Ministerie van Economische Zaken en Klimaat

Development Framework for Offshore Wind Energy

Adopted by the Council of Ministers on 8 November 2019

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Publication details

Development Framework for Offshore Wind Energy

Ministry of Economic Affairs and Climate Policy
Directorate-General for Climate and Energy
PO Box 20401
2500 EK The Hague

Definitive

First version adopted by the Council of Ministers on 1 July 2016

Updated 15 June 2017:
- Stipulation of final date of completion of the part of the offshore grid for connection to the wind farms at *Hollandse Kust (zuid)* Wind Farm Sites I and II. See Section 4.2;
- The Cabinet's designation on 8 December 2016 of the area between the 10 and 12 nautical mile zones in the *Hollandse Kust (zuid and noord)* Wind Farm Zones incorporated in Figures 1 and 4 as well as in Section 2.2.

Updated September 2018:
- Stipulation of final date of completion of the part of the offshore grid for connection to the wind farms at *Hollandse Kust (zuid)* Wind Farm Sites III and IV. See Section 4.2;
- Sections 1.4, 3.3, and 4.1 updated for now completed tenders and the published Offshore Wind Energy Roadmap 2030;
- As they appeared to cause confusion, the terms "nominal capacity" and "installed capacity" in the text (particularly in Sections 3.6 and 3.7) were replaced by "installed capacity" in accordance with the provisions and definitions of Wind Farm Site Decisions III and IV for *Hollandse Kust (zuid)*;
- Adapted text to allow for the possibility of tenders without subsidy;
- Lost links to documents on the internet fixed;
- Correct title of Minister/Ministry of Economic Affairs and Climate Policy included.

Updated Autumn 2019, adopted by the Council of Ministers on 8 November 2019:
- Stipulation of final date of completion of the part of the offshore grid for connection to the wind farm at *Hollandse Kust (noord)* Wind Farm Site V. See Section 4.2;
- Adjustment for the Offshore Wind Energy Roadmap 2030:
  - Reference to specification of 49 TWh offshore wind energy in 2030 in the Coalition and Climate Agreements;
  - Addition of *Hollandse Kust (west)*, *North of the Frysian Islands,* and *IJmuiden Ver* Wind Farm Zones;
  - Addition of direct current concept for *IJmuiden Ver*;
  - Addition of guaranteed transmission capacity of 2 GW for direct current concept for *IJmuiden Ver*;
- Removal of provisions on stepping-stone function and addition of "WindConnector" (Section 3.3);
- Changes in provisions to bring them in line with Metering Code (Section 3.10);
- Addition of provisions on nature-inclusive installation (Section 3.11);
- Clarification of provisions on delivery and delivery date (Chapter 4);
- Update and clarification of provisions on service life (Chapter 5).

Contents

1 Why a Development Framework for Offshore Wind Energy?

1.1 Rationale behind the Development Framework

To achieve the contribution of offshore wind energy to reducing CO_2 emissions by 2030, as agreed in Coalition Agreement[1] and the Climate Agreement[2], Dutch offshore wind farms will have to produce 49 terawatt hours (TWh) of electricity in that year. This will require a total operational capacity of approximately 11 gigawatt (GW), equal to 11,000 megawatt (MW), in 2030. A structured approach with a control function for the Government will be necessary to make this a reality. Part of that approach is the construction of an offshore grid. To do this, it is advisable to work according to a plan that includes the investments for the offshore grid, comparable with the plans the transmission system operators draw up for onshore grids. The complicating factor, however, is that the transmission system operator for the offshore grid and market parties cannot, in principle, independently evaluate the basic principles upon which their investment plan should be founded. After all, where and when the wind farms can be constructed in the coming years and their size depends on government policy.

Control by the Government is exercised through:

- An Offshore Wind Energy Roadmap[3]:
- Wind Farm Site Decisions and permits issued under the Offshore Wind Energy Act;
- If necessary, subsidies under the Stimulation of Sustainable Energy Production Decision; and
- A Development Framework for the development of offshore wind energy, and that of the offshore grid in particular. Section 16e of the Electricity Act 1998 (*Elektriciteitswet 1998*) stipulates that the Minister of Economic Affairs and Climate Policy[4] defines the Development Framework.

1.2 Objective of the Development Framework

The objective of the Development Framework for Offshore Wind Energy is to create an outline framework for the design, construction, availability, and service life of the offshore grid. It combines with the Roadmap, Wind Farm Site Decisions, and permits referred to above to provide clarity in advance to offshore wind farm developers regarding the schedule and preconditions for the development of offshore wind energy in the Netherlands.

This clarity in advance is extremely important because, unlike the onshore high-voltage grid, the offshore grid is constructed specifically for offshore wind farms. As a result, choices made in terms of the design of the offshore grid generally have direct implications for the design and profitability of the connected wind farms. It is essential for offshore wind farm developers to be aware of these choices before they bid for a site in a Wind Farm Zone.

The Development Framework broadly outlines the functional requirements and the technical concept for the offshore grid the wind farms are connected to. The basic principles and intended objectives here are to always minimise the total costs for offshore

[1] Confidence in the future; Coalition Agreement 2017 – 2021; VVD, CDA, D66 and ChristenUnie, 10 October 2017.
[2] Climate Agreement, 28 June 2019, Parliamentary Paper 32813, No H, blg-890294.
[3] The Offshore Wind Energy Roadmap consists of two parts: one part until the end of 2023 (based on the 2013 Energy Agreement; see Parliamentary Paper 33 561, No A/11) and another part for the years 2024 to 2030 (based on the Coalition Agreement and the (draft) Climate Agreement; see Parliamentary Paper 33561, No 42 and Parliamentary Paper 33561, No 48).
[4] In this document, in all cases, this refers to: the Minister/Ministry of Economic Affairs and Climate Policy, or their legal successor(s).

wind energy, i.e. the combined costs of the wind farms and the offshore grid.

The Development Framework also delineates the task of the transmission system operator for the offshore grid, TenneT.[5] Based on Section 16e of the Electricity Act 1998, TenneT is obliged to draw up a document every two years that shows the investments needed for the offshore grid to implement this Development Framework. This is to ensure TenneT completes the connection of the wind farms in good time.

Partly on the basis of this Development Framework, and prior to the construction phase of the offshore wind farms, TenneT is to conclude a Realisation Agreement and a Connection and Transmission Agreement[6] with the permit holders for the offshore wind farms, which further elaborate the technical details.

1.3 Cross-checking with the Development Framework

The third paragraph of Section 20d of the Electricity Act 1998 stipulates that the costs of investments made by TenneT for the offshore grid to implement the Development Framework will be included in the permitted incomes. This guarantees there will be no after-the-fact discussion of the extent to which investments made were useful and necessary. This shall not prevent the Netherlands Authority for Consumers & Markets (hereinafter referred to as the ACM) from monitoring to ensure TenneT only recovers the rational costs for these investments.

1.4 Scope and updating of the Development Framework

The Development Framework relates to the objective for offshore wind energy up to 2030 in the Coalition Agreement and the Climate Agreement. The stipulations in the Development Framework apply to the Wind Farm Zones in the Offshore Wind Energy Roadmap; see Figure 1. The technical-functional specifications and the technical concept for the offshore grid apply to its entire service life. Where applicable, the Development Framework lays down specific stipulations for the individual Wind Farm Zones and the parts of the offshore grid relevant to them. For instance, Section 4.2 of this Development Framework sets the delivery date for the different parts of the offshore grid associated with the different Wind Farm Zones and the different sites in them.

The Minister of Economic Affairs and Climate Policy will update the Development Framework should the situation require it. The basic principle here is that the functional specifications and the technical concept for the offshore grid do not change (in essence), so the standardisation (see Section 3.2) and cost savings that go hand in hand with this are ensured. This also gives wind farm developers the certainty that they will not have to modify their design subsequently.

