



High-voltage grid in the North Sea  
**A vision for the future**

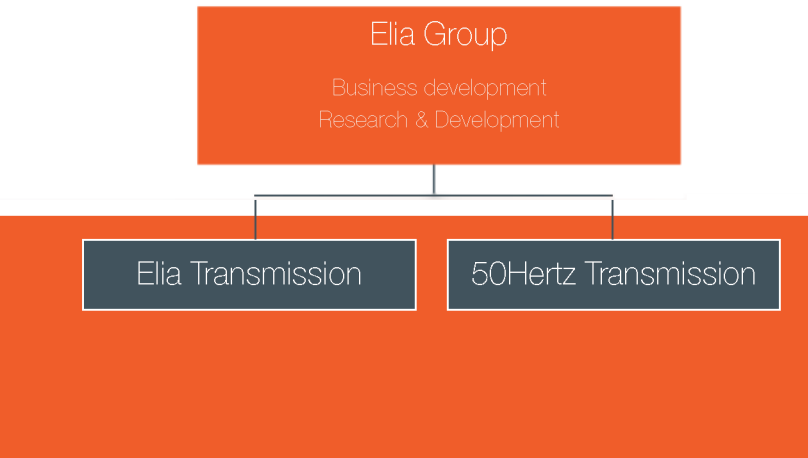


Achieving Belgian and European goals in terms of combating global warming requires that a significantly greater proportion of electricity be generated from renewable energy sources. In particular, this will entail greater use of offshore wind energy.

Elia wants to connect future wind farms off the Belgian coast in the North Sea as efficiently as possible for the benefit of the community by creating a genuine offshore grid, thus laying the foundations for a large European offshore grid going forward.

## A vision for the future!





With its two transmission system operators, **Elia Transmission** in Belgium and **50Hertz Transmission**, one of four German transmission system operators (active in the northern and eastern part of the country), the **Elia Group** is among the top five European transmission system operators. It is a driving force behind the development of the European electricity market and is firmly committed to delivering security of supply and to integrating more renewable energy sources into the energy mix. The acquisition of 50Hertz, which was completed in May 2010, has, in this regard, provided the group with significant leverage thanks to the expertise gained in Germany in this field.



## Stage one: **consolidate the onshore grid**

In 2004, following the decision of the Belgian government to support the development of 2000 MW of wind-power generation capacity off the Belgian coast, Elia began to consolidate its onshore grid in coastal areas to allow for a massive injection of energy into that decentralised region of Belgium and for said energy to be transported to consumption areas inland. The work to consolidate the onshore grid was an essential project since the system was not originally designed to accommodate this level of generation capacity on its periphery; historically it had been developed to connect the main consumption areas with centralised generation facilities.

The first stage of the project entailed laying a new 150-kV underground line connecting the Koksijde and Slijkens substations, upgrading the Slijkens high-voltage substation and strengthening the connection between Zeebrugge and Blauwe Toren with two 150-kV cables, and an additional cable between Brugge en Blauwe Toren. These developments made it possible to connect the first wind farms, providing a capacity of approximately 900 MW.

At the same time, Elia launched the Stevin project to extend the 380-kV grid as far as Zeebrugge, where a new 380-kV high-voltage substation is to be constructed near the port area.



## From the ‘spaghetti’ scenario...

To date, the developers of the first wind farms, C-Power and Belwind, have connected their respective facilities to the Slijkens and Zeebrugge 150-kV substations themselves. Elia contributes to the cost of financing the underwater cables, providing up to €25 million per connection over five years.

Although this approach might have made sense initially, it is far from optimal in the long run in terms of technical, economic and environmental considerations. It will ultimately lead to the proliferation of ‘point-to-point’ underwater cables between the different wind farms and the high-voltage coastal substations to which they are connected.

This sort of ‘spaghetti’ cable network is expensive (the more connections, the higher the cost), is not environmentally friendly (sea beds offshore and coastal areas in the vicinity of high-voltage substations onshore are covered up with cables), and is far from ideal from a technical perspective (for example, in terms of operational safety).

Elia is therefore seeking, in conjunction with the developers, to develop an optimal solution from a technical, economic and environmental standpoint and has formulated a vision to establish, on a step by step basis, a genuine meshed offshore grid. In this new scenario, the various wind farms will be connected offshore to high-voltage substations located on platforms in the vicinity of the various concessions. This offshore grid will be integrated into its onshore counterpart managed by Elia.



