THE ENVIRONMENTAL BENEFITS OF CIRCULAR ECONOMY STRATEGIES IN THE NUCLEAR INDUSTRY: A LIFE CYCLE ASSESSMENT STUDY

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In the United Kingdom, nuclear energy is poised to play a key role in decarbonising the power generation sector in the coming decades. The management of nuclear wastes generated from the nuclear fuel cycle represents a hotly debated topic. The amount of nuclear wastes, and thus the associated environmental impacts, could be minimized via implementation of circular economy approaches. This work builds upon extensive research efforts conducted in the past years at University College London (UCL) in collaboration with the National Nuclear Laboratory, which, among other achievements, led to the development of a pioneering model for assessing radiological impacts in LCA. Here, we demonstrate how Life Cycle Assessment (LCA) can be used in the nuclear industry to investigate the environmental benefits of two circular economy strategies that aim at reducing the amount of intermediate level waste to be disposed of in a geological disposal facility. The first case study focuses on a novel technology developed in the US for recycling Zircaloy™ wastes, which are used as cladding of nuclear fuels. The second case study investigates the environmental benefits of using depleted uranium to produce uranyl nitrate - a key chemical used to separate plutonium from uranium when recycling used nuclear fuels. The environmental impacts are quantified using the Environmental Footprint 2.0 method and the UCL model for radiological impacts. Our results show that both circular approaches outperform conventional ones across all environmental categories. This is not only because they bring a reduction in the amount of waste to be disposed of, but also because they are assumed to induce a reduction in the demand for mining of primary zirconium and uranium. When both approaches are combined, the environmental benefits range from 4% in the category freshwater and up to 94% in the category resource use, energy carriers (see Figure 1).

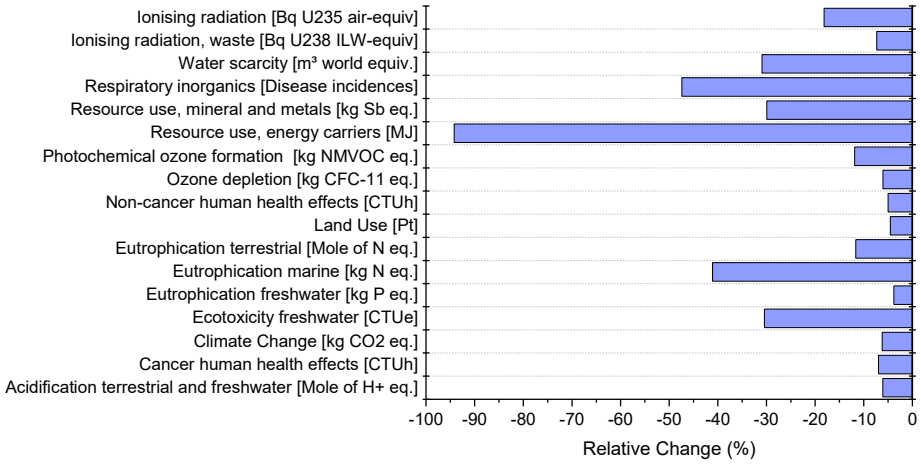

Figure 1 – Relative changes between the baseline scenario and the implementation of recycling Zircaloy™ cladding and producing uranyl nitrate from DepU.