Engineering our climate

Challenge Overview Sheet

What is the challenge?

Perhaps the greatest challenge we face in the 21st century is that global temperatures are rising? The enhanced greenhouse effect, created by human activity, will cause global temperatures to rise between 1°C and 5°C by 2100. This is a best/ worse case scenario with the likelihood falling somewhere in between the two. The predicted impacts of the rise in global temperatures are of increasing concern particularly as the more frequent occurrence of climatic and environmental hazards in recent years have caused such devastation in localities around the world. A rise in global temperatures of between 2-4°C could be catastrophic in some regions.

Current predictions suggest that the world's energy needs will continue to grow between 2-3% annually. By 2030 there is a predicted 55% growth in energy demands to which fossil fuels, one of the largest sources of carbon dioxide emissions, will contribute 84%. The major concern is that with current policies and infrastructure, these demands will be met through energy sources that continue to pump greenhouse gas (ghg) emissions into the atmosphere and therefore global temperatures will continue to rise indefinitely with potentially fatal consequences.

What are we doing about it?

At present the response to climate change has been to focus on reducing ghg emissions to stop the problem from becoming more severe. Action has been taken by individuals at local and national levels and by the international community to try to reduce output of ghg emissions. So far, despite global agreements and national policies on climate change there has been very little progress made in reducing emissions to levels that are deemed to be acceptable. **Professor David Keith (Environmental scientist)** identifies reducing emissions as the long term priority in tacking climate change. He suggests that developed countries like the USA and UK could make a significant reduction in their emissions within 20 years with strong economic policy and investment of 2% of their GDP, much less than is spent on healthcare and for many countries the equivalent of their military spending budget. He continues to be amazed at the apathy felt by governments and the public towards climate change and suggests that the reasons for the slow progress result from uncertainty and inertia; the uncertainty of what the impacts will actually be and when they will actually happen. This is coupled with the inertia towards such a large scale problem that will happen in the future but may not directly impact on our lives today.

What is geo-engineering?

That said, concern over the lack of progress being made in reducing emissions and the ever increasing body of evidence that suggest the impacts of global warming are beginning to emerge, has led to new discussions about the solutions offered by geo-engineering. Geo-engineering involves manipulating the Earth's natural processes to counteract the effects of global warming. It is a response to the effects rather than the cause of global warming.

In this debate **Professor David Keith**, a proponent of geo-engineering techniques, clearly states that geo-engineering is not considered to be an alternative to reducing emissions but it is a means of limiting the effects of the carbon dioxide already in the atmosphere.

Geo-engineering takes a number of forms and includes:

- **Carbon Capture Storage (CCS)**

This is when carbon dioxide (CO^2) is trapped as it is emitted from point sources such as power plants, then transporting the CO^2 in a liquid state to suitable sites and storing it underground, often in depleted oil and gas reserves or other geological formations.

- **Sulphur screens**

Sulphur particles would be added to the upper atmosphere by planes or rockets. A screen of sulphur particles at high altitudes would partially reflect solar radiation back into space. The sulphur shield would recreate natural processes that occur during volcanic eruptions, i.e., the sulphur particles block the suns rays entering the lower atmosphere, acting like a curtain blocking the light.

- **Ocean fertilisation**

Adding large quantities of iron or other nutrients to areas of the ocean. The nutrients encourage the growth of huge blooms of algae and phytoplankton which use up CO^2 during photosynthesis as they grow and when they die it is thought they will sink to bottom of ocean taking CO^2 with them in their dead organic matter.

- **Artificial trees**

Machines that can capture CO^2 from the air and filter it out as air passes through them. Artificial trees or 'carbon scrubbers' can trap CO^2 on absorbent plastic sheets called ion exchange membranes. These membranes can then 'exhale' CO^2 so it is trapped and stored underground (CCS).

- **Increasing reflectivity**

Using reflective materials on rooftops or pavements and painting them white or paler colours will aid reflection of the incoming solar radiation.
More reflective materials will increase the albedo of urban areas rather than absorb solar radiation. Research is being carried out into increasing the reflectivity of other land areas including agricultural areas, deserts and ice caps.

- **Increasing cloud reflectivity**

A fleet of specially designed wind-powered ships would spray sea water particles into the atmosphere. Salt particles formed by evaporation act as a core for water droplet condensation to form clouds. High concentration of particles increases number of individual water droplets in clouds, making them more dense so increasing the reflectivity of the clouds.

Of the techniques outlined above, some are far more controversial than others but what is certain is that the debate over whether scientific research should continue to improve the viability of these options is hotting up. Previously the talk of academics and scientists, geo-engineering is now being discussed by governments, the media and the public. The scientific theory works, the cost is relatively low, and the impacts of rising temperatures are being felt around the world, so what is the problem? Why aren't we pouring investment into these innovative techniques?

What are the concerns?

Dr Paul Johnson (Head of the Science Unit for Greenpeace International) raises the concerns of the non-governmental organisation (NGO) community, specifically Greenpeace who were the first NGO to campaign on climate change issues in the late 1980s. Greenpeace, and many others, do not support geo-engineering because it distracts from the real solution of reducing emissions. He questions whether geo-engineering is a defensible response to climate change, particularly as past attempts to manipulate planetary systems have failed.

The evolution of the debate has followed a series of stages:

- *Ignorance* of the issue
- *Denial* that it is happening and/or has been caused by human activity
- *Acceptance* that climate change really exists but a sense that we have time to do something about it
- *Urgency* due to the realisation that we must act now

- *Panic* so it is all too late and anything goes. Dr Johnson argues that geo-engineering reflects this stage and is a desperate measure rather than a well considered response to global warming.

He identifies the key assumptions that are made in the discussion: manipulating planetary systems is technically feasible, it is predictable and possible, it is reversible, it is desirable and/or necessary and he highlights the need to question these assumptions. He is concerned that the impacts of geo-engineering will not be uniform which could potentially lead to conflict between the winners and losers as the geo-politics of climate change continue to be dictated by the power imbalance. Greenpeace is not anti-scientific research but they want it to be fully justified, carefully and consistently assessed with precautions in place to monitor the process. At present they believe that the investment should focus on the cause and not the effects of global warming.

Both David Keith and Dr Paul Johnson agree that progress in reducing emissions is too slow and has been ineffective so far. However their responses to plan B differ, with David Keith arguing for greater research and debate of geo-engineering techniques and Dr Paul Johnson focusing on continued attempts to mitigate emissions.

There are concerns over the message that this debate brings to the table; that by even discussing geo-engineering the need to reduce ghg emissions appears less important. Some may see it as a green light to continue to emit ghg as a technological fix offers the solution. There is also concern over the effect that using geo-engineering techniques could have on the global communities' long term response to climate change. For some, it may dissolve responsibility to consider the long term future as we are able to geo-engineer the short term and therefore takes the pressure off governments and individuals.

This discussion presents a dilemma for governments. Do they invest in scientific research for geo-engineering? Do they have a responsibility to 'fix' the problem created in the past for this generation? Or should their action reflect the more sustainable long term approach in which they take responsibility for their contributions to global warming? Geo-engineering raises many economic, social, environmental, political and ethical questions. Do we have a right to manipulate planetary systems? Many suggest that by increasing the volume of carbon dioxide in the atmosphere to thirty times its natural level, we already have. Who will the winners and losers be? It is inevitable that there will be some losers and they are likely to be those with least responsibility, yet at greatest risk from global warming.

Whatever the questions, there are no easy answers. It is a matter of weighing up one environmental risk against another, or rather, one unknown against another. Perhaps the greatest risk is not considering all the options?