Statement on the second draft of the 2037/2045 grid development plan

Berlin, 18 November 2023

As a manufacturer of innovative superconducting cables, SuperNode welcomes the fact that the 2037/2045 grid development plan explicitly addresses the role of innovations in the electricity system of the future in Chapter 6 "Innovations". Unfortunately, however, the definition of innovation is far too narrow and not technology-neutral. This excludes disruptive grid technologies such as superconductors, which are dependent on demonstration projects in order to make their critical contribution to the long-term goals of an industrially resilient, European-integrated and fully decarbonised electricity system set out in the NDP.

Many of the innovation vectors currently listed in the NEP are already available and scalable in the short term. It is therefore all the more important that the NEP enables the testing and demonstration of further innovative technologies in a controlled environment for a limited period of time until the production of these technologies can also be scaled up and commercialised. This would fulfil the overarching objectives of the European Commission, which proposes the establishment of "Net-Zero Regulatory Sandboxes". The NEP should encourage and request grid operators to set up such net-zero technology real-world laboratories "that enable the development, testing and validation of innovative net-zero technologies in a controlled real-world environment for a limited period of time before their commercialisation or commissioning, thus promoting regulatory learning and potential scaling up and wider deployment."[1]

As rightly stated in the NEP, large-scale testing and validation of technologies must be ensured in order to create a secure and resilient German and European electricity system that is largely based on variable renewable generation in the form of photovoltaics and wind power. However, innovative and potentially disruptive technologies must also be given a development perspective on the way to commercial application and demand for these technologies must be triggered on the part of grid operators. The current draft of the NDP does not trigger this demand.

Due to the time horizon of long-term grid planning up to 2045, the innovation chapter must give greater weight to technologies that are expected to reach market and application maturity within this period. Last but not least, German companies are market leaders in the field of superconductors and, in contrast to cable technologies based on copper or aluminium, are only minimally dependent on imports of raw materials and components. Superconductors can therefore also guarantee a resilient electricity system with significant economic cost benefits in the long term. To ensure that the innovation chapter can fulfil its intended purpose, we propose the following adjustments.

1) Expansion of the concept of innovation

[1] European Commission (2023) Net Zero Industry Regulation [Available online at: https://eur-lex.europa.eu/legal-content/DE/TXT/HTML/?uri=CELEX:52023PC0161]

Chapter 6 of the second draft of the grid development plan correctly recognises that "the use of current solutions and concepts alone is not sufficient to achieve the transformation of the energy system".[2] At the same time, the grid development plan "only takes into account those innovations whose market availability or readiness for use is already available or foreseeable today".[3] This would correspond to a technological readiness level (TRL) of 9. High-temperature superconductors (HTS) are already commercially available in urban applications. Pilot projects, such as the AmpaCity project in Essen, have already demonstrated the benefits of superconductors. Nevertheless, superconductors do not seem to fulfil the restrictive requirements of the NEP and are not listed as a possible technology option for the electricity grid of the future.

According to the NEP, the main reason for this is the lack of testing of the technology. This is at odds with the demonstration project at transmission level by Stadtwerke München (SuperLink). The project aims to "investigate how the load centre in the south of the Bavarian capital can be connected to the main feed-in of the transmission grid in the north via a 12 km long HTS cable."[4] The aim is to transmit an electrical output of 500 MVA at the 110 kV voltage level via a single HTS cable. The project is funded by the BMWK and started in October 2020.

The decision not to mention superconductors as a technology option in Chapter 6 significantly slows down the further development, implementation of demonstration projects and scaling up to market maturity by the grid operators. The necessary validation does not materialise because superconductors are not given the necessary backing and the associated planning security.

