmental considerations, and policy trust-building, and requires the most careful and complex procedures in the practice of the NOVA principles (See Figure 24).

Figure 24 **Planning the route of SuedLink's underground transmission grid considering ecological and geographical factors**



Source TransnetBW, "NOVA principle. Responsibility in network construction", accessed on March 23, 2025.

The NOVA principle is a philosophical guideline and institutional framework that goes beyond simple technical design criteria in Germany's power grid operation. It is a strategic solution that balances the realistic challenges of the energy transition (large-scale renewable energy transmission) with social needs (environmental protection, community participation). By prioritizing optimization first, followed by reinforcement and then expansion, this approach helps reduce unnecessary investment, minimize resource consumption, and ultimately supports developing a sustainable energy system.

NOVA is today the standard for operating the German power grid and is also establishing itself as a sustainable infrastructure operation principle that is attracting attention in Europe. It is expected to continue to develop in a more sophisticated manner based on technological innovation and social cooperation.

3.3.8 Improving the efficiency of the implementation of environmental impact assessments (EIA)

In pursuit of a transition to renewable energy, Germany is systematically expanding its power grid and offshore wind power infrastructure, and is establishing an environmental assessment system that integrates environmental impact assessments (EIA) and strategic environmental impact assessments (SEA). Germany is now conducting EIAs at the final approval stage and proactively incorporating SEAs into the early stages of project planning to systematically review environmental impacts throughout the entire process.

This structure is implemented through a five-step procedure for expanding the power grid. The process begins with establishing a scenario framework, laying the foundation for long-term planning. This is followed by formulating the National Electricity Plan (NEP), which outlines strategic objectives for grid development. Next comes the Bilateral Plan (BBPlG), detailing specific projects of national importance. The fourth step involves the creation of the Federal Sector Plan, which provides spatial and technical specifications for proposed projects. Finally, the process concludes with plan approval, granting the necessary legal authorization to proceed with implementation.

The environmental assessment system in Germany operates on a multi-layered structure. SES is part of a strategic review in the early stages of product planning, while detailed impacts are analyzed through EIAs in the final stages.

SEAs are legally mandatory. They forecast major environmental risks at an early stage and allow for the consideration of alternative possibilities, thereby minimizing potential conflicts with the subsequent EIA and greatly improving the efficiency of the licensing process.

German laws on the electricity grid, such as NABEG, BBPlG, EEG, and WindSeeG, institutionally support this multi-level environmental impact assessment system and function as an advanced model that streamlines procedures while strengthening the quality of the assessment.

(1) Scenario framework planning stage

The first stage of project planning is when long-term development goals are set. Although EIAs are not conducted at this stage, environmental concerns included in the public and stakeholder opinion-gathering processes because environmental issues are critical factors of consideration when setting the direction and scope of development plans. Scenarios outlined at this stage serve as the basis for reflecting environmental considerations in the subsequent SEA.

(2) Network development planning stage

The National Electricity Plan (NEP) is jointly prepared by the four transmission system operators It presents the technical expansion needs of the power grid for the next 10 to 15 years. This is the point at which SEAs get underway. The Federal Network Agency (BNetzA) publishes a draft of the SEA as part of a preliminary environmental report. It also conducts public hearings and surveys public opinion.

This is also the stage at which the necessity of grid expansion is reviewed. A preliminary analysis of various alternatives to expansion is performed to prevent conflicts and improve the efficiency of the licensing process.

(3) Federal Requirements Plan approval stage

The Federal Requirements Plan is is essentially a screening stage that ensures that only the transmission routes that do not conflict with the public interest and are evaluated to have met minimum environmental requirements in the NEP process are selected. The SEA is also legally mandatory at this stage, and in particular, the potential to avoid and/or mitigate impacts on environmentally sensitive areas (Natura 2000 areas, protected areas, etc.) is reviewed with a focus on the public interest.

The BBPlG ensures that only environmentally feasible projects that also satisfy the public interest can proceed to the next stage, as they are approved as legislation by the German Bundestag. This minimizes the possibility of subsequent route changes and ensures that the conclusions of the analyses are legally binding.

(4) Federal sectoral planning stage

This procedure examines more specific alternative routes and spatial arrangements for corridors approved by law. The SEA is also applied here and comprehensively examines specific environmental risk-sensitive areas. This is also the point at which a technical feasibility analysis is conducted.

SEAs are also legally required at this stage and authorities must hold public meetings, survey public opinion, hold consultations with stakeholders, and lay out the process for raising grievances. These pre-adjustments have the effect of preventing environmental conflicts and litigation risks in the subsequent planning approval stage.

(5) Planning approval stage

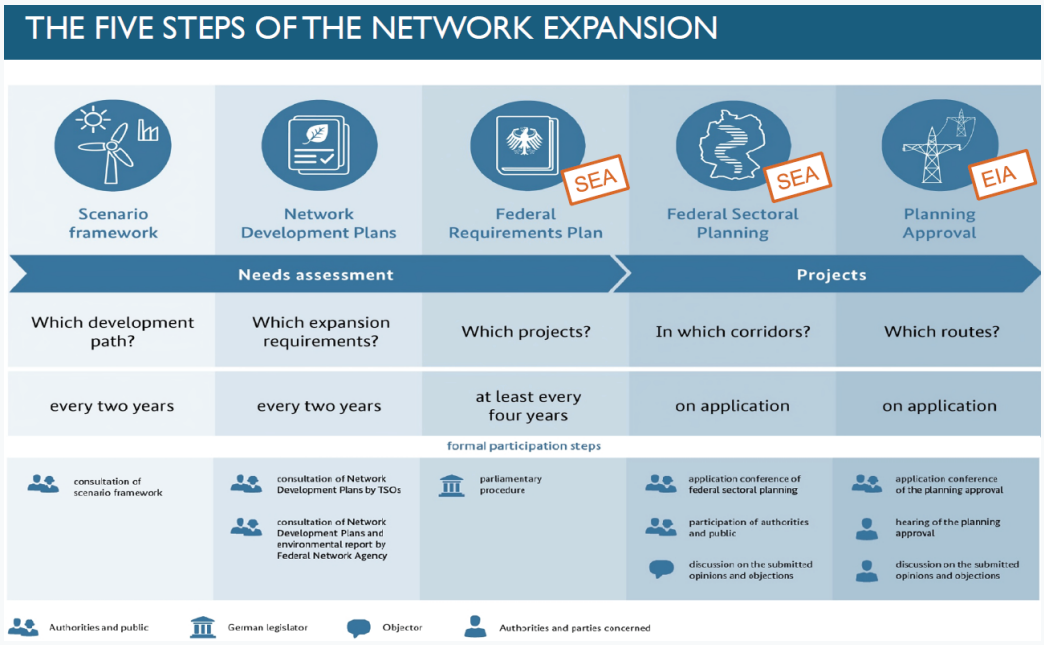
At the planning approval stage, the actual route for the transmission infrastructure is selected and technical specifications are finalized, and at this point, the government is legally obligated to perform an EIA.

EIAs comprehensively assess project impacts on biodiversity, water quality, soil, air quality, and the topography of the affected area(s), and mitigation or compensation measures are determined if necessary.

The EIA process basically a detailed technical analysis and final confirmation of the findings of the earlier SEA. Public acceptance and environmental risk are also reviewed in this stage, and the final decision on whether to approve the plan is made.

In addition, it is at this stage that public hearings are held and grievances heard, and the final decision on whether to approve the plan is made after reviewing any objections and environmental risk (See Figure 25).

Figure 25 **Five-step procedure for expanding the power grid**



Source Genz, A. (2018), "Electricity Grid Planning in Germany", Knowledge-exchange between US and German Power System Operators, May 25, Berlin: German Federal Ministry for Economic Affairs and Energy (BMWi), p. 7.

3.4 Comparison

3.4.1 Offshore wind power and grid policy linkages: A comparison of the EU, the UK, and Germany

At the national and EU levels, laws and policies for expanding renewable energy and the power grid are interlinked systematically coordinated focusing on offshore wind power generation. The EU plays a role in coordinating cooperation among member states, while the UK and Germany are implementing their offshore wind and power grid expansion strategies through their respective legal and policy frameworks.

(1) EU

The European Union (EU) has legally stipulated that its member states achieve their targets for expanding renewable energy through the Renewable Energy Directive (RED), and is pushing for more transboundary connections of transmission infrastructure power grids through the Power Grid Act (TEN-E and EU Action Plan for Grids) to achieve this. In particular, it calls for the coordination of offshore wind power generation and power grid policies at the EU level and the maintenance of a balance between offshore wind power generation and the protection of marine ecosystems through the Marine Spatial Planning Directive (MSP Directive). In addition, the Offshore Network Development Plan (ONDP) coordinates the integration of the Marine Spatial Plan (MSP) and the EU power grid, and promotes energy cooperation at the European level by specifically planning how offshore wind farms in each country will be connected to the power grid.

(2) The UK

The UK has adopted clean energy sources such as solar power and nuclear power, with a focus on offshore wind power, by linking the expansion of renewable energy with improvements to the power grid through the Clean Power 2030 Action Plan. To achieve this, the government is operating a Holistic Network Design (HND) and promoting an Offshore Transmission Network Review (OTNR) to improve between offshore wind power and the power grid. In addition, the optimal transmission route is determined by linking the HND, the OTNR, and the MSP the location of offshore wind farms and transmission routes. In addition, the UK is playing an important role in the European clean energy supply chain through offshore wind power and grid expansion by using transmission infrastructure connected to the EU power grid to coordinate power exchanges within Europe.

(3) Germany

Germany coordinates the expansion of renewable energy and the expansion of the power grid by linking the Renewable Energy Act (EEG) and the Electricity Grid Act (EnWG & NABEG). In particular, it supports offshore wind power generation by building a power grid infrastructure that connects the North Sea and the Baltic Sea. The WindSeeG (Wind Special Act on Offshore Wind Energy), which legally supports offshore wind power generation, is systematically supporting the expansion of offshore wind power in Germany, and the areas for offshore wind power generation and the locations of the transmission network are being coordinated in conjunction with the FEP (Flächenentwicklungsplan, or spatial development plan). In addition, the National Electricity Development Plan (NEP) and the Maritime Spatial Plan (FEP) are linked to each other to optimize the transmission of offshore wind power plants to the mainland, and Germany's transmission network is directly connected to the EU's electricity network to maintain a stable supply and demand of electricity in coordination with the EU's Electricity Network Directive (TEN-E). Through this, Germany is playing a leading role in realizing its net-zero target by organically linking the expansion of renewable energy and the expansion of the transmission grid.

(4) Comprehensive

The EU is leading the coordination and integration of power grids among its member states through the Renewable Energy Directive (RED), the Electricity Network Directive (TEN-E), the Marine Spatial Planning Directive (MSP Directive), and the Offshore Network Development Plan (ONDP), thereby promoting the connection of power grids between countries and the spread of renewable energy. The UK is operating independent offshore wind and grid optimization strategies through Clean Power 2030, HND (grid integration plan), OTNR (grid reform), and MSP (marine spatial planning), and is working on effective ways to connect offshore wind farms and the grid. Germany is promoting the expansion of offshore wind power and the expansion of transmission networks by linking the EEG (Renewable Energy Act), EnWG & NABEG (Electricity Grid Act), WindSeeG (Offshore Wind Act), FEP (Marine Spatial Planning), and NEP (Electricity Grid Development Plan), thereby establishing a renewable energy-based power system. Based on this policy coordination, countries and the EU are cooperating toward the goal of net-zero carbon emissions and are systematically moving toward a clean energy transition centered on offshore wind power (See Table 41).

Table 41 **The European, the UK, and German offshore wind and power grid policy systems**

Category	EU	The UK	Germany
Renewable Energy	• Renewable Energy Directive (RED: Renewable Energy Directive)	• Climate Change Act (2008) • Energy White Paper (2020)	• Renewable Energy Act (EEG: Erneuerbare-Energien-Gesetz) • Renewable Energy Sources Ordinance (EEV)
Power Grid	• TEN-E regulations • EU Action Plan for Grids	• Clean Power 2030 Action Plan (2024) • OTNR (Offshore Transmission Network Review) • HND (Holistic Network Design)	• Grid laws • (EnWG and NABEG)
Offshore wind power	• TEN-E Regulation • EU Offshore Wind Strategy (Offshore Renewable Energy Strategy)	• Offshore Transmission Network Reform (OTNR)	• Special Act on Offshore Wind (WindSeeG)
Marine Spatial Planning	• MSP Directive (Maritime Spatial Planning Directive) • ONDP (Offshore Network Development Plan)	• Marine Spatial Planning (MSP)	• MSP Act (MSP)
Interrelation ships	• The EU Renewable Energy Directive (RED) sets the direction for the expansion of renewable energy, and based on this, the TEN-E Regulation and the EU Action Plan for Grids expand the power grid infrastructure. • The offshore wind strategy and the MSP guidelines work together to encourage countries to make efficient use of their power grids and maritime space	• Promote the expansion of offshore wind power based on renewable energy targets, and for this purpose, closely link the power grid reform (OTNR, HND) and marine spatial planning (MSP) • Build an efficient power grid by utilizing the integrated power grid design (HND) for offshore wind power generation, and allocate optimal marine sites through MSP	• The expansion of renewable energy (EGG, EEV) is directly linked to the development of offshore wind power (WindSeeG), and the Electricity Grid Act (EnWG, NABEG) regulates the offshore transmission grid to support this. • Marine spatial planning determines the location of offshore wind power, and the grid connection is built accordingly.

Source The authors.

3.4.2 Comparison of European, the UK, and German offshore wind and power grid policy strategies

(1) Deriving similarities

A systematic approach to expanding renewable energy

The European Union (EU), the United Kingdom, and Germany all employ a systematic approach to expanding renewable energy, and each operates in conjunction with its own laws and policies. The UK's Climate Change Act, Germany's EEG (Renewable Energy Act), and the EU's RED (Renewable Energy Directive) provide the basic framework for expanding renewable energy, and countries are promoting the development of offshore wind power and power grids based on this. In particular, offshore wind power is considered a key energy source for achieving carbon neutrality, and the power grid and marine spatial planning are being coordinated to operate it effectively.

Integrated operation of the power grid and offshore wind power

In addition, as offshore wind power generation increases, countries are strengthening their policies for integrated operation with the power grid. The UK is promoting power grid optimization through the Offshore Transmission Network Reform (OTNR) and the Electricity Network Integration Plan (HND), while Germany is supporting the smooth transmission of renewable energy power through the Electricity Network Act (EnWG) and the Accelerated Expansion of Electricity Networks Act (NABEG). At the EU level, the TEN-E (Trans-European Energy Network) and the EU Action Plan for Grids are also laying the policy foundation for the expansion of inter-state power grids and the connection of offshore wind farms.

Marine Spatial Planning (MSP) and the connection of offshore wind farms

Marine Spatial Planning (MSP) plays a vital role in coordinating the development of offshore wind farms and the construction of power grids. Countries coordinate the location of offshore wind farms and assess their environmental impact through the MSP Directive (EU), WindSeeG (German Offshore Wind Act), and ONDP (Offshore Network Development Plan), thereby efficiently allocating marine space. Through this policy coordination, countries harmoniously promote offshore wind power generation and power grid expansion and establish a sustainable energy transition system.

(2) Comparing differences

The table below summarizes the differences in offshore wind power generation and power grid policies in the Europe, the United Kingdom, and Germany (See Table 42).