1.5 Content of the Development Framework

Parts of this Development Framework have already been laid down whilst others are still being worked on, such as the National Water Plan,[7] the Offshore Wind Energy Roadmap, and the Wind Farm Site Decisions. The following parts have already been laid down:

- The sequence for development of the wind farms. This sequence shows the zones that have to be developed first and those that will follow subsequently. The sequence is as outlined in the Wind Energy Roadmap;
- The way in which the wind farms are connected to the onshore grid, via the offshore grid. TenneT connects the wind farms, and constructs and manages an offshore grid

[5] On 5 September 2016, the Minister of Economic Affairs and Climate Policy designated TenneT as the offshore grid operator.
[6] The content of these agreements is known prior to the opening of the relevant subsidy tender.
[7] National Water Plan 2016 – 2021, Parliamentary Paper 31 710, No 45.

needed for this, with an eye to a planned implementation and the realisation of cost savings. The basic principle for the offshore grid is also outlined in the Wind Energy Roadmap.

These decisions have, in fact, already taken a broad outline account of the integral consideration of the costs of the wind farms, spatial aspects, and consequences for the transmission system operator of the offshore grid as stated in the Electricity Act 1998 in relation to the Development Framework. This Development Framework contains further elaboration of these broad outlines as well as a number of new elements. These elements are:

- The delivery dates for the various parts of the offshore grid; see Section 3.2 et seq. It is important the connection for the wind farms is ready in time to prevent yield losses and damage to the wind farms. Overrunning the delivery dates set out in this Development Framework could be reason for TenneT to compensate the wind farm permit holder, in accordance with the provisions in Section 16f of the Electricity Act 1998;
- Further elaboration of the technical preconditions and functional specifications for the offshore grid. The Development Framework specifies the technical choices with which the offshore grid must comply. These preconditions and functional specifications contribute to establishing the technical design of the wind farms and thereby provide clarity and certainty for both TenneT and the permit holders for the offshore wind farms.
  In doing so, this Development Framework specifies the technical preconditions and functional specifications that are determinative for the design and the costs of the offshore grid. The detailed completion of the preconditions and specifications, as well as the creation of technical-operational agreements, will be done by TenneT, in close cooperation with interested parties from the wind sector. Eventually, the technical details and technical-operational agreements will be included in the Connection and Realisation Agreement that TenneT and the permit holders of the wind farms will enter into and in the technical codes (the conditions based on Section 31 of the Electricity Act 1998);
- The anticipated technical service lives that must be assumed for the wind farms and the offshore grid.

1.6 Creation of this Development Framework

Considering the importance of the Development Framework and the wider interests it involves, the Development Framework has been prepared in consultation with TenneT, the wind sector (Netherlands Wind Energy Association, NWEA), the ACM, and the Ministry of Finance. There was also an internet consultation prior to the first publication in 2016.

2 Sequence for development of the wind farms

2.1 Clustered realisation in designated Wind Farm Zones

During the evaluation of the previous issue round of offshore wind energy, the conclusion was drawn that cost benefits would ensue if the realisation of offshore wind energy was clustered and controlled by central government.[8] This was recognised when the agreements were made in the Energy Agreement,[9] which are continued in the Climate Agreement. In concrete terms, this means the realisation will occur in clusters per Wind Farm Zone as designated in the National Water Plan. Sites will then be established for each Wind Farm Zone. The permits and any subsidy will be issued using a tender procedure in accordance with the Offshore Wind Energy Act.

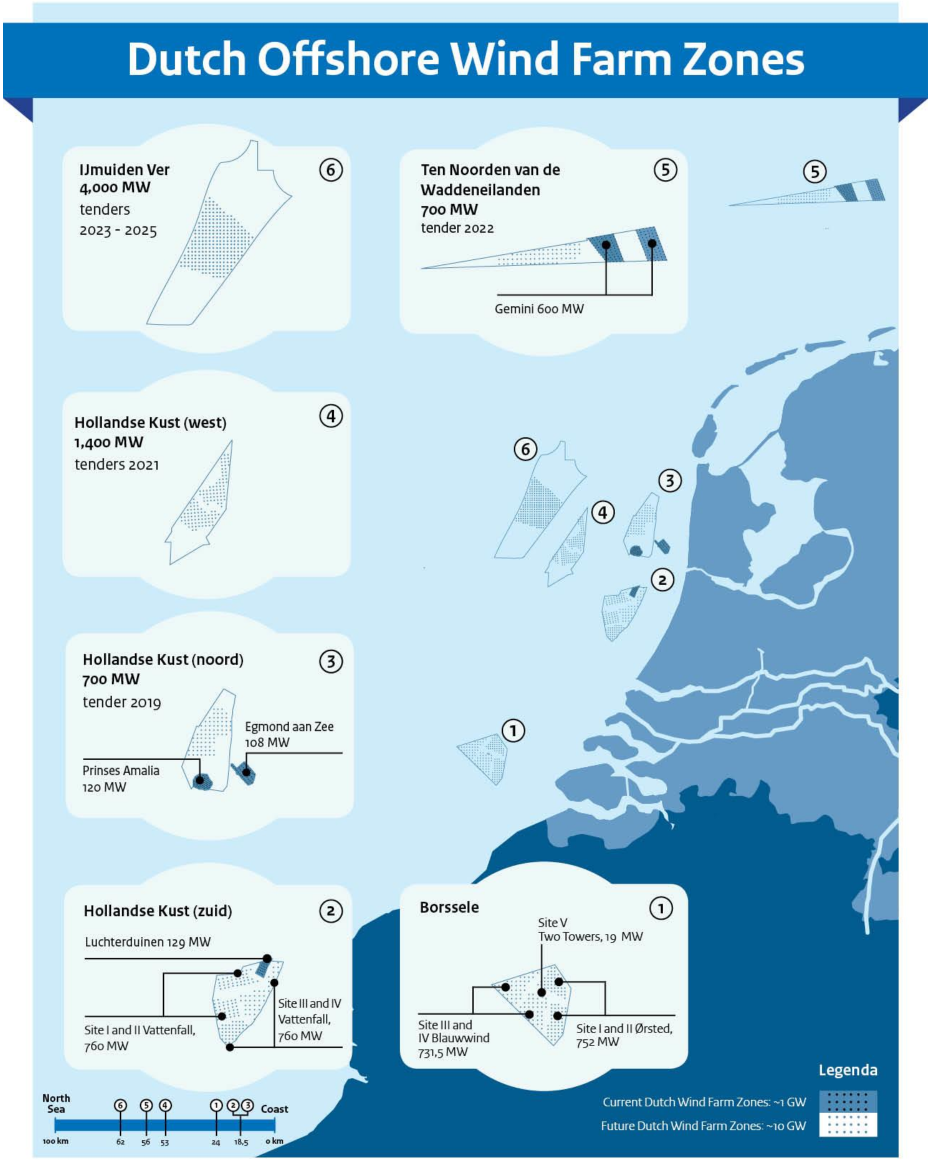

Figure 1 Wind Farm Zones to which the Development Framework relates

[8] Final report of the Offshore Wind Energy Task Force, May 2010. www.rijksoverheid.nl/binaries/rijksoverheid/documenten/brochures/2010/05/18/windenergie-op-zee/publicatie-windenergie-op-zee.pdf

[9] Energy Agreement for Sustainable Growth, 6 September 2013 (Parliamentary Paper 30 196, No 202, blg-248998)

The Wind Farm Zones in which wind farms can be constructed using the lowest costs have been established on the basis of calculations by Energy Research Centre for the Netherlands (ECN)[10]. These are the Wind Farm Zones closest to the coast; see Figure 1. The relatively short connections from the wind farms to the national high-voltage grid in particular, and the advantage that they can be installed using relatively cheap alternating current technology, ensure the costs per kilowatt hour for wind farms close to the coast are lower than for wind farms situated further from the coast. As specified in the Offshore Wind Energy Roadmap, the development of offshore wind energy starts with the *Borssele* (approximately 1.4 GW), *Hollandse Kust (zuid)* (approximately 1.4 GW) and *Hollandse Kust (noord)* (approximately 700 MW) Wind Farm Zones.

