Learning from the Climate Change Debate to Avoid Polarisation on Negative Emissions

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Abstract

This paper identifies critical lessons from the climate change experience to guide how communications and engagement on negative emissions can be conducted to encourage functional public and policy discourse. Negative emissions technologies present a significant opportunity for limiting climate change, and are likely to be necessary to keep warming below 2ºC. While the concept of negative emissions is still in its infancy, there is evidence of nascent polarisation, and a lack of nuance in discussion of individual technologies. We argue that if negative emissions technologies are to be implemented effectively and sustainably, an effective governance regime is needed; built on functional societal discourse and avoiding the ideological baggage of the broader climate change debate or the controversies concerning geoengineering. At its core, our argument is to avoid the *ideological bundling* of negative emissions; this can be pursued directly and via careful selection of communication frames and the use of non-partisan, trusted messengers. Whether these lessons are heeded may determine if negative emissions are governed proactively, or are distorted politically, misused and delayed.

Climate change and negative emissions

Scientific understanding and consensus on the causes and impacts of climate change is growing; and the task of addressing global warming has become an urgent endeavour (IPCC, 2018). However, it remains highly politicised in many countries (Carmichael and Brulle, 2017, Hornsey et al., 2018). Where concerted global action is needed to slow the rate of change to the climate, there is evidence instead of polarisation among some citizenries and groups of policy-makers, for example in the United States, one of the largest absolute contributors to climate change (Althor et al., 2016), the United Kingdom, Australia, and Canada (Smith and Mayer, 2019).

The 2015 Paris Agreement on climate change has enshrined a goal to limit global warming to well below 2ºC, with an aspirational target of 1.5ºC (United Nations Framework Convention on Climate Change, 2015). However, current international commitments and policies to reduce emissions indicate that global efforts are likely to fail to limit warming to 'safe' levels (Fuss et al., 2014, Minx et al., 2018). As a result, there is increasing academic and policy attention given to negative emissions technologies – approaches that can remove existing greenhouse gases (GHG) from the atmosphere to compensate for historical emissions (Hansen et al., 2016) or future failures in emissions reduction efforts (Field and Mach, 2017) – as likely requirements for reaching net-zero emissions (Fuss et al., 2014, Rogelj et al., 2015, Smith et al., 2016). As an emerging suite of technologies that has the potential to become an important dimension of efforts to address climate change, negative emissions options run the risk of following the path of the emissions reduction discourse into polarisation and dysfunctional debate, fuelling poor policy choices. Now is the time to take stock of the lessons from climate change – establishing the scientific evidence base and informing the emissions reduction debate in particular, as well as other issues within climate debates, including adaptation and geoengineering. By learning from this, we raise the prospects of a functional discourse on negative emissions – that is, solutions focused, constructive discourse where parties in conflict navigate challenges to secure a resolution rather than polarising and endeavouring primarily to 'defeat' their opponents (Colvin et al., 2015).

The fuzzy taxonomy of negative emissions

The term *negative emissions* describes both the act of removing GHG from the atmosphere (Fuss et al., 2014), and the goal for GHG accounting to be net negative (i.e. more GHG removed from the atmosphere than added) (Rogelj et al., 2015). *Negative emissions technologies* are a range of approaches and technologies that can be deployed to meet the goals of negative emissions. Key approaches include the use of bioenergy with carbon capture and storage (BECCS), afforestation and reforestation, changed agricultural practices, land management for soil carbon, biochar, enhanced rock weathering, direct air capture with storage, and ocean fertilisation (Smith et al., 2016).

Negative emissions are positioned between mitigation – which involves reducing emissions to limit effects on the climate system – and geoengineering – which is often described as changing earth systems to limit effects of emissions, but without actually affecting the emissions (Honegger and Reiner, 2017). While the broad mitigation agenda has focused on reducing the amount of GHG emissions entering the atmosphere, negative emissions do not focus on reducing emissions but instead on *removing* existing GHG from the atmospheric stock (Heyward, 2013).

