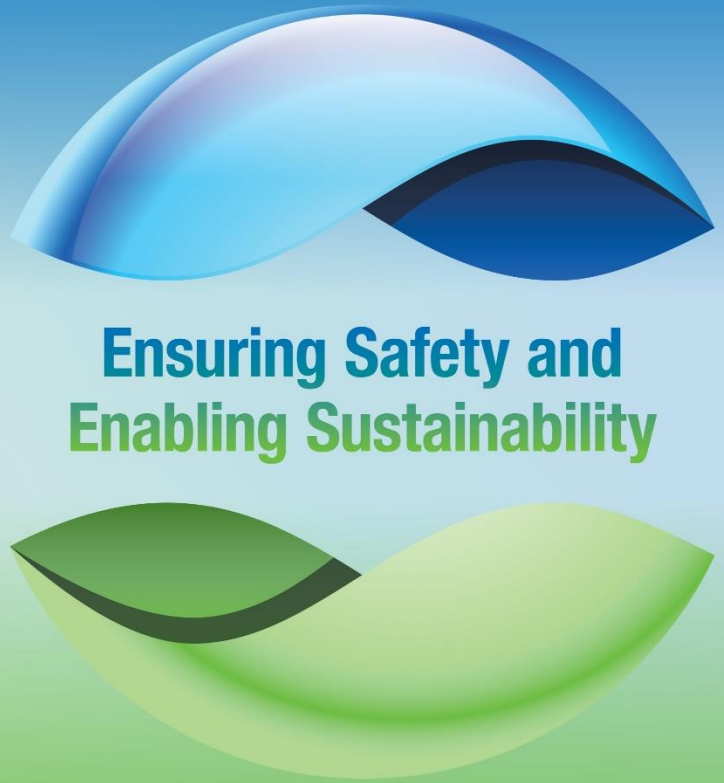
International Conference on

The Safety of Radioactive Waste Management, Decommissioning, Environmental Protection and Remediation



Ensuring Safety and Enabling Sustainability

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APPLYING A LIFE CYCLE ENVIRONMENTAL PERSPECTIVE TO THE DEVELOPMENT OF RADIOACTIVE WASTE TREATMENT TECHNOLOGIES

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PREDIS

MANCHESTER 1824
The University of Manchester

What is Life Cycle Assessment (LCA) ?

- Quantification of environmental **burdens**
- Translating burdens into potential **impacts**
- Identification of **opportunities** for environmental improvements – 'hot spots'
- ISO 14040/44

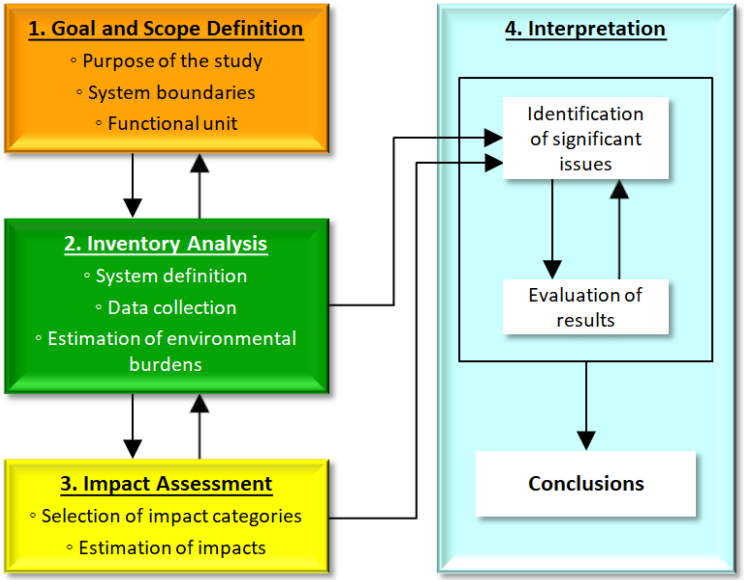

Figure 1: The four phases of life cycle assessment as defined in ISO 14044

LCA and Life Cycle Costing (LCC) in PREDIS

- LCC is less standardised but a general method exists (from the Society of Environmental Toxicology and Chemistry, SETAC)
- PREDIS incorporates LCA and LCC into the development of treatment options for metallic wastes, liquid organics and solid organics, as well as waste store monitoring technology.
- All LCC aligns with the LCA models with each flow having a cost attached
- Protocol for the use of LCA/LCC: https://predis-h2020.eu/wp-content/uploads/2021/09/PREDIS_MS14_T2.5-LCA-protocol-guidance_31.8.2021.pdf