2.2 Sequence for development of Wind Farm Zones

The sequence for development of the Wind Farm Zones in the Offshore Wind Energy Roadmap is summarised in the table below:

Table1 Sequence for development of offshore wind energy

Capacity (GW)	Wind Farm Zone, Site(s)	Site Tenders	Anticipated Commissioning Date
0.7	*Borssele*, Sites I and II	Implemented in 2016	2020
0.7	*Borssele*, Sites III, IV and V	Implemented in 2016	2020
0.7	*Hollandse Kust (zuid)*, Sites I and II	Implemented in 2017	2022
0.7	*Hollandse Kust (zuid)*, Sites III and IV	First quarter of 2019	2022
0.7	*Hollandse Kust (noord)*, Site V	Fourth quarter of 2019	2023
0.7	*Hollandse Kust (west)*, Site VI	Second quarter of 2021	2024 to 2025
0.7	*Hollandse Kust (west)*, Site VII		2024 to 2025
0.7	*North of the Frysian Islands*, Site I	Fourth quarter of 2022	2026
1.0	*IJmuiden Ver*, Site I	Fourth quarter of 2023	2027 to 2028
1.0	*IJmuiden Ver*, Site II		2027 to 2028
1.0	*IJmuiden Ver*, Site III	Fourth quarter of 2025	2029 to 2030
1.0	*IJmuiden Ver*, Site IV		2029 to 2030

[10] Parliamentary Paper 33 561, No 12.

3 Method of connecting the wind farms

3.1 Background

The Energy Agreement stipulates that, where it is more efficient than a direct, individual ("radial") connection of wind farms to the onshore grid, there should be an offshore grid for connecting the offshore wind farms with the onshore grid and TenneT will be given responsibility for it.

As the Minister of Economic Affairs and Climate Policy stated in his letter of 18 June 2014[11], a study by Royal HaskoningDHV, commissioned by the Ministry of Economic Affairs and Climate Policy, concludes that the construction of an offshore grid, managed by TenneT, has advantages over radial connections. The advantages are in the fields of availability (security of supply), planning coordination, financing burdens, standardisation, and the associated cost reductions from advantage of scale for purchasing, maintenance, knowledge development, and learning effects. This model also simplifies compensating grid fluctuations, flow management, and balancing supply and demand, whilst integral grid operation also leads to knowledge pooling and a clear distribution of tasks and responsibilities in the electricity system. This also means TenneT can take advantage of the knowledge and experience gained with its German offshore activities.

In the aforementioned letter, the Cabinet takes the directional decision to legally appoint TenneT as the transmission system operator for the offshore grid. The Electricity Act 1998 contains the legal basis for appointing TenneT and elaborates a number of matters. In anticipation of the appointment, TenneT is temporarily charged with the legal task of conducting preparatory activities for the offshore grid based on the Electricity Act 1998.

As a result of the above, TenneT is tasked with identifying the costs of realising the offshore grid and bearing responsibility for the connections between the wind farms and the offshore grid.[12] This suggests that substantial savings are possible by making TenneT responsible for all offshore infrastructure. DNV GL subsequently validated the technical concept and cost substantiation on behalf of TenneT.[13] This report is being assessed by ECN on behalf of the Ministry of Economic Affairs and Climate Policy.[14] Just like DNV GL, ECN concluded that coordinated connection of offshore wind farms by TenneT leads to lower public costs compared to individual connections. The Minister of Economic Affairs and Climate Policy's letters to the House of Representatives[15] on the costs of the offshore electricity grid confirm this conclusion.

In September 2016, the Minister of Economic Affairs and Climate Policy designated TenneT as the offshore grid operator.

3.2 Concept for the offshore grid

The basic principle behind the offshore wind energy assignment is to realise the wind farms in the most cost-effective manner. This is done by starting with a TenneT concept for the offshore grid that is standardised as far as possible.[15] This concept uses substation platforms; in the case of alternating current platforms, approximately 700 MW of wind energy capacity can be connected to each one. Where direct current platforms

[11] Parliamentary Paper 31 510, No 49.
[12] Vision for Electricity Grid Design and Roll-out Strategy, Future-proof Electricity Grid Optimisation, TenneT, 21 July 2014.
[13] Review of Electricity Grid Design and Roll-out Strategy for TenneT Offshore Wind Farms, public version, DNV GL, 14 May 2014.
[14] Public version of validation of DNV GL document "Review of Electricity Grid Design and Roll-out Strategy for TenneT Offshore Wind Farms", ECN-N--14-020, 11 August 2014.
[15] Parliamentary Paper 33 561, Nos 15, 19, 21 and 25.

are used, the connected capacity is approximately 2 GW. The wind turbines in the wind farms are connected to the platform; see Figure 2.

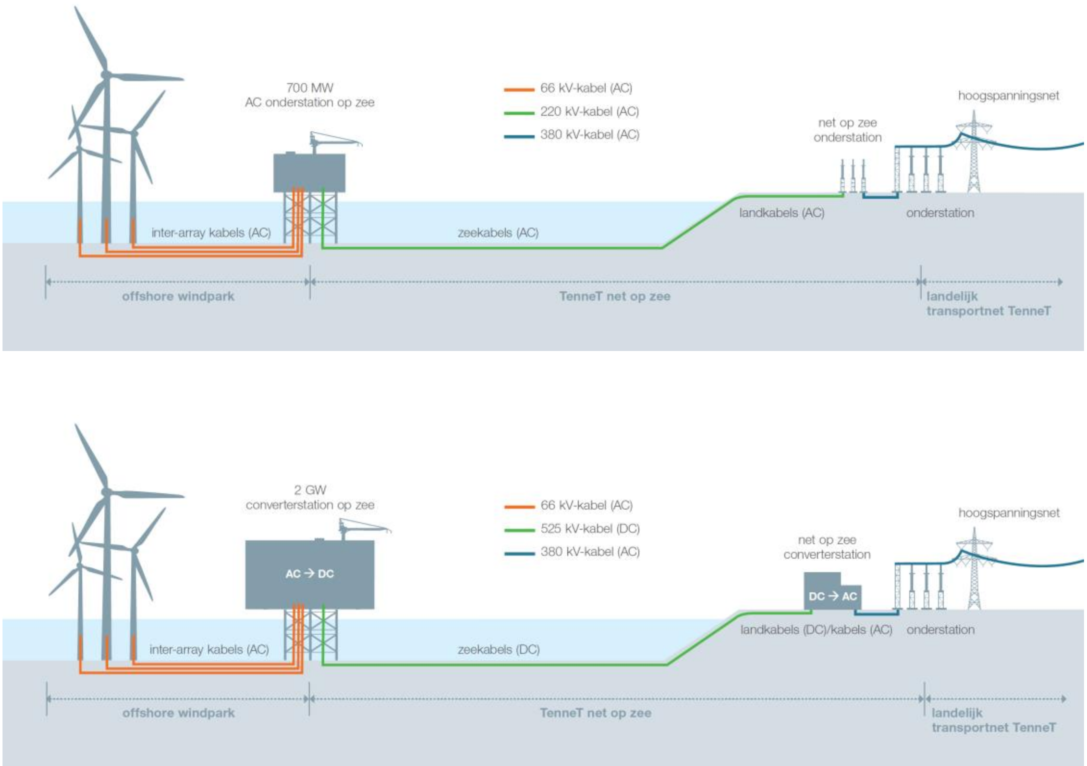

Figure 2 Schematic depiction of the grid, alternating current (above) and direct current (below)

The offshore grid comprises separate parts that connect the wind farms to the onshore national high-voltage grid. These parts will be constructed in phases, so each of them will be completed in time to transport the electricity generated by wind farms connected to that part.

This connection method reduces the number of platforms required compared with the situation in which each wind farm is connected to the national high-voltage grid by an individual platform and an individual connection. As a result of the standardisation and bundling of connections, cost savings are made and pressure on the environment minimised by a limited traversal of the landscape. In addition, there will be benefits with regard to availability and it will be easier to meet the timetable in the Offshore Wind Energy Roadmap.

The offshore grid consists of the platforms, subsea cables, land cables, and part of (the expansion of) an onshore station. What are known as inter-array cables, which connect the wind turbines to TenneT’s platform, are not part of the offshore grid, but rather are part of the wind farm.