Geoengineering, broadly defined, is a deliberate human intervention in the climate system intended to alleviate climate change (The Royal Society, 2009). In its more narrow conception it is often conflated with *solar radiation management*, where techniques or technologies are deployed to limit the amount of incoming radiation (Talberg et al., 2017). Whether or not negative emissions technologies are considered forms of geoengineering can depend on the technologies in question, as well as one's perspective, ideology, and motivations (Honegger and Reiner, 2017). However, geoengineering is often used as a 'catch all' term that includes negative emissions and solar radiation management (Minx et al., 2017), and they are often paired and interchanged in public dialogue. Here, we agree with the view (Talberg et al., 2017, Heyward, 2013, Lenzi, 2018) that negative emissions and geoengineering are most helpfully considered separate suites of approaches. Further, we consider that discussion of negative emissions, too, can be most functional when each negative emissions technology is considered independently. The technological, policy, economic, environmental and public acceptance challenges and risks are likely to be unique to each technology. The line of reasoning we follow is that the more we can emphasise nuance and avoid broad brush categorisations, the better-equipped we will be for functional and informed public discourse and effective governance.

The state of negative emissions: accelerating research and risk-based governance

Short of major advancements in global emissions reductions, the need for negative emissions is likely to increase in urgency and extent. Despite this need and the growing body of research on negative emissions (Minx et al., 2017, Minx et al., 2018), the potential impact of negative emissions options on future climate change is uncertain (Minx et al., 2017). Most major integrated assessment models (IAMs), such as those synthesised by the Intergovernmental Panel on Climate Change (IPCC), include negative emissions in the form of just two technologies – BECCS and afforestation/ reforestation (Smith et al., 2016). Other negative emissions technologies by contrast have to date not been widely reflected in IAMs and hence have received less attention.

Similarly, there are questions around the social and economic feasibility and risks of negative emissions (Heck et al., 2018). Most risks, trade-offs, and opportunities are specific to individual negative emissions technologies (Fuss et al., 2018), but there are broader concerns. These include the potential for competition for land with conservation management and food production, water availability, unintended adverse ecological consequences, and creating a moral hazard by delaying urgent emissions reductions (Lenzi, 2018).

The nature of risks from negative emissions technologies are likely to be highly dependent on the technologies themselves (Campbell-Arvai et al., 2017) in combination with the specifics of how they are implemented and governed (Bellamy et al., 2019). For example, BECCS and afforestation/ reforestation present substantial challenges for balancing potential large-scale land use with achieving the UN sustainable development goals, in particular ensuring future security of food, water and biodiversity protection (Fuss et al., 2018). Direct air capture with storage, in contrast, is likely to generate fewer land use pressures, but carries complications in the economics of research, development, energy use and deployment and management of intellectual property (Nemet et al., 2018).

Systems to *govern* negative emissions similarly require substantial development. There are indications of "governance by default" for negative emissions, where a patchwork of pre-existing governance frameworks developed for issues other than negative emissions are applied non-strategically and non-selectively to negative emissions endeavours as they arise (Talberg et al., 2017) – a triumph of convenience over forethought. Specific to geoengineering, some meaningful progress has been made, for example via proposed principles (Rayner et al., 2013) or codes of conduct (Hubert et al., 2016) to guide research and governance, especially concerning issues of procedural justice, transparency, and inclusion.

Some distinct negative emissions technologies are currently explicitly governed in some jurisdictions, such as afforestation, but governance of negative emissions as a cross-technology endeavour is lacking. Where negative emissions technologies are included in governance frameworks (variously as negative emissions or geoengineering) they are usually framed as a risk to be managed (Galaz, 2012, Virgoe, 2009, Redgwell, 2011).

Nonetheless, the negative emissions agenda is young, in terms of both its science and governance. There is an opportunity to encourage functional discourse that enables solutions-focused debates and effective governance; but is the negative emissions discourse heading in this functional direction?

Tracking towards polarisation: negative emissions is very different from solar radiation management

Public awareness of negative emissions – both as a broad agenda and as a distinct set of approaches – is low (Pidgeon et al., 2013, Wright et al., 2014, Bellamy et al., 2017, Braun et al., 2018), but already there are signs of nascent polarisation in some fora (Lawford-Smith and Currie, 2017).

Important debates concern the potential for negative emissions to be a 'moral hazard'; that is, a justification for continuing with business as usual or slowing mitigation efforts (Corner and

Pidgeon, 2014). For instance, the negative emissions agenda may reinforce the lock-in of carbon-intensive energy systems through undermining the need for urgent decarbonisation. Similarly, there is a concern that negative emissions may 'crowd out' resources necessary for effective mitigation. This reflects similar concerns about climate change adaptation in the early 1990s (Burton, 1994), where investment in adaptation was seen to diminish effort on emissions reductions.

