

Incentivise negative emissions responsibly

Rob Bellamy

Nation states need to incentivise negative emissions technologies if they are to take the decarbonisation of whole energy systems seriously. This incentivisation must account for public values and interests in which technologies to incentivise, how they should be incentivised and how they should be governed once incentivised.

The Paris Agreement requires nothing less than a fundamental transformation of whole energy systems, ranging from the decarbonisation of electricity generation, heat and transport to reductions in energy demand across all economic sectors and smart energy storage and grid management¹. Yet, even with such changes to energy production, consumption and distribution it may not be possible to achieve the targets of the Paris Agreement. Indeed, the Intended Nationally Determined Contributions on climate action pledged under the agreement still suggest a median warming of between 2.6 and 3.1 °C by the end of the century². The Intergovernmental Panel on Climate Change (IPCC) maintains that meeting the targets is possible, but nearly all of their successful integrated assessment model scenarios rely on the widespread deployment of prospective negative emissions technologies (NETs) for the net removal of CO₂ from the atmosphere^{3,4}.

The principal NET upon which the IPCC's scenarios rely is bioenergy with carbon capture and storage (BECCS), which would involve energy production through burning biomass coupled with the capture of CO₂ and its storage in geological or other reservoirs. Other NETs currently under consideration include afforestation, reforestation and forest management, direct air capture and storage, soil carbon sequestration, biochar, enhanced weathering and ocean fertilisation⁵. Not all NETs would produce energy, but they do all seek to remediate the negative externalities – those wrought by greenhouse gas-induced climate change – of energy production. If we are to take the challenge of whole system transformation seriously then, we need to broaden our understanding of the energy system to consider remediation symmetrically alongside production, consumption and distribution. This is all the more crucial given that, despite growing recognition of the increasingly likely need for NETs, they are given a low priority by state and non-state climate policy actors around the world⁶ and are far from resembling the sorts of complete sociotechnical systems – the combination of technical apparatuses and social arrangements that act together as a single system – that would be needed for their deployment.

Responsible incentivisation

To determine the potential contributions of NETs to the transformation of whole energy systems there is therefore a clear need to responsibly incentivise research, development, demonstration and (hypothetically) deployment (RDD&D) into NETs and to establish such incentives directly as an explicit policy goal. Policy instruments – the methods by which governments exert their power to effect change – would then need to be applied to achieve this goal. Wider climate policy goals and instruments – such as plans for a new land use, land use-change and forestry regulation in the European Parliament that integrates greenhouse gas emissions and removals – might also contribute to the incentivisation indirectly by creating carbon removal targets that can only be met by developing

the technologies capable of delivering on those targets. Of course, the bottom-up architecture of the Paris Agreement makes it essential that the goal and instruments of incentivising NETs RDD&D would not be set internationally, but rather by individual states to be reflective of diverse national political cultures and priorities. The key to *responsibly* incentivising RDD&D lies with the extension of this attention to diversity from the level of nation states to their citizens. This will require the participation of citizens in choosing which NETs to incentivise in the first instance; which policy instruments to perform the incentivisation; and under what principles of conduct the RDD&D for those NETs that are incentivised should be implemented.

We already know that diverse public participation in decision making is vital to engendering the sorts of pluralism and humility needed to overcome problems of contending interests and uncertainty surrounding new technologies⁷. But this is equally vital for overcoming problems of contending interests and uncertainty surrounding the ways in which technologies are governed. The means to incentivising NETs must therefore be established through diverse public participation in the very definition of those means. There will nevertheless be pressures to bypass citizens, owing to the sheer scale and speed of transformation that is required. But with effective, acceptable and democratic decision making at stake, it will be important to resist such pressures. Publics contribute knowledge that experts miss, lend legitimacy and have the right to influence decisions that will affect their interests⁸. In other words, if incentivisation is not done responsibly – that is to say, if publics are not involved – then we risk taking ineffective, opposed and technocratic decisions that are both scientifically and socially unsound.

Technology selection and good governance

Although there has been far less research into public perceptions of NETs than there has for their more controversial taxonomic cousins, geoengineering by solar radiation management (and in particular stratospheric aerosol injection), scholars of public engagement with science (PES) have begun to identify the criteria under which NETs may or may not be judged publicly acceptable, and through this which of them may or may not be legitimate objects for incentivisation. Public workshops, deliberative mapping and survey experiments with sociodemographically representative citizens have found that afforestation and biochar, for example, while raising concerns about biodiversity and land-use conflicts, have been deemed acceptable on several fronts including environmental safety, reversibility and locality^{9–11}. Direct air capture and storage is more ambiguous, being seen as contained, reversible and well understood, but at the same time as aesthetically intrusive, end-of-pipe and technically difficult to scale up^{9,10,12,13}. Ocean fertilisation, however, has been roundly condemned as posing irreversible and unknown transboundary risks that interfere with natural ecosystems^{9,13}. While much less is known about perceptions of enhanced weathering, early results suggest more support than opposition¹³. With the exception of research into UNFCCC delegate and stakeholder perceptions of BECCS⁶ very little is known about public perceptions of BECCS and soil carbon sequestration.