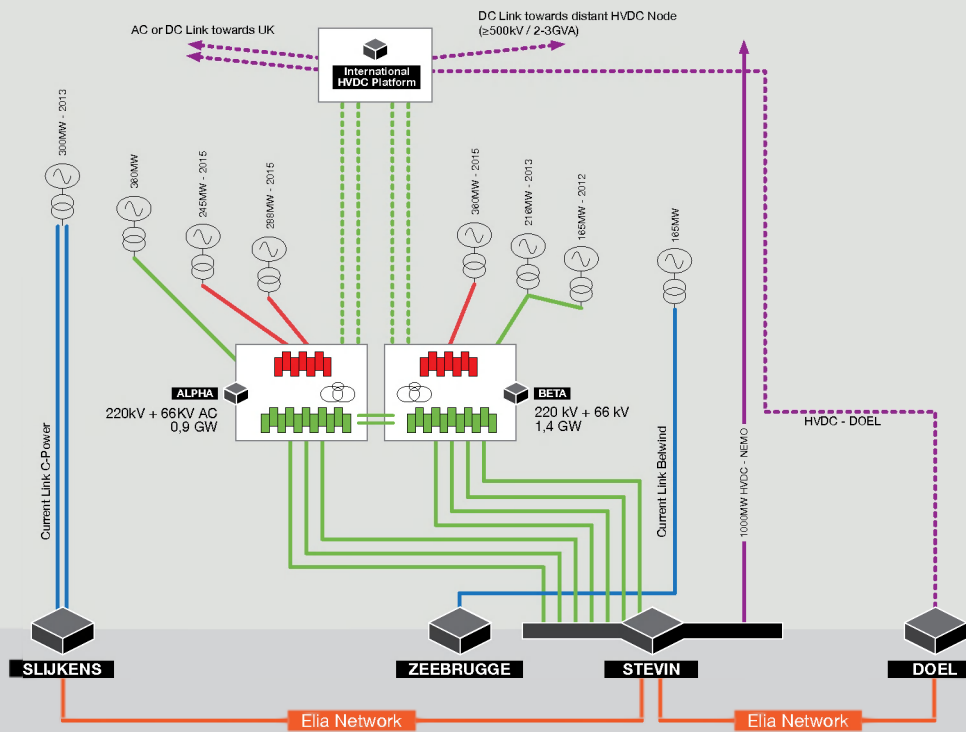
## ... to the first meshed offshore grid off the Belgian coast

The concept being proposed by Elia entails laying the foundations, on a phase-by-phase basis in line with the progressive commissioning of the various wind farms, of a genuine meshed grid providing benefits comparable to those offered by the existing onshore grid. In terms of reliability, this means benefits in the form of the redundancy created by the meshed structure, optimisation of investment and fewer cable connections to the onshore grid.

The ultimate aim of the project is to establish two platforms in the North Sea, alpha and beta, connected, via 220-kV connections, both to each other and to the Stevin substation to be built near the Zeebrugge port area.

It will be rolled out gradually, with each stage forming a part of the overall solution. The connection stations to the onshore network will be Zeebrugge and Stevin.

On each of these platforms a genuine offshore high-voltage GIS substation will be installed with the transformers required to accommodate the 66-kV and 220-kV cables coming from the different wind farms to be constructed in the vicinity.



