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[Invited] Strategy for developing the EU-DEMO Magnet System in the Conceptual Design Phase

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Fusion power plants offer the prospect of a new sustainable source of energy for future generations. The design and R&D of future reactors is expected to largely benefit from the experience gained in the design, construction and operation of ITER. However, deploying reliable fusion power plants, requires to overcome the design challenges and to address the remaining readiness gaps. Europe is starting the Conceptual Design Phase for building a superconducting DEMOnstration Fusion Power Plant (DEMO) and starting operations around the middle of the century. The aim is demonstrating the production of 500 MWs of net electricity, with a closed tritium fuel cycle and adequate plant availability.

For the design of the Superconducting magnet system several variants of coils have been investigated in the pre-conceptual design phase, which has concluded in 2020. Some of them are very close to ITER design, therefore have a relatively high technology readiness level. The "alternative"proposed solutions, that are very promising in terms of costs and performances, need a validation to industrial scale in order to be eligible for the down-selection expected in 2024. In particular, the validation regards the design of the layer-wound graded TF winding pack based on React&Wind Nb3Sn conductors, and the hybrid, layer-wound graded CS coil. The challenging aspect is that the CS magnet is made of REBCO conductors in high-field, React&Wind Nb3Sn conductors in medium field and NbTi conductors in low field. Also innovative techniques need be studied for insulating critical parts of the coils, as penetrations, discontinuities and joints.

The main issues of the technological development are illustrated. A conspicuous R&D work plan is presented for the Conceptual Design phase to validate the technology within 2024 and demonstrate the operational capabilities by testing superconducting insert coils, that is about 50-m long wound conductors, by 2027.

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