USE OF FULL OXY-FUEL COMBUSTION AND ACCELERATED CARBONATION CURING FOR CARBON CAPTURE AND STORAGE IN CONCRETE MANUFACTURING

A PROPOSAL FOR CLIMATE ENGINEERING GOVERANCE IN PURSUIT OF ETHICAL AND EFFECTIVE RESEARCH

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SOCIOTECHNICAL SYNTHESIS

Humanity's modus operandi for interacting with the natural world is currently propelling itself straight into an environmental catastrophe; however, emerging, controversial technologies known as climate engineering can disrupt the status quo and save the Earth and everything living on it. In fact, without climate engineering, total disaster is inevitable. Climate engineering falls into two categories: carbon dioxide removal and solar radiation management. The technical portion offers an example of carbon dioxide removal within the concrete industry, while the sociotechnical report proposed a regulatory system for both types. Concrete is an enormous opportunity for carbon dioxide removal due to its high emissions, demand, and overall scope. Concrete production with carbon capture and storage is an example of a readily marketable climate engineering technology of which there is few due to public apprehension. The sociotechnical research paper investigates this distrust and how to overcome it. The paper examines the scientific and regulatory reality of climate engineering, focusing on the most controversial technologies, and proposes a solution to public apprehension and lack of oversight.

Concrete manufacturing is a massive emitter of carbon dioxide, singlehandedly producing more carbon emissions than almost every country globally and almost every other industry. However, concrete in its final form is also a natural carbon sink, which provides an organic pathway toward reducing concrete-related carbon emissions via permanent carbonate storage. The technical project reimagines the typical ordinary Portland cement concrete manufacturing process as a carbon capture and storage technique through the addition of full oxy-fuel combustion and accelerated carbonation curing. On top of reducing the carbon footprint, this process can also enhance the structural properties of the concrete, showing that industrial climate engineering is quite beneficial and worth pursuing.

With the modifications mentioned above, a small-scale plant operating at 3,000 tons of clinker per year should capture 608.3 metric tons of carbon dioxide per year and store 82% of the captured carbon dioxide in concrete masonry units known as cinder blocks. As there are many uses for pure carbon dioxide, selling the rest will prevent its release into the atmosphere and boost profits. The cement plant built in the technical project is pilot-scale and serves more as a proof of concept than an economically viable solution. However, scale-up calculations show that a full-scale cement plant implementing the same process can be highly profitable. Overall, further research is necessary.

The sociotechnical research paper investigates using Actor-Network theory the unclear governance surrounding climate engineering, especially solar radiation management, and how this deficit impedes progress, citing actual examples in the recent history of research failing due to regulatory issues. The research attempts to answer how establishing an international regulatory system can properly foster climate engineering research. To this end, the discussion considers current United States, international, and wartime law. Additionally, Actor-Network theory shows that creating regulatory structures promotes safe research and protects human and environmental rights.

Currently, all regulation that peripherally pertains to climate engineering is unclear and loose at best. The eventual success of climate engineering requires regulation so that researchers know how to proceed and the global public feels safe. Additionally, it ensures climate engineering protects the global ecosystems and biodiversity and promotes mitigation efforts. The guidelines should be designed with the Oxford Principles in mind and supplemented by features shown to work, such as a transparent permitting system, a standing secretariat and dedicated institutions, and recurring conventions of parties, among more.

Climate engineering is not an infallible or independent cure to climate change. Technologies and policies like those discussed in this portfolio, once implemented, will buy humanity much-needed time. In the end, contemporary society must radically change to preserve the natural world and humankind.