Table 42 **Differences in offshore wind and power grid policies in the Europe, the UK, and Germany**

Category	EU	The UK	Germany
Connection of renewable energy and the power grid	• TEN-E Regulation and EU Action Plan for Grids coordinate electricity network and renewable energy policies in each country • Focus on expanding power grid connections across the EU and strengthening energy exchanges between countries	• Through the Clean Power 2030 plan, the expansion of the power grid and renewable energy are considered in an integrated manner • Through OTNR and HND, the existing individual transmission grid method is being transformed into a 'network-based' approach	• The EEG and EnWG/NABEG function as a unified system for renewable energy and electricity networks • Electricity network expansion and coordination are managed by the EnWG and the NABEG, and plans are established to consider the connection with renewable energy generation
Renewable energy and offshore wind power	• Promote inter-country offshore wind energy cooperation at the EU level to develop a joint transmission network. • The approach to strengthening the EU's entire network through the Offshore Renewable Energy Strategy	• OTNR (Offshore Transmission Network Review) is undergoing reforms to integrate offshore wind power generation and power grid connections • Planning a 'shared' network between offshore wind power plants, rather than a centralized one	• WindSeeG designates offshore wind plant locations while considering grid connections • The connection method from offshore wind farms to the onshore power grid is based on the connection of the transmission network for each individual project, but in the long term, discussions are underway to build an integrated offshore transmission network
Linkage with marine spatial planning	• Aim to coordinate the entire EU marine space through the MSP Directive • Guide the efficient expansion of offshore wind power networks through the Offshore Network Development Plan (ONDP)	• Marine Spatial Planning (MSP) considers offshore wind power and marine ecosystem protection at the same time • Evaluate environmental and social impacts when determining offshore wind power locations	• The Spatial Planning Act coordinates marine space for offshore wind power and transmission grid construction in conjunction with WindSeeG and NABEG • Establish plans for the allocation of marine space and infrastructure development by reflecting the offshore wind development targets set by EEG and WindSeeG

Source The authors.

3.4.3 Policy comparison for enhancing the efficiency of environmental impact assessment (EIA) implementation

(1) Preliminary detailed planning and roadmapping

EU: The EU recommends establishing an evaluation roadmap from the project concept stage under the TEN-E Regulation, and scoping is used to identify legal requirements and expected environmental impacts at an early stage.

UK: Strategic pre-selection is carried out based on the FES and ETYS reports of National Grid ESO when selecting locations for power grids and offshore wind farms, and scoping is carried out to set the scope of the environmental impact assessment (EIA) in the Development Consent Order (DCO) process.

Germany: The procedure for expanding the power grid is divided into five stages: scenario setting, the National Energy Plan (NEP), the Federal Requirements Plan (BBPlG), the Federal Sector Plan, and plan approval. Plans are established with a SEA conducted at the scenario planning stage.

(2) Integrated operation of EIA, SEA, and AA

EU: The tiering principle between strategic environmental assessment (SEA), environmental impact assessment (EIA), and Appropriate Assessment (AA) is applied to ensure that the results of the evaluations of the higher-level plan are reflected in lower-level assessments, thereby preventing redundant assessment.

UK: SEAs are conducted in advance in connection with the Marine Spatial Plan (MSP). For offshore wind projects, data from previous surveys and studies is stored on the OWEER platform. This data can be used to minimize the scope of environmental assessments and prevent redundancies.

Germany: SEAs are legally required at the NEP, BBPlG, and Federal Sector Planning stages, and an EIA is conducted at the final plan approval stage.

(3) Licensing system and one-stop-shop operation

EU: Under the TEN-E regulations, one of the following licensing systems can be selected: integrated, coordinated, or cooperative, and the central authority is designed to coordinate the entire environmental assessment process.

UK: The DCO system is operated under the Planning Act 2008, and the Planning Inspectorate (PI) manages all procedures, including environmental assessment, public hearings, and approval

recommendations, in an integrated manner.

Germany: A consistent federal procedure is operated from planning to approval in accordance with NABEG and BBPlG, and the Federal Network Agency (BNetzA) is responsible for this.

(4) Data collection, sharing and evaluation quality control

EU: The EU provides the necessary environmental information through public data-based platforms such as Natura 2000 Viewer and recommends external expert review to ensure the quality of the assessment report.

UK: The UK has established the Offshore Wind Environmental Evidence Register (OWEER) to share ecological survey data related to offshore wind power and is strengthening digital-based information accessibility.

Germany: The public hearing and consultation procedures at each stage are specified, and the data collected in the SEA process is institutionalized for reuse in EIAs.

(5) Environmental consultation process

EU: A joint cooperation procedure based on the ESPOO Convention and the SEA Protocol is being established, and a European Coordinator can be appointed if necessary.

UK: Projects subject to DCOs can include consultations other countries in accordance with international agreements, but the consultation method is decided autonomously on a case- by-case basis.

Germany: Germany established pre-project consultation procedure for connecting cross-border power grids and operates an assessment system that considers cross-border environmental impacts, including SEA.

(6) Public participation structure

EU: The EU requires that the initial roadmap stage include a plan for public participation, and it specifies that information access and public hearings are guaranteed based on the EIA/SEA and the Aarhus Convention.

UK: UK law does not obligate developers or authorities to actively engage the public, but public participation is strongly recommended at an early stage, and public hearings and briefings are also actively encouraged.

Germany: There is a procedure for collecting public opinions and filing objections at each stage, and a substantive consultation structure operates in addition to the formal procedures specified in the law.

(7) Special and latest system changes

EU: Various legal frameworks such as TEN-E, RED, MSP, and ONDP are being promoted in a mutually linked manner, and the EU is also providing a toolkit and financial support to improve the quality of EIA.

UK: The existing EIA/SEA system will be converted to an EOR system under the Levelling Up and Regeneration Act, which was announced in 2023, with the aim of achieving results-oriented decision-making and streamline procedures.

Germany: Early SEAs are being carried out to prevent last-minute changes to transmission routes and head off potential conflicts in advance, and alternative routes are considered from the early stages of planning (See Table 43 and Table 44).

Table 43 Comparison of EIA streamlining schemes

Category	EU	Germany	The UK
System Objective	• Streamline and integrate the assessment for achieving the TEN-E and RED objectives (especially for PCI/PMI)	• Conduct efficient EIA in the integrated permitting process for NSIPs	• Streamline EIA and minimize conflicts through a step-by-step preliminary environmental review
Legal basis	• TEN-E Regulation (2022/869) • RED III (2023/2413) • SEA/EIA Directive (2001/42/EC, 2011/92/EU)	• Planning Act 2008, EIA Regs 2017, NSIP Guidelines	• NABEG, BBPlG, EEG, WindSeeG, etc.
Evaluation structure	• Integration (tiering) between SEA–EIA–AA • Mandatory evaluation roadmap	• Including EIA in the Development Consent Order (DCO) • Implementer-centric procedure	• Five-step system: • Scenario → NEP → BBPlG → Sector Plan → Final EIA approval
Strategic environmental assessment (SEA)	• **Legal obligation** • Implementation from the planning stage	• Not a direct obligation • Linked to MSP and marine-related SEA	• **Legal obligation** • BBPlG and sectoral planning stage

Table 43 **(continued)**

Category	EU	Germany	The UK
Environmental impact assessment (EIA)	• Streamlining or exemption possible within e designated area (provided that conditions are met)	• Mandatory within the DCO procedure • Scope adjustment through initial consultation	• Implementation at the final approval stage • Efficiency improvement based on the results of the SEA
Appropriateness Assessment (AA)	• Mandatory when Natura 2000 is affected • Scientific review throughout the entire process	• Response, including in EIA, when marine protected areas are affected	• Initial review and avoidance strategy in conjunction with SEA and EIA
Initial consultation and participation	• Encourage participation of residents and stakeholders in the evaluation roadmap and scoping stage	• Pre-application (pre-app) is mandatory • Encourage voluntary participation under the supervision of the PI	• Strengthen the public hearing and objection system at each stage
Data and digitization	• atura2000 Viewer, integrated portal • Recommendation to share SEA/EIA results	• Use of OWEER data platform (offshore wind ecological information, etc.)	• BNetzA-centric data management and opinion gathering procedures
Other special notes	• EIA exemption possible when designating dedicated infrastructure zones • Introduction of 30-day preliminary screening, etc.	• EOR (Environmental Performance-Based Report) system to be introduced	• Minimization of conflicts and securing of project stability through review of transition zones based on SEA

Source The authors.

Table 44 Key factors related to EIA streamlining

Category	EU	Germany	The UK
SEA utilization	O Mandatory	△ Limited (mainly related to the ocean)	O Mandatory
EIA streamlining method	Designation of a dedicated area + tiering + streamlined screening	Scope adjustment + data sharing	Based on an initial SEA, alternative route review
Initial consultation structure	Emphasis on resident participation in the roadmap and scoping stages	Mandatory pre-application consultation	Legalization of public hearings and opinion collection system
Appropriateness assessment (AA)	Required when impacts on protected areas, scientific evidence required	Indirectly reflected (if necessary)	Reflected in SEA, avoidance considered first

Source The authors.

3.4.4 Governance structure comparison

(1) EU: Multilevel and coordination-based governance structure

The EU's energy and renewable energy governance system is composed of a multi-level and coordination-based structure. This stems from the structural characteristics of the EU as a political and economic union involving multiple member states rather than a single country, and it adopts a method of coordinating transnational integration and cooperation while guaranteeing the policy autonomy of individual countries. The EU's governance system reflects its complexity, being a collection of many nations, but it balances integration and autonomy through an efficient coordination mechanism to achieve common goals.

Policy formulation and enforcement: European Commission

Policies and legislation are established at the EU level, with the European Commission, particularly the Directorate-General for Energy (DG ENER), playing a central role. The Commission is responsible for setting overall EU renewable energy targets, the EU Offshore Renewable Energy Strategy, the Renewable Energy Directive (RED), the EIA/SEA Directive, the Marine Spatial Planning (MSP) Directive, and the TEN-E Regulation, as well as monitoring implementation in member states. The EU's energy targets are linked to the autonomous plans of each country, and the Commission intends to adjust the differences between countries through policy guidance and financial support.

Licensing and coordination of transboundary projects: TEN-E and European Coordinating Point System

Among energy infrastructure projects, transboundary and strategic projects are designated as Projects of Common Interest (PCI) under the TEN-E Regulation (EU 2022/869). PCIs pursue pan-European interests, such as connecting national power grids and building offshore wind power transmission infrastructure, and can receive special exemptions such as streamlined licensing, coordinated environmental assessment, and joint funding. Member states shall carry out environmental assessments and permits such as EIA and SEA based on their own licensing systems, but in the event of transboundary conflicts or bottlenecks, the Commission may appoint a European Coordinator mediate. This system plays an important role in the development of infrastructure with strong cross-border connectivity, such as offshore wind power and HVDC (high-voltage direct current) transmission networks.

Technical and operational governance: ENTSO-E and ACER

The EU has a coordination system not only at the policy level but also at the working level. ENTSO-E (European Network of Transmission System Operators for Electricity) is a consultative body in which transmission network operators across Europe participate, and it performs functions such as planning the operation of the power grid, integrating the transmission network, and standardizing technologies. For example, ENTSO-E coordinates long-term transmission network planning by establishing a Ten-Year Network Development Plan (TYNDP). ACER (Agency for the Cooperation of Energy Regulators) is an independent body that performs market regulation harmonization and investment reviews of energy regulators in member states, and it is responsible for coordinating functions related to cross-border transactions in the electricity market.

Renewable energy policy based on cooperation

The EU sets overall targets through the Renewable Energy Directive (RED), etc. Member states set and implement individual targets according to their energy mix and national priorities. Each country uses EU-level technical support, funds, and directives to develop plans and reports their National Energy Plans (NECP) to the Commission. This is typical of EU-style governance, which seeks to strike a balance between flexibility and harmony. In addition, the location of offshore wind farms is determined by each country's Marine Spatial Plan (MSP), but this requires connectivity at the EU level in accordance with the MSP Directive (Directive 2014/89/EU). If there is a need for competition or coordination between national plans, ENTSO-E and the Commission will arbitrate (See Table 45).

Table 45 Features of the EU's energy governance structure

Category	Description
Structure	• Multi-layered governance based on EU directives and member state implementation
Policy actors	• European Commission (DG ENER), ACER (regulatory coordination), ENTSO-E (technical coordination)
Licensing & coordination	• Each country takes the lead in licensing under the TEN-E regulations • Cross-border projects can be designated as EU coordinators
Environmental planning	• Both SEA and EIA are mandatory • Emphasis on tiering
Public participation	• Guarantee of the right to access information, participate, and seek judicial relief based on the Aarhus Convention
Data & funding	• Provision of data such as the Natura 2000 viewer • Availability of EU funds such as CEF and Horizon
Features	• Strengthening of transboundary cooperation • Harmonization of autonomy and common goals • Integrated coordination of institutional, technological, and environmental functions

Source The authors.

(2) UK: Centralized integrated governance structure

The UK is establishing a central government-led integrated governance system for the development of large-scale energy infrastructure, including renewable energy, power grids, and offshore wind power. This governance structure focuses on minimizing overlapping procedures and administrative delays between multiple ministries and improving the predictability and efficiency of project implementation through a clear division of roles centered on a central agency and an integrated policy and licensing system. Overall, the UK maintains a centralized policy-making and licensing management system centered on DESNZ, while maintaining a clear division of roles between key agencies that perform different functions. This can be evaluated as a unified governance model with relatively high levels of integration and policy consistency, compared to a dualized structure in EU member states such as Germany.

Energy policy oversight: DESNZ

First, the formulation and strategic coordination of energy policy is overseen by the Department for Energy Security and Net-Zero (DESNZ). Since its establishment in 2023, DESNZ has been promoting the expansion of renewable energy, strengthening energy security, and reorganizing the electricity market as its main policy goals. DESNZ also attracts investment and implements incentive policies to achieve long-term climate goals at the national level, and determines the policy direction for

large-scale infrastructure such as power grids and offshore wind power.

Electricity grid operation: National Grid ESO

National Grid ESO is rthe UK's national grid operators, responsible for managing electricity demand and ensuring the stable supply and delivery of electric power across the country. In late 2024 it was nationalized and designated as the UK's (Independent System Operator, ISO), and is set to play a more public-interest-oriented and neutral role going forward.

Marine planning and permitting: MMO

The Marine Management Organisation (MMO) has the authority to plan and license offshore wind farms. The MMO establishes the Marine Spatial Plan (MSP) for the waters of the UK and reviews the suitability and legal requirements of individual projects based on the plan. The MMO promotes harmony between marine ecosystems and marine activities by conducting strategic environmental assessments (SEA) early in the project planning stages.

Managing offshore locations: The Crown Estate and Crown Estate Scotland

The Crown Estate and Crown Estate Scotland hold the rights to lease and manage offshore wind farm sites, and they operate by allocating sites through project-specific bidding and charging rent. In other words, if a private operator wants to develop offshore wind power, it must secure a site from these agencies in advance, which contributes to strengthening fairness and transparency.

Energy market regulation: Ofgem

In addition, Ofgem (Office of Gas and Electricity Markets) is the UK's energy market regulator, responsible for stabilizing energy prices, reviewing regulations on transmission and distribution investments, and protecting consumers. It plays a key role in determining how to recoup investments in power grid expansion and interconnection facilities, often through direct links to the project's profit structure.

Licensing and environmental impact assessment: DCO System

In terms of environmental impact assessment, the UK operates the Development Consent Order (DCO) system based on the 2008 Planning Act, and for National Significant Infrastructure Projects (NSIPs), all procedures, including environmental impact assessment (EIA), technical review, public consultation, and approval, are handled by a single central agency called the Planning Inspectorate (PI) as part of an integrated system. DCO is mainly applied to power grids and offshore wind projects, enabling predictable schedules and streamlined procedures (See Table 46).

Table 46 Features of the UK's energy governance structure

Category	Description
Structure	• Central government-led integrated governance system
Policy actors	• DESNZ (energy policy), PI (planning assessment body), MMO (marine space), National Grid ESO (electricity grid), Crown Estate (location), Ofgem (regulation)
Licensing & coordination	• DCO: unified permitting by Planning Inspectorate (PI), including EIA, review, and consultation
Environmental planning	• EIA is included in the DCO procedure • MSP-based SEA is conducted in advance (organized by MMO)
Public participation	• Encourage resident participation in the initial consultation and scoping process • Hold official public hearings
Data & funding	• Operate OWEER (shared platform) • Based on central government funding and private profit
Features	• High speed and predictability • Integrated processing without multiple departments

Source The authors.

(3) Germany: Decentralized federal governance

Power grid development: A five-step legislative-based procedure and a federal- state cooperation structure

Germany's energy and renewable energy governance system is decentralized and operates using a step-by-step process grounded in legislation that reflects the characteristics of a federal state. The structure is one in which the central and state governments clearly separate their powers but cooperate with each other. In particular, a sophisticated process is in place under the law for large-scale infrastructure projects such as the expansion of the power grid and the development of offshore wind power. The expansion of the German power grid is carried out in stages through cooperation between the federal and state governments, and the procedures for developing the power grid are systematized into a total of five steps. This process is centered on the National Action Plan for the Expansion of the Electricity Grid (NABEG), enacted in 2011, and each step clearly distinguishes the roles of the central and local governments based on relevant laws. Germany is expanding its electricity grid infrastructure based on the legal basis for each step and the division of roles between the federal and state governments, and is building a predictable and reliable infrastructure development system that considers environmental acceptability and seeks to prevent social conflicts in the early stages of project planning.