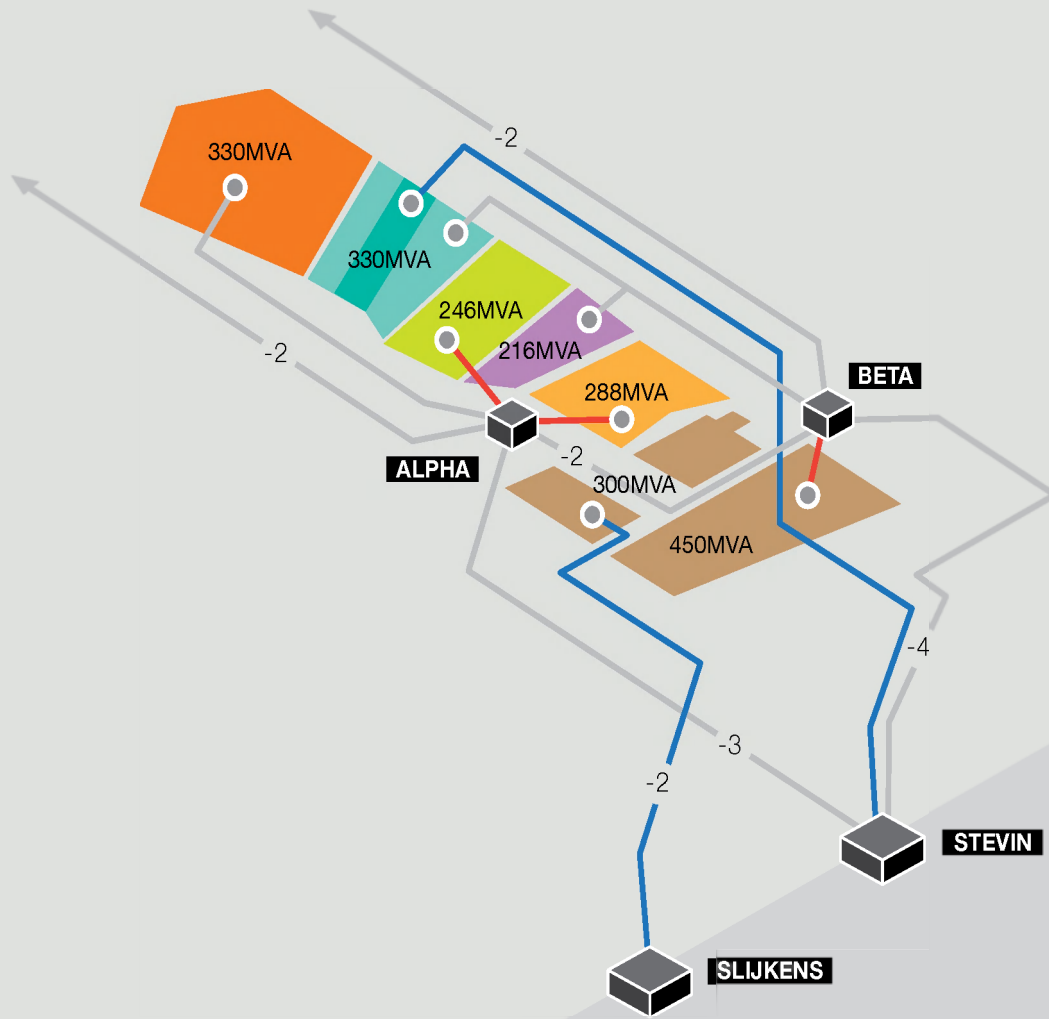
Indicative diagram showing the values known at the time of publication.

### The project offers many advantages, including:

- optimal use of the investment for Elia, the developers and the community as a whole;
- option to stagger investment over time, based on actual requirements at a given juncture;
- capacity to optimise maintenance costs;
- clear separation between grid facilities and the developers' facilities;
- the redundancy and reliability provided by a meshed grid;
- the non-discriminatory nature of such a grid vis-à-vis wind farm developers;
- lesser encroachment of connection cables on coastal areas.

### It also provides a technical solution of the highest quality, based on optimising criteria such as:

- the weight, size, number and design of the platforms;
- the number of cables to be laid in the seabed and those used for connection to the onshore grid;
- the distance from the coast and between the platforms and the wind farms;
- the capacity of onshore substations;
- the number of transformation poles and the rated power of the transformers;
- losses (due to transformation and transmission via cables);
- nominal power;
- energy flows;
- ancillary services, through mutual assistance between the platforms and wind farms;
- the use of proven technologies.



Indicative values mentioned as work hypothesis.  
 The proposed solution is robust enough in case of  
 additional power increase.



## Ready for connection to a future international platform

**This offshore meshed grid off the Belgian coast will be built in stages** alongside work on wind farms for the seven concessions awarded and could begin to be operational in the relatively near future, from 2014.

It will also serve as an outpost for a future connection to an international platform.

In fact, neighbouring countries, such as the United Kingdom and the Netherlands, are also working on developing offshore grids in their territorial waters in the North Sea.

Looking ahead, an international AC/DC platform to convert alternating current to direct current (thereby enabling greater quantities of power to be conveyed over long distances) may be built in cooperation with other TSOs; such a platform, could, for example, be situated a few kilometres to the northwest and could be connected to 'local' offshore grids via (high-voltage) AC cables.

**This sort of set up would facilitate access to other types of energy** including hydropower in Scandinavia, which would be available in the event of there being insufficient wind in the North Sea, and would enable wind power to be stored for future use where an excess is generated that is not required locally.

This solution would also enable Belgian consumers to be supplied with 'green' electricity via the new North Sea grid, even when there is insufficient wind!

In addition, this long-term vision, which would come to fruition by approximately 2025, falls squarely within the framework drawn up by the European Commission as part of its energy policy and by the North Sea Countries' Offshore Grid Initiative being implemented by the Member States surrounding the North Sea.



## Anticipating the future development of onshore generation facilities!

In conclusion, the concept outlined here entailing connection to an international DC platform is entirely consistent with the grid's long-term capacity. If it is confirmed that the Doel nuclear power plant is to close, the power generated by the latter could, in the future, be generated instead by just such an international platform, for example, via a DC cable connection laid in the *Scheldt*; such a solution would ensure both security of supply and access to a diverse and high-quality energy mix in terms of sustainability.

Such a project would enable Elia to fulfil its role as a TSO committed to delivering security of supply, guaranteeing optimal market operation, and adopting a proactive stance in combating global warming.



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