Research into public perceptions of NETs has also begun to elicit principles for the good governance of RDD&D, assuming NETs were incentivised. Table 1 draws together five such principles from across different public perceptions studies. Transparent purposes, activities and reporting and the minimization and monitoring of risks posed to the environment and ecosystems are consistently voiced in public deliberations as such principles of conduct^{9,10,13–17}. These are often accompanied by a vocal mistrust of corporate or otherwise private interests, underpinning further principles of independence and/or regulatory oversight^{13–17}. Starting with smaller scale activities before moving to those that are larger scale has also emerged as a principle^{9,14}, but ‘scale’ has also been shown to function as a proxy for the more elastic notion of controllability¹³. If scale is to be used as a marker of governance then it must always be considered in relation to, and qualified by, other dimensions of

control, including level of containment, reversibility of impacts, uncertainty of outcomes and scientific purity or intent. Irrespective of the scale of RDD&D activities, some studies have revealed a desire for multilateral governance at the international level^{9,15}. Others, however, have shown governance preferences to be technology and RDD&D specific, with self-governance or independent oversight at the national or local levels often being selected as more appropriate than blanket international principles of conduct¹³.

Table 1 | Public principles for the good governance of NETs RDD&D

Principle	Example	References
Transparent purposes, activities and reporting	Trust in those performing NETs RDD&D that they are acting in the public interest can be enhanced by ensuring transparency around any activities.	9,10,13–17
Minimisation and monitoring of environmental impacts	Taking measures to minimise and monitor environmental impacts on complex ecosystems (e.g. by oceanic enhanced weathering) is widely approved of.	9,10,13–17
Independence from or oversight of private interests	Activities that are performed outside of the controls of the scientific community (e.g. the ocean iron fertilisation carried out by the Haida Salmon Restoration Corporation in 2012), can be highly unacceptable.	13–17
Scale of activities qualified by perceived controllability	A small, contained activity (e.g. in ocean fertilisation) can still be unacceptable if it were deemed to eventually require an irreversible release of materials in the open environment to prove its full scientific validity.	9,13,14
Technology and activity specific governance protocols	Self-governance or independent oversight can be more desirable than multilateral governance for certain types of activities (e.g. modelling) or all activities for certain types of NETs (e.g. direct air capture and storage).	9,13,15

Policy instrument choice and packaging

While research on public perceptions is yielding answers to the questions of which NETs to incentivise and under what principles of conduct RDD&D should be implemented, there has so far been no empirical research into which policy instruments should be used to perform the incentivisation itself. Policy instruments come in three flavours¹⁸: economic ‘carrots’ (which involve giving or taking away material resources), regulatory ‘sticks’ (which involve prescribing or proscribing actions through rules) and informational ‘sermons’ (which involve transmitting encouraging or warning signs about certain actions). Given the absence of an evidence base, empirical research into policy instrument choice among diverse public perspectives and interests must be funded in order to make progress. In the meantime we can nevertheless theorize about which instruments might and might not be acceptable, and to whom¹⁹.

We know that publics are diverse and so too are their preferred styles of decision making. At least three approaches have proven particularly salient for NETs RDD&D: individualistic, consensual and majoritarian (Fig. 1)¹³. ‘Individualistic’ citizens prefer that decisions be left to individuals and firms and are therefore likely to support instruments that remunerate RDD&D into NETs. This would include economic instruments but not regulatory or informational instruments that would threaten

autonomy. ‘Consensual citizens’, on the other hand, prefer that decisions are not left to individual actors and are therefore likely to support instruments that uniformly coerce RDD&D into NETs. This would include strict regulatory instruments, regulated economic instruments and informational instruments that are used to hold individual actors to account. ‘Majoritarian’ citizens prefer that decisions be left to elected regulators and are therefore likely to support instruments that variably remunerate and coerce RDD&D into NETs. This would include flexible regulatory instruments, regulated economic instruments and informational instruments that reinforce regulatory tasks.

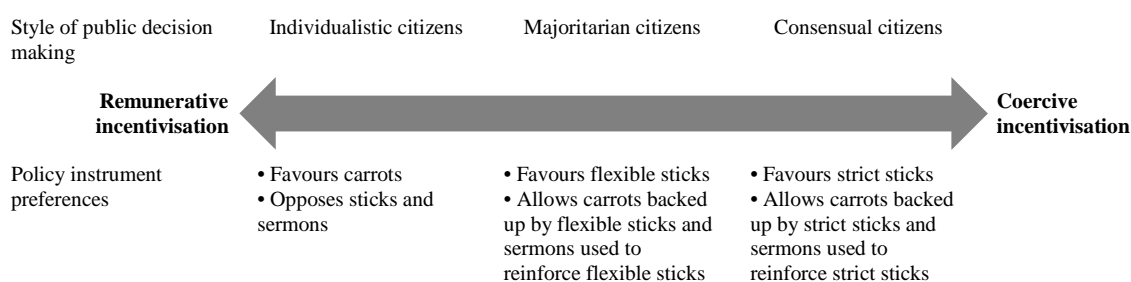


Fig. 1 | Policy instrument preferences among different styles of public decision making

