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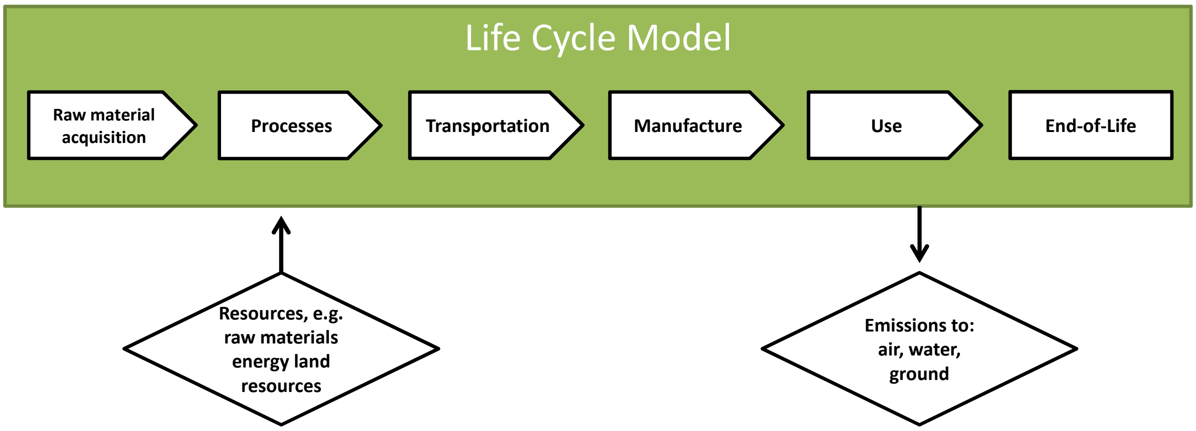
Contribution to the Nanotech Grand Challenge Project

The overarching goal of the Nanotech Grand Challenge work is to develop a pilot scheme to capture the greenhouse gas carbon dioxide (CO_2) from the free environment and to then convert this gas into useful chemical compounds. The separation of CO_2 molecules from the atmosphere will be made using nano-porous (in the size range of 10^{-9}metres) Metal Organic Frameworks (MOF) which will channel CO_2 towards chemical and biological conversion processes, these include: the Fischer Tropsch catalytic conversion of CO_2, liquid and gas phase electrochemical reduction of CO_2, and fixation of CO_2 using microbial fuel cells; these routes are being investigated by the other Nanotech team members.

In essence, my goal is to help identify the process(es) which demonstrate best efficiency and smallest environmental burden so that these can be developed further as a pilot demonstrator, to do this I will use the Life Cycle Assessment (LCA) environmental management tool. LCA adopts a cradle-to-grave approach in which all stages of a product or system's life is investigated from raw material acquisition through to end-of-life management (disposal, recycle, reuse etc.) , see fig 1. A systematic approach is used to document all material and energy inputs and outputs and any environmental emissions associated with these life cycle stages, this allows the environmental impact of the of system to be quantified and allows major contributors to the overall footprint to be identified and addressed accordingly.

Figure 1: The life cycle model



The Nanotech team will be using engineered nanomaterials (ENMs), or objects with one or more dimension less than 100nm, e.g. MOFs, carbon nanotubes, nanoparticles of gold and copper, carbon black particles; very little definitive information is available for the life cycle impacts of such materials. In recent years manufacturing processes and potential applications have evolved at an astounding rate which makes modelling such a new industry difficult, the challenge will be to produce LCAs which cover the whole system boundary with an acceptable degree of accuracy in order to best inform decisions on the selection of the CO_2 conversion processes.

ENM emissions carry additional uncertainties compared to 'traditional' materials due to increased reactivity and toxicity associated with their physiochemistry, there are concerns being raised over the potential risk they may pose to human health and the wider environment. Part of my work will be to monitor which materials are being used and in what application in order to determine whether or not a release and exposure of ENMs are likely to occur over the system's life cycle.