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Marine wind energy and the North Sea Offshore Grid Initiative: A Multi-Level Perspective on a stalled technology transition?



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ABSTRACT

Building electricity grids out to sea implies a radical transformation of grid topologies. In time, a marine super-grid is conceivable. If growing numbers of subsea electricity cables are meshed with marine renewable, a 'greening' of such grids is also possible. Based on interview research, this paper examines one such ambitious proposal: the Northern Seas Countries Offshore Grid Initiative (NSCOGI). The Multi-Level Perspective (MLP) on technology transitions is used to evaluate progress to date. Obstacles uncovered include competing and still immature grid technology niches. There is only equivocal support from key actors within the relevant socio-technical electricity regime. National grid Transmission System Operators (TSOs) appear more interested in subsea cables to trade electricity rather than enhancing marine renewables. While the EU might be assumed to be a vital actor to support a North Sea Grid, it has only limited influence. National policy insiders and decisions matter more. This paper stresses the residual importance of the national level for offshore wind and electricity grids. A marine super-grid wired up with offshore wind-farms throughout the North Sea, is both more tentative in its emergence, but also ambiguous in its support for offshore wind.

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1. Introduction: offshore grids-an idea whose time has come?

At the end of 2015, over 11,000 MW of offshore wind capacity has been installed in European waters, a figure which looks set to grow [1]. This remarkable success story has invited speculation that Europe's electricity grids could also be extended offshore [2]. Such proposals typically seek to connect nearby offshore wind farms together, rather than as now, each being cabled individually to shore. Also envisaged are at sea connections to a growing number of nearby HVDC (High Voltage Direct Current) sub-sea electricity trading cables.

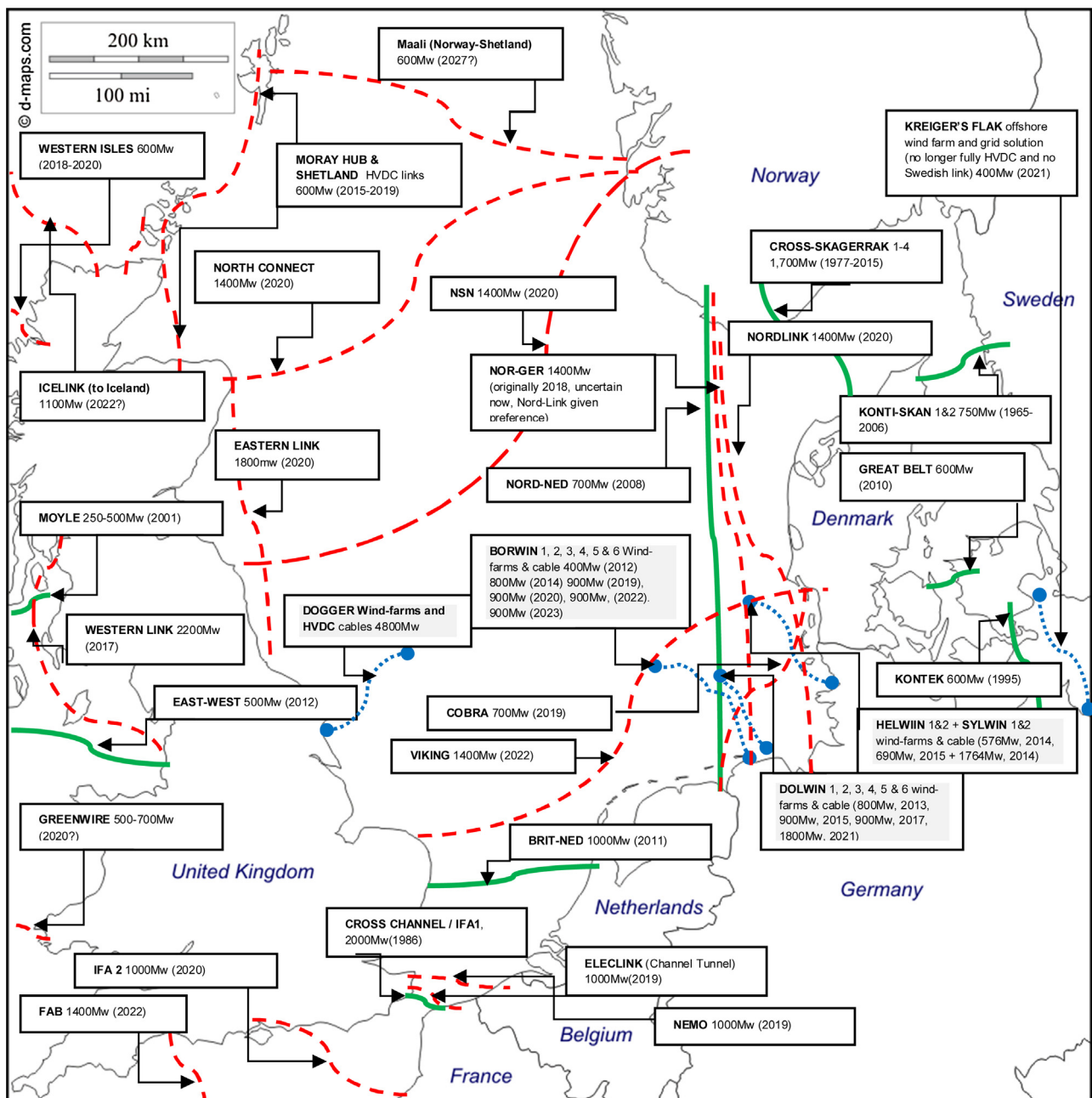
As Map 1 shows, there has been a steady growth in subsea HVDC projects in the North Sea, although most of these are straightforward electricity trading cables. As of 2016, only a few wind-farms use their own high capacity HVDC cables. Most offshore wind-farms still rely on shorter HVAC cabling back to land. Yet European HVDC infrastructure at sea is growing as part of a wider global trend. Charts 1 and 2 plot the progression of all European HVDC subsea projects between 1954 and 2016, and includes planned and advocated projects to 2033. By 2016 circa 40 marine HVDC projects have

