Written evidence from Professor Nick Pidgeon

Memorandum on ***Public Acceptability and Governance of Negative Emissions Technologies at Scale***.

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1. Cardiff University is a leading international academic institution where the social aspects of science and technology are a strong focus of internationally competitive research. The Understanding Risk research group at the School of Psychology Cardiff University is a leading centre of expertise for the study of public risk perception, risk communication, and public engagement with science, new (emerging) technologies, and the environment. Empirical work with UK publics to understand their acceptance and governance of greenhouse gas removal and associated technologies is a particular focus of our work going back to 2008.

2. I was co-investigator in the EPSRC Integrated Assessment of Geoengineering Proposals programme (IAGP, 2010-2014)[1] and currently the Leverhulme Centre for Climate Change Mitigation (LC^{3}M, 2016-2025). LC^{3}M is a major 10-year collaboration led by Sheffield University[2] to explore the underlying science, field-trial methodologies, risks and benefits, and social and ethical implications of the enhanced weathering greenhouse gas removal technology. LC^{3}M partners also lead a recently announced NERC Greenhouse Gas Removal Demonstrator project (2021-2026) to establish UK field trial sites for enhanced weathering carbon removal. As a result my group has built up internationally unique expertise in public acceptance and engagement with NETs technologies. I was also a member of the group that developed in late 2009 what have been come to be known as the 'Oxford Principles' for governance of geoengineering research'[3].

3. Negative Emissions Technologies (NETS) have come to prominence as a result of the 2015 Paris Climate accord, associated commitments to net-zero emissions and the realisation that it will be very difficult for developed countries to reduce their emissions to absolute zero.

4. Prior to 2015 NETs were discussed in terms of the more generic category of 'planetary geoengineering', being placed alongside more controversial solar radiation management (SRM) techniques[4]. Since 2015 there has been a concerted attempt by the international science community to separate the two approaches to planetary geoengineering, although when deployed at scale both approaches still raise very similar social and ethical questions.

5. Note also that even 10+ years back some integrated assessment models assumed at-scale deployment of NETs (typically bioenergy with carbon capture) in order to demonstrate that global warming would be kept to below the then 2 degrees C limit for dangerous climate change. Many current models that limit warming to the lower level of 1.5 degrees have to

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[1] http://www.iagp.ac.uk/index.html
[2] http://lc3m.org/
[3] https://publications.parliament.uk/pa/cm200910/cmselect/cmsctech/221/10011315.htm
[4] e.g. Royal Society, 2009. *Geoengineering the Climate: Science, Governance and Uncertainty.* Science Policy Centre Report 10/09. The Royal Society, London.

assume deployment of NETs. However, there is an emerging debate in the scientific literature which raises the question of whether NETs will be required to meet net zero if we can make major changes to our lifestyles and consumption. In effect these pose vastly different visions of what the future will be, between (i) one where society makes extensive lifestyle changes now using known means to create technology efficiencies, limit energy demand, and reduce our individual consumption or (ii) while decarbonising energy supply rapidly society nonetheless relies upon the development and deployment of new technologies (some of which may well hold a risk of failing at scale) such as Carbon Capture and Storage (CCS) and NETs to cope with residual emissions. My own view is that this is a false debate - we likely need effort in relation to both approaches if we are to limit the major impacts of warming (some aspect of demand reduction, particularly through radical societal changes, risk failure at-scale as much as does new technology development involve risk).

6. The Select Committee has chosen to focus upon the engineered solutions of BECCs and DAC and to not consider more 'nature-based' solutions. Not only is the 'nature-based' vs 'engineered' distinction ultimately unhelpful (BECCS as an engineered technology uses plant material as its input, while in turn modern 'nature-based' agriculture is a highly managed process relying upon technologies such as artificial fertilizers), if the UK does have to remove greenhouse gasses at the scale envisaged by both the recent Royal Society and the Climate Change Committee reports (say 50-100 $MTCO_2$ per annum) a portfolio of technologies are likely to be required, some more immediately deployable and others more speculative and long term[5]. It might be better to think of current Technology Readiness Level (TRL) and ultimate sequestration timescale when categorising NETs approaches.