"The first step is to establish a scenario framework, which will lay out the basic strategy by reflecting long-term power demand forecasts and renewable energy expansion targets. In the next step, the National Electricity Network Plan (NEP) stage, the four transmission system operators (TSOs) will establish plans for medium- to long-term grid expansion, which will be reviewed by the Federal Network Agency (BNetzA), after which a strategic environmental assessment (SEA) will be carried out.

In the third stage, the BBPlG selects with proven environmental and public feasibility and submits them to the Bundestag, which must approve or dismiss them. The subsequent stage of the Federal Sector Plan involves a detailed review and public hearing of alternative routes and technical feasibility. In the final stage of plan approval, an environmental impact assessment (EIA) is carried out, and the state is responsible for the practical implementation of construction permits, compensation, and handling of complaints.

Offshore wind power development: A centralized coordination system centered on WindSeeG

In terms of offshore wind power development, Germany has a relatively centralized coordination structure, and the relevant procedures are operated mainly under the Offshore Wind Power Act (WindSeeG) and the Renewable Energy Act (EEG). In this system, marine spatial planning, site designation, auction procedures, and grid connection are clearly defined by law. The location and planning of the complex in the maritime space is organized by the Federal Maritime and Hydrographic Agency (BSH), which establishes the Maritime Spatial Plan (MSP) and controls the bidding process. Once the location for an proposed offshore facility is selected, the Federal Network Agency (BNetzA) will coordinate the construction of the transmission infrastructure that connects the project to the land-based power grid. Germany has a system in place that integrates the management of offshore wind power and the power grid, with the state responsible for connecting offshore wind power generation facilities to transmission infrastructure. As a result, the offshore location and the associated network are not separated but coordinated, and each state with relevant stakeholders with local residents and obtaining site permits. It is in this way that offshore wind power development in depending on coordination between the federal government and local authorities to make strategic use of marine space and efficiently connect transmission infrastructure.

Policy establishment and budget: Planning at the federal level, implementation at the state level

The overall energy policy is established under the federal government's leadership, and the Federal Ministry for Economic Affairs, Energy, and the Environment (BMWK) is responsible for national renewable energy targets, support policies, and budget allocation. The BMWK plays a wide range of

roles, including cooperation with the European Union (EU) and implementation of international climate targets, and operates a national renewable energy roadmap and budget support system. The development of the transmission grid and coordination of the transmission business are mainly handled by the Federal Network Agency (BNetzA), while the Federal Maritime and Hydrographic Agency (BSH) is in charge of offshore wind locations and permits. These are all agencies under the central government and have strong coordination authority in the planning and assessment stages. Meanwhile, each state (Land) has the executive authority to conduct specific licensing, public consultation, and compensation decisions for energy projects. This allows for different renewable energy targets and implementation speeds from state to state, and is designed to harmonize the federal government's strategic goals with the on-site enforcement power of the state governments. Ultimately, Germany is promoting the energy transition and expanding renewable energy through a multi-layered and decentralized governance system that combines strategic planning by the central government and implementation by state governments, and is characterized by a sophisticated legal division of roles (See Table 47).

Table 47 **Features of Germany's energy governance structure**

Category	Description
Structure	• Federal and state decentralized governance based on a five-step legal framework (NABEG-based)
Policy actors	• BMWK (Federal Ministry for Economic Affairs and Climate Protection), BNetzA (power grid), BSH (maritime), state governments
Licensing & coordination	• Federal planning (BNetzA) • Licensing, compensation, etc. are carried out by the state governments
Environmental planning	• SEA legally required at early planning stages (NEP, BBPlG) • EIA at final approval stage
Public participation	• Formal opinion gathering, public hearings, and objection procedures are specified at each stage.
Data & funding	• Data collected at the SEA stage is reused in the EIA • State-specific support systems vary
Features	• High reliability of plans • However, coordination between states and political consultation may take time

Source The authors.

(4) Comparison of governance structures

The European Union has established its renewable energy objectives through the Renewable Energy Directive (RED), aiming to harmonize member states' efforts to expand clean energy. Alongside this, legal frameworks such as the TEN-E Regulation and the EU Action Plan for Grids strengthen

cross-border electricity transmission infrastructure. The integration of offshore wind development is guided by RED and TEN-E and coordinated through the Maritime Spatial Planning (MSP) Directive, which seeks a balance between ecological protection and offshore energy development. The Offshore Network Development Plan (ONDP) complements this framework by coordinating marine spatial plans with electricity grid expansion, ensuring offshore wind generation is efficiently connected to national power systems.

The United Kingdom, under its Clean Power 2030 Action Plan, has adopted a comprehensive approach that links renewable energy deployment—particularly offshore wind—with grid modernization. This strategy is operationalized through the Holistic Network Design (HND), which outlines a coordinated design for offshore and onshore networks. The Offshore Transmission Network Review (OTNR) plays a central role in enhancing the connection of offshore wind farms and the national grid. Furthermore, the integration of MSP with the HND allows for optimized site selection and transmission route planning, improving infrastructure development's efficiency and social acceptability.

Germany has pursued a similarly integrated path, using the Renewable Energy Sources Act (EEG) and the Energy Industry Act (EnWG), along with the Grid Expansion Acceleration Act (NABEG), to link renewable expansion with transmission planning. The WindSeeG legislation provides a legal foundation for offshore wind development, including site designation, permitting, and grid connection. Maritime spatial planning is implemented through the Flächenentwicklungsplan (FEP), which aligns offshore wind zones with onshore grid infrastructure. The country's grid development strategy (Netzentwicklungsplan, NEP) is closely coordinated with these spatial plans, facilitating seamless power transfer from offshore sites to inland demand centers. Germany's grid is also directly linked to the broader EU electricity network, ensuring regulatory consistency with European standards.

A common policy direction is evident across the EU, the UK, and Germany. Each has developed an integrated legal and planning framework to advance renewable energy, with offshore wind identified as a central pillar of their clean energy transitions. There is a shared recognition that energy infrastructure—especially transmission infrastructure for offshore renewable energy projects—must be planned alongside power generation projects to avoid bottlenecks and inefficiencies. Legal instruments in these countries aim to harmonize renewable energy targets, grid expansion strategies, and marine spatial planning, allowing for environmental safeguarding and infrastructure deployment. The integration of these domains ensures that the energy transition is technically feasible, institutionally coordinated, and spatially optimized (See Table 48).

Table 48 **Key factors related to governance structures**

Category	EU	The UK	Germany
Governance structure	Multi-layered, coordinated structure	Central government-centered integrated structure	Legislation-based, Federal decentralized structure
Key coordinator	EU Commission, ENTSO-E, ACER	DESNZ, PI, MMO, Ofgem, National Grid, etc.	NetzA, BMWK, BSH, State Governments
SEA/EIA integration	Tiered SEA/EIA integration emphasized	SEA in MSP; EIA via DCO	SEA at planning; EIA at final stage
Licensing framework	member states lead, EU supports for PCIs	DCO unified process for NSIPs	NABEG 5-step legal path
Public engagement	Aarhus Convention-based, early scoping	Encouraged early-stage consultation by PI	Formal public consultation at each stage
Cross-border projects	Mandatory EU coordination for PCIs	Via international agreements, case-specific	Possible but state-led
Flexibility vs. speed	High coordination, lower speed	High speed, centralized control	High legitimacy, lower speed

Source The authors.

Chapter 4

Policy Implications

4.1 Directions of policy improvement

In South Korea, renewable energy sources such as offshore wind power are expanding nationwide, but power grid to support them is severely lacking. This has led the Korea Electric Power Corporation (KEPCO) the largest electric utility in Korea, to take measures to curtail output that the grid cannot accommodate, while private entities build transmission infrastructure to connect offshore wind power to the onshore grid. It is against this backdrop that this study reviewed policies and renewable energy case studies from the United Kingdom, the European Union, and Germany. These countries have successfully enhanced their power grids to support the expansion of offshore wind—which has the largest generation capacity among all sources of renewable energy—and this cases carry serious implications for renewable energy power grid policy in Korea (See Table 49).

Table 49 **Comparison of onshore and offshore aspects of domestic and international power grids**

Category	EU	Germany	The UK	South Korea
Onshore	Onshore and offshore grid integration plan	Regional development, offshore connection line	Integrated design of offshore and onshore grids and substations Based on the HND method	Surveying in accordance with the Electric Power Development Promotion Act
Offshore	Separate configuration of offshore power grid items	Submarine connection lines		-

Source The authors.

In the EU, Germany, and the UK, electricity grid legislation encompasses both offshore and onshore grids. The national laws of Germany and the UK also include provisions for spatial planning related to the onshore connection of offshore grids, such as substations and grid connection points. In South Korea, offshore-related matters in the Special Act on Electricity Grids are limited to advisory opinions from appointed members of the Electricity Grid Committee specializing in the marine sector. Among various fields, only three experts with extensive knowledge and experience in marine affairs meaning that marine expertise may be lacking. Offshore-related matters are currently limited to maritime traffic and agenda processing, lacking integration and alignment with marine spatial planning, the Offshore Wind Power Act, and other related regulations (See Tables 50 to 54).

Table 50 **EU grid law**

Regulation (EU) 2022/869 of the European Parliament and of the Council of 30 May 2022 on guidelines for trans-European energy infrastructure, amending Regulations (EC) No 715/2009, (EU) 2019/942 and (EU) 2019/943 and Directives 2009/73/EC and (EU) 2019/944, and repealing Regulation (EU) No 347/2013
CHAPTER V Offshore grids for renewable integration Article 14 Offshore grid planning
3. The high-level strategic integrated offshore network development plans shall be consistent with regional investment plans published pursuant to Article 34(1) of Regulation (EU) 2019/943 and integrated within the Union-wide ten-year network development plans in order to ensure coherent development of onshore and offshore grid planning and the necessary reinforcements.

Source EU Law Information Center, "REGULATION (EU) 2022/869 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2022 on guidelines for trans-European energy infrastructure, amending Regulations (EC) No 715/2009, (EU) 2019/942 and (EU) 2019/943 and Directives 2009/73/EC and (EU) 2019/944, and repealing Regulation (EU) No 347/2013", accessed on December 1, 2024.

Table 51 **EU grid implementation law**

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Grids, the missing link - An EU Action Plan for Grids
Action 2: ENTSO-E to enhance top-down planning towards 2050 by integrating the identification of offshore and onshore system needs and further considering hydrogen
Cross-border transmission infrastructure development builds on a decade of experience in pan-European network planning through the ten-year network development plans (TYNDP). The revised TEN-E Regulation adopted in 2022 went a step further by making the long-term direction set by member states on regional offshore ambitions to 2050 the starting point for the offshore network planning exercise, closing the gap between policy expectations and grid development. This strategic long-term logic currently implemented in the first offshore network development plans (ONDPs) due on January 2024 should be expanded to the rest of the European network with the objective of bringing together offshore and onshore network planning under a common framework through the next TYNDP process.

Source EU Legislation Information Center, "COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, Grids, the missing link - An EU Action Plan for Grids", accessed on December 1, 2024.

Table 52 German grid law

Grid Expansion Acceleration Act for Transmission Networks (NABEG)
§ 2 Scope of Application, Authorization to Issue Regulations
(1) This law applies only to the construction or modification of interregional or cross-border extra-high voltage lines and offshore connection lines that are designated as such in a law on the Federal Requirement Plan pursuant to § 12e (4) sentence 1 of the Energy Industry Act. § 18 (2) remains unaffected.
§ 4 Purpose of Federal Spatial Planning
For extra-high voltage lines designated as interregional, cross-border, or offshore connection lines in a law on the Federal Requirement Plan pursuant to § 12e (4) sentence 1 of the Energy Industry Act, the Federal Spatial Planning determines route corridors. These corridors serve as the basis for the subsequent planning approval procedures.
§ 5 Content of Federal Spatial Planning
(6) When conducting federal spatial planning for offshore connection lines, the Federal Network Agency must take into account the area development plan in accordance with § 5 of the Offshore Wind Energy Act in its current version.
§ 17 Federal Grid Plan
The route corridors determined through federal spatial planning, as well as the routes or route corridors designated for offshore connection lines and cross-border power lines in the current area development plan pursuant to § 5 of the Offshore Wind Energy Act, are included in the Federal Grid Plan for informational purposes. The Federal Grid Plan is maintained by the Federal Network Agency and must be published by the agency once per calendar year in the Federal Gazette.
§ 18 Requirement for Planning Approval
(1) The construction, operation, and modification of lines as defined in § 2 (1), except for ancillary facilities of offshore connection lines, require planning approval from the competent authority.
(2) Upon request by the project developer, facilities necessary for operation, particularly converter stations, phase shifters, substations, and grid connection points, including ancillary facilities of offshore connection lines, may be approved through planning approval by the competent authority pursuant to paragraph (1). These facilities may be integrated into the planning approval procedure for lines as defined in § 2 (1). A subsequent integration into the planning approval decision through a supplementary planning procedure is possible as long as the planning approval decision remains valid.

Source German Federal Ministry of Justice and Consumer Protection, "Netzausbaubeschleunigungsgesetz Übertragungsnetz (NABEG)", accessed on January 10, 2025.

Table 53 The UK's grid policy

Offshore transmission network review
Offshore wind generation plays a central role in decarbonising our energy system to reach net-zero and to meet growing consumer demand. The UK is aiming to generate 50GW of secure, home-grown offshore wind power by 2030. As we increase offshore wind generation, we will need to reinforce the onshore and offshore transmission network infrastructure to deliver the energy from wind farms at sea to consumers across Great Britain. The transmission infrastructure and why we need more of it To achieve our 2030 ambition, we need to transform Great Britain's energy system. We are working to enable the most efficient and coordinated grid reinforcement to be delivered by relevant parties, keeping new developments to a minimum. However, the transition to net-zero will need to be underpinned by new network infrastructure across GB, both onshore and offshore, to meet the scale and pace of demand, and to transport electricity where it is best placed to be generated, to where it is needed most. Transmission infrastructure is required to transfer the electricity generated offshore, onshore. Overhead lines, underground cables (in designated areas), substations and sub-sea cables are key components of transmission infrastructure.

Source UK Government, "Offshore Transmission Network Review", accessed on March 23, 2025.

Table 54 South Korean grid law

Special Act on the Expansion of the National Core Power Grid
Article 9 (Composition and Operation of the Electricity Grid Committee) ① The Electricity Grid Committee shall be composed of approximately 35 members, including one chairperson. The Prime Minister shall serve as the chairperson, and the members shall be as follows: Ex officio members: a. The Ministers of Strategy and Finance, Land, Infrastructure and Transport, Environment, Interior and Safety, and Trade, Industry and Energy, as well as the heads of other relevant central administrative agencies specified by Presidential Decree. b. Certain Metropolitan Mayors, Special Self-Governing Mayors, Governors, and Special Self-Governing Province Governors designated by Presidential Decree in accordance with Article 106 of the Local Autonomy Act. Appointed members: Three experts recommended by the Prime Minister and three experts recommended by the relevant National Assembly Standing Committee. These members shall be individuals with extensive knowledge and experience in fields such as energy and resources, disaster management, environment and marine environment, forestry, fisheries, land use, science and technology, advanced future industries, conflict mediation, and power facility development. Article 13 (Deemed Approval and Authorization under Other Laws) ① When a project implementer receives approval or modification approval for an implementation plan under Article 11, it shall be deemed to have obtained the following approvals, permits, licenses, notifications, designations, decisions, consents, consultations, deregulations, reviews, registrations, or dispositions (hereinafter referred to as "approvals and authorizations"). Furthermore, when an implementation plan is publicly announced under Article 11(7), the approvals and authorizations required under the following laws shall be considered publicly announced or published. 21. The Maritime Traffic Safety Act, Article 13: Maritime Traffic Safety Assessment.

Source Korea National Law Information Center, "Special Act on Expansion of National Power Grid".