emerged with around half of these being built in just the last decade. Large numbers of such projects are either planned for the future. While many of these are speculative, subsea HVDC cable projects will be an established feature of future European grids. Moreover, the capacity and voltage of these HVDC cables are also increasing: 1000 MW is now unremarkable as are voltages of 500 kV DC [3]. When looked at in this context, the potential for an offshore grid seems tantalizing close and achievable.

Some advocates are bullish about the potential for a North Sea Offshore super-grid, arguing it could contribute as much as 200 GW of electricity by the 2050s [4]. Environmental NGOs are mostly supportive of these ideas. For example, the environmental think-tank E3G has argued:

"Achieving power sector de-carbonisation in Europe and internationally will require ... inter-regional electricity transmission grids. ... The North Seas Grid represents one of the most promising examples(of this)" [5]. Greenpeace also backs such grids as a means of solving the intermittency problem which bedevils renewables like wind. They argue: 'in an interconnected offshore grid, a lower level of electricity output at a single wind farm can usually be balanced against a simultaneous high output from another wind farm several hundred kilometers away' [6].

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Map 1. Existing and Promised Significant Subsea HVDC Cable projects in the North Sea, including the most important offshore wind, HVDC led, developments (2016). Overlays are authors own. Note, the positioning of submarine cable routing and placement of offshore wind-farms is indicative only. Thick lines are actual cables built. Dashed lines indicate future or proposed cables. Some of these are more certain than others. Dotted lines ending in rounded points are dedicated HVDC wind-farm cable systems. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Source Map: Open source from D-maps.com, <http://www.d-maps.com/index.php?lang=en>.

The early literature on offshore grids explicitly justified their rationale as a means of both making the most of offshore wind, which is generally more efficient than on land, and mitigating the wind variability problem [7]. However, building a North Sea Grid is not the most obvious, or necessarily the cheapest way [8] to address such intermittency, the extent of which is anyhow contested. Electricity regulators, TSOs and the larger utilities complain [9] that significant amounts of variable wind capacity is difficult for them to manage unless there are technical features like a larger degree of interconnection with other grids to allow opportunities for exporting, importing and balancing demand. So the case for a North Sea Grid has to be made in the face of intense commercial pressure from

more conventional approaches, using land based interconnections or alternative balancing strategies that emphasise stable base-load fuels such as natural gas.

A large body of technical expert literature has emerged which examines the potential of an offshore grid, but the topic has been less examined in the social sciences. The engineering literature is usually optimistic about the potential for offshore grids, stressing technological feasibility in contrast to political indecision over what would be a potentially massive maritime infrastructure project [10]. For example, Spro et al. examined the merits of a North Sea Offshore grid stressing its 'double promise' as a platform that would both enhance the integration of marine renewables and an infras-

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