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European roadmap to fusion energy

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The European Roadmap to the realisation of fusion energy breaks the quest for fusion energy into eight missions. For each mission, it reviews the current status of research, identifies open issues, proposes a research and development programme and estimates the required resources. It points out the needs to intensify industrial involvement, to educate the fusion scientists and engineers of the future, and to seek all opportunities for collaboration outside Europe.

A long-term perspective on fusion is mandatory since Europe has a leading position in this field and major expectations have grown in other ITER parties on fusion as a sustainable and secure energy source. China, for example, is launching an aggressive programme aimed at fusion electricity production well before 2050. Europe can keep the pace only if it focuses its effort and pursues a pragmatic approach to fusion energy. With this objective the present roadmap has been elaborated. The roadmap covers three periods: The short term which roughly covers the period until ITER comes into operation and the DEMO Conceptual Design is completed, the medium term which runs until ITER is in routine operation at high performance and the DEMO Engineering Design is completed and the long term.

ITER is the key facility of the roadmap as it is expected to achieve most of the important milestones on the path to fusion power. Thus, the vast majority of resources proposed in the short term are dedicated to ITER and its accompanying experiments. The medium term is focussed on taking ITER into operation and bringing it to full power, as well as on preparing the construction of a demonstration power plant DEMO, which will for the first time supply fusion electricity to the grid. Building and operating DEMO is the subject of the last roadmap phase: the long term. It might be clear that the Fusion Roadmap is tightly connected to the ITER schedule. A number of key milestones are the first operation of ITER, the start of the DT operation, and reaching the full performance at which the thermal fusion power is 10 times the power put in to the plasma. DEMO will provide first electricity to the grid. The Engineering Design Activity will start a few years after the first ITER plasma, while the start of the construction phase will be a few years after ITER reaches full performance. In this way ITER can give viable input to the design and development of DEMO. Because the neutron fluence in DEMO will be much higher than in ITER (atoms in the plasma facing components of DEMO will undergo 50-100 displacements during the full operation life time, compared to only 1 displacement in ITER), it is important to develop and validate materials that can handle these very high neutron loads. For the testing of the materials a dedicated 14 MeV neutron source is needed. This DEMO Oriented Neutron Source (DONES) is therefore an important facility to support the fusion roadmap.

The presentation will focus on the strategy behind the fusion roadmap and will describe the major challenges that need to be tackled on the road towards fusion electricity. Encouraging recent results will be given to demonstrate the outcome of the focused approach in European fusion research.

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