Variations on the 'moral hazard' framing are evident in the discourse on negative emissions in the media (Nogrady, 2017) and popular science (Klein, 2015), and it is often used as a justification to argue for a moratorium on geoengineering and/or negative emissions research altogether. Although the moral hazard argument deserves consideration (Anderson and Peters, 2016, Lenzi, 2018), its empirical basis is weak (Merk et al., 2018). A case in point, today, climate change adaptation is typically seen as a necessary complement to mitigation rather than a threat. Some recent studies focusing on solar radiation management suggest that increased awareness of these novel technologies may support a greater appreciation of technological risks and complexity (Merk et al., 2018) and therefore spur increased emissions reduction efforts (Millard-Ball, 2012), or could simply result in no detrimental effect (Fairbrother, 2016).

However, are we guilty here of ascribing to negative emissions findings from research on social responses regarding solar radiation management? Discussion ostensibly on the whole range of geoengineering and negative emissions approaches often ends up predicated on solar radiation management (Lenzi et al., 2018) as the "paradigm example of geoengineering" (Gardiner, 2013, Porter, 2017, ETC Group and Heinrich Böll Foundation, 2017). Does such analogical reasoning hold? In such instances, the nature and extent of risks specific to solar radiation management shape perceptions that inform attitudes toward negative emissions technologies. Complexity and nuance are undermined, and instead an extreme (and false) view of geoengineering and negative emissions as solar radiation management-like endeavours might prevail. The tendency for this is especially problematic as research has shown that, when prompted, members of the public can and do differentiate between different types of technologies, with non-solar radiation management generally seen as more desirable (Pidgeon et al., 2013, Braun et al., 2018, Lawford-Smith and Currie, 2017, Campbell-Arvai et al., 2017).

We argue, based on these observations, that there is a risk that the negative emissions discourse will become polarised, and that this is especially likely to occur through the conflation of negative emissions with solar radiation management approaches. Solar radiation management is already polarising (Ott, 2018). This matters, because polarisation can undermine the capacity for developing a functional discourse and result in debate that is focused on digging into entrenched positions at the expense of seeking solutions (Colvin et al., 2015).

The direction the discourse on negative emissions takes as it gains greater public awareness could be critical to shaping its future governance regime. This is both through the direct influence of shaping the perception of governance actors and elites, and indirectly by public opinion guiding the agenda of which technologies are to be governed and which will be banned or left unregulated (Nemet et al., 2018, Beiser-McGrath and Bernauer, 2019). If negative emissions are unavoidable realities of a future in which the worst impacts of climate change are avoided, then maximising the benefits of negative emissions and minimising the risks require an effective governance regime built on functional public discussion.

Lessons from climate change for negative emissions

Learning from the past may determine whether the negative emissions discourse follows a path toward functional governance that opens opportunities for climate solutions and sustainable development, or falls into the familiar trap of polarisation (Bolsen and Shapiro, 2017) that locks in poor outcomes. Here, we present a synthesis of three key, interrelated, insights from the scholarship of climate change – spanning applied psychology, communications, and governance – to guide how we can take an informed approach to developing the negative emissions discourse in a functional way.

At its core, our argument is to avoid *ideological bundling*; this can be pursued directly and via careful selection of communication frames and consideration of who delivers the message. In this article, we look to the climate change experience broadly, though with a focus on emissions reductions and public acceptance of climate science. By reflecting on what led the climate change debate toward polarisation, we may be able to avoid the same fate for negative emissions.

Avoid ideological bundling

In some societies, climate change has become or is perceived to be, a domain of the political 'left'[1], where the commitment to action on resolving climate change is often bundled with other progressive agendas (Bolsen and Shapiro, 2017). This is especially the case in the Anglophone countries of the United States, United Kingdom, Canada, and Australia (Smith and Mayer, 2019). This *ideological bundling* means that attitudes toward other, unrelated

[1] In this article we use the short hand terms 'left' and 'right' to reflect common discourse on political ideology, while recognising that these terms are inherently oversimplified and limited: 'left' approximates progressive political thought and 'right' approximates conservative political thought.

issues, will colour attitudes toward climate change. This bundling can then become a heuristic for developing attitudes on climate change, rather than a deep engagement with evidence and arguments.

Climate change entering the political arena means political candidates are likely to make commitments around climate change in efforts to secure electoral success, and climate change then can become a point of differentiation between political parties. This can inhibit effective climate action (Kemp, 2017, Bailey et al., 2012). Such political positioning can drive polarisation as the climate change agenda becomes part of a political ideology informing voting preferences and policy-making (Unsworth and Fielding, 2014), or even a social identity informing day-to-day beliefs, attitudes, and practices (Colvin et al., 2015). This was the conclusion of a recent review of polling data in the US, which showed that since the late 1990s, opinion on global warming has divided across partisan and ideological lines (Egan and Mullin, 2017).