3.3 Locations and method of connection

The cables from the platforms in the Wind Farm Zones are connected to the onshore high-voltage grid at different locations. Table 2 below provides an overview. The connection sites and cable routes, which are still to be further explored, for Site VII of *the Hollandse Kust (west) Wind Farm Zone, and,the North of the Frysian Islands* and *IJmuiden Ver* Wind Farm Zones, were selected after a broad survey process (Survey of the Landfall of Offshore Grids (*Verkenning Aanlanding Netten Op Zee*, or VANOZ[16])), with early involvement by public authorities, companies, and civil society organisations. The selection was based on the examined impact on technology, costs, environment, surroundings, and durability. This resulted in a geographically distributed connection pattern, with connection points preferably located close to the industrial clusters on the coast and avoiding, as far as possible, the need for investments in the onshore high-voltage network.

The VANOZ survey also resulted in a decision to opt for conventional electrical connections. Non-electrical alternatives, involving the generated electricity being converted to hydrogen offshore before being transported ashore by means of a pipeline, for instance, proved to be unrealistic within the time frame provided by the roadmap (2030). This and similar concepts are still at such an early stage of development that there is insufficient scale and insufficient competition on cost level.[17]

Table 2 Locations for connection to the onshore high-voltage grid

Wind Farm Zone, Site(s)	**Onshore connection site**
Borssele, Sites I and II	Borssele
Borssele, Sites III, IV and V	Borssele
Hollandse Kust (zuid), Sites I and II	Maasvlakte
Hollandse Kust (zuid), Sites III and IV	Maasvlakte
Hollandse Kust (noord), Site V	Beverwijk
Hollandse Kust (west), Site VI	Beverwijk
Hollandse Kust (west), Site VII	Beverwijk, route yet to be determined
North of the Frysian Islands, Site I	Yet to be determined: Eemshaven, Burgum or Vierverlaten
IJmuiden Ver, Sites I and II	Yet to be determined: Borssele, Rilland or Geertruidenberg
IJmuiden Ver, Sites III and IV	Yet to be determined: Maasvlakte or Simonshaven

Routes for the sea cables and onshore cables of the offshore grid are determined with due observance of the physical and legal feasibilities, cost-efficiency, and consequences for the environment, as part of the State Coordination Scheme (*Rijkscoördinatieregeling*, RCR). To this end, separate environmental impact assessments will be drawn up for the network connections (platforms, cables, and the onshore transformer and/or converter stations). The connection sites and cable routes will be determined in a preferred alternative by the Minister of Economic Affairs and Climate Policy, based on a comprehensive impact assessment which, in addition to outlining the environmental impact, also examines the impact of alternatives in terms of cost, technology, surroundings, and durability. The Minister will also take into account the responses of involved parties[18] to phase 1 of the environmental impact assessments and to the comprehensive impact assessment when deciding on a preferred alternative. Advice will also be sought from the independent Netherlands Commission for Environmental

[16] See Parliamentary Paper 33561, No 48, blg-879079 and https://www.rvo.nl/onderwerpen/bureau-energieprojecten/lopende-projecten/hoogspanning/verkenning-aanlanding-netten-op-zee-2030.
[17] See also Parliamentary Paper 33561, No 48.
[18] Anyone can respond to the comprehensive impact assessment by means of Internet consultation.

Assessment as well as the regional authorities (provinces, municipalities, and water authorities).

This Development Framework stipulates that the construction method for the land sections of the offshore grid is to be in accordance with the cabling method[19], provided this is technically feasible. In the case of the land sections of the offshore grid, any additional costs for underground construction are justified on the basis of the following considerations:

- Public support. The tentative locations of the planned onshore substations are partly in heavily populated areas, as a result of which the land sections of the offshore grid could have a major impact on the environment;
- Feasibility of the plan for realising the Roadmap and consequently the agreements on offshore wind energy in the Energy Agreement, the Coalition Agreement, and the Climate Agreement. Previous projects for high-voltage connections have revealed that the lead time for the integration procedures are significantly shorter because there is much less public resistance;
- Use of less space and more flexibility in construction. An underground cable section requires less safety space than an above ground section;
- No objection with regard to security of supply. Cabling is safe because the offshore grid is not a direct part of the national high-voltage grid (transmission) and is not crucial to power supply on a national or European level. However, account should be taken of the possible technical effects that cabling could have on the national high-voltage grid and any mitigating measures that may be required;
- Relatively short sections for the most part. The possible substations are largely situated so the land sections of the offshore grid will be of limited length. This limits both the total additional costs and the technical consequences of cabling for the onshore national high-voltage grid.

This Development Framework stipulates that, in the case of the Wind Farm Zones where more than one platform will be used for connections to wind farms, the land sections for the cables from both platforms can be laid simultaneously if this method limits the environmental impact, if it is more cost-effective, or for other substantiated reasons.

Given the relatively short distance from the Wind Farm Zones to the onshore connection sites and the relatively limited size of the capacity to be provided, the offshore grid for the *Borssele* and *Hollandse Kust* Wind Farm Zones will be configured for alternating current. The same also applies for the *North of the Frysian Islands* Wind Farm Zone, notwithstanding the fact that the distance from this zone to an onshore connection site is at the limit of what is possible with alternating current. In view of the relatively large distance to the onshore connection sites and the large capacity to be connected (approximately 4 GW), the Wind Farm Sites in the *IJmuiden Ver* Wind Farm Zone will be connected using direct current technology (HVDC).

3.4 Possible "WindConnector" to the UK

For some time now, experts and policymakers have been considering the eventual interconnections for the wind farms in the North Sea, whether or not in combination with interconnectors, to form a so-called "North Sea electricity grid" in this way.[20] This type of international offshore network could provide additional cost savings, but requires far-reaching coordination between countries and parties. Discussions are ongoing concerning the development of an electricity grid of this type in the North Sea in the framework of the political declaration for cooperation between North Sea countries

[19] Cabling is understood to mean laying a high-voltage cable underground.
[20] See, for example, the North Seas Countries' Offshore Grid Initiative, https://www.entsoe.eu/about/system-development/#the-north-seas-countries-offshore-grid-initiative-nscogi

signed in 2016.[21]

One of the most promising options identified in this regard involves linking the offshore grid for the *IJmuiden Ver* Wind Farm Zone with an interconnector to the United Kingdom, as indicated by the Cabinet in the Offshore Wind Energy Roadmap 2030. Referred to as "WindConnector" by TenneT, the concept would result in enhanced capacity utilisation of the grid connection, while at the same time yielding cost savings for the interconnector, since it can largely "piggyback" on the offshore grid for *IJmuiden Ver*. Expanding the interconnection capacity (with the UK) would contribute to further market integration and therefore lead to social benefits, including more stable electricity price development, integration of sustainably generated electricity, system flexibility, and security of supply, as highlighted in the European network development plans drawn up by ENTSO-E.[22]

The possibility of establishing a "WindConnector" calls for anticipatory investments in the offshore grid for *IJmuiden Ver*. Additional space will need to be reserved on the platforms for connecting an interconnector, whether in the short term or later. This possibility will be further examined by TenneT and the Ministry of Economic Affairs and Climate Policy over the course of 2019, together with relevant UK parties. Decision-making on the necessary anticipatory investments for a "WindConnector" will then be published in this Development Framework.

There is currently no clear regulatory framework that facilitates linking the wind farm connections with an interconnector. Based on the current national and EU regulatory framework (Clean Energy Package) for *regular* interconnectors, at least 70% of the maximum available interconnection capacity should be made available to the market and allocated in a non-discriminatory manner, while priority dispatch for sustainably generated electricity has been abolished. Strict application of these regular interconnector rules does not allow for specific connected wind farms to be prioritised in relation to other capacity users of an interconnector when congestion occurs. This therefore requires adjustments of or exemptions from all or parts of the regulatory framework, which will be included in the decision-making process.

