RECOMMENDATIONS FOR RESEARCH FUNDERS AND DECISION-MAKERS

Recognise that public opinion and understanding of a subject can complement and support information from scientists and policy-makers in the decision-making process.

Ensure future plans for geoengineering research and deployment take place in the context of the continuing need for mitigation, considering the 'moral hazard' and opportunity costs faced in research decisions.

Consider participants' concerns around perceived 'naturalness' in discussions about future geoengineering research and deployment.

Take account of participants' specific concerns that geoengineering research and deployment should be assessed in terms of: controllability, reversibility, cost effectiveness, timeliness, and fair regulation.

Continue to engage with the public as geoengineering research develops; public opinion is dependent on context and will change over time. Dialogue may be needed on specific issues relating to different technologies.

Keep the public involved in the decision-making process by making information about the efficacy, costs and side effects of developing technologies available to them as quickly as possible.

Consider the need for international dialogue that includes the public and scientists from around the world, and especially people in the developing world.

Recognise that further engagement activities are needed to explore public attitudes to, and scientific understanding of, the role of humans in natural systems.

NATURAL ENVIRONMENT RESEARCH COUNCIL

THE ROYAL SOCIETY

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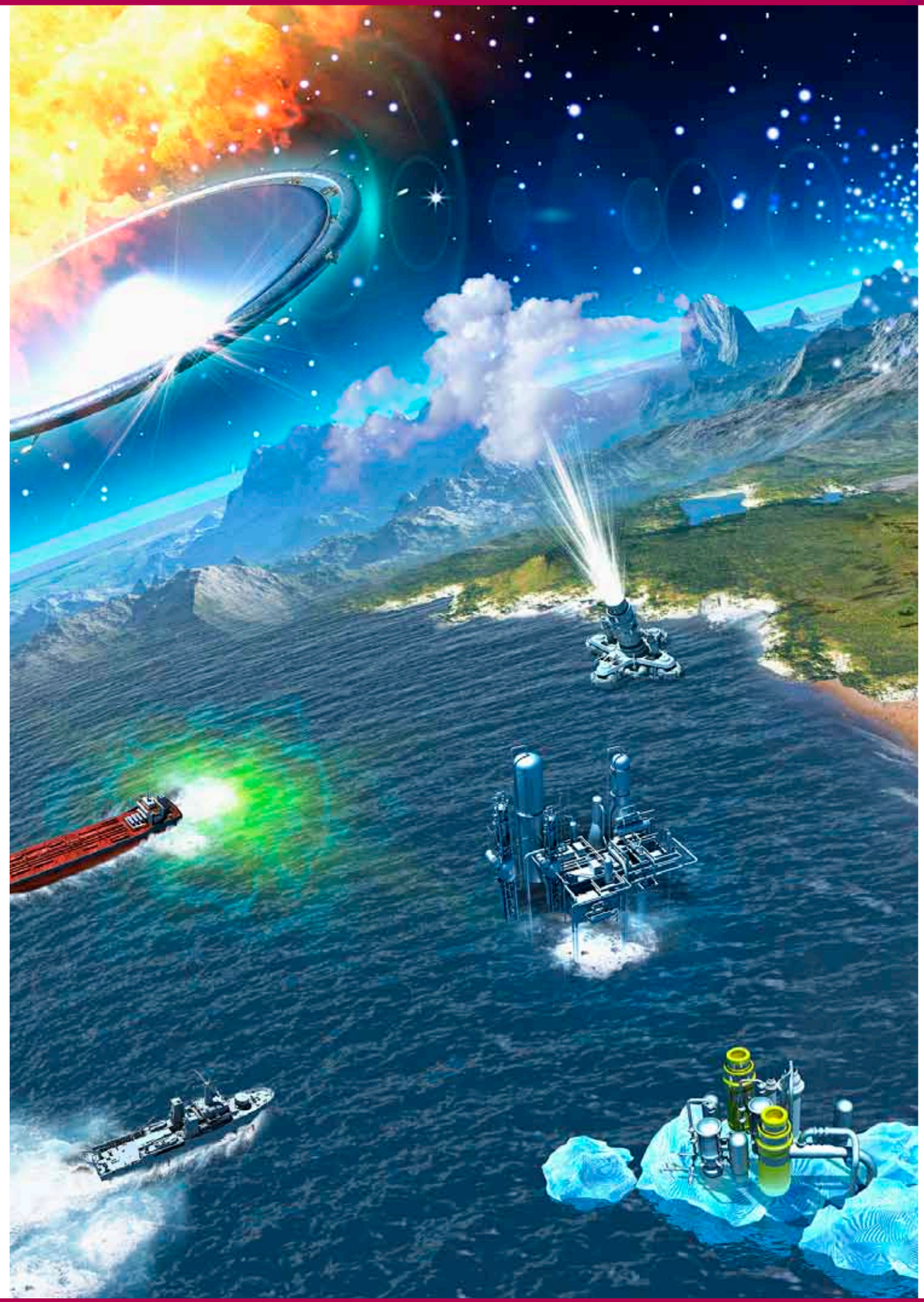