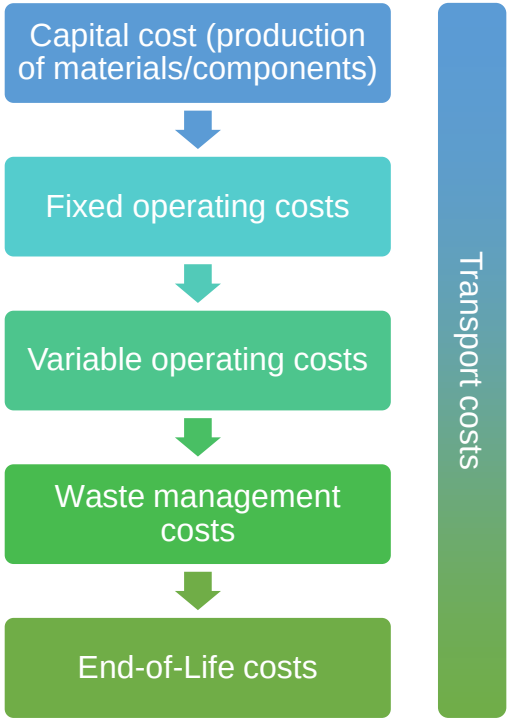

Figure 3: LCC methodology

LCA/LCC in Nuclear Sector

- Literature review 2021-2022: established the very small pool of radioactive waste treatment LCA, few papers considering decommissioning or back end nuclear fuel cycle
  - Over 120 papers screened

Case Study - Decontamination using Gel

- Application of a self-drying cracking gel (SDC gel) which incorporates surface contamination
- Collaboration on inventory data with CEA
- FU is the treatment of 10 m^2 of planar stainless steel surface
- System boundary:

  production of reagents and equipment → removal of the treatment gel

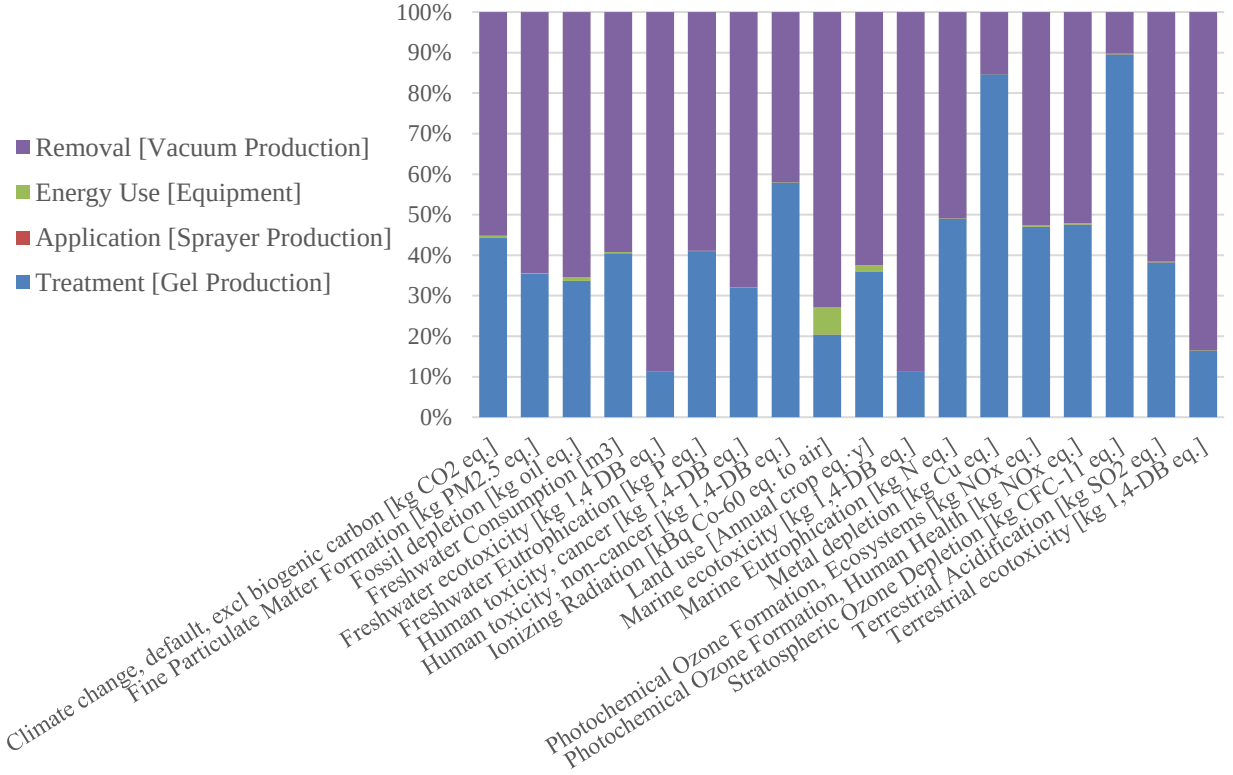

Figure 4: Impacts of treating 10 m^2 of planar stainless steel surface using SDC gel