Table 55 **South Korean offshore wind law**

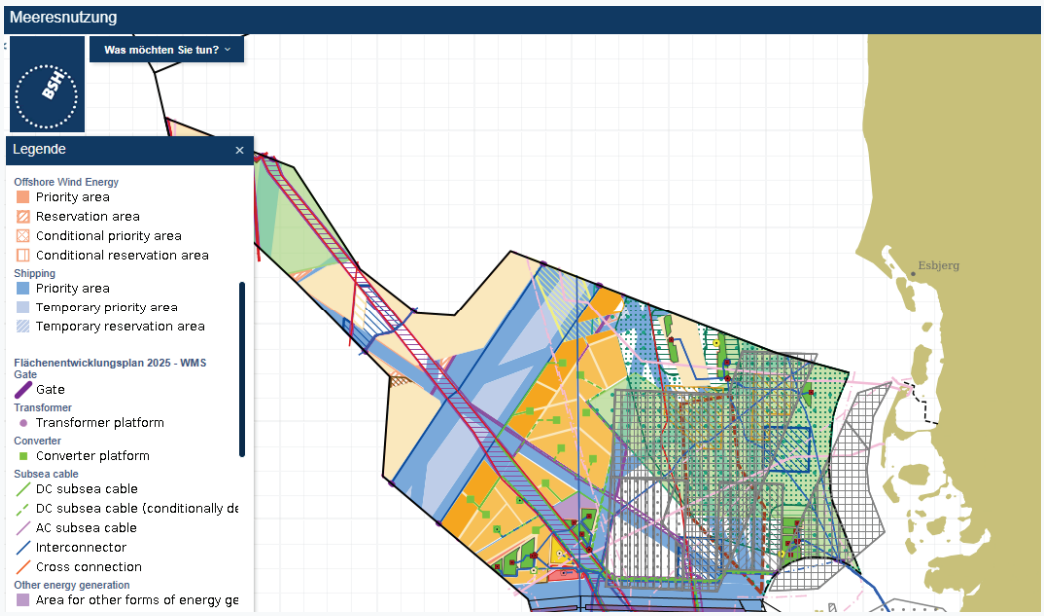
Special Act on the Expansion of the National Core Power Grid
Article 2 (Definitions)
The terms used in this Act are defined as follows:
5. "Basic design" refers to the preliminary design for the installation of offshore wind power facilities in a designated preliminary zone. This design is based on location information, wind conditions, and other relevant data and includes the layout of offshore wind power facilities, the capacity of offshore wind turbines, and the connection to the power grid as defined in Article 2(14) of the Electric Utility Act.
Article 3 (Responsibilities of the National and Local Governments, etc.)
⑦ The national and local governments shall cooperate to ensure the orderly deployment of offshore wind power, secure public acceptance, and facilitate offshore wind power grid integration to effectively establish and implement offshore wind power planned sites.
Article 19 (Designation of Power Generation Zones)
③ Before designating a power generation zone, the Minister of Trade, Industry, and Energy must request confirmation from the transmission operator, as defined in Article 2(6) of the Electric Utility Act, regarding the grid connection of the power generation zone and ensure the availability of grid access.
Article 20 (Grid Connection of Power Generation Zones)
① The Minister of Trade, Industry, and Energy may request the transmission operator, as defined in Article 2(6) of the Electric Utility Act, to construct shared connection facilities for power generation zones exceeding a certain scale, as specified by Presidential Decree, where multiple offshore wind power developers jointly use such facilities. In this case, the transmission operator must comply unless there are exceptional circumstances specified by Presidential Decree.
② The transmission operator may impose costs related to the construction, operation, and maintenance of the shared connection facilities on offshore wind power developers connecting to these facilities in accordance with Article 15 of the Electric Utility Act.

Source Korea National Law Information Center, "Special Act on the Expansion of the National Power Grid".

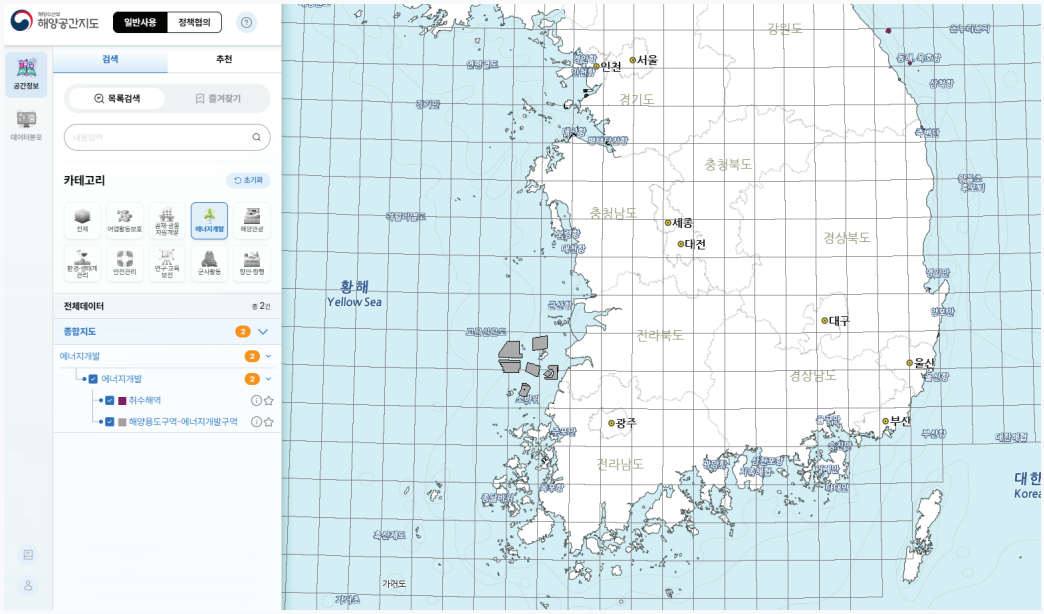
The Minister of Trade, Industry, and Energy mandates grid connections through KEPCO, the national transmission operator; however, discussions on how offshore wind power and the offshore power grid will be integrated with the onshore grid are lacking (See Table 57).

Their respective marine spatial plans clearly reflect the contrast between Germany and South Korea (Figure 26). Germany integrates offshore wind development with designated offshore grid corridors, whereas Korea's plan indicates only offshore wind sites without corresponding transmission grid planning. This gap is further evident in power grid planning (Figure 27). Germany presents a detailed layout showing how offshore wind power will connect to the onshore grid. In contrast, Korea identifies only two to three vague connection points on land, marked in red, suggesting multiple uncertain access points. This lack of clarity may lead to local conflicts and delays in future grid construction.

Figure 26 **Comparison of Marine Spatial Planning in Germany and Korea**

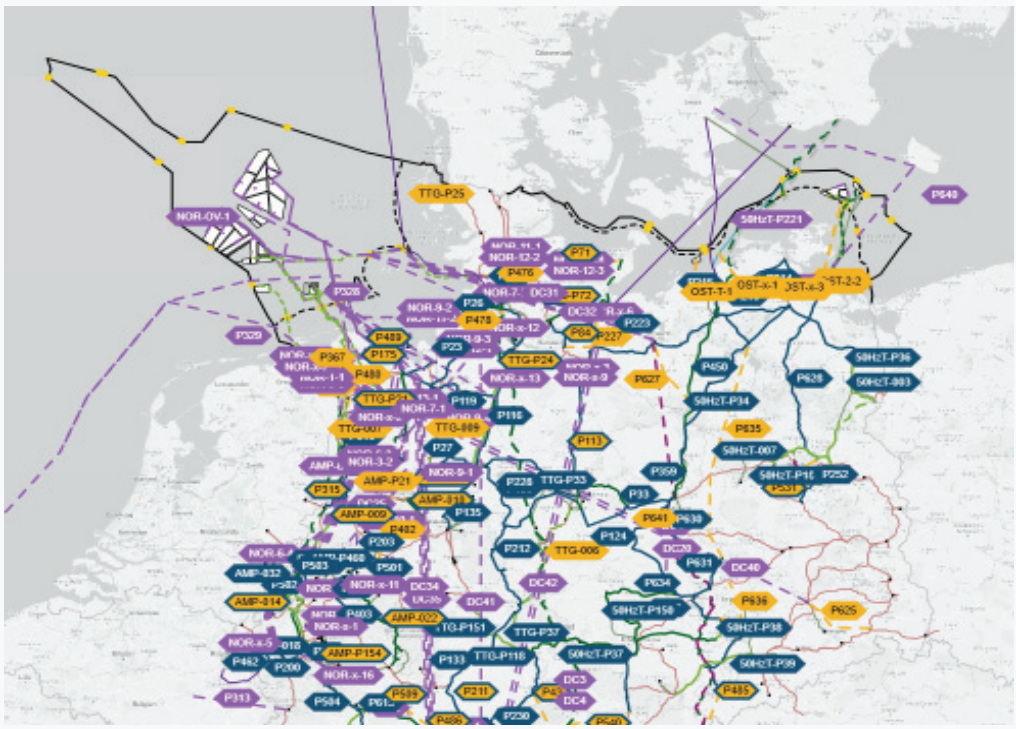


Note Germany's marine spatial plan. Note how it incorporates offshore wind power into grid planning.
Source German Maritime Spatial Planning System, "Marine Spatial Map", accessed on December 1, 2024.



Note South Korea's marine spatial plan, including wind power zoning.
Source Integrated Marine Spatial Management Information System, "Marine Spatial Map", accessed on December 1, 2024.

Figure 27 **Comparison of power grid status in Germany and Korea**



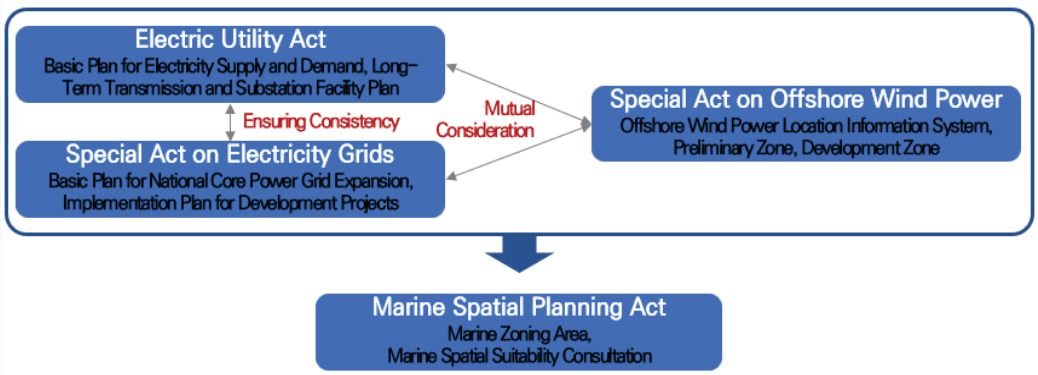
Note Germany's integrated offshore-onshore grid.
Source Netzentwicklungsplanstrom, "Projekte im NEP 2037/2045(2023)", accessed on March 6, 2025.

Note South Korea's power grid. Note the uncertain connection points between the onshore grid and offshore power generation facilities.
Source Electric Power Journal (EPJ), "[이슈체크] 국내 풍력시장 외산 기자재가 장악?…점유율 살펴보니", accessed on March 22, 2025.

4.2 Proposed legal improvements

It is necessary to establish a linkage structure between the Special Act on Electricity Grids and the Special Act on Offshore Wind Power (See Figure 28). When formulating the Basic Plan for Electricity Supply and Demand and the Long-Term Transmission and Substation Facility Plan under the Electric Utility Act, as well as the Basic Plan and Implementation Plan under the Special Act on Electricity Grids, considerations should include the Offshore Wind Power Location Information System, Preliminary Zones, and Development Zones stipulated in the Special Act on Offshore Wind Power.

Figure 28 **Establishing an interconnected legal framework**



Source The authors.

Similarly, when designating Preliminary Zones and Development Zones under the Special Act on Offshore Wind Power, provisions should be established to ensure alignment with the Basic Plan for Electricity Supply and Demand and the Long-Term Transmission and Substation Facility Plan under the Electric Utility Act, as well as the Basic Plan and Implementation Plan under the Special Act on Electricity Grids.

The Marine Spatial Planning Act should incorporate transmission and distribution in addition to energy development and production. By integrating transmission and distribution infrastructure into marine zoning regulations and marine spatial suitability consultations, constraints on offshore wind power development can be effectively mitigated (See Table 56). Therefore, the establishment of a legal interconnection framework is proposed to achieve the following three objectives:

To support this, we proposed establishing an interconnected legal framework. Doing so would help Korea achieve three key objectives: first, to incorporate considerations related to the Special Act on Offshore Wind Power into both the Electric Utility Act and the Special Act on Electricity Grids; second, to revise the Special Act on Offshore Wind Power to reflect considerations from the Special Act on

Electricity Grids—in addition to its existing references to the Basic Plan for Electricity Supply and Demand and the Offshore Wind Power Facility Plan; and third, to explicitly include transmission and distribution infrastructure within the scope of the Marine Spatial Planning Act.

Table 56 **Establishing an interconnected legal framework**

Category		Current Legislation	Proposed Revisions
"Electric Utility Act"	Basic Plan for Electricity Supply and Demand	Insufficient consideration of marine aspects	Consideration of the "Special Act on Offshore Wind Power"
"Special Act on Expansion of National Power Grid"	Definition		
	Basic Plan		
	Implementation Plan		
"Special Act on Offshore Wind Power"	Preliminary Zone	Consideration of the Offshore Wind Power Location Information System (including the power grid)	Consideration of the "Electric Utility Act" and "Special Act on Expansion of National Power Grid"
	Power Generation Zone	Power Grid Connection Plan proposal	
"Act on Marine Spatial Planning and Management"	Energy Development Zone	Marine Energy Development and Production Zone	Include "transmission"
	Marine Spatial Suitability Consultation		

Source The authors.

The following outlines the additions that incorporate considerations for the Special Act on Offshore Wind Power into the Electric Utility Act and the Special Act on Electricity Grids (See Tables 57 to 60).

Table 57 **Proposed revisions to the Electric Utility Act**

Category	Current	Revised	Remarks
Basic Plan for Electricity Supply and Demand	Article 25 (Formulation of the Basic Plan for Electricity Supply and Demand) ① The Minister of Trade, Industry, and Energy shall formulate a Basic Plan for Electricity Supply and Demand (hereinafter referred to as the "Basic Plan") to ensure stable electricity supply and demand. <Amended on March 23, 2013, and July 30, 2013> ② When formulating or modifying the Basic Plan, the Minister of Trade, Industry, and Energy must consult with the heads of relevant central administrative agencies, conduct public hearings to collect opinions, and finalize the plan after deliberation by the Electricity Policy Deliberation Committee under Article 47-2. However, if public hearings cannot be conducted normally due to unavoidable circumstances beyond the Minister's control, as specified by Presidential Decree, they may be omitted. In such cases, alternative methods equivalent to public hearings must be used to gather opinions as prescribed by Presidential Decree. <Newly established on July 30, 2013> ③ If changes to the Basic Plan involve minor adjustments as defined by Presidential Decree, the procedures outlined in Paragraph ② may be omitted. <Newly established on July 30, 2013> ④ Once the Basic Plan is finalized in accordance with Paragraph ②, the Minister of Trade, Industry, and Energy shall promptly announce it and notify the relevant central administrative agencies. <Newly established on July 30, 2013> ⑤ When formulating or revising the Basic Plan, the Minister of Trade, Industry, and Energy must report it to the relevant National Assembly Standing Committee. In this case, considerations specified in Article 3(2) must be included. <Newly established on July 30, 2013, and amended on March 21, 2017> ⑥ The Basic Plan must include the following elements: <Amended on July 30, 2013, May 18, 2015, and April 23, 2019> Fundamental direction for electricity supply and demand Long-term outlook on electricity supply and demand Plans for power generation facilities and major transmission and substation facilities Management of electricity demand Evaluation of the previous Basic Plan 5-2. Expansion of distributed energy sources Other necessary matters related to electricity supply and demand	Article 25 (Formulation of the Basic Plan for Electricity Supply and Demand) ① The Minister of Trade, Industry, and Energy shall formulate a Basic Plan for Electricity Supply and Demand (hereinafter referred to as the "Basic Plan") to ensure stable electricity supply and demand. <Amended on March 23, 2013, and July 30, 2013> ② When formulating or modifying the Basic Plan, the Minister of Trade, Industry, and Energy must consult with the heads of relevant central administrative agencies, conduct public hearings to collect opinions, and finalize the plan after deliberation by the Electricity Policy Deliberation Committee under Article 47-2. However, if public hearings cannot be conducted normally due to unavoidable circumstances beyond the Minister's control, as specified by Presidential Decree, they may be omitted. In such cases, alternative methods equivalent to public hearings must be used to gather opinions as prescribed by Presidential Decree. <Newly established on July 30, 2013> ③ If changes to the Basic Plan involve minor adjustments as defined by Presidential Decree, the procedures outlined in Paragraph ② may be omitted. <Newly established on July 30, 2013> ④ Once the Basic Plan is finalized in accordance with Paragraph ②, the Minister of Trade, Industry, and Energy shall promptly announce it and notify the relevant central administrative agencies. <Newly established on July 30, 2013> ⑤ When formulating or revising the Basic Plan, the Minister of Trade, Industry, and Energy must report it to the relevant National Assembly Standing Committee. In this case, considerations specified in Article 3(2) must be included. <Newly established on July 30, 2013, and amended on March 21, 2017> ⑥ The Basic Plan must include the following elements: <Amended on July 30, 2013, May 18, 2015, and April 23, 2019> Fundamental direction for electricity supply and demand Long-term outlook on electricity supply and demand Plans for power generation facilities and major transmission and substation facilities Management of electricity demand Evaluation of the previous Basic Plan 5-2. Expansion of distributed energy sources 5-3. Matters Related to the Promotion of Offshore Wind Power Deployment Other necessary matters related to electricity supply and demand	Addition of Offshore Wind Power Deployment Promotion

Source Written by the authors from "Electric Utility Act", accessed on April 24, 2025.