NATURAL ENVIRONMENT RESEARCH COUNCIL

Experiment Earth?

FINDINGS FROM A PUBLIC DIALOGUE ON GEOENGINEERING

This leaflet summarises the findings from a public dialogue on geoengineering held in early 2010. The dialogue was commissioned by the Natural Environment Research Council (NERC), in association with the Sciencewise Expert Resource Centre (supported by the Department for Business, Innovation and Skills), the Royal Society and the multi-agency Living With Environmental Change programme.

Geoengineering technologies involve the deliberate and large-scale manipulation of the Earth's climate to counteract the effects of global warming. There are two main types: carbon dioxide reduction (CDR) techniques, which aim to reduce greenhouse gases in the atmosphere directly, and solar radiation management (SRM) techniques, which seek to reflect more of the Sun's energy back into space.

The aim of the dialogue was to identify and understand public views on geoengineering, including its moral, ethical and societal implications, to help inform the future planning, conduct and communication of geoengineering research by NERC and other funding bodies. It may also be of value to science users, such as industry and policy-makers, who may play a role in further research and deployment of geoengineering, as well as to science communicators.

> **"How do you get everyone, all countries, to agree?**
>
> *Cornwall event*

It should be noted that the results of this relatively small-scale dialogue are qualitative and indicative, and may not fully represent UK public opinion. The full report is available at www.nerc.ac.uk/about/consult/geoengineering.asp

HOW IT WORKED

Three groups of up to 30 people (85 in total, selected by professional recruiters to give a representative sample of the local population) met in Cardiff, Birmingham and St Austell. Each group met for two full days, one week apart. A smaller group of participants from all three locations then attended a final event in Southampton to discuss the findings, and explore some of the technologies in more depth, with senior NERC staff and others.

> **“Who would give permission? Who owns the ocean?**
>
> *Birmingham event*

During the workshops, the public met with scientists and science ethicists to debate the issues around nine geoengineering technologies covering CDR and SRM. Participants had time to think through their priorities, principles and concerns about each method in a variety of informal facilitated sessions, following presentations on each technology and associated pros and cons.

Additional views were gathered through two further discussion groups, one with people at risk of flooding, the other with people aged 16-18; a qualitative online survey which elicited 65 responses; and open access events at science centres in Cardiff, Birmingham and Oxford.

Evidence from all the activities was synthesised for the report.

The dialogue was conducted by Ipsos MORI, with Dialogue by Design and the British Science Association, and overseen by a steering group of academics and representatives from business, government and Non-Governmental Organisations (NGOs).

MAIN FINDINGS

Awareness and knowledge of geoengineering were low prior to the dialogue sessions, but developed as the dialogue proceeded. The dialogue process revealed much about how participants viewed climate science, the scientific method and scientists.

Some of the views expressed suggest there are important gaps in the public's understanding of climate science. Many of the following findings could therefore have important implications for science communication.