Case Study - Decontamination using Gel

- Once treated the stainless steel can be recycled/free-released
- The carbon footprint of decontaminated stainless steel is 99.8% lower than that of virgin stainless steel, even before savings in disposal space are accounted for:

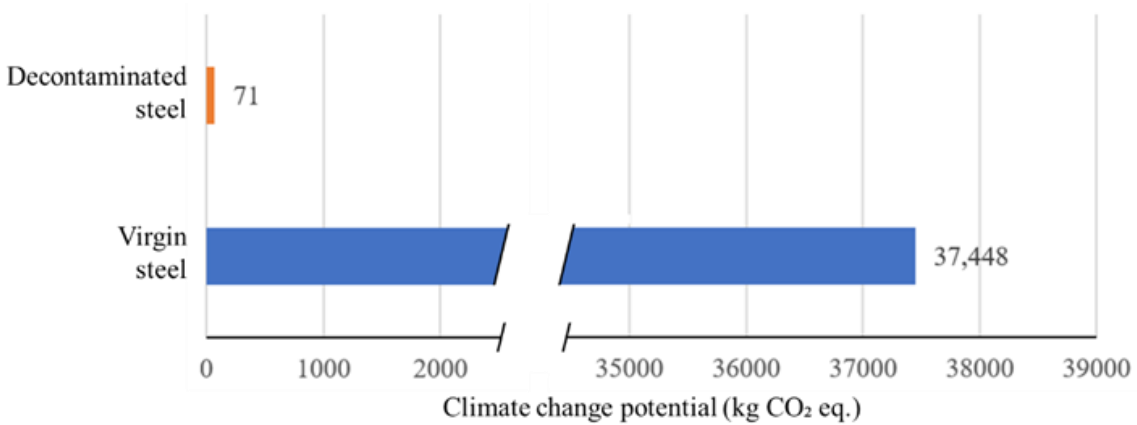

Figure 5: SDC gel treatment compared to stainless steel production

- (Note that this assumes only surface decontamination was present, with no subsurface contamination/activation.)

Case Study - Geopolymer Encapsulation

- Tuff geopolymer encapsulation of radioactive solid organic waste (RSOW)
  - Collaboration on inventory data with Politecnico di Milano
  - FU: the pre-disposal processing of 1 kg of intermediate level RSOW surrogate
  - System Boundaries: receipt of waste at the treatment facility to the handoff of a conditioned waste drum to a final repository
- Varying waste loading scenarios based on R&D compared to OPC encapsulation

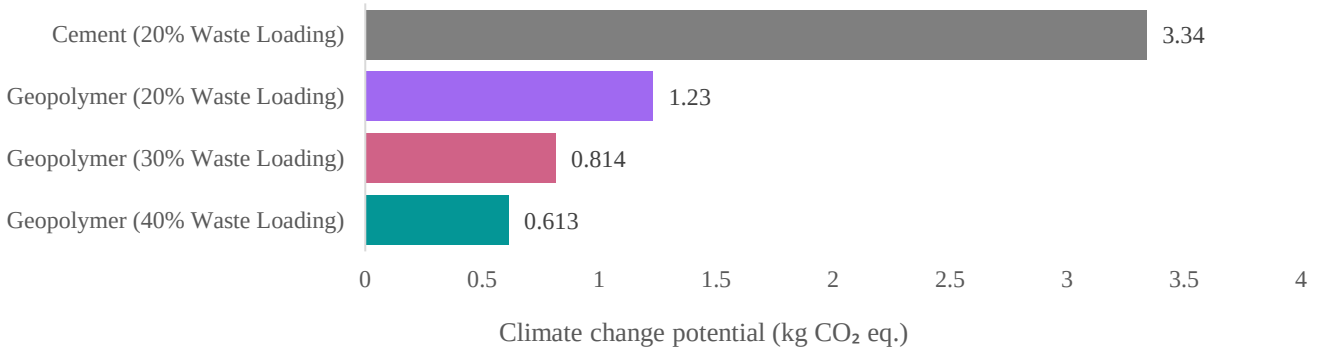

Figure 6: Climate Change potential of tuff geopolymer encapsulation

Conclusions

- LCA and LCC can be useful tools to identify the most effective and efficient routes for waste treatment R&D. Currently they are underutilised.
- Gel decontamination of planar steel surfaces appears highly beneficial from an environmental perspective.
    - Impacts are dominated by the gel and vacuum cleaner → alternative oxidants and minimisation/reuse of vacuum cleaners are the best strategy
- Geopolymer encapsulation can outperform cementation by >60%.
    - Costs and optimisation of waste loadings are key focal points

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