We know then that for NETs to be responsibly incentivised, they will need to be so with a combination of policy instruments that satisfies diverse attitudes towards decision making. The horizontal packaging of instruments – where two or more instruments are targeted at the same actor – most clearly attends to this problem of contending interests¹⁸. By way of example, if BECCS were deemed an appropriate technology to incentivise, we might consider incentivising RDD&D by fossil fuel companies through the combined application of standards, subsidies and moral suasion. This could involve placing a direct obligation on certain new and/or existing fossil fuel power plants to be converted to biomass and fitted with a CCS facility from a specified date. To facilitate compliance with these standards, the government might offer financial assistance in parallel by providing a loan guarantee to repay the principal and interest on loans taken out from traditional lending sources. This could be simultaneously accompanied by jawboning by government officials on the fossil fuel industry, persuading key decision makers and appealing to the reputation and corporate social responsibility of the industry. Of course, the presently high cost of building CCS points to another area in need of incentivisation, although there is some cause for optimism that costs will be lowered as a result of the recent update to the US tax credit for CCS, 45Q.

Implications for future research and policy

If we are to take the challenge of decarbonising whole energy systems seriously we need to broaden our understanding to consider NETs as part of a remediation strategy and to address the empirical gaps in our understanding of how to responsibly incentivise that strategy. Specifically, we need to know much more about which NETs we should incentivise, how they should be incentivised and how they should be governed once incentivised. This enterprise will need to be interdisciplinary, bringing together PES scholars with the scientists and engineers developing the NETs, as well as economic and legal scholars working in the energy policy and governance landscapes. Dedicated funding for this research needs to be a priority for national energy ministries and research funders committed to the Paris Agreement. The Department for Business, Energy and Industrial Strategy in the UK, for

example, has already identified NETs, and in particular BECCS, as an area of research interest, which could be expanded to consider the questions of responsible incentivisation surrounding them. Energy companies and NETs start-ups have a clear interest in advancing these technologies too, and funding research to help with their responsible incentivisation will build trust between providers and consumers. To foster multilateral coordination, bodies such as the UNFCCC should also fund international research collaborations through their commitment to capacity building for technology development. Such endeavours will help us to instil the sorts of pluralism and humility needed to responsibly bring about whole energy system change.

Rob Bellamy is at the Institute for Science, Innovation and Society, University of Oxford, 64 Banbury Road, Oxford, OX2 6PN, United Kingdom. rob.bellamy@insis.ox.ac.uk

References

1. Royal Academy of Engineering *A Critical Time for UK Energy Policy* (2015); <https://www.raeng.org.uk/publications/reports/a-critical-time-for-uk-energy-policy>
2. Rogelj, J. et al. *Nature*, **534**, 631 – 639 (2016).
3. Anderson, K. and Peters, G. *Science*, **354**, 182 – 183 (2016).
4. van Vuuren, D. et al. *Nat Energy*, **2**, 902 – 904 (2017).
5. Fuss, S. et al. *Environ Res Lett*, **11**, 115007 (2016).
6. Fridahl, M. *Energ Policy*, **104**, 89 – 99 (2017).
7. Genus, A. and Stirling, A. *Res Policy*, **47**, 61 – 69 (2018).
8. Fiorino, D. *Sci Technol Hum Val*, **15**, 226 – 243 (1990).
9. Ipsos Mori *Experiment Earth?* (2010); https://www.ipsos.com/sites/default/files/publication/1970-01/sri_experiment-earth-report-on-a--public-dialogue-on-geoengineering_sept2010.pdf
10. Bellamy et al. *Public Underst Sci*, **25**, 269 – 286 (2016).
11. Braun, C. et al. *Clim Policy*, DOI: 10.1080/14693062.2017.1304888 (2017).
12. Wright, M. et al. *Nature Clim Change*, **4**, 106 – 110 (2014).
13. Bellamy et al. *Global Environ Chang*, **45**, 194 – 202 (2017).
14. Pidgeon, N. and Spence, E. *Biol Lett*, **13**, 20170024 (2017).
15. McLaren et al. *Global Environ Chang*, **41**, 64 – 73 (2016).
16. Royal Society Geoengineering The Climate (2009); <https://royalsociety.org/topics-policy/publications/2009/geoengineering-climate/>
17. Wibeck et al. *Energy Res Soc Sci*, **7**, 23 – 30 (2015).
18. Bemelmans-Videc, M. et al. (Eds.) *Carrots, Sticks and Sermons* (Transaction: New Jersey, 2007).
19. Rayner, S. *Evaluation Rev*, **15**, 75 – 102 (1991).