Once a topic becomes politically polarised, citizens' attitudes are likely to be influenced not by the substantive detail of the topic, but instead by whether their political ideology is seen to be 'pro' or 'anti' (Fielding and Hornsey, 2016). From here, research suggests that many citizens do update their knowledge when presented with new information (Wood and Porter, 2019). However, those citizens and elites who are most active, engaged and vocal often practice selective engagement with information that reinforces pre-existing beliefs (Guess and Coppock, 2018). They do so by seeking perceived credible sources that may differ from authoritative, scientific knowledge (Druckman and McGrath, 2019). As a result, individuals interpret the 'reality' of an issue to fit a pre-existing ideology, rather than adapting beliefs in light of evidence (Druckman et al., 2012, Bolsen and Shapiro, 2017). As a consequence, support for research, programs, policy and other action can become unreliable, limiting progress.

The public awareness-raising work of ex US Democrat vice-president Al Gore via the 2006 film *An Inconvenient Truth* may have helped drive politicisation of climate change in the US from 2007 (Bolsen and Shapiro, 2017). This, in effect, bundled climate change with other causes of the Democratic Party, situating the agenda for action on climate change as the ground of the political 'left'. As pushback against the 'left' climate agenda (Hoffarth and Hodson, 2016), the insertion of climate change denialism into the agenda of the political 'right' has important material and ideological dimensions. Specifically, while global warming denialism is an ideological factor, much of the extensive material work of denialism (e.g. report writing, lobbying, media appearance) has been underwritten by businesses and individuals whose interests would be harmed by emissions reduction (Brulle, 2018, Downie, 2017).

A complexity for implementing negative emissions arises in the fact that there are existing perceptions that proponents of geoengineering (including from the scientific community), and by affiliation negative emissions, may be seen as both 'techno-optimists' and ideologically aligned with the 'right' (Kintisch, 2010). Perceptions of, characterisations about, and responses to this perceived 'geoclique' (a specific term coined by Kintisch (2010)) suggest that there is a strong potential for negative emissions projects, via affiliation with ideas about geoengineering, to become ideologically bundled with 'right' aligned ideologies. This could result in ideologically-motivated pushback and resistance from 'left' aligned ideologies, suggesting that if negative emissions become politically polarised, it could be the mirror image of the emissions reductions debate, with advocates on the ‘right’ and opponents on the ‘left’.

Environmental non-governmental organisations – as key political actors and ideological signposts – do not have a consensus view on whether to support negative emissions as climate change solutions, or oppose them as threats to biodiversity or a ‘moral hazard’ (Talberg et al., 2017). There is also a possibility that material interests may be either threatened by negative emissions, for example where fisheries interests conflict with those of ocean fertilisation, or enriched by them, for example where miners may pursue new opportunities to produce the materials required for enhanced weathering (Buck, 2018). Whether these groups decide to support or oppose negative emissions technologies may fundamentally shape the way the agenda is positioned ideologically and may have significant impacts on the ensuing discourse. So far, such positioning has not happened at scale across broad ideologies and interests.

To avoid ideological bundling of negative emissions, it might be helpful to consider the broad array of ideologies and interests and how these may accord with or oppose negative emissions. Negative emissions offer a new social endeavour that does not have to be limited by the ideological baggage of climate change, or for that matter, geoengineering. Foregrounding opportunities such as the development of new industries and revitalisation of old industries may open negative emissions to the ‘right’ aligned ideologies that have been closed to climate change action. It may be instrumental to identify early the interests likely harmed or aided by negative emissions, and to consider the impacts of any costs to those interests as part of negative emissions measures (Rayner et al., 2013).

Meanwhile, the benefits from halting climate change for human and non-human wellbeing and future generations may engender openness from 'left' aligned ideologies that are otherwise resistant due to pre-existing views on the perceived 'geoclique' and geoengineering. Negative emissions can be analysed across, and argued for, in terms of the benefits that speak to a range of ideologies (e.g. Bain et al., 2016). This can challenge a potentially dominant narrative that would position negative emissions as solely the domain of a particular ideology, political party or social identity.