Table 58 **Proposed revisions to Definition of the Special Act on Expansion of National Power Grid**

Category	Current	Revised	Remarks
Definition	Article 2 (Definitions) The terms used in this Act are defined as follows: 1. "Transmission and Substation Facilities" refer to electrical facilities used for electricity transmission and transformation, including transmission towers, transmission lines, substations, and related auxiliary facilities. 2. "National Core Power Grid Facilities" refer to transmission and substation facilities with a voltage of 345 kV (kilovolts) or higher, included in the Major Transmission and Substation Facility Plan under Article 25(6)(3) of the Electric Utility Act, and designated in accordance with Article 8(2)(1) of this Act. These facilities include: a. Transmission and substation facilities used to supply electricity generated from renewable energy, as defined in Article 2(2) of the New and Renewable Energy Development, Utilization, and Deployment Promotion Act. b. Transmission and substation facilities used to supply electricity generated from nuclear energy, as defined in Article 2(1) of the Nuclear Safety Act. c. Transmission and substation facilities used to supply electricity to National Advanced Strategic Industry Clusters, as defined in Article 2(3) of the Special Act on Strengthening and Protecting National Advanced Strategic Industry Competitiveness. 3. "National Core Power Grid Development Project" (hereinafter referred to as the "Development Project") refers to projects for the installation of National Core Power Grid Facilities and other related facility developments as prescribed by Presidential Decree. 4. "Power Grid" refers to the power grid as defined in Article 2(14) of the Electric Utility Act.	Article 2 (Definitions) The terms used in this Act are defined as follows: 1. "Transmission and Substation Facilities" refer to electrical facilities used for electricity transmission and transformation, including transmission towers, transmission lines, substations, and related auxiliary facilities. 2. "National Core Power Grid Facilities" refer to transmission and substation facilities with a voltage of 345 kV (kilovolts) or higher, included in the Major Transmission and Substation Facility Plan under Article 25(6)(3) of the Electric Utility Act, and designated in accordance with Article 8(2)(1) of this Act. These facilities include: a. Transmission and substation facilities used to supply electricity generated from renewable energy, as defined in Article 2(2) of the New and Renewable Energy Development, Utilization, and Deployment Promotion Act. b. Transmission and substation facilities used to supply electricity generated from nuclear energy, as defined in Article 2(1) of the Nuclear Safety Act. c. Transmission and substation facilities used to supply electricity to National Advanced Strategic Industry Clusters, as defined in Article 2(3) of the Special Act on Strengthening and Protecting National Advanced Strategic Industry Competitiveness. 3. "National Core Power Grid Development Project" (hereinafter referred to as the "Development Project") refers to projects for the installation of National Core Power Grid Facilities and other related facility developments as prescribed by Presidential Decree. 4. "Power Grid" refers to the power grid as defined in Article 2(14) of the Electric Utility Act <u>and includes shared connection facilities as specified in Article 20 of the Special Act on the Promotion and Development of the Offshore Wind Power Industry.</u>	Addition of Shared Connection Facilities under the Marine and Offshore Wind Power Special Acts

Source Written by the authors from "Special Act on Expansion of National Power Grid", accessed on April 24, 2025.

Table 59 **Proposed revisions to Basic Plan of the Special Act on Expansion of National Power Grid**

Category	Current	Revised	Remarks
Basic Plan for National Core Power Grid Expansion	Article 6 (Basic Plan for National Core Power Grid Expansion) ① The Minister of Trade, Industry, and Energy shall establish a Basic Plan for National Core Power Grid Expansion (hereinafter referred to as the "Basic Plan") every five years, incorporating a long-term 30-year outlook to ensure the systematic and efficient expansion of National Core Power Grid Facilities and to enhance the effectiveness of the basic plans specified in Article 7. ② The Basic Plan shall prioritize areas with power grid congestion and shall include the following elements: 1. Mid- to long-term policy goals and directions for power grid expansion 2. Forecasts for power grid expansion and phased implementation strategies 3. Establishment and revision of systems for the systematic and efficient expansion of power grids 4. Evaluation of the previous Basic Plan 5. Integration with transmission power grids not classified as part of the National Core Power Grid 6. Financial resources and investment strategies to expand investments required for power grid expansion 7. Development and management of infrastructure and the industrial ecosystem for power grid facilities 8. Enhancement of social acceptance for power grid expansion 9. Other key matters related to power grid expansion as determined by the Minister of Trade, Industry, and Energy	Article 6 (Basic Plan for National Core Power Grid Expansion) ① The Minister of Trade, Industry, and Energy shall establish a Basic Plan for National Core Power Grid Expansion (hereinafter referred to as the "Basic Plan") every five years, incorporating a long-term 30-year outlook to ensure the systematic and efficient expansion of National Core Power Grid Facilities and to enhance the effectiveness of the basic plans specified in Article 7. ② The Basic Plan shall prioritize areas with power grid congestion and shall include the following elements: 1. Mid- to long-term policy goals and directions for power grid expansion 2. Forecasts for power grid expansion and phased implementation strategies 3. Establishment and revision of systems for the systematic and efficient expansion of power grids 4. Evaluation of the previous Basic Plan 5. Integration with transmission power grids not classified as part of the National Core Power Grid 6. Financial resources and investment strategies to expand investments required for power grid expansion 7. Development and management of infrastructure and the industrial ecosystem for power grid facilities 8. Enhancement of social acceptance for power grid expansion 9. Matters related to the Offshore Wind Power Location Information System, Preliminary Zones, Development Implementation Plans, Offshore Wind Power Generation Zones, and the Construction of Shared Connection Facilities under the Special Act on the Promotion and Development of the Offshore Wind Power Industry. 10. Other key matters related to power grid expansion as determined by the Minister of Trade, Industry, and Energy	Addition of Considerations for the Special Act on Offshore Wind Power

Source Written by the authors from "Special Act on Expansion of National Power Grid", accessed on April 24, 2025.

Table 60 **Proposed revisions to the Implementation Plan in the Special Act on Expansion of National Power Grid**

Category	Current	Revised	Remarks
Implementation Plan	Article 10 (Preliminary Survey) ① To formulate the Implementation Plan under Article 11, the project implementer may conduct investigations or surveys regarding land, buildings, structures, and other necessary matters in the designated site selected in accordance with Article 5-3 of the Electric Power Development Promotion Act, as prescribed by Presidential Decree. ② A person conducting an investigation or survey under Paragraph ① may request relevant data from administrative agencies, local governments, public institutions, government-funded research institutes, and other relevant agencies. The head of the requested institution must comply unless there are exceptional circumstances. Article 11 (Formulation and Approval of the Implementation Plan) ① The project implementer must formulate an Implementation Plan, including the following elements, and obtain approval from the Minister of Trade, Industry, and Energy: 1. Overview of National Core Power Grid Facilities 2. Location and area of the National Core Power Grid Development Project Zone (hereinafter referred to as the "Development Project Zone") 3. Implementation period of the Development Project 4. Required funding for the Development Project and financing plans 5. Installation of public facilities related to the National Core Power Grid Facilities and cost-sharing measures 6. Conservation of national land and the natural environment 7. Other matters prescribed by Presidential Decree related to the Development Project	Article 10 (Preliminary Survey) ① To formulate the Implementation Plan under Article 11, the project implementer may conduct investigations or surveys regarding land, buildings, structures, and other necessary matters in the designated site selected in accordance with Article 5-3 of the Electric Power Development Promotion Act, as prescribed by Presidential Decree. ② A person conducting an investigation or survey under Paragraph ① may request relevant data from administrative agencies, local governments, public institutions, government-funded research institutes, and other relevant agencies. The head of the requested institution must comply unless there are exceptional circumstances. ③ The project implementer shall formulate the Implementation Plan considering the Preliminary Zones, Power Generation Zones, and Shared Connection Facilities as stipulated in the Special Act on the Promotion and Development of the Offshore Wind Power Industry. Article 11 (Formulation and Approval of the Implementation Plan) ① The project implementer must formulate an Implementation Plan, including the following elements, and obtain approval from the Minister of Trade, Industry, and Energy: 1. Overview of National Core Power Grid Facilities 2. Location and area of the National Core Power Grid Development Project Zone (hereinafter referred to as the "Development Project Zone") 3. Implementation period of the Development Project 4. Required funding for the Development Project and financing plans 5. Installation of public facilities related to the National Core Power Grid Facilities and cost-sharing measures 6. Conservation of national land and the natural environment 7. Other matters prescribed by Presidential Decree related to the Development Project	Addition of Considerations for the Special Act on Offshore Wind Power

Source Written by the authors from "Special Act on Expansion of National Power Grid", accessed on April 24, 2025.

The following outlines the additions that incorporate considerations for the Special Act on Electricity Grids into the Special Act on Offshore Wind Power (See Table 61 and Table 62).

Table 61 **Proposed revisions to the designation of the Preliminary Zones in the Special Act on Offshore Wind Power**

Category	Current	Revised	Remarks
Preliminary Zone	Article 14 (Designation of Preliminary Zones, etc.) ① The Minister of Trade, Industry, and Energy and the Minister of Oceans and Fisheries may designate areas that meet all of the following criteria as Preliminary Zones based on deliberation and resolution by the committee, utilizing the Offshore Wind Power Location Information System under Article 12. In this process, they must consider the Wind Power Facility Plan in the Basic Plan for Electricity Supply and Demand under Article 25 of the Electric Utility Act. The designated Preliminary Zones must meet all of the following conditions: 1. Possess wind conditions suitable for offshore wind power generation. 2. Have minimal impact on fishing activities. 3. Not obstruct maritime traffic safety. 4. Not interfere with the use and operation of ports and fishing harbors. 5. Have a minimal impact on the marine environment and ecosystem. 6. Have a minimal impact on military operations. 7. Meet other conditions prescribed by Presidential Decree.	Article 14 (Designation of Preliminary Zones, etc.) ① The Minister of Trade, Industry, and Energy and the Minister of Oceans and Fisheries may designate areas that meet all of the following criteria as Preliminary Zones based on deliberation and resolution by the committee, utilizing the Offshore Wind Power Location Information System under Article 12. In this process, they must consider the Wind Power Facility Plan in the Basic Plan for Electricity Supply and Demand under Article 25 of the Electric Utility Act, as well as the Basic Plan for National Core Power Grid Expansion and the Implementation Plan for Development Projects under the Special Act on National Core Power Grid Expansion, must be considered. The designated Preliminary Zones must meet all of the following conditions: 1. Possess wind conditions suitable for offshore wind power generation. 2. Have minimal impact on fishing activities. 3. Not obstruct maritime traffic safety. 4. Not interfere with the use and operation of ports and fishing harbors. 5. Have a minimal impact on the marine environment and ecosystem. 6. Have a minimal impact on military operations. 7. Meet other conditions prescribed by Presidential Decree.	Addition of Considerations for the Special Act on Electricity Grids

Source Written by the authors from "Special Act on Offshore Wind Power", accessed on April 24, 2025.

Table 62 **Proposed revisions to the Power Generation Zones in the Special Act on Offshore Wind Power**

Category	Current	Revised	Remarks
Power Generation Zone	Article 16 (Formulation and Approval of the Basic Design, etc.) ① The Minister of Trade, Industry, and Energy shall formulate a Basic Design Plan for Preliminary Zones, including the following elements, and finalize the Basic Design after deliberation and resolution by the committee. The same shall apply when making significant changes to the finalized Basic Design, as prescribed by Presidential Decree. The Basic Design Plan shall include the following: 1. Name, location, and area of the Preliminary Zone 2. Layout and capacity of offshore wind power facilities 3. Implementation method of the offshore wind power project 4. Power grid connection plan and major infrastructure plans 5. Preliminary investigation plans for environmental impact, maritime traffic safety, military operations, and national heritage impacts 6. Plans for securing stakeholder acceptance within the planned development site 7. Other matters related to the Preliminary Zone as prescribed by Presidential Decree	Article 16 (Formulation and Approval of the Basic Design, etc.) ① The Minister of Trade, Industry, and Energy shall formulate a Basic Design Plan for Preliminary Zones, including the following elements, and finalize the Basic Design after deliberation and resolution by the committee. <u>In this case, the Long-Term Transmission and Substation Facility Plan under Articles 25 and 27 of the Electric Utility Act, as well as the Basic Plan for National Core Power Grid Expansion and the Implementation Plan for Development Projects under the Special Act on National Core Power Grid Expansion, must be considered.</u> The same shall apply when making significant changes to the finalized Basic Design, as prescribed by Presidential Decree. The Basic Design Plan shall include the following: 1. Name, location, and area of the Preliminary Zone 2. Layout and capacity of offshore wind power facilities 3. Implementation method of the offshore wind power project 4. Power grid connection plan and major infrastructure plans 5. Preliminary investigation plans for environmental impact, maritime traffic safety, military operations, and national heritage impacts 6. Plans for securing stakeholder acceptance within the planned development site 7. Other matters related to the Preliminary Zone as prescribed by Presidential Decree	Addition of considerations for the Special Act on Electricity Grids Change “Power Grid Connection Plan” to “Power Grid Plan”

Source Written by the authors from “Special Act on Offshore Wind Power”, accessed on April 24, 2025.

In addition, the elements related to energy transmission within the Marine Spatial Planning Act can be summarized as shown in Tables 63 and 64.