Superconducting cables already have a high degree of maturity and are being further developed in various projects in Germany and around the world to achieve higher transmission capacities, lower investment and operating costs, as well as redundancy and reliability. By 2030, a TRL level (TRL = Technology Readiness Level) of 9 is targeted for superconducting cables in both the transmission and distribution grids. Superconductors are already rated by ENTSO-E with a TRL 5-6 for direct current transmission and TRL 7-8 for alternating current transmission.[5]

The next generation of superconducting cables will extend the range to several hundred kilometres and make offshore applications possible. Pilot projects can start from 2024, with commercialisation targeted before 2030. This means that the technological maturity of superconductors for long-distance transmission will be achieved well within the time horizon of the grid development plan by 2045 and can make a real contribution to the challenges of the climate-neutral grid. An assessment based solely on the current TRL contradicts the premise of technological openness and cancels out the development of new, innovative grid

[2] Electricity Network Development Plan 2037/2045 (2023), second draft | Transmission system operator CC-BY-4.0
[3] *Ibid.*
[4] Mercer, William J. and Pashkin, Yuri A. (2023) Superconductivity: the path of least resistance to the future, Contemporary Physics [Available online at: https://www.tandfonline.com/doi/full/10.1080/00107514.2023.2259654?scroll=top&needAccess=true]
[5] ENTSO-E (2023) High Temperature Superconductor (HTS) Cables [Available online at: https://www.entsoe.eu/Technopedia/techsheets/high-temperature-superconductor-hts-cables]

technologies and their contribution to the overarching energy, environmental and industrial goals.

This narrow interpretation of the concept of innovation means that valuable innovation potential is left untapped. **Young technologies in particular, which are at earlier stages of the innovation cycle, urgently need investment signals and incentives for demonstration projects so that they can bridge the so-called *"valley of death"* and be transferred from laboratory to demonstration to commercial application. Only by suggesting a technological development path for leap innovations such as superconductors can the current chicken-and-egg problem with regard to innovations in network planning be resolved.**

In addition, there is unequal treatment with other technological innovations that have a comparable TRL (high-temperature conductor lines = TRL 7) to superconductors, but are given their own sub-chapter in the innovation chapter. It is therefore incomprehensible why superconductors are not assessed within a *level playing field* with these technologies and are largely ignored in the innovation chapter.

2) Discrepancy between research policy priorities and long-term system planning

One of the aims of the Network Development Plan is to create a reliable planning basis in order to achieve the German government's climate protection targets. In this context, the NDP considers it fundamental that "the infrastructure [...] must be equipped with innovative technologies and further expanded".[6] The exclusion of technologies with a lower degree of maturity than TRL 8 mentioned in the previous chapter creates a discrepancy between the political will to innovate and the reality of grid planning.

In the recently presented *8th Energy Research Programme* of the BMWK, high-temperature superconductors are presented as a technology that is particularly predestined for the transport of electricity over long distances.[7] The energy research programme pursues the explicit goal of testing innovative technologies, business models and processes in practice, optimising operation and creating trust in new solutions. However, this innovation policy objective in favour of greater development of superconductors at the R&D stage must be flanked by demand-side stimuli. Without early testing of superconductors under real market conditions in cooperation with the TSOs and DSOs, the investor confidence required for large-scale application cannot be achieved. Otherwise, Germany risks missing out on translating its innovation leadership in superconductors into industrial policy successes.

The CDU/CSU parliamentary group in the Bundestag has also drawn attention to the danger of the lack of commercialisation of superconductors in a small question. The CDU/CSU is

[6] Electricity Network Development Plan 2037/2045 (2023), second draft | Transmission system operator CC-BY-4.0

[7] BMWK (2023) 8th Energy Research Programme for Applied Energy Research - Research Missions for the Energy Transition

calling for "concrete long-term projects to test the technology for the energy transition in practice and to utilise it in the medium term". [8]

Germany is the only European country with a comprehensive ecosystem and the entire superconductor value chain. Scientific institutions such as the KIT, as well as small and medium-sized companies (e.g. Theva) are global thought leaders and market leaders. It would be negligent to leave these significant value creation potentials for a domestically developed future industry unutilised.

Research and industrial policy potential must therefore be combined with a market "pull" in favour of superconductors. The network development plan is an important basic document for sending the right signals and setting the course for transferring projects from the research level to the practical level. There is therefore a need for closer integration of research policy priorities and grid planning and a more far-sighted assessment of leap innovations such as superconductors.

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About SuperNode and Superconductors
SuperNode 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. Electricity grids 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 producers and consumers in a way that facilitates the most efficient integration of large-scale renewables and the achievement of energy independence and a decarbonised pan-European energy system.
SuperNode, headquartered in Dublin, Ireland, 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.

[8] German Bundestag (2023) Minor interpellation by the CDU/CSU parliamentary group - The use of superconductors for the energy transition in Germany