Choose communication frames carefully

The terms that are selected to communicate an issue, such as climate change or negative emissions, invariably influence the way the issue is perceived. Framing is the process of deploying groups of terms that build a desired narrative (Druckman et al., 2012). In this process, a 'frame' is placed around some, but not all, aspects of an issue, emphasising them at the expense of others. In the case of climate change and more specifically the dominant discourse on emissions reductions, a number of frames have been used to shape perceptions, ranging from the level of scientific consensus, to consequences for environment, national security and public health, to morality and the politics of action (Nisbet, 2009, Bolsen and Shapiro, 2017). A prevalent framing of climate change is that of *environment versus economy* (Bolsen and Shapiro, 2017). In such a frame, action on climate change is posed as being antithetical to economic prosperity (Klein, 2014), creating a dichotomy that causes fear and reluctance to act (Bain et al., 2016). This contributes to the ideological bundling, whether justified or not, of climate change with 'left' ideologies and against 'right' ideologies.

Adopting frames for climate change that emphasise patriotism or waste reduction engage people with a 'right' aligned ideology whereas the framing of 'climate justice' polarises and alienates them (Whitmarsh and Corner, 2017). Framing the future under climate change and various action scenarios in terms of gains, rather than losses, is more likely to generate support for climate policy (Spence and Pidgeon, 2010, Gifford and Comeau, 2011). Evidence is mixed on the impact of emotion in climate change framing (Chapman et al., 2017), with some studies indicating fear inhibits personal action on climate change (O'Neill and Nicholson-Cole, 2009) and others finding the same for messages around policy efficacy (Hornsey and Fielding, 2016).

In this context, what emerges is framing contests where rival groups of actors compete to strategically frame debates to set agendas and draw attention to their concerns. In other words, they engage in rounds of framing and counter-framing as they try to replace an existing frame with their preferred frame (Sell and Prakash, 2004). A climate change related example of this is the recent rise of the *co-benefits* frame for emissions reduction as a reaction to the *environment versus economy* frame (e.g. The New Climate Economy, 2018). A salient example is provided in the efforts by the US government under President Obama to link the positive consequences of mitigation, such as reduced air pollution, with health benefits (Bailey, 2018). Achieving the dominant frame is vital because of its capacity to shape the discourse and in turn influence policy outcomes. Doing so is likely to be easier in the agenda-setting phase when the public first encounters an issue because shaping initial perceptions is easier than attempting to change perceptions later (Ecker et al., 2011).

We can take stock of these lessons from framing climate change during the prevailing efforts for emissions reduction and take an informed approach to engaging with the emerging negative emissions discourse and governance regime. The experience with promoting emissions reduction tells us that we should employ language around negative emissions carefully, considering the impacts of potentially loaded terms, such as ‘geoengineering’, which we already know can create public resistance or polarisation (Pidgeon et al., 2013, Braun et al., 2018, Lawford-Smith and Currie, 2017, Heyward, 2013). The power of framing is highlighted by Corner and Pidgeon (2015) who found that framing geoengineering projects as akin to natural processes increases public support for geoengineering. Research on effective framing for negative emissions that is proactive rather than reactionary could steer the discussion toward functional discourse by identifying and avoiding frames that cause polarisation.

A potential challenge for early framing around negative emissions is the moral hazard frame. There is evidence to suggest that the moral hazard argument about geoengineering is appealing to the (UK) public: the public agrees that geoengineering presents a moral hazard (Corner and Pidgeon, 2014). While the moral hazard argument is significant in varying dimensions across geoengineering and negative emissions, and is deserving of judicious examination, framing negative emissions first and foremost as a moral hazard potentially constructs a false dichotomy where negative emissions technologies are viewed as an alternative to emissions reduction. Instead, negative emissions could be framed as a complement to meaningful mitigation actions, as many climate scientists argue that this is what is required to limit future climate change (Hansen et al., 2016).

Use non-partisan, trusted messengers

It is not just the nature of the message (how it is framed, the information it delivers), but likely also perceptions about the messenger that influence how the message is received. Perceptions about the messenger’s ideology, identity, similarity to oneself, and the potential for hidden agendas all can affect the efficacy of how a message is delivered and received

(Rabinovich et al., 2012, Hoffarth and Hodson, 2016, Fielding and Hornsey, 2016, Moser, 2010, Nisbet, 2018), and whether that message emerges bundled with an existing ideological standpoint. For instance, perceptions among 'right' aligned people that some environmentalists use climate change to covertly encourage more government control (i.e. a 'left' agenda) drives 'right' aligned opposition to