7. It is clear that different NETs raise a range of specific risk perception, societal, and ethical issues. While most are uncontroversial as a trial or at small-scale, as we have seen with some forms of renewable energy (e.g. onshore wind) societal issues arise the moment one wishes to deploy the technology at scale. This inquiry should not underestimate the risks of failing to gain a social license to operate for some NETs technologies, hence more research on public perceptions and engagement is clearly warranted.

8. Generic ethical questions that have been discussed in the scientific literature and which apply to most NETs include (a) whether they will they bring unintended environmental or social impacts of the technology deployment at scale (especially local ecosystem detriments, community disruption or global societal impacts)? (b) whether they will fail to gain a social license to operate because they are perceived as simply representing a 'sticking plaster' rather than dealing with the root causes of climate change (i.e. emissions)? (c) whether the promise/availability of NETs based solutions in the future reduces motivation amongst the public or politicians to make difficult and radical choices, hence delaying urgently needed cuts in our emissions and consumption now (the idea of 'mitigation deterrence') (d) the extent to which NETs represent an unacceptable form of 'messing with nature', a factor which is particular salient in public risk and technology perceptions more generally (all other things being equal people tend to prefer more 'natural' technologies and solutions to any problem)[6]. Our own research over some 15 years shows that the general public worries about all of these issues, hence all will need serious consideration in relation to any approach (labelled as 'engineered' or otherwise) before NETs can be deployed across the UK at scale.

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[5] https://www.deliveringnetzero.org/greenhouse-gas

[6] Corner, A.J., Parkhill, K.A., Pidgeon, N.F. and Vaughan, N.E. (2013) Messing with nature? Exploring public perceptions of geoengineering in the UK. *Global Environmental Change*, 23,938-947.

9. NETs deployed at scale also raise a range of difficult local siting issues – even planting trees at scale will be controversial, let alone siting major DACC plants or CCS facilities in new locations. Siting typically places any real or perceived detriment to local people and communities in competition with the judged national benefits of greenhouse gas removal at scale. There is now a wealth of evidence from the study of siting (and sometimes failing to site) risky technologies[7] and renewable energy projects[8] that will need to be drawn upon to foster appropriate discussions with local communities who are being asked to host major NET schemes. In particular, there is a need for: full inclusion of affected communities at an early stage and throughout the siting process, working for a fair process and for trust, a just distribution of risks and benefits, full consideration of any local environmental and community impacts and concerns, and the consideration of appropriate community compensation.

10. With regard to the two technologies that are the focus of this inquiry, my group have conducted a major piece of empirical work involving in-depth deliberative workshops and nationally representative surveys with members of the public in both the USA and UK in 2018-19 asking about 3 current NETs approaches: DACCs, BECCS and Enhanced Rock Weathering (ERW).[9] Aside from the generic concerns listed above (para 8) we found the following:

11. Most people are still completely unaware of any of these technologies, so were surprised to learn that they were being considered at all, hence we used extensive information provision in the workshops to explain the technologies to people. Equally, people are not opposed to well-regulated research taking place – as noted above, issues arise when people think about deployment at scale.

12. People generally saw BECCS as the more natural and more feasible of the three technologies studied. However, BECCS would need to avoid causing other environmental problems, and people thought simply planting forests would generally be much more preferred. With BECCS there are also well-documented concerns people have about storing carbon dioxide underground[10], which may be a major barrier for Direct Air Capture as well.

13. People found Direct Air Capture as less easy to understand as the process of capturing carbon dioxide from the air is not intuitive, and people may wonder why it is being deployed in apparently ‘unpolluted’ areas. The main barriers relate to current lack of engagement and understanding, perceived cost and energy requirements, as well as again (as with BECCS) concerns about risks and impacts of storing carbon dioxide permanently underground.