3.5 Platform locations and accessibility

This Development Framework stipulates that the locations for the platforms must be selected in such a way that they make an optimal contribution to lowering the total costs of the electricity generated in the wind farms concerned. When doing so, account must be taken of other, relevant interests, including existing sections of electricity grids, pipelines, telecommunications cables, and interconnectors, as well as archaeological interests. The initial search areas for the platform locations will be determined by the designation of sites in the Wind Farm Zones, which will be done for the Wind Farm Site Decisions. The definitive locations will be laid down in the Water Act (*Waterwet*) permit to be drawn up for each network connection.

Depending on the definitive arrangement of the sites for the *Hollandse Kust* and *IJmuiden Ver* Wind Farm Zones and the final locations of the platforms, it could prove inadvisable for reasons of cost-effectiveness, space, or otherwise for these zones to follow the preferred cable corridors in accordance with the 2016 – 2021 North Sea Policy Document.[23]

[21] https://www.rijksoverheid.nl/documenten/convenanten/2016/06/06/political-declaration-on-energy-cooperation-between-the-north-seas-countries
[22] See https://tyndp.entsoe.eu/tyndp2018/projects/projects/260.
[23] Part of the 2016 – 2021 National Water Plan, Parliamentary Paper 31 710, No 45.

This Development Framework further stipulates that the standard method of accessing the platforms in the offshore grid is by ship.[24] This applies in any event to the alternating current platforms. To this end, the platforms should have a provision that facilitates the safe docking of ships and the transfer of personnel and equipment, and that increases the accessibility of the platform by ship under various weather conditions.

Based on a study commissioned by TenneT[25], in consultation with the wind sector, this Development Framework stipulates that the alternating current platforms will not be equipped with a helicopter deck. This is based on the following arguments[26]:

- The platforms are located fairly close to the coast and ports, making the time gained from accessibility by helicopter minimal;
- The portion of time when access by ship is impossible and a helicopter can provide added value is minimal, given the envisaged high accessibility of the offshore grid;
- Omitting a helicopter deck will provide cost savings of several million euros (both investment costs and operating costs, together approximately 0.1% of the total costs);
- Increased space will be available for wind turbines, because there is no need for obstacle-free helicopter approach routes at the sites;
- There is a general tendency towards servicing offshore installations by ship instead of helicopter due to the risk of serious accidents involving helicopters.

One possible disadvantage of the lack of a helicopter deck is that it could take longer to repair a fault in the electricity grid or in the connection between the wind turbines and the offshore grid under unfavourable weather conditions (heavy seas), for instance. However, the probability of this is small and does not stack up against the savings. Moreover, the platforms will be equipped with a heli-hoist facility[27], which would allow individuals to be transported from and to the platforms in cases of special urgency or disaster.

The necessity of a helicopter deck for the planned direct current platforms in the *IJmuiden Ver* Wind Farm Zone will be discussed and determined further in consultation with the wind sector in 2019. Decision-making on the accessibility of these platforms will then be laid down in this Development Framework.

TenneT is entering into further agreements with wind farm permit holders on access to the TenneT platforms in the Realisation and Connection Agreements. The basic principle here, within safety restrictions, is workable access by the wind farm permit holders to equipment and systems they own and which are housed on the TenneT platform for reasons of cost-effectiveness.

The requirement for transport to the wind farms and TenneT's platforms will be reduced as far as possible by largely being able to operate them remotely. To facilitate this, for each wind farm, TenneT will make sufficient space available near the onshore substation to which the offshore grid for that wind farm is connected, as well as on the platforms themselves, for the necessary computer and communications equipment as well as provisions for the duplex data traffic, and it will enter into further agreements on this with the wind farm permit holders in the Connection and Realisation Agreements.

[24] This is also understood to mean crew transfer vessels, platform supply vessels and "walk to work" solutions.
[25] High level review helideck and accommodation; Helideck and accommodation facilities on offshore platforms for wind farms, public version, DNV GL, Report No 130112-NLD-R1, Rev. A-Public, 9 June 2015. See https://www.tennet.eu/fileadmin/user_upload/Our_Grid/Offshore_Netherlands/Consultatie_proces_net_op_zee/Technical_Topics/27_130112_NLLD_R_A_public_version.pdf
[26] See also TenneT consultation position paper "T.4 Access to platform", https://www.tennet.eu/fileadmin/user_upload/Our_Grid/Offshore_Netherlands/Consultatie_proces_net_op_zee/Technical_Topics/26_ONL_15-184-T4_Access_to_platform_PP_v2.pdf
[27] A facility to allow people and (to a very limited extent) goods to be winched down from a helicopter.

3.6 Availability and minimum guaranteed transport capacity

The benefits from constructing the offshore grid should be found in, among other things, higher availability (reliability) of the transport capacity.[28] To this end, the alternating current platforms should each be connected to the onshore high-voltage grid with two 220-kilovolt cables. This provides additional availability, decreasing the risk of a partial or total interruption of the transport capacity. In addition, the electrical installation on the side to which the wind turbines connect is to be set up in such a way that the wind farms can be switched to one of the offshore transformers even if one of the 220-kilovolt cables or the transformers connected to them fails. This also provides additional availability, allowing at least half of the transport capacity to remain intact.

The direct current platforms in *IJmuiden Ver* will each be connected to the onshore high-voltage grid via two 525-kilovolt cables.

The *Borssele*, *Hollandse Kust (zuid),* and *Hollandse Kust (west)* Wind Farm Zones each contain two alternating current platforms. A connection between the two platforms in each zone will provide additional availability. A costs/benefits analysis commissioned by TenneT[29] reveals that the benefits of a 66-kilovolt connection outweigh the additional costs. This Development Framework therefore stipulates that there is to be a 66-kilovolt voltage level connection between the platforms in each of the aforementioned Wind Farm Zones. The provisions above will deliver high availability and it will not be necessary to furnish the platform with the capability to install diesel generators as a back-up provision to condition the wind turbines in case of power failure. This does not appear to be usual in the sector when there is a comparable level of availability for an electricity grid connection in an offshore wind farm.

The advisability of inter-connecting the direct current platforms in *IJmuiden Ver* will be examined further in 2019.

Unless specific (location) circumstances prevent this, the minimum guaranteed transport capacity of the offshore grid is 700 MW per alternating current platform. In the case of the direct current platforms in *IJmuiden Ver*, this is 2 GW per platform. The need to reduce the transport capacity to less than the guaranteed transport capacity could arise for reasons of electrical grid safety, or the failure of a cable or a transformer, for instance. This reduction takes place across the connected wind farms in proportion to the bandwidths stated in the relevant Wind Farm Site Decisions for the total installed capacity[30] per site. As a result, the capacity eventually realised in a site is not determinative. TenneT is to include conditions for reducing the capacity in its Connection and Transmission Agreements.

3.7 Maximum power input from the wind farms

From a cost-effectiveness perspective, it could be beneficial to install more capacity than the guaranteed transport capacity. After all, the wind farms will not always run at full capacity, as a result of which the offshore grid transport capacity will usually only be

[28] See Vision for Electricity Grid Design and Roll-out Strategy, Future-proof Electricity Grid Optimisation, TenneT, 21 July 2014, Review
of Electricity Grid Design and Roll-out Strategy for TenneT Offshore Wind Farms, DNV GL, 14 May 2014 and Public version of the validation of DNV GL document "Review of Electricity Grid Design and Roll-out Strategy for TenneT Offshore Wind Farms", ECN-N--14-020, 11 August 2014.

[29] https://www.tennet.eu/fileadmin/user_upload/Our_Grid/Offshore_Netherlands/Consultatie_proces_net_op_zee/Technical_Topics/56_ONL_15-216-T12_Redundancy_availability_PP_v2.pdf

[30] Installed capacity: the intended sustained renewable electricity output of the offshore wind farm under normal conditions, guaranteed by the supplier during continual use (the capacity to be supplied temporarily by a booster is not included).

used partly. Installing more wind power ("overplanting") could increase the amount of electricity generated at low wind speeds and could reduce the costs per unit of electricity (kWh).[31] This is to the benefit of the intended cost reduction for offshore wind energy.