- No one was against geoengineering as a matter of principle, but there were serious concerns with specific technologies.
- Public attitudes towards government, science and institutions formed an important context for their views on climate issues.
- Participants' views of the seriousness of climate change affected their views on geoengineering.
- Participants found it difficult to envisage the scale of likely climate-change impacts, and found it useful to have imagery that expressed these on a human scale.
- Participants found it difficult to form firm views on the issues, in light of perceived levels of uncertainty about climate change.
- The concept of 'natural' processes evoked a strong emotional response. There was a widespread believe that 'natural systems' are balanced and self-contained, and should be respected.
- Participants felt it was both ethically and practically important to link any new climate change solutions to continued mitigation. (This contradicts the 'moral hazard' argument that geoengineering would undermine popular support for mitigation or adaptation.)
- The majority favoured the combination of several different international geoengineering approaches with international, national and individual mitigation efforts.
- Participants did not see ethical issues as inherently separate from scientific and economic ones.
- Participants drew a distinction between deliberately manipulating the climate (through geoengineering), which they saw as less acceptable, and manipulating the climate accidentally as a consequence of industrialisation, which was seen as regrettable, but more acceptable.

> **“Geoengineering should not be an alternative to living more sustainably, this is the only real long term soution.**
>
> *Online survey*

KEY OUTPUTS

At the end of the dialogue participants gave cautious support to research in geoengineering, but wanted the following key questions to be applied to future research.

- **What effect might this have on mitigation efforts?** Geoengineering should not conflict with mitigation, and wherever possible should augment mitigation efforts.
- **How far does it support 'natural processes'?** Most participants believed that geoengineering should be considered in terms of how well it preserves what they perceived to be 'natural systems'.
- **How controllable is it?** Participants did not support scientists 'interfering' with nature's complex systems unless detailed assessments of the consequences were carried out first.
- **How reversible is it?** Scientists should be able to 'switch off' a geoengineering project. Participants called for research to progress in small stages, to reduce the likelihood of irreversible consequences.
- **Is it cost effective?** Core benefits should be weighed against costs, taking into account the two related benefits of amount of CO_2 removed from the atmosphere and overall global temperature reduction (because participants were less confident in SRM technologies and wanted to ensure that the benefits of CDR technologies were appreciated).

  Participants suggested the following cost factors should be considered:
  - the amount of CO_2 generated by the geoengineering process itself
  - the direct financial cost of research and implementation
  - intangible costs to lifestyle, environment, future generations
  - the opportunity cost (ie by focussing on geoengineering, opportunities to spend money and resources elsewhere would be reduced)
  - the overall investment burden for the UK
- **When should it be done?** Government or other authorities should set a timetable to establish when climate change becomes urgent (i.e. a 'climate emergency'). The public should then be kept up-to-date on the efficacy, costs and side effects of any technologies that are researched so they can give or withdraw support.
- **How can it be regulated?** International governments should come together to ensure that geoengineering effects and benefits are distributed equitably across the globe. The voices of those in the developing world must be heard in the process. The UK government should think about the long-term consequences of geoengineering, not its short-term political ramifications.

> **“People still need to remember to cut CO_2.**
>
> *Cardiff event*

Overall, CDR techniques were favoured over SRM. Some technologies were considered more acceptable than others.

CARBON DIOXIDE REMOVAL (CDR)

CDR was consistently highlighted as the preferred method of geoengineering.

Afforestation and **biochar** were preferred because they were seen as 'natural' approaches.

Support for ocean based methods such as **iron fertilisation** and **liming** was low, though at the reconvened event participants were more prepared to consider these.

Support for **air capture** increased as the dialogue progressed. Participants liked the fact that it could be carried out locally without the need for international regulation, and may produce quicker results than afforestation.

SOLAR RADIATION MANAGEMENT (SRM)

There was less support for SRM, as it was not seen to tackle the root cause of climate change (which participants considered to be greenhouse gases).

Cloud whitening and **sulphate particles** were the most positively received of the SRM technologies, but were not endorsed by a majority.

Mirrors in space were seen as expensive and risky, and **white roofs** were viewed as likely to be ineffective and not feasible. Neither received much support.