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STEP Cryogenic Refrigeration –a Roadmap

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Fusion is one of the most promising options for generating the cleaner energy the world badly needs. Recent milestones in fusion include the new JET3 world record of generating 69 megajoules of fusion energy for five seconds by feeding two milligrams of deuterium and tritium. This is enough to power 12,000 households for about the same period. Delivering fusion energy to the grid is a challenge of physics and engineering but to do so commercially will require industrial capability.

At the heart of the UK Government's Fusion Strategy is STEP (Spherical Tokamak for Energy Production). The programme will build a prototype fusion energy plant at West Burton in Nottinghamshire, targeting operations in 2040. Demonstrating net energy from fusion will pave the way for the development of a fleet of future fusion powerplants around the world. The STEP Commercial Pathway is working with industrial partners to focus and develop the essential capability needed for commercial fusion power plants.

STEP and commercial fusion power plants will require large refrigeration loads at various cryogenic temperatures, probably 80K, 50K and 15K. The refrigeration load is likely to be equivalent to around 100kW at 4.5K. As net power production is the prime driver, the cryogenic plant will have to be as power efficient as possible. It also has to be reliable, to maximise production and minimise down time. This presents an opportunity for advances in the field of large-scale cryogenic refrigeration.

The challenges of deploying proven technologies in innovative ways, to drive up efficiency, will be discussed. Intelligent use of thermodynamic balances to optimise the refrigeration process will be explored. Experience of proven technologies in the areas of compression, heat exchangers and expanders will be shared. The roadmap through detailed design, manufacture, installation and operation will be presented, together with opportunities for the cryogenics community to get involved.

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