Table 63 **Proposed revisions to the Energy Development Zone in the Act on Marine Spatial Planning and Management**

Category	Current	Revised	Remarks
Marine Zoning Area	Article 12 (Designation of Marine Zoning Areas, etc.) ① The Minister of Oceans and Fisheries and Provincial Governors may designate or modify Marine Zoning Areas based on the Management Plan Guidelines under Article 7(4) and the Marine Spatial Characteristic Assessment Results under Article 13, according to the following classifications: 1. Fisheries Activity Protection Zone: Areas designated to protect and promote licensed and permitted fisheries activities and to ensure the sustainable production of marine products. 2. Aggregate and Mineral Resource Development Zone: Areas required for the efficient and stable supply of marine aggregates and mineral resources. 3. Energy Development Zone: Areas designated for the development and production of marine energy. 4. Marine Tourism Zone: Areas necessary for the maintenance and development of marine tourism functions. 5. Environmental and Ecosystem Management Zone: Areas requiring conservation and management of the marine environment, ecosystems, and landscapes. 6. Research and Education Conservation Zone: Areas designated for marine and fisheries research and educational activities. 7. Port and Navigation Zone: Areas necessary for maintaining port functions and ensuring the safe navigation of vessels. 8. Military Activity Zone: Areas designated to protect national defense and military operations. 9. Safety Management Zone: Areas required for the protection of marine facilities and maritime safety. ② If multiple uses under Paragraph ① overlap within a Marine Zoning Area, the Minister of Oceans and Fisheries and Provincial Governors must prioritize management by considering natural environmental conditions, socioeconomic factors, and the current status of marine area use and conservation.	Article 12 (Designation of Marine Zoning Areas, etc.) ① The Minister of Oceans and Fisheries and Provincial Governors may designate or modify Marine Zoning Areas based on the Management Plan Guidelines under Article 7(4) and the Marine Spatial Characteristic Assessment Results under Article 13, according to the following classifications: 1. Fisheries Activity Protection Zone: Areas designated to protect and promote licensed and permitted fisheries activities and to ensure the sustainable production of marine products. 2. Aggregate and Mineral Resource Development Zone: Areas required for the efficient and stable supply of marine aggregates and mineral resources. 3. Energy Development Zone: Areas designated for the development, production, production, generation, and transmission of marine energy. 4. Marine Tourism Zone: Areas necessary for the maintenance and development of marine tourism functions. 5. Environmental and Ecosystem Management Zone: Areas requiring conservation and management of the marine environment, ecosystems, and landscapes. 6. Research and Education Conservation Zone: Areas designated for marine and fisheries research and educational activities. 7. Port and Navigation Zone: Areas necessary for maintaining port functions and ensuring the safe navigation of vessels. 8. Military Activity Zone: Areas designated to protect national defense and military operations. 9. Safety Management Zone: Areas required for the protection of marine facilities and maritime safety. ② If multiple uses under Paragraph ① overlap within a Marine Zoning Area, the Minister of Oceans and Fisheries and Provincial Governors must prioritize management by considering natural environmental conditions, socioeconomic factors, and the current status of marine area use and conservation.	Addition of "Transmission"

Source Written by the authors from "Act on Marine Spatial Planning and Management", accessed on April 24, 2025.

Table 64 **Proposed revisions to marine spatial suitability in the Act on Marine Spatial Planning and Management**

Category	Current	Revised	Remarks
Marine Spatial Suitability Consultation	Article 15 (Marine Spatial Suitability Consultation, etc.) ① When the heads of central administrative agencies or local governments intend to approve, formulate, modify, or designate plans or zones related to the use and development of marine space in any of the following categories, they must consult in advance with the Minister of Oceans and Fisheries or obtain approval from the Minister of Oceans and Fisheries as prescribed by Presidential Decree (hereinafter referred to as "Marine Spatial Suitability Consultation, etc."). 1. Development plans for marine tourism complexes 2. Plans for the extraction of petroleum (including natural pitch and combustible natural gas) in marine space 3. Plans for the extraction of minerals, aggregates, and other resources in marine space 4. Development plans for ports and fishing harbors 5. Plans for the development of water resources in marine space 6. Plans for the development of marine energy 7. Plans for the development of fishing grounds 8. Other plans related to the use and development of marine resources ② The types of plans and designated zones subject to Marine Spatial Suitability Consultation, etc., as well as the timing of consultation, shall be determined by Presidential Decree.	Article 15 (Marine Spatial Suitability Consultation, etc.) ① When the heads of central administrative agencies or local governments intend to approve, formulate, modify, or designate plans or zones related to the use and development of marine space in any of the following categories, they must consult in advance with the Minister of Oceans and Fisheries or obtain approval from the Minister of Oceans and Fisheries as prescribed by Presidential Decree (hereinafter referred to as "Marine Spatial Suitability Consultation, etc."). 1. Development plans for marine tourism complexes 2. Plans for the extraction of petroleum (including natural pitch and combustible natural gas) in marine space 3. Plans for the extraction of minerals, aggregates, and other resources in marine space 4. Development plans for ports and fishing harbors 5. Plans for the development of water resources in marine space 6. Plans for the development, production, generation, and transmission of marine energy 7. Plans for the development of fishing grounds 8. Other plans related to the use and development of marine resources ② The types of plans and designated zones subject to Marine Spatial Suitability Consultation, etc., as well as the timing of consultation, shall be determined by Presidential Decree.	Addition of "Generation" and "Transmission"

Source Written by the authors from "Act on Marine Spatial Planning and Management", accessed on April 24, 2025.

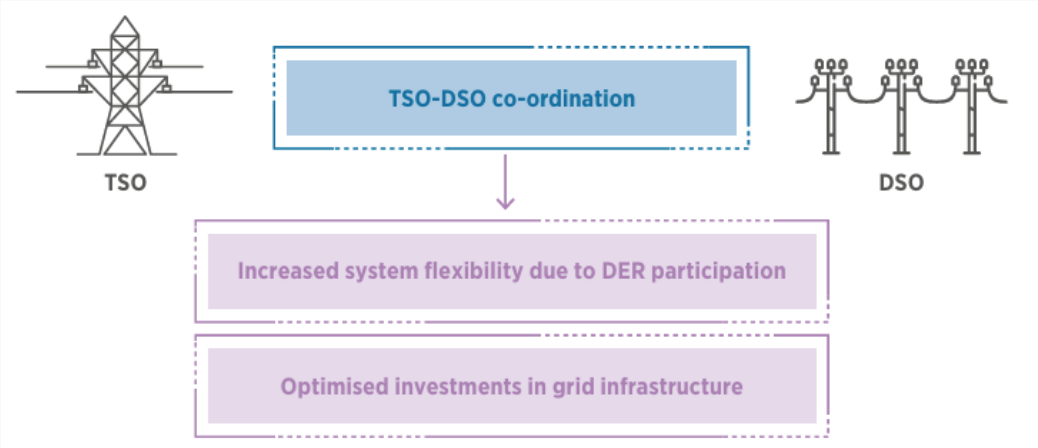
4.3 Future directions for the integration of renewable energy, power grids, and spatial planning

4.3.1 Defining the relationship with the Special Act on Distributed Energy

Subordinate legislation (Enforcement Decrees and Enforcement Rules) and the Basic Plan for Distributed Energy are needed to enhance the interactions among the Special Act on Electricity Grids, the Special Act on Offshore Wind Power, and Marine Spatial Planning by facilitating concrete discussions on the location and capacity of shared connection facilities. Furthermore, this framework should be structured to integrate with the Special Act on Distributed Energy, covering distribution networks, grid connections, electricity tariffs, and benefits.

The Special Act and the Basic Plan on Distributed Energy Activation should also provide the legal basis for distribution network connections, tariffs, and benefits. In addition future research is needed to explore how these aspects can be integrated with the Special Act on Electricity Grids and the Special Act on Offshore Wind Power (See Figure 29 and Table 65).

Figure 29 Key contributions of TSO-DSO coordination to power sector transformation



Source IRENA (2020), p. 13.

Table 65 **Legislation on distributed energy in South Korea**

Special Act on Distributed Energy Activation (Distributed Energy Act)
Chapter 5: Distribution Network Management and Supervision Article 16 (Obligations of Distribution Business Operators for Proper Facility Installation and Management, etc.) ① Distribution business operators shall install and manage facilities that comply with the standards set and announced by the Minister of Trade, Industry, and Energy to ensure that distributed energy businesses connected to the distribution network can smoothly supply electricity according to changes in electricity demand and supply. ② Distribution business operators shall publicly disclose a distribution network management policy, specifying the purpose, scope, conditions, procedures, and methods of distribution network management, as prescribed by Presidential Decree. When taking necessary distribution network management measures, they must notify affected distributed energy businesses about the actions taken and their impact. However, if direct notification is unfeasible due to unavoidable circumstances, a public announcement may substitute direct notification. ③ Distribution business operators must not unreasonably discriminate in distribution network access or disconnection based on the type or provider of distributed energy. However, reasonable disconnection of power supply may be permitted if deemed necessary. ④ Distribution business operators may disconnect access to the distribution network under the following circumstances: 1. When necessary to ensure the security and stability of the distribution network. 2. When required to protect the interests of multiple distributed energy businesses, power producers, or electricity consumers from distribution network congestion caused by temporary overloads, electrical facility maintenance, construction, or operation. 3. When required by a request from a national institution under applicable laws or for the enforcement of other legislation. 4. When requested by the Korea Power Exchange (KPX), as defined in Article 35 of the Electric Utility Act, or by a transmission business operator to ensure security and stability of the transmission network or to resolve transmission congestion due to maintenance, construction, or operation of transmission facilities. ⑤ Detailed conditions for distribution network disconnection under Paragraph ④ (Items 1 and 2) shall be determined by Ministerial Decree of the Ministry of Trade, Industry, and Energy. Chapter 8: Regional Electricity Pricing and Benefits Article 45 (Regional Electricity Pricing) Electricity sales businesses may set differentiated electricity tariffs, considering transmission and distribution costs, when preparing the Basic Supply Terms and Conditions under Article 16(1) of the Electric Utility Act, in order to promote balanced national development. Article 46 (Expansion of the Social and Economic Benefits of Distributed Energy Businesses) ① The Minister of Trade, Industry, and Energy shall endeavor to expand the social and economic benefits of distributed energy businesses, ensuring their stable operation. These benefits include: Cost savings from avoiding the installation of large-scale power generation facilities and transmission networks due to increased distributed energy usage. Reduction of social conflicts related to energy infrastructure projects. Contribution to electricity supply stability and energy system resilience. ② The Minister of Trade, Industry, and Energy may designate an institution, as prescribed by Presidential Decree, to assess the benefits outlined in Paragraph ①. ③ The specific measures required to expand the social and economic benefits of distributed energy businesses under Paragraph ① shall be determined by Presidential Decree.

Source Korea National Law Information Center, "Special Act on Activation of Distributed Energy", accessed on April 24, 2025.

Subordinate legislation would also do much to help clarify institutional linkages between the Special Act on Electricity Grids and the Special Act on Distributed Energy, including enforcement decrees and enforcement rules. In particular, specific provisions concerning the location and capacity of shared connection facilities, distribution network integration, electricity tariff structures, and benefit-sharing mechanisms are more likely to be implemented through detailed procedures and criteria set out in these lower-level regulations, rather than in the main text of the higher-level laws.

While the Special Act on Electricity Grids focuses primarily on transmission infrastructure planning, institutional and technical coordination with the Special Act on Distributed Energy, which governs the expansion of distribution networks, local energy systems, and cost allocation frameworks, is essential. Future research must explore how these legal and Basic Plan frameworks can be harmonized through subordinate legislation, including structural alignment, cross-referencing provisions, and interfaces between transmission and distribution systems.

4.3.2 Integrating energy planning with land and marine spatial planning

As Korea accelerates its energy transition, the need to coordinate energy infrastructure planning—such as offshore wind, transmission networks, and hydrogen systems—with national land and marine spatial planning is becoming increasingly urgent. Large-scale renewable energy projects often overlap with roads, railways, industrial zones, and aquatic ecosystems, making spatial coordination essential.

The European Union has adopted a coordinated approach through the TEN-E Regulation and the Offshore Renewable Energy Strategy, and is now developing the Offshore Network Development Plan (ONDP) to align offshore grid infrastructure with marine spatial planning across member states. The United Kingdom implements the Holistic Network Design (HND) and the Offshore Transmission Network Review (OTNR) to jointly plan offshore wind zones and transmission networks in line with marine use priorities.

Germany provides a particularly relevant model by legally requiring coordination between energy infrastructure and spatial planning through Section 46 of the Energy Industry Act (EnWG) (See Table 68). Transmission system operators must consult spatial planning authorities when planning new grid infrastructure. This legal obligation is operationalized by integrating the Flächenentwicklungsplan (FEP) and the Netzentwicklungsplan (NEP), which are jointly used to synchronize offshore wind zoning and grid connection points. FEP and NEP coordination in terms of timing and location ensures seamless integration between offshore and onshore power systems.

In contrast, Korea's energy, land-use, and marine spatial plans are still largely siloed, leading to misalignment between offshore wind sites and grid connection points and increasing the risk of

delays and local conflicts. To address this, Korea should establish a legal and institutional framework that links energy planning with national and regional spatial planning systems. A long-term solution would be to develop a National Integrated Infrastructure Plan that encompasses electricity, transport, and land use, enabling more efficient deployment of energy infrastructure while promoting carbon neutrality and balanced regional development (See Table 66).

Table 66 **German Electricity and Gas Supply act**

Electricity and Gas Supply Act in Germany (Energy Industry Act, EnWG)
§ 46 Utility easement agreements (1) Municipalities shall make available their public rights of way for the laying and operation of lines, including telecontrol lines for grid control and accessories, for the direct supply of end-users in the municipal area on a non-discriminatory basis by contract. Notwithstanding their obligations under sentence 1, municipalities may refuse to conclude contracts as long as the energy supply company refuses to pay concession fees at the maximum rates under section 48(2) and an agreement on the amount of the concession fees has not yet been reached. (2) Contracts between energy supply companies and municipalities for the use of public rights of way for the laying and operation of lines belonging to a general supply network in the municipal area may be concluded for a maximum term of 20 years. If such contracts are not extended after their expiration, the previous authorized user shall be obliged to transfer ownership of its distribution facilities necessary for the operation of the general supply networks in the municipal area to the new energy supply company in return for payment of an economically appropriate remuneration. The new energy supply company may demand that it be granted possession instead of transfer of ownership. The objectively determined capitalized value of the energy supply grid, measured according to the revenues to be generated, shall be decisive for the commercially reasonable remuneration. The possibility of agreeing on a remuneration based on other factors remains unaffected.

Source Bundesministerium der Justiz, "Gesetz über die Elektrizitäts- und Gasversorgung (Energiewirtschaftsgesetz - EnWG) § 46 Wegenutzungsverträge", accessed on February 27, 2025.

4.3.3 Institutionalizing a control tower governance system

As energy transition and carbon neutrality have emerged as core national priorities, South Korea's energy-related legal framework has rapidly expanded in both scope and complexity. Currently, a range of laws are in effect, including the Electric Utility Act, the Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy, the Special Act on the Expansion of National Power Grid, the Special Act on the Promotion of Offshore Wind Power and Industrial Development, the Special Act on Distributed Energy, the Smart Grid Act, the Framework Act on Energy, the Energy Use Rationalization Act, and the Hydrogen Economy Promotion and Hydrogen Safety Management Act.

However, these laws are administered by different government ministries with varying policy goals, often resulting in fragmented implementation, overlapping regulations, and legal gaps. Key areas such as offshore wind power, distributed energy, power grids, and hydrogen infrastructure frequently fall under multiple legal frameworks, yet they lack institutional coordination. For example, the Special Act on Offshore Wind Power focuses primarily on site designation and industrial development, while concrete integration with grid planning remains insufficient. Similarly, the Hydrogen Economy Act emphasizes production and utilization, but as hydrogen begins to serve as a transmission medium alongside electricity, coordination with the Special Act on Electricity Grids becomes increasingly necessary.

To resolve these challenges and enhance the coherence and effectiveness of energy transition policies, it is essential to establish a Special Committee on Energy within the National Assembly. Drawing inspiration from the National Assembly's Special Committee on the Climate Crisis, this proposed committee would possess legislative authority and the ability to review budgets, enabling it to serve as an interministerial coordinating body overseeing all energy-related legislation and policy development.

The energy transition is not merely a technical shift but a structural transformation that requires coordinated policymaking, institutional clarity, and active stakeholder collaboration. The proposed committee would serve as a strategic governance platform capable of responding flexibly to technological changes while improving the predictability and accountability of energy policies.

Establishing such a governance structure goes beyond creating a new organization—it demands a thoughtful design that ensures real decision-making power and implementation capacity. Therefore, in-depth preparatory research is needed on the committee's composition, authority, scope of responsibility, and mechanisms for inter-ministerial coordination. Given the diverse interests involved in the energy sector—from technology and industry to environment and communities—a carefully crafted governance model tailored to these complexities must be developed in advance (See Figure 30).

Figure 30 A "control tower" for energy laws

Source The authors.

To ensure this governance system operates effectively, the role of the Office for Government Policy Coordination (OPC) and central government ministries must be strengthened. These bodies should serve as the administrative backbone of cross-ministerial coordination, complementing the legislative oversight of the proposed Special Committee on Energy. In particular, they must address critical temporal mismatches across different laws and policy domains—for instance, the discrepancy in construction timelines between offshore wind power projects and power grid infrastructure.