There is, however, an optimum: at a certain point, the installed wind power will exceed the guaranteed transport capacity of the offshore grid to such an extent that, during high winds, an increasingly large proportion of the electricity can no longer be transported by TenneT. This could result in the need to switch off wind turbines. For each wind farm, this optimum will depend on the choice of type of wind turbine, the space available for wind turbines, and the increase in wake effects[32], as a result of which it is not possible to state a single optimal capacity for the wind farm.
Based on consultation meetings between TenneT and the wind sector, the Minister of Economic Affairs and Climate Policy decided in 2015 that the maximum installed capacity of the wind farms is to be 760 MW per alternating current platform.[33] This maximum installed capacity will be laid down in the site decisions for the individual wind farms. Given our evolving understanding of the development of generating capacity of wind farms and wind turbines, the possibility cannot be automatically excluded that an increased overplanting margin will be permitted in site decisions in the future.

As TenneT has configured the components and their security in the platform design for the maximum capacity of 760 MW originally determined by the Minister, it is necessary for this Development Framework to stipulate that the maximum installed capacity of the wind farms at the transfer point on alternating current platforms is 760 MW.

The precise portion of the power input above the guaranteed transmission capacity that TenneT can transport to the onshore high-voltage grid is also determined by the cables' capacity.[34] TenneT has investigated the option to temporarily provide additional transmission capacity by temporarily increasing the load on the cables (dynamic loading) during high winds. This possibility relies in part on cooling the cables, which in turn depends on the seabed conditions. The size and duration of this temporary additional transmission capacity will therefore vary for each wind farm. TenneT will publish these details prior to each tender procedure for Wind Farm Sites to enable wind farm developers to make their own estimate of the expected availability of the temporary additional transmission capacity.

The temporary additional transmission capacity is not a guaranteed offshore grid transmission capacity as in the preceding section, and no rights may be derived in this respect. In the case of sustained overloading of the offshore grid, TenneT will ask the permit holders of the wind farms to dial back the additional capacity that is not guaranteed. If the connected parties do not comply with the instruction to dial back capacity, TenneT will find it necessary to switch off one or more 66-kilovolt connections (the inter-array cables) in order to reduce capacity. As stated in Section 3.5, TenneT will include conditions for this in its Connection Agreement.

3.8 66-kilovolt voltage level connections to the wind turbines

[31] Allowing overplanting could increase the total subsidy required (where applicable) for offshore wind energy on the one hand, but there will be an increase in electricity production on the other. The costs per kilowatt hour would decrease.
[32] This refers to the mutual capture of wind by adjacent wind turbines.
[33] In his letter of 19 May 2015 (Parliamentary Paper 33 561, No 19), the Minister of Economic Affairs and Climate Policy stated that 380 MW is the maximum permitted capacity for each site of 350 MW, or 760 MW for each alternating current platform of 700 MW. The possibilities for overplanting are different in the case of the direct current platforms in *IJmuiden Ver*. This will be one of the subjects discussed during consultations with the wind sector in 2019. Decision-making in this regard will then be laid down in the relevant site decisions.
[34] TenneT guarantees a transport capacity of 700 MW per platform; see Section 3.5.

The transmission capacity of the connections (the inter-array cables) connecting the wind turbines to the substation is directly linked to the voltage level of the connections. Currently, the voltage level used is 66 kilovolts in the case of new wind farms. This voltage level has cost and other advantages compared to the voltage level of 33 kilovolts that applied until recently. This was described in detail in the first version of this Development Framework.

The Minister of Economic Affairs and Climate Policy has consequently informed the House of Representatives by letter[35] that the voltage level for connections (inter-array cables) for the wind farms in the Offshore Wind Energy Roadmap will be 66 kilovolts. This also means the offshore grid must be suitable for connecting wind farms at a voltage level of 66 kilovolts. The 66-kilovolt installation on the TenneT platform (substation), up to the physical connection with the inter-array cables that are part of the wind farm installation, is therefore considered to form part of the offshore electricity grid.

As a result of opting for a voltage level of 66 kilovolts, approximately 60 to 70 MW can be transported per connection. This also limits the number of J-tubes for conducting the connections to the platform. Theoretically, a capacity of 700 to 760 MW per wind farm (in the case of alternating current) and a capacity of 60 – 70 MW per connection requires a minimum of 12 J-tubes. However, during TenneT's consultation with the wind sector, it was concluded that a higher number of J-tubes is needed to provide sufficient flexibility in cabling for the wind turbines, including in sites that are less favourably situated. As a result, this Development Framework stipulates that alternating current platforms are to be equipped with 16 J-tubes per 700 MW wind farm. As well as these 16 J-tubes, there should be an additional J-tube for testing[36] and an additional J-tube for the cable that mutually connects the two platforms in the Wind Farm Zone.[37] This brings the total number of J-tubes for the connections side to 18. The number of J-tubes for the 220-kilovolt connections per alternating current platform is two.

The number of J-tubes for the direct current platforms in *IJmuiden Ver* will be determined further in consultation with the wind sector in 2019. Decision-making on the number of J-tubes on these platforms will then be published in this Development Framework.

3.9 Electrical properties and safety devices

The system formed by the wind farms and the offshore grid should function as efficiently as possible so the yield of sustainable electricity is as high as possible. This means TenneT's alternating current platforms must include the following provisions:

- A provision for compensating the reactive power on the 220-kilovolt connections, in addition to the provision that exists for this in the onshore station;
- The reactive power on the connection should be compensated using the capabilities of the wind turbines.[38] To this end, TenneT is to provide a reactive current set point with which the wind turbines can comply. This is considered to be fine-tuning. TenneT controls the broad steps for compensating the reactive power by switching coils or capacitors at the onshore station. If the connected wind turbines should unexpectedly be unable to comply with the requirements, as drawn up by TenneT, in relation to reactive power compensation near zero load, TenneT will adjust the reactive power management to this situation. However, the permit holder still bears primary responsibility for the reactive current compensation with regard to its cables and turbines;

[35] Parliamentary Paper 33 561, No 19.
[36] This is also understood to mean demonstration activities at an innovation site.
[37] This applies to the *Borssele, Hollandse Kust (zuid), and Hollandse Kust (west)* Wind Farm Zones.
[38] The European code for generators (Requirements for Generators) requires that contemporary wind turbines must provide reactive current compensation near zero load;

- Sufficient fields for establishing the connections to the platform, but not an unnecessarily high number so as to limit the risk of unused fields. Given the anticipated number of at least six 66-kilovolt connections, TenneT's electrical installation will have to factor in at least six switching fields per wind farm. If a wind farm nonetheless needs more connections (maximum of eight), two cables will be connected to one or two switching fields. It must be possible to separate the combined connections established at a single switching field in case of a fault on one of these cables. There should be a separate switch for wind turbines on an innovation site, if there is one. TenneT is to set out further agreements on the operation of the fields and switches in its Connection and Transmission Agreement. During TenneT's consultation process, there was unanimous agreement that TenneT should be responsible for this operation, as is currently the case on land. This Development Framework therefore stipulates this choice.

In exploiting the standardisation concept to the maximum, an electrical safety system with a general functional specification that has been standardised by TenneT will have to be used for the connections. The ownership, operation, and maintenance of this safety device will rest with TenneT. As owner of this standard installation, TenneT will bear the costs of ownership, operation, and maintenance. TenneT will not pay for any deviations or additions to the standard installations for wind farms if they are required by permit holders.

With respect to the direct current platforms in *IJmuiden Ver*, consultations will be held with the wind sector in 2019 in order to determine which electrical and technical requirements the connection must meet and how its electrical safety will be guaranteed. Decision-making in this regard will then be published in this Development Framework.

3.10 Metering the electricity yield

It is important that agreements are made on metering electricity yields from the wind farms so the wind farms' contribution to sustainable energy objectives can be established, as well as in connection with the possible eligibility of wind farm permit holders' for SDE+ subsidy. Having regard to safety and logistics, among other things, the Electricity Metering Code[39] provides that the parties connected to an offshore platform that is connected to the offshore grid will, assisted by the operator of the relevant offshore platform (TenneT), jointly designate a single meter operator for all the connections to the offshore platform concerned.

