

# iMAGINE - a Breakthrough Technology for Closing the Fuel Cycle without Reprocessing

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The energy trilemma and UN-SDG 7 are drivers for energy research to support the UK governments net-zero emissions law. Nuclear reactors are a highly attractive candidate for reliable, 24/7 available, low-carbon electricity generation. However, current technology reactors and their related fuel cycles suffer from unreasonably high cost, a lack of sustainability, and a waste problem due to the absence of recycling. Molten salt technologies will be a key step into the future of nuclear supporting a disruptive way of optimizing the whole nuclear system to enhance sustainability and affordability. Main advantage, compared to existing technologies, is elimination of complex solid fuel production and fuel cycle technologies. Molten salt systems will be a breakthrough for most efficient fuel use, by operating on existing spent fuel while drastically reducing the cost of nuclear and solving the long-term waste problem. However, developing a disruptive, highly sustainable and affordable fuel cycle –instead of just a reactor –requires a strong inter-disciplinary approach, linking physics, engineering, and chemistry.

Primary key is to deliver the essential step into any new reactor technology: a zero-power facility to research the game-changing technology in safe settings, to advance knowledge and capabilities in the technology to grow the skills base in the UK. Core activity is improving simulation and demonstration of innovative control and safety features to allow a qualified response to regulatory requests and to support the formation of the required skilled workforce to support BEIS, aiming to achieve an industrially demonstrated, market ready product in 2050.

The proposal pushes the breakthrough technology delivering significantly improved sustainability indices, characterized by:

- avoiding mining (major source of eco-toxicity, carbon emissions, and cost) & avoiding enrichment (major energy consumption, proliferation-risk, and cost)
- reducing waste production and storage demand by the reuse of existing spent fuel & eliminating highly-radiotoxic transuranium isotopes (reducing the final disposal challenge)
- eliminating reprocessing (proliferation risk, prohibitively expensive prior step for closed fuel cycle) & solid fuel production (major cost driver and radiation source in closed fuel cycle)
- replacing reprocessing with demand driven salt clean-up & applying low pressure technology

The ultimate aim is to prepare the UK for a net-zero future using highly-innovative technologies. The impact of the proposed technology and the attractiveness of the vision is evidenced by the rapid take-up through the major industrial technology developers, including Terrestrial Energy, Terrapower, Elysium Industries...

An overview on the research plan will be given.

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