Without strategic coordination, there is a significant risk that wind farms will be completed long before the necessary grid connections are ready. Conversely, it risks delaying the construction of new grid infrastructure due to uncertainties in offshore permitting or siting. Similar challenges may arise with hydrogen infrastructure and distributed energy systems. Therefore, the OPC and relevant ministries must lead in harmonizing implementation schedules, aligning planning procedures, and ensuring that technical and legal sequencing across laws is synchronized.

This calls for the establishment of an inter-ministerial planning framework that integrates energy policy with infrastructure development timelines, supported by legal instruments and executive- level enforcement mechanisms. The success of Korea's energy transition will depend not only on legislation, but also on the government's ability to align planning horizons and execution windows across the full life cycle of energy projects.

4.3.4 Proposal: A dedicated Offshore Grid Act to support the expansion of offshore wind

As offshore wind development scales up rapidly, the construction of offshore transmission infrastructure—commonly referred to as the offshore grid—has become a critical component of the broader energy transition. In South Korea, however, the current legal framework governing electricity transmission is largely focused on land-based infrastructure. There is no dedicated legal basis for planning, installing, or operating offshore transmission systems, which has led to uncertainty about how and where offshore wind power will be connected to the onshore grid. This ambiguity increases the risk of project delays, regulatory conflicts, and local opposition.

In contrast, many advanced countries have already begun institutionalizing offshore grid development through independent legal and planning frameworks. For instance, the European Union has introduced the Offshore Network Development Plan (ONDP), a legally mandated planning tool prepared by national transmission system operators (TSOs) in cooperation with ENTSO-E. This plan identifies optimal offshore transmission routes based on projected generation capacity, wind resource locations, and existing onshore grid access points.

The United Kingdom, too, has developed a comprehensive coordination framework for offshore transmission through the Offshore Transmission Network Review (OTNR). These initiatives go beyond project-by-project planning and instead adopt a system-wide perspective. OTNR provides integrated policy, technical, and regulatory guidance to facilitate joint grid connections for multiple offshore wind farms—enabling more efficient and less environmentally intrusive infrastructure development (See Figure 31).

In light of these international practices, the National Assembly in South Korea needs to pass a dedicated Offshore Grid Act. This legislation would serve as a legal foundation for offshore grid development by defining routes, connection points, and infrastructure priorities. It should also provide a governance framework for coordination among relevant ministries, agencies, and stakeholders while supporting integrated planning and permitting procedures.

A standalone Offshore Grid Act would not only enhance policy predictability but also enable a more strategic and cost-effective rollout of offshore wind infrastructure—laying the groundwork for Korea's long-term energy security and carbon neutrality goals.

Figure 31 **Offshore grid laws and policies in the EU and the UK**

Source ENTSO-E (2024); Department for Energy Security & Net Zero (2023).

4.3.5 Streamlining environmental impact assessments for power grid projects

The construction of power grid infrastructure is an essential element for the successful expansion of renewable energy and energy transition. However, transmission line projects often span vast geographical areas and may include forests, farmland, coastal areas, residential areas, and other sensitive sites, leading to environmental impact assessments (EIAs) that involve multiple stakeholders and agencies and result in complex and lengthy procedures. If the scope of the assessment is not clearly defined from the initial stage, delays are inevitable due to administrative inefficiencies, duplicate reviews, and repeated requests for data. To resolve these issues, it is important to institutionalize "pre-scoping" and "early definition of core environmental elements" in the environmental impact assessment process.

However, Korea's current environmental impact assessment system operates with strategic environmental assessment (SEA) and EIA at the individual project level institutionally separated. SEA was introduced to comprehensively consider ecological factors when establishing higher-level plans such as national or regional plans; however, in practice, it is often conducted after major planning

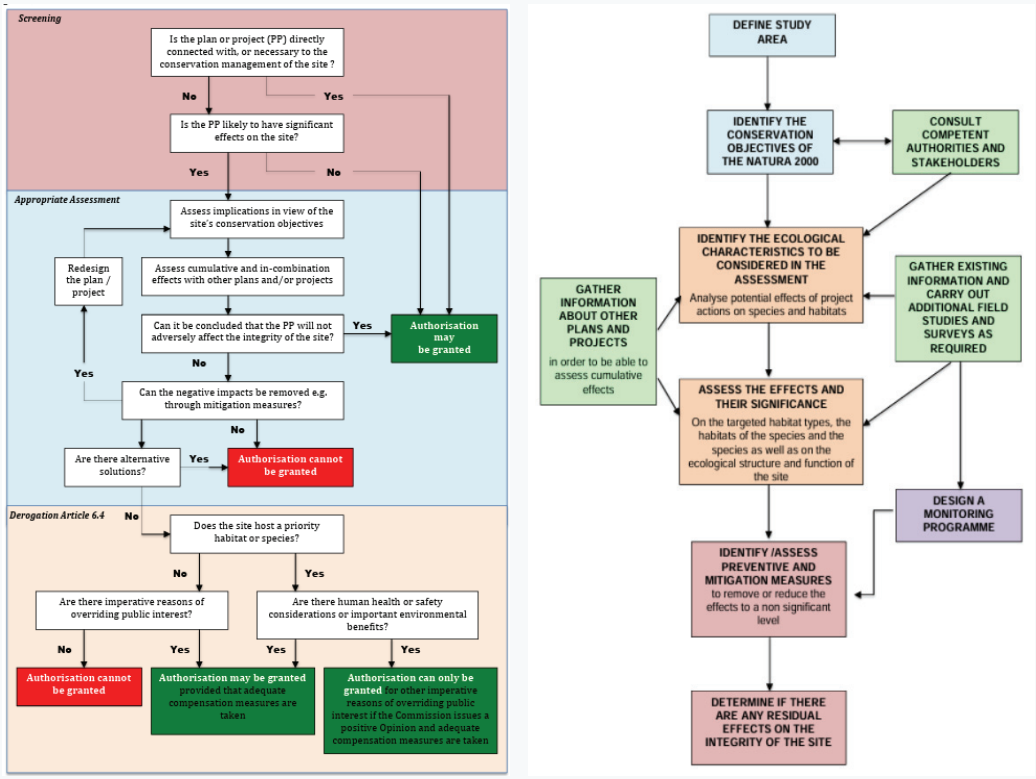
decisions have been made, resulting in structural limitations where its outcomes are not effectively reflected in subsequent EIA procedures. In contrast, countries like Germany conduct SEA from the initial planning stages and incorporate it into national land use plans or energy plans, thereby institutionalizing a system that enables substantive environmental review. This institutional separation between SEA and EIA makes it challenging to identify environmentally sensitive areas or elements with high conflict potential at an early stage and strategically review alternative sites, increasing the likelihood of environmental and social issues surfacing belatedly during the project implementation phase, leading to social backlash or schedule delays.

Scoping is a core procedure in all EIAs, aimed at predefining key environmental factors that may be affected by the project and setting the scope of the evaluation. The European Union (EU) has institutionalized these procedures through the TEN-E (Trans-European Networks for Energy) Regulation and the Guidelines on Projects of Common Interest (PCI), requiring project developers to conduct initial scoping consultations, establish environmental roadmaps, and pre-identify key affected areas. This approach is not merely a procedural shortcut but enhances administrative predictability, prevents duplication, and strengthens strategic ecological considerations (See Figure 32).

The concept of "appropriateness assessment" used in the EU is significant as it reinforces scoping while enabling systematic linkage between environmental factors defined at the strategic level and project plans. In Korea, it is necessary to establish an adjustment mechanism or integrated review system to link SEA results with project approval and EIA, and to revise relevant technical guidelines and legal frameworks to mandate environmental sensitivity analysis equivalent to appropriateness assessment at the regional or national planning stage.

In particular, appropriateness assessment should not be limited to technical-level preliminary reviews. Still, it should function as a mechanism to enhance public acceptance by institutionalizing environmental information sharing and stakeholder consultation procedures. In large-scale infrastructure projects such as power transmission lines, it is essential to disclose environmentally sensitive information such as the overlap of protected areas, endangered species habitats, and residential areas from the initial stages of the project and to establish a structure that allows residents and local governments to express their opinions. This enables residents to be recognized as active participants in initial decision-making rather than passive recipients of post-facto notifications, allowing for proactive measures such as proposing alternative routes, addressing concerns, and negotiating compensation based on acceptability before conflicts escalate. By institutionalizing such an early-stage participation-based strategic environmental review process, Korea can establish a foundation for developing power grid plans that ensure environmental sustainability while achieving social legitimacy through conflict prevention.

Figure 32 Streamlining environmental assessments for energy PCIs: EU procedural overview



Source European Commission (2018), p. 55, p. 59.

References

[Publications]

Department for Energy Security & Net Zero (2023), *Offshore Transmission Network Review: Future Framework.*

ENTSO-E (2024), *Offshore Network Development Plan (ONDP) 2024 - European Offshore Network Transmission Infrastructure Needs.*

European Commission (2013), *Guidance Document: Streamlining Environmental Assessment Procedures for Energy Infrastructure Projects of Common Interest (PCIs).*

European Commission (2018), *Guidance on Energy Transmission Infrastructure and EU Nature Legislation.*

European Commission DG MARE & IOC-UNESCO (2017), Joint roadmap to accelerate maritime/marine spatial planning processes worldwide (MSP).

European Union (2023), *EU Action Plan for Grids, Luxembourg: Publications Office of the European Union,* DOI: 10.2775/919160.

European Union (2024), *Guidance on Designating Renewables Acceleration Areas (SWD(2024) 333 final).*

Genz, A. (2018), "Electricity Grid Planning in Germany", Knowledge-exchange between US and German Power System Operators, May 25, Berlin: German Federal Ministry for Economic Affairs and Energy (BMWi).

German Federal Ministry of Justice and Consumer Protection (2023). *Erneuerbare-Energien- Gesetz.*

German Federal Ministry of Justice and Consumer Protection (2025), *Erneuerbare-Energien-Verordnung – EEV.*

IRENA (2020), "Co-operation between Transmission and Distribution System Operators", *Innovation Landscape Brief.*

Kwak, Eun-Sup et al. (2025), *Technical Report on the Future Comprehensive National Power Grid Planning*.

Lee, Sung-Kyu (2024), "Power Grid Connection and Expansion Plan in Response to Offshore Wind Power Expansion in South Korea", *How to Expand Offshore Wind Power Grid*, Seminar held by Marine Grid Industry Association on October 28, 2024, p. 6.

National Grid ESO (2022), *Holistic Network Design (HND) Report*.

UK Government (2024), *Clean Power 2030: Action Plan – A new Era of Clean Electricity*.

UK Government (2020), Energy White Paper: Powering Our Net Zero Future (CP 337).

The Crown Estate (2021), *OTNR Generation Map. Offshore Transmission Network Review,* p. 1.

[Online Materials]

Bundesministerium der Justiz, "Gesetz über die Elektrizitäts- und Gasversorgung (Energiewirtschaftsgesetz – EnWG) § 46 Wegenutzungsverträge", https://www.gesetze-im-internet.de/enwg_2005/__46.html, accessed on February 27, 2025.

E2 News(May 31, 2024), "Power Grid in 'Hypertension and Atherosclerosis' Crisis", https://www.e2news.com/news/articleView.html?idxno=308987, accessed on March 23, 2025.

ENTSO-E, "ENTSO-E Transmission System Map", https://www.entsoe.eu/data/map/, accessed on February 27, 2025.

Electric Power Journal (EPJ), "[이슈체크] 국내 풍력시장 외산 기자재가 장악?…점유율 살펴보니", https://www.epj.co.kr/news/articleView.html?idxno=20598, accessed on March 22, 2025.

European Commission(March 18, 2020), "In focus: Renewable Energy in Europe", https://commission.europa.eu/news/focus-renewable-energy-europe-2020-03-18_en, accessed on March 22, 2025.

EU Law Information Center, "Regulation (Eu) 2022/869 of the European Parliament and of the Council of 30 May 2022 on Guidelines for Trans-European Energy Infrastructure, Amending Regulations (Ec) No 715/2009, (Eu) 2019/942 And (Eu) 2019/943 and Directives 2009/73/Ec and (Eu) 2019/944, and Repealing Regulation (EU) No 347/2013", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R0869&qid=1729574427106, accessed on December 1, 2024.

European Union (2022), "Regulation (Eu) 2022/869 of the European Parliament and of the Council of 30 May 2022 on Guidelines for Trans-European Energy Infrastructure and Repealing Regulation (EU) No 347/2013", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R0869, accessed on December 1, 2024.

EU Legislation Information Center, "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions,

Grids, the Missing Link - An Eu Action Plan for Grids", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A757%3AFIN&qid=1701167355682, accessed on December 1, 2024.

European Union, "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Delivering on the European Green Deal through Climate Action in the EU and Internationally (COM(2023) 668, final)", https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX%3A52023DC0668, accessed on February 17, 2025.

European Union, "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – European Wind Power Action Plan (COM(2023) 669 final)", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0669&qid=1702455143415, accessed on February 17, 2025.

European Union, "Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 Establishing A Framework for Maritime Spatial Planning", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32014L0089, accessed on February 17, 2025.

European Union, "Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 on energy efficiency", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023L2413, accessed on February 17, 2025.

European Union, "Regulation (EU) 2022/869 of the European Parliament and of the Council of 30 May 2022 on guidelines for trans-European energy infrastructure and repealing Regulation (EU) No 347/2013", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R0869, accessed on February 17, 2025.

European Union, "Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure and repealing Decision", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0347, accessed on February 17, 2025.

German Federal Ministry of Justice and Consumer Protection, "Netzausbaubeschleunigungsgesetz Übertragungsnetz (NABEG)", https://www.gesetze-im-internet.de/nabeg/BJNR169010011.html, accessed on January 10, 2025.

German Federal Ministry of Justice and Consumer Protection, "Gesetz zur Entwicklung und Förderung der Windenergie auf See(Windenergie-auf-See-Gesetz - WindSeeG)", https://www.gesetze-im-internet.de/windseeg/BJNR231000016.html, accessed on January 10, 2025.

German Maritime Spatial Planning System, "Marine Spatial Map", https://gdi.bsh.de/mapapps/resources/apps/meeresnutzung/index.html?lang=de, accessed on December 1, 2024.

Integrated Marine Spatial Management Information System, “Marine Spatial Map”, https://www.vadahub.go.kr/imap/index.do, accessed on December 1, 2024.

KEA Journal(October 15, 2024), “Government to Reflect Renewable Energy Generation Ratio in Power Plan… Experts ‘Welcome’ the Move”, http://www.keaj.kr/news/articleView.html?idxno=5649, accessed on April 24, 2025.

Korea Law Information Center, “Act on Marine Spatial Planning and Management”, https://elaw.klri.re.kr/kor_service/lawView.do?hseq=51031&lang=ENG, accessed on January 10, 2025.

Korea Law Information Center, “Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy”, https://law.go.kr/%eb%b2%95%eb%a0%b9/%ec%8b%a0%ec%9e%ac%ec%83%9d%ec%97%90%eb%84%88%ec%a7%80%eb%b2%95, accessed on January 10, 2025.

Korea National Law Information Center, “Electric Utility Act”, https://law.go.kr/%eb%b2%95%eb%a0%b9/%ec%a0%84%ea%b8%b0%ec%82%ac%ec%97%85%eb%b2%95, accessed on April 24, 2025.

Korea Law Information Center, “Special Act on Activation of Distributed Energy”, https://elaw.klri.re.kr/kor_service/lawView.do?hseq=68004&lang=ENG, accessed on April 24, 2025.

Korea Law Information Center, “Special Act on Expansion of National Power Grid”, https://law.go.kr/LSW/lsInfoP.do?lsiSeq=270195&viewCls=lsRvsDocInfoR#, accessed on April 24, 2025.

Korea National Law Information Center, “Special Act on Offshore Wind Power”, https://law.go.kr/LSW/lsInfoP.do?lsiSeq=270173&viewCls=lsRvsDocInfoR#AJAX, accessed on April 24, 2025.

Netzentwicklungsplanstrom, “Offshore Netzentwicklung”, https://www.netzentwicklungsplan.de/verstehen/offshore-netzentwicklung, accessed on March 6, 2025.

Netzentwicklungsplanstrom, “Projekte im NEP 2037/2045 (2023)”, https://www.netzentwicklungsplan.de/projekte/projekte-im-nep-20372045-2023, accessed on March 6, 2025.

News Who Plus(January 4, 2024), “Chungnam Province to Lead Renewable Energy Transition through Community Engagement”, https://www.newswhoplus.com/news/articleView.html?idxno=5922, accessed on April 24, 2025.