The metering of all the connections of a single wind farm will be added together to determine the quantity of electrical energy at the point of input into the public grid.

3.11 Shared services and nature-inclusive design

In addition to the wind farm operators and TenneT, other parties such as the Coast Guard, various port companies, and the Royal Dutch Meteorological Institute (KNMI) would like to exploit opportunities offered by TenneT platforms, to take measurements, for example. To this end, TenneT will make space available on its platforms for the necessary equipment, in so far as this is reasonably possible within the existing design. The Directorate-General for Public Works and Water Management (Rijkswaterstaat) will purchase these shared services and manage and maintain them. This will contribute to achieving the lowest possible social costs. Rijkswaterstaat will draw up a business plan for this. Costs will be charged to the parties concerned, through Rijkswaterstaat.

[39] As amended by a decision of the Netherlands Authority for Consumers & Markets of 14 May 2019, reference ACM/UIT/510948, amending the conditions referred to in Section 31 of the Electricity Act 1998 concerning responsibility for metering on connections to the offshore grid, Government Gazette No 26779, 15 May 2019.

In order to deliver on the commitment in the Climate Agreement to taking additional broader measures aimed at improving the conservation status of vulnerable species, taking into account their biotopes, and reducing the negative effects on the natural environment (such as biodiversity), TenneT will, to the extent reasonably possible, adopt a nature-inclusive approach to designing and constructing the offshore grid.

These measures should be proportionate to efforts made by permit holders of the wind farms, pursuant to a best-endeavours obligation or condition in the Wind Farm Site Decision requiring them to design and build the wind farm in such a way that it actively enhances the sea's ecosystem, helping to foster conservation efforts and goals relating to sustainable use of species and habitats that occur naturally in the Netherlands. The measures to be implemented will be assessed for each project in terms of technical feasibility, risk, costs, and project-specific circumstances (project phase and location).

4 Timeline

4.1 Time at which the wind farms are taken into use

To meet political agreements on the development of offshore wind energy as speedily as possible, it is essential that the wind farms be built and commissioned as quickly as possible after the permit has been awarded. The various tender regulations stipulate that a wind farm must be fully in use no later than five years[40] after the (subsidy) decision has been awarded.

4.2 Delivery date for the offshore grid

To make full use of offshore wind energy, it is important that the grid is ready on time and that the wind turbines can be connected to it. At the same time, the construction demands the requisite care and a realistic plan. Based on the timetable for the tenders, the anticipated construction times for the wind farms, TenneT's experience with building platforms, and experience with the time required for permit procedures, Table 3 shows the delivery dates for parts of the offshore grid for the purpose of connection to the wind farms for which a tender has already been published or will shortly be published.

Table3 Delivery date for the offshore grid

Site	Delivery of parts of the offshore grid
Borssele I and II	31 August 2019
Borssele, Sites III, IV, and the innovation site (V)	31 August 2020
Hollandse Kust (zuid) (Sites I and II)	30 June 2021
Hollandse Kust (zuid) (Sites III and IV)	31 March 2022
Hollandse Kust (noord) (Site V)	31 March 2023

The delivery date is the day on which the relevant part[41] of the offshore grid is ready for the electrical commissioning of the connection from the wind farms concerned. This means that the electrical installation on TenneT's platform has been built in accordance with the required functionality as set out in this Development Framework, and that it is ready for the electrical connection of the wind farms, after which the testing and commissioning period for the wind farms at the aforementioned sites will commence. In addition, it should be possible for duplex data traffic (data transmission) in the interest of SCADA and metering systems to take place between the areas that TenneT makes available to the wind farm owner on the onshore substations and on the platform, which areas should be suitable for the intended purpose. It goes without saying that, on the delivery date, the cable between the relevant platform and the onshore high-voltage grid will also be able to provide the minimum guaranteed transmission capacity, and the connection to the onshore high-voltage grid will be technically capable of further

[40] The basic principle is that the wind farms should be operational within four years after the (SDE+) subsidy has been obtained. Section 14 of the Offshore Wind Energy Act consequently stipulates that a permit can only be granted if, based on the application, a sufficiently plausible case has been made that the construction and operation of the wind farm can commence within four years of the date on which the permit becomes irrevocable. This entails advance evaluation of the feasibility of that time frame. To provide some freedom in the actual realisation to compensate for unexpected occurrences, it has been decided to adopt a period that is one year longer in the conditions relating to the decision. In the case of a subsidy, the subsidy term of 15 years starts after 5 years.

[41] The relevant part of the offshore grid is understood to mean the assembly of components that are required for the wind farm concerned to function fully. For example, for Sites I and II of the *Borssele* Wind Farm Zone, this means that the Borssele Alpha platform to which the wind farms on these sites will be connected is ready, but that the Borssele Beta platform does not have to be ready yet.

transporting this quantity of electricity.

The Completion Certificate for the relevant part of the offshore grid is based on the sole criterion that the relevant part of the offshore grid must be ready in time, including the 66-kilovolt installation. This provides a clear delivery time and prevents a wait for the initial moment at which the guaranteed transmission capacity can actually be transported. After all, because the wind farms are usually commissioned in stages, this could take months. The Completion Certificate will be issued by an independent expert on the instructions of TenneT.

It is expected that the delivery of the planned direct current connections in the *IJmuiden Ver* Wind Farm Zone will require a separate procedure, since the entire wind farm needs to be connected and operational to allow full testing of the connections. This delivery procedure will be determined further during a consultation process with the wind sector in 2019, after which it will be incorporated into this Development Framework.

If TenneT completes the relevant part of the offshore grid later than the stated date, an entitlement to compensation could arise for the permit holders of the wind farms, in accordance with Section 16f of the Electricity Act 1998. The entitlement to compensation as a result of late completion ceases at the time of completion. After this time, there only remains entitlement to compensation for the non-availability of the offshore grid, in accordance with the aforementioned Section 16f. It is important that this moment is clearly marked to prevent any question about what type of losses can be claimed (losses as a result of delay or as a result of non-availability).

Once a tender procedure for one or more sites in a Wind Farm Zone has been successfully completed, TenneT will consult with the permit holder(s) of the wind farm(s) in that site or those sites for the purpose of making further agreements, including agreements on the schedule the construction of wind farm(s) and the respective part of the offshore grid. If it follows from this that the commissioning of the wind farm(s) will take place considerably later than the delivery date for the respective part of the offshore grid given in Table 3, TenneT may submit a request to the Minister of Economic Affairs and Climate Policy for that part of the offshore grid to be delivered at a later date. TenneT will take into account the framework of the Public Procurement Act as well as programme-related aspects, among other things, when weighing up whether to submit such a request. A request of this nature should be accompanied by a declaration of no objection issued by the permit holder(s) of the wind farm(s).

As set out in Chapter 1, this Development Framework will be updated prior to each separate tender procedure, also setting out the delivery date for the relevant part of the offshore grid. For the time being, Table 4 below shows the indicative delivery dates for the parts of the offshore grid belonging to Wind Farm Zones and sites in Wind Farm Zones for which tender procedures will be held in the future. No rights can be derived from Table 4.

Table 4 Indicative delivery date for the offshore grid

<table>
<tr><th>Site</th><th>Indicative date for tender procedure for sites</th><th>Indicative delivery[42] of parts of the offshore grid</th></tr>
<tr><td>Hollandse Kust (west), Site VI</td><td rowspan="2">Second quarter of 2021</td><td>First quarter of 2024</td></tr>
<tr><td>Hollandse Kust (west), Site VII</td><td>Second quarter of 2025</td></tr>
<tr><td>North of the Frysian Islands, Site I</td><td>Fourth quarter of 2022</td><td>Third quarter of 2026</td></tr>
<tr><td>IJmuiden Ver,
Site I</td><td rowspan="2">Fourth quarter of 2023</td><td rowspan="2">Third quarter of 2027</td></tr>
<tr><td>IJmuiden Ver,
Site II</td></tr>
<tr><td>IJmuiden Ver,
Site III</td><td rowspan="2">Fourth quarter of 2025</td><td rowspan="2">First quarter of 2029</td></tr>
<tr><td>IJmuiden Ver,
Site IV</td></tr>
</table>

[42] The precise delivery dates will be announced before the opening of the tender procedures for the relevant sites.

