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How nuclear decommissioning can be made compatible with a net zero carbon trajectory

Nuclear derived power features heavily in the strategies of most nations to decarbonise electricity production and industrial processes. It is widely accepted and documented that nuclear generation has a very low carbon intensity when used for electricity production and similar logic can be used to extrapolate this to non-electric applications. These studies have principally focused on accessing lifetime emissions associated with the construction, operation and decommissioning of modern Generation III/III+ and IV systems. The carbon intensity of legacy nuclear facilities, including Generation I reactors, that were developed and commissioned between 1950 and 1960 are less clear cut, given existing decommissioning, waste storage and disposal strategies. It is not a surprise to note that the carbon intensity of dealing with this legacy is dominated by construction and demolition activities –and is carbon emitting, particularly within the strict nuclear safety setting of the industry. While research is ongoing, the decarbonisation of common construction materials (concrete and steel) is difficult, with limited proven and commercial scale technology that can be implemented within the constraints of current regulatory and industry practice in the timeframe required.

In general, current decommissioning plans are pushing long term disposal and site end states further into the future, adding significant carbon to the industry through interim storage and long quiescence periods. Understanding the whole life carbon of decommissioning relative to the net zero by 2050 timeline and the diminishing national carbon budgets, is necessary to support the no-regrets policy decisions. Also, decommissioning of the legacy facilities could set the precedent for future nuclear decommissioning and waste management activities. In this systems-thinking context, there is a risk that a high carbon decommissioning sector jeopardises the low carbon credentials of the nuclear energy generation –and hence credible decarbonisation pathways adopted by many countries. Thus, it is important to address these challenges now.

Arup, has co-authored the PAS2080:2023 and its decarbonisation principles that considers the Net zero carbon transition at the systems-level. For example, global Decommissioning Missions are sacrosanct –but it must fit in the time and carbon budgets that are set at national and international levels. Thus every asset must, on a systems level, be compatible with the net zero transition of the system that it is part of.

This paper will discuss common decarbonisation challenges associated with decommissioning of legacy facilities and waste disposal with a very fixed net zero milestone of 2050. In addition, it will provide a view on the suitability, or otherwise, of prolonged interim storage as a means to defer final disposal to the far future. Noting associated national and global decarbonisation trajectories. It will also discuss worked decarbonisation examples in action and explore opportunities for the need to prioritise nature-based solutions in managing carbon, including the role of land use change (site end states) in increasing climate resilience and hence reduce the carbon for hard infrastructure provision and avoided disruption; but also enhance the carbon sequestration potential.

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