14. Enhanced Weathering was perceived as the most risky of the three, with people initially judging it as too energy-intensive and too ‘industrial’. However, while people also said that there are currently “too many ‘maybes’” around this technique, most support more research. Impacts on ocean ecosystems and opening new mines for the rock resource to be spread

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[7] Pidgeon, N.F. and Demski, C. (2012) From nuclear to renewable: energy system transformation and public attitudes. *Bulletin of the Atomic Scientists*, 68(4), 41-51.

[8] Devine-Wright P. (ed) (2011) *Renewable Energy and the Public*. London Earthscan.

[9] Cox, E., Spence, E. and Pidgeon, N.F. (2020) Public perceptions of Carbon Dioxide Removal in the US and UK. *Nature Climate Change*, July, 10, 744–749

[10] Thomas, G., Pidgeon, N.F. and Roberts, E. (2018) Ambivalence, naturalness and normality in public perceptions of carbon capture and storage in biomass, fossil energy, and industrial applications in the United Kingdom. *Energy Research and Social Science*, 46, 1-9.

on agricultural land could both be 'red lines' for public acceptability of Enhanced Rock Weathering technology.

15. Note that none of the three were free from significant questions over their practical deployment. The research project also identified a new temporal issue, not identified in the literature before, as raised by a number of our participants. Put simply, in the light of current climate urgency and the need to move quickly on reducing emissions our participants asked whether any of these technologies would be ready in time to make the necessary difference to global emissions? On the other hand, and as noted above, participants also questioned the long-term sustainability of the technologies given their 'sticking plaster' status in the eyes of some? So, what exactly is the role of NETs to be and can a social licence be built if in the eyes of the public they achieve neither short-term or long-term sustainability goals?

16. One conclusion from our research programme in Cardiff as a whole, is that people will make well founded judgements about NETs if given the time and right resources to learn about and debate these technologies. We would therefore strongly recommend that extensive public and stakeholder engagement be a part of any programme of research and development for large-scale NETs deployment (e.g. drawing upon the UKRI's 'Responsible Innovation' framework).

17. Finally, on the question of regulation and governance of NETs, the Oxford Principles[11] make 5 recommendations about research into geoengineering which seem as applicable today to the NETs debate as when developed in 2009.

    - Principle 1: NETs should be **regulated as a public good**.
    - Principle 2: Ensure wide and early **public participation** in decision-making about NETs
    - Principle 3: Disclosure of research and **open publication** of results
    - Principle 4: **Independent assessment** of NETs impacts
    - Principle 5: Develop proposals for **governance of NETs before any deployment**

18. I am happy to discuss further any other aspect of our work in Cardiff on NETs, geoengineering or CCS technologies.

Interest Statement: Professor Pidgeon currently serves as a member of the Chief Scientist's Science Advisory Council at the Department of Transport and served a similar role at the former Department of Energy and Climate Change (2009-13). He also recently served as co-Chair of the independent oversight group for the BEIS-Sciencewise Carbon Capture Utilisation and Storage public dialogue[12]. As well as the LC_3M programme (www.lc3m.org) he is a Co-Investigator in the UK Energy Research Centre (www.ukerc.ac.uk) and delivers a project on community engagement within the UKRI Industrial Decarbonisation Research and Innovation Centre (www.idric.org). He currently jointly leads a UKRI research project to investigate the potential for research to facilitate the UK reaching net-zero (https://www.deliveringnetzero.org/). His work is independent of all stakeholders to the current climate change and energy system debate and he has been funded to study geoengineering and NETs issues since 2008 through grants from UKRI, the charity the Leverhulme Trust, and the US National Science Foundation.

[11] Rayner, S., Heyward, C., Kruger, T., Pidgeon, N., Redgwell, K. and Savulescu, J. (2013) The Oxford Principles. *Climatic Change*, 121(3), 499-512.

[12] https://www.gov.uk/government/publications/carbon-capture-usage-and-storage-ccus-public-dialogue

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