5 Service life and depreciation of the offshore grid

5.1 The ACM decides the depreciation period for the offshore grid

The ACM regulates TenneT's income and also decides the depreciation periods that TenneT is allowed to use to pass on the costs for the offshore grid.[43] A number of factors influence the decision on this depreciation period:

1. The required technical service life of the offshore grid. The technical service life determines the quality required for the design as well as the components and materials used. This concerns the parts of the platforms as well as the cables and the onshore substations. This means the anticipated service life of the wind farms is determinative for the minimum technical service life of the offshore electricity grid, as the electricity grid is being constructed for these wind farms;
2. The future requirements, technological, and political developments that influence the use or reuse of the electricity grid in the longer term. These determine the *maximum* required technical service life; at the same time, they are difficult to predict;
3. The particular situation for the offshore grid compared with that onshore. The offshore grid is specifically for the offshore Wind Farm Zones. Unlike onshore, there are no other producers or major users that can make use of any abandoned connection on the offshore grid.[44] This can be factored in when establishing the depreciation period so as to prevent assets being incompletely depreciated and customers paying for a service they no longer need.

This Development Framework deals with the required technical service life for the Dutch offshore grid and with the future expectations for the offshore grid; it also provides the technical preconditions for this. In doing so, the Development Framework provides guidance on the economic preconditions for the offshore grid and provides guidance to the ACM for establishing the depreciation period.

5.2 Minimum service life of the offshore grid

Given that the offshore grid supports the wind farms, the service life of the wind farms will be the prime determiner for the minimum required technical service life of the offshore grid. This will be based on the economic service life of the wind farms.[45] Up until the mid-2010s, the anticipated economic service life of an offshore wind farm was generally 20 years. This stems from the manufacturers' 20-year certified service life for wind turbines, which the wind farm developers use in their business cases. An economic service life of 20 years was also factored into the determination of the maximum amounts for the tender procedure with subsidy.[46] It was assumed that permit holders of the wind farms will have their wind farms continue to produce electricity for another 5 years after the expiry of the SDE+ subsidy period of 15 years.

Developments in offshore wind energy are evolving rapidly, and show a clear tendency toward an increasingly longer service life for offshore wind farms. For instance, the certified service life of the latest generation of wind turbines is 25 years in many cases[47]

[43] The ACM also determines the efficiency of TenneT's investments and determines the translation of those investments into the costs TenneT is allowed to pass on in the regulated tariff income. In addition to a reasonable return on investment, those costs include the depreciations and costs for maintenance and management.
[44] Section 15a of the Electricity Act 1998 provides that the offshore grid is intended for the transmission of electricity and connects one or more offshore wind farms to the national high-voltage grid.
[45] The economic service life is normally shorter than the technical service life. After all, it is often more cost effective to replace an installation before it actually breaks down.
[46] Parliamentary Paper 33 561, No 19.
[47] The Siemens D6 offshore wind turbine, model SWT-6.0-154, is an example of this. See https://www.siemens.com/press/en/presspicture/?press=/en/presspicture/2014/energy/wind-power/ewp201407059-01.htm&content[]=EW&content[]=WP

and there are offshore wind farms that are still in use after 20 years.[48]

Section 15 of the Offshore Wind Energy Act provides that the period for which the permit is valid is in keeping with the expected service life of a wind farm and the specific area to which the permit relates, nonetheless subject to a limit of 30 years. The Wind Farm Site Decisions stipulate the actual term of a permit, which, to date, has also been set at 30 years. This includes the periods for construction, operation, and decommissioning of the wind farm. The permits are based on the following assumptions:

- The construction of the wind farm will be completed in five years at most, starting from the date on which the permit becomes irrevocable;
- The wind farm may become operational from Year 3 and may continue to be operational until Year 29 (inclusive);
- The removal period can commence from year 25 and last through to year 30.

This means that the maximum operating period for an offshore wind farm is approximately 27 years, and that the minimum technical service life of the offshore grid is therefore also 27 years.

5.3 Potentially required additional service life

It is conceivable that a technical service life significantly longer than 27 years is desirable for the offshore grid. In this way, the sustainable electricity produced offshore at a later time can use the existing offshore grid. This idea stems from the ambition to limit costs to the public purse for offshore wind energy.
The longer service life can be achieved on the basis of:

1. The standard service life in accordance with the international standards for the HV equipment, which is already usually longer than 27 years;
2. Options for extending service life, such as additional maintenance activities and replacements by building the necessary flexibility into the maintenance and replacement schedule for the offshore grid. This mainly concerns being able to continue using components that are difficult to replace, such as the transformers, switching gear, and the platform structure itself;
3. Replacing components that are more easily replaceable more frequently. Replacement of these components is often already factored in, given that the service life is less than 27 years. The equipment concerned relates to safety, communication, and auxiliary systems (e.g. air conditioning), for instance.

The desire to continue to use parts or all of the offshore grid longer than the first round of wind farms can become concrete if:

1. The term of a permit is extended. A bill to amend the Offshore Wind Energy Act[49] is currently being debated in the House of Representatives. This bill makes it possible to extend the maximum term of a permit for a wind farm, which is currently 30 years, by a maximum of 10 years. This makes a maximum operational phase of 37 years possible. The possibility of extending the term of a permit is being introduced in light of the expectation that the service life of wind turbines will increase further in the coming years as well. The option to extend also has the effect of improving the business case for a wind farm. Once the bill has been adopted by parliament, the provisions on the service life of the offshore grid in this Development Framework will be adjusted;
2. Establishment of a "WindConnector" (combination of a connection for connecting a wind farm and an interconnector) from the *IJmuiden Ver* Wind Farm Zone to the UK (see Section 3.3). Once the decision-making process for a "WindConnector" has been

[48] The first offshore wind farm in the world, Vindeby in Denmark, was taken into use in 1991 and was decommissioned in September 2017.
[49] Parliamentary Paper 35092, No 2.

completed, any implications for the required service life of the offshore grid will be incorporated into this Development Framework;

3. Replacement of wind farms. This Development Framework assumes that the wind farms will be dismantled and removed when their economic service life has expired, as stipulated in Section 6A of the Water Decree. Given the expectation that offshore wind energy will also be required further into the future, it is conceivable that the designated offshore Wind Farm Zones will continue to be designated as Wind Farm Zones after the life cycle of the first wind farms and that new wind farms could be developed in those zones. Whether or not this will actually occur also depends on developments in the cost for offshore wind energy in the coming 25 to 30 years in relation to alternative energy sources, as well as on the need and political will to pursue incentive policy for this. Both developments are difficult to predict for such a long term.
   An additional uncertainty is the question of whether the limits to the electrical design of the current offshore grid, with a maximum transport capacity of 700 MW per alternating current platform and 2 GW per direct current platform and a voltage level of 66 kilovolts for the connections, are sufficient for a second round of wind farms. Given the rapid technological developments in offshore wind energy, it is conceivable, however, that it will be wiser to replace the entire offshore grid with the prevailing state of technology at the time, or to transport the energy that is generated ashore using non-electrical means.

In light of the above, this Development Framework requires TenneT to design the offshore grid and make the necessary investments for a service life of 27 years.
In view of the possibility that the term of permits for wind farms may be extended to a maximum of 40 years and/or to provide for the possibility of a "WindConnector" to the UK, a deviating service life for all or parts of the offshore grid may be incorporated into this Development Framework. This will take place after decisions in this regard have been adopted by parliament and in consultation with TenneT.

Ministerie van Economische Zaken
en Klimaat

Development Framework for Offshore Wind Energy
Ministry of Economic Affairs and Climate Policy
Directorate-General for Climate and Energy
PO Box 20401
2500 EK The Hague

Definitive
Adopted by the Council of Ministers on 8 November 2019.