ESB: Innovation to Deliver the Electricity Network for a Clean Electric Future

03/03/23

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About SuperNode and Superconductors

SuperNode, headquartered in Dublin, Ireland, is a global technology development company that designs and delivers cutting-edge, superconducting cable systems for bulk electricity transmission.

Conventional transmission cables are limited in terms of current levels which in turn limit their power transfer capability. Networks based upon superconducting cable systems can move larger quantities of power over longer distances with smaller and less obtrusive infrastructure, without electrical losses and at significantly lower voltages. SuperNode's technology will connect electricity markets in a way that facilitates the integration of large-scale renewables and the achievement of a decarbonised pan-European energy system.

SuperNode was founded in 2018 by Dr. Eddie O'Connor and renewable energy developer Mainstream Renewable Power Ltd. SuperNode is jointly owned by Dr. O'Connor and Norwegian green investment group AKER Horizons.

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Introduction

Ireland's ability to innovate and be an early adopter of key renewable and enabling technologies will be the deciding factor on whether we achieve our climate and energy goals. Ireland's energy system will undergo an unprecedented transformation out to 2050 and should thus proactively adopt transformative technologies such as superconducting cables that can have a positive short-term impact (2030) but also the potential for immense impact in the medium to long-term (2050).

ESB Innovation Strategy and Portfolio

Ireland's Climate Action Plan targets a network of 80% renewable electricity by 2030, a fully decarbonised electricity system by 2040 and full decarbonisation by 2050. ESB's innovation strategy is intended to enable the delivery of these essential goals. In light of these goals, it is the view of SuperNode that the current innovation strategy and portfolio approach is excessively conservative, incremental in nature, and focused on the short-term. The portfolio is dominated by demand side management and the optimisation of the current system. This is of course an important and necessary objective - the lights must stay on and economic activity must not be obstructed.

However, given the transformative effect renewable energy and general electrification is going to have on our energy system, higher priority should be placed on more forward looking innovations that will better serve the transformed energy system of the future which will largely be based on wind, solar and much greater interconnection with our neighbours. If we are to achieve our energy and climate goals, the energy systems of 2040 and 2050 will not be an adapted, optimised thermal based energy grid but instead a high functioning efficient, electric grid powered predominantly by renewables. It must therefore be designed around the specific characteristics of renewable energy – variable and intermittent, remote from demand centres and fully electric. We should be looking for innovative technologies that match that vision rather than patching together an already antiquated system designed for fossil fuels.

Further to this, we must not assume a fixed technology world for core technologies such as cables and transmission lines. The maintenance of our current energy system is an important task but an innovation strategy is inherently built on big ideas and change, ESB's definition of innovation is:

"to implement new ideas for the enduring benefit of our customers and business."

We must not limit our innovations to small tweaks around the edges. Surely it is here in the innovation portfolio that a more forward looking mindset should be taken, proactively trialing technology that could transform our energy system and bring about the enduring benefits of a renewable energy future.

Urban Congestion

One key issue we have identified worthy of attention is that of urban congestion in Dublin. Congestion in the city of Dublin is already causing challenges, at both the Transmission and Distribution voltage levels. As we bring more renewables onto the system and we continue to electrify more and more of

our economy, the issue of urban congestion will continue to worsen. As pointed out in the consultation document to which we are responding:

"The electrification of heat and transport will lead to increased demand loads and potential congestion on LV networks with the proliferation of LCT (low carbon technologies)."[1]

There is already a limitation on new capacity that can be brought into Dublin. This will hinder our ability to construct new offshore wind generation in the Irish Sea, with limited available capacity to connect to the Capital and our biggest energy consumers. This is a serious issue which could result in missed targets, security of supply risks, and could threaten to derail the green agenda.

The Dublin grid congestion issue affects not only the Green transition, but the broader economic wealth of the state as well. We cannot locate any further data centers in the Leinster area because of grid congestion. We cannot repower Dublin Bus with a green electricity fleet because of grid congestion; we cannot commit ourselves to 100% green transport until we install a high density fast charging easily accessible charging system until the grid congestion problem is solved. We cannot do as Luxembourg did and mandate that all home heating be done by heat pumps until the grid congestion issue is solved.

Superconductivity

Our proposed solution involves Superconductivity. It has 2 great attributes which work in a city environment: it has a tiny footprint, compared to the conventional copper based cable solutions, and it can transfer extremely large amounts of power from Substation A to Substation B. Superconducting connection systems are already operating in Seoul in South Korea and in Essen in Germany. There is another project in planning for Munich which will transfer 500MW over 12km and another in Chicago that is already moving power over a distance of 4 to 5km using superconducting cable technology. These cities all faced similar urban congestion problems as Dublin.

Superconducting cables will increase the resilience, the reliability, and most importantly the capacity of Dublin to accept more transmitted power, as well as the ability to mesh the distribution grid. Superconducting cables would therefore fulfill 3 of the 6 categories in the ESB's Impact Assessment Framework in 'Network Reliability and Resilience', 'Facilitating Market Growth and New Connections', and 'Environment'. Superconducting cables would also fit appropriately into ESB's 'Fast Follower' approach which seeks to leverage research and innovation already implemented by other utilities and DSO's abroad.

Furthermore, SuperNode and its partners are leading efforts in the superconducting industry to develop superconductors for new applications such as long-range, bulk transmission, both terrestrial and offshore, capable of carrying up to 10GW in a single cable. SuperNode's experience and connections can also be leveraged to connect with and bring the planners and operators of the superconducting connections to Ireland, to coordinate with ESB, Eirgrid and any interested, involved stakeholders.

Long-Term Benefits

It has become clear now that Ireland is facing the biggest economic and environmental opportunity in generations in our offshore wind resources. The development of our offshore wind resource will allow Ireland to fully decarbonise while also becoming a major exporter of power with the potential to provide up to 10% of Europe's overall power, as part of an interconnected European energy system

[1] Section 3.3.2

based predominantly on renewable energy. It is up to Ireland now whether we can turn this comparative advantage into a competitive one.

For Ireland to achieve this, we are going to need an onshore and offshore grid capable of moving the massive amounts of power (at least 30GW in 2050) produced off our shores, both around Ireland itself as well as exporting it to our energy hungry European neighbours. Grid technology today is simply not capable of moving around this level of power. The development of innovative new grid technologies capable of carrying much higher levels of power, up to 10GW, will be critical in the long run.

It is already increasingly difficult to construct large overhead lines due to public opposition and current underground HVDC cable technology is capacity constrained and is not likely to ever be able to carry the required levels of power. Todays state-of-the-art 525kV cables are capable of carrying 2GW of power and by 2050 800kV cables are predicted to extend this to 3.5GW. This capacity will severely limit the power flows of a renewable based energy system, it will hinder our ability to decarbonise and jeopardise Ireland's opportunity to become a renewable energy superpower.

It should therefore be a high priority of ESB, in collaboration with Eirgrid, to recognise and establish a clear vision of the energy system in 2050 and start innovating and developing technologies that will contribute in the future so that when they are commercially ready, there is no delay in adopting them. The implementation of superconducting cables to solve Dublin's congestion problems would offer the dual benefits of alleviating Dublin's issues in the short term as well as developing experience, expertise and relationships in what could be a critical technology in the medium to long-term.

There is an incredible opportunity for Ireland in the coming green industrial revolution. This is an opportunity that we must take. But in order to do that we must not wait until there is a problem to solve but rather we must be proactive and seize the initiative.