NEWSIS(November 11, 2024), “Ministry of Industry to Include Renewable Energy Generation Ratio in 10th Power Plan”, https://mobile.newsis.com/view/NISX20241111_0002954904, accessed on April 24, 2025.

Offshore Coalition for Energy and Nature, “About OCEaN”, https://offshore-coalition.eu/about-us/#members, accessed on March 22, 2025.

Open Infrastructure Map, “Open Infrastructure Map”, https://openinframap.org/, accessed on March 22, 2025.

Renewables Grid Initiative, “European Grid Declaration”, https://renewables-grid.eu/publications/eu

ropean-grid-declaration.html, accessed on March 22, 2025.

Renewables Grid Initiative, “Marine Grid Declaration”, https://renewables-grid.eu/publications/marine-grid-declaration.html, accessed on March 22, 2025.

Renewables Grid Initiative, “Public Engagement for Energy Infrastructure”, https://renewables-grid.eu/activities/engage4energy.html, accessed on March 22, 2025.

Renewables Grid Initiative, “Renewables Grid Initiative”, https://renewables-grid.eu, accessed on March 22, 2025.

Renewables Grid Initiative, “RGI Grid Awards”, https://renewables-grid.eu/activities/rgi-grid-awards.html, accessed on March 22, 2025.

TransnetBW, “NOVA Principle. Responsibility in Network Construction”, https://www.transnetbw.com/en/world-of-energy/nova-principle, accessed on March 23, 2025.

UK Government, “Offshore Transmission Network Review (OTNR)”, https://www.gov.uk/government/groups/offshore-transmission-network-review, accessed on February 27, 2025.

UK Government, “Climate Change Act 2008”, https://www.legislation.gov.uk/ukpga/2008/27/contents, accessed on February 27, 2025.

재생에너지-전력망 통합계획 제도화방안 연구

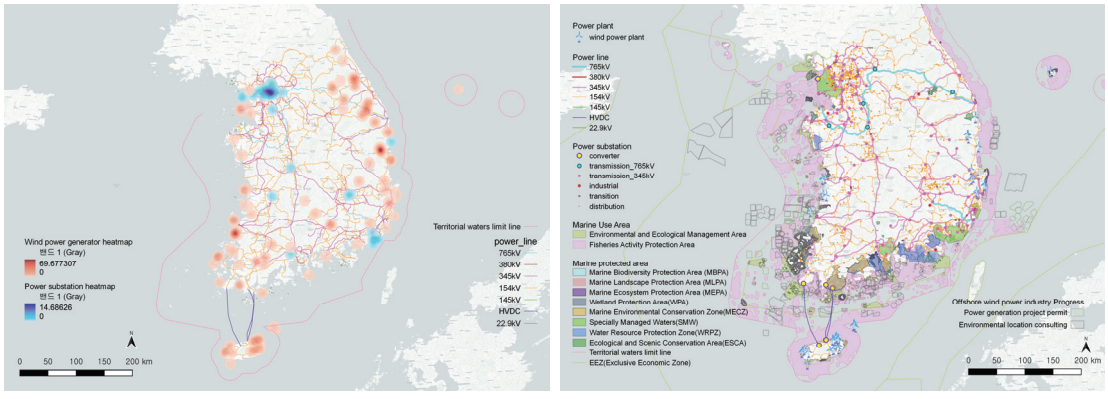
이재혁 외

1. 국내 재생에너지 계통확보 현황과 주요 문제점

해상풍력 등 재생에너지가 전국으로 확대되고 있지만, 이를 지원할 전력망은 턱없이 부족하여, 한전은 발전제한, 출력제한 등의 조치가 이루어지고 있는 상황이다. 또한 해상풍력의 경우, 해상풍력 민간회사가 계통접속을 위해 스스로 공동접속설비의 위치를 선정하는 과정에서 민간회사간 조율이 안 되어 난개발이 우려되고 있는 상황이다. 나아가 해상풍력이 공동접속설비까지 연결이 되더라도 내륙 송전망의 건설이 어려워 수요처까지의 전송은 여전히 어려움을 겪고 있다. 첫 번째 원인은, 수요처에 가까운 변전소는 수도권 및 대도시에 몰려있고, 해상풍력을 비롯한 재생에너지 발전단지는 지방에 위치하여 공급과 수요의 불균형이 문제이다(그림 1 왼쪽 참조). 두 번째 원인은, 대표적 재생에너지인 해상풍력과 내륙사이 해양전력망 건설이 미흡하여, 해상풍력 발전단지의 에너지 송전에 대한 문제가 존재한다(그림 2 오른쪽 참조).

그림 1 국내 재생에너지-전력망 현황

변전소(수요)와 해상풍력발전(공급) 비교 | 해상풍력과 내륙연결 전력망 미흡



자료: Open Infrastructure Map, “Open Infrastructure Map”, 검색일: 2025.3.22의 한국 전력망 데이터를 토대로 저자 작성.

이에 본 연구는 해상풍력을 중심으로 재생에너지와 전력망에 대하여 EU, 영국, 독일 등 해외 주요국의 법·제도와 국내 현황을 비교 분석하여, 재생에너지와 전력망이 통합적으로 계획 운영될 수 있는 방안을 제시하고자 한다.

2. 국내외 관련 제도 비교

표 1 국내외 해상과 육상에 대한 전력망 법제 비교

구분	EU	영국	독일	한국
육상 전력망	육상과 해양의 통합 전력망 계획 강조	해상풍력, 해양전력망, 육상전력망을 통합계획하는 HND 설계 운영	지역개발(육상)과 해양 전력망 연결 강조	「전원개발촉진법」에 따라 실시계획 진행
해양 전력망	해양 전력망 항목 별도 존재		해저 전력망 항목 별도 존재	X

자료: 저자 작성.

<표 1>과 같이 EU, 영국, 독일의 전력망 법제에서는 육상과 해양의 통합계획을 강조하고 있으며, 개별국가인 독일과 영국 제도에서는 해상풍력에 대한 육지 변전소 및 기타 설비에 대한 육상 공간계획을 제시하고 있다. 하지만 한국 「국가기간 전력망 확충 특별법」의 해양 관련 사항으로 전력망 위원회에 해양 분야 자문의견을 줄 수 있는 위촉위원만을 두도록 한정하고 있으며, 이 또한 다양한 분야 중 3명을 위촉하기 때문에 해양 분야가 빠질 가능성도 존재한다. 또한 해양에 대한 사항은 해상교통 등이 의제처리되고 있어, 해양공간계획, 「해상풍력 특별법」과의 정합성이 떨어지며, 해양공간 난개발의 우려도 존재한다.

물론 「해상풍력 보급 촉진 및 산업 육성에 관한 특별법」에서도 산업통상자원부장관이 송전사업자(한전)을 통해 계통연계를 하도록 하나, 해상풍력, 해상전력망이 공동접속설비를 통해 육상계통과 어떻게 연결될지에 대한 계획 논의는 미흡하다. 「해양공간계획 및 관리에 관한 법률」(이하, 해양공간계획법)에서는 해양에너지 개발을 위한 전송구역 논의는 부재한 상황이다.

3. 법제도 개선방안

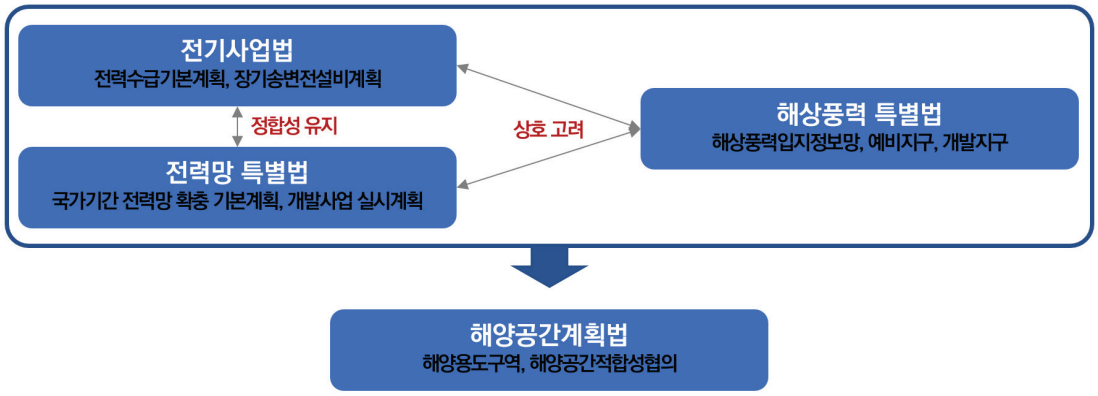
첫째, 전력망 법제에서 해상풍력의 공간계획을 염두에 두는 제도 개선방안이 필요하다. 현재 해양 전력망 투자를 위해서는 해상풍력을 비롯한 해양재생에너지 위치를 반영한 전력망 계획이 요청되나, 현재 「전기사업법」, 「국가기간 전력망 확충 특별법」에서는 해상풍력 및 해양재생에너지 위치를 고려한 근거가 부족하다. 이에 「전기사업법」의 전력수급기본계획과 장기송변전설비계획, 「국가기간 전력망 확충 특별법」의 기본계획과 실시계획 수립시, 「해상풍력 보급 촉진 및 산업 육성에 관한 특별법」의 해상풍력입지정보망, 예비지구, 개발지구의 고려가 필요할 것이다.

둘째, 해상풍력 법제에서도 전력망 계획을 고려하는 제도가 만들어져야 한다. 현재 「해상풍력 보급 촉진 및 산업 육성에 관한 특별법」에는 개발지구 선정 시에 전력계통 연계방안만 제시하도록 되어 있어, 대안경로 주민들끼리 갈등을 야기할 가능성이 크고, 실제로 전북 서남해 해상풍력 송전선로 문제로 부안-고창이 갈등이 존재한다. 이에 해상풍력 발전지구의 입지조건으로 전력망이 초기부터 고려하여 이러한 갈등을 줄이며, 출력제약, 발전제약의 문제를 사전에 예방할 수 있도록 해야 한다. 따라서 「해상풍력 보급 촉진 및 산업 육성에 관한 특별법」의 예비지구, 개발지구 선정 시, 「전기사업법」의 전력수급기본계획과 장기송변전설비계획, 「국가기간 전력망 확충 특별법」의 기본계획과 실시계획을 고려하는 규정이 필요할 것이다.

셋째, 「해양공간계획 및 관리에 관한 법률」에서도 '에너지 전송'에 대한 항목이 추가되어야 할 것이다. 현재

「해양공간계획 및 관리에 관한 법률」에서 제시하는 에너지개발구역은 해양에너지 개발과 생산구역만으로 한정되어 있어, 전력망에 대한 고려가 미흡하다. 따라서 현재 「해양공간계획 및 관리에 관한 법률」의 에너지개발구역과 해양공간에 대한 적합성 협의 항목의 '해양 에너지개발 및 생산 구역'을 '해양 에너지개발, 생산 및 전송 구역'으로 변경할 필요가 있다(그림 2와 표2 참조).

그림 2 전력망 관련 법률사이 연계구조



자료: 저자 작성.

표 2 해상풍력-전력망 연계를 위한 법제도 개선방안

구분		현재	제안
전기사업법	전력수급기본계획	해양 언급 미흡	「해상풍력 보급 촉진 및 산업 육성에 관한 특별법」 고려
국가기간 전력망 확충 특별법	정의		
	기본계획		
	실시계획		
해상풍력 보급 촉진 및 산업 육성에 관한 특별법	예비지구	해상풍력입지정보망(전력계통 포함) 고려	「전기사업법」 및 「국가기간 전력망 확충 특별법」 고려
	발전지구	전력계통 연계방안 제안	
해양공간계획 및 관리에 관한 법률	에너지개발구역	해양에너지 개발과 생산 구역	'에너지 전송' 추가
	해양공간 적합성협의		

자료: 저자 작성.

4. 재생에너지, 전력망, 공간계획 통합을 위한 미래 정책 방향

앞으로 에너지 전환 정책의 실행력을 높이기 위해서는 계획, 제도, 환경, 거버넌스 전반에 걸친 통합적 정책이 필요하다. 우선, 신재생에너지, 해상풍력, 전력망 등 대규모 재생에너지원 중심의 국가 계획과 지역 단위의 분산형 에너지 계획이 분산형 에너지계획이 유기적으로 연결될 수 있도록, 「분산에너지 활성화 특별법」과의 체계적인 연계 방안을 마련할 필요가 있다. 또한, 송전망, 발전설비 등 에너지 기반 시설과 기반시설과 도로, 철도 등 국토계획이 충돌하지 않고 조화를 이룰 수 있도록 에너지계획과 공간계획의 연계 체계 구축이 요구

된다. 더 나아가 「국가기간 전력망 확충 특별법」, 「해상풍력 보급 촉진 및 산업 육성에 관한 특별법」, 「분산에너지 활성화 특별법」 등 개별 에너지 법률들이 시간적·공간적으로 정합성을 유지하고 실행 단계에서 유기적으로 작동할 수 있도록 이를 조정하고 통합하는 컨트롤타워형 거버넌스 체계에 대한 제도 설계가 필요하다. 아울러 해상 인프라의 특수성을 반영하여, 해상 송전 인프라의 노선 지정, 접속 지점접속지점 확보, 인허가 절차 등을 포괄할 수 있는 별도의 "해양 전력망 계획" 마련 타당성에 대한 검토도 중요하며, 환경영향평가 제도의 효율화를 위해 사전 환경성 사전환경성 검토를 통해 주요 환경요소를 조기에 식별하고, 전략환경영향평가 및 본안 시간을 단축할 수 있는 제도적 기반을 마련하는 방안도 함께 모색되어야 한다. 이러한 과제들은 단절된 영역별 접근이 아닌 통합적 관점에서 설계되어야 하며, 에너지전환 과정의 예측 가능성과 정책 일관성을 높이는 핵심 기반이 될 것이다(표 3 참조).

표 3 미래 정책방향

순번	항목	세부내용
1	「분산에너지법」과 연계	신재생에너지, 해상풍력 등 대규모 재생에너지원 관련 송전망 계획과 지역의 소규모에너지 발전원 관련 배전망 계획 연계제도 마련
2	전력망계획과 공간계획의 연계	전력망 계획과 도로, 철도 등 국토계획을 연계하여 계획할 수 있는 연계방안 마련
3	에너지 관련 법률 간 조정을 위한 컨트롤타워 구축	다양한 에너지 법률들이 시간적, 공간적으로 정합될 수 있도록 조정해주는 컨트롤타워 마련
4	해양전력망 계획 마련	기존 에너지법들 사이 연계구조를 강화하는 것이 어려울 경우, 해양의 특수성을 고려한 해양 전력망법계획 마련 및 해양전력망 공사 설립
5	사전환경성 검토를 통한 환경영향평가 기간 단축	미리 중요한 사항을 사전환경성 검토를 통해 확인함으로써, 전략환경영향평가 및 환경영향평가에 소요되는 시간 단축할 수 있는 방안 마련

자료: 저자 작성.

주제어 재생에너지, 해상풍력, 송전망, 전력망, 공간계획, 법률

Research Staff

Lee, Jae-hyuck (Lead Researcher)

Senior Research Fellow, Korea Environment Institute
jaehyuck@kei.re.kr

Major Publications
- A Study on Ensuring Public Acceptance of Transmission Line Plans (2023)
- A Study on Just Transition Policy Framework Development (2023)

Kim, Dokyun

Senior Research Fellow, Korea Environment Institute
dkkim@kei.re.kr

Kim, Leejin

Senior Researcher, Korea Environment Institute
ljkim@kei.re.kr

Lee, Jukyung

Researcher, Environmental Planning Institute at Seoul National University
jukyung25@snu.ac.kr

Simioli, Cristina

(contributed to the parts concerning Renewables Grid Initiative)
Director - Offshore Energy and Nature, Renewables Grid Initiative
cristina@renewables-grid.eu

Shefer, Ira

(contributed to the parts concerning Renewables Grid Initiative)
Manager - Energy Systems, Renewables Grid Initiative
ira@renewables-grid.eu

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KEI Korea Environment Institute

370 Sicheong-daero, Sejong, 30147, Republic of Korea
TEL 044-415-7777 FAX 044-415-7799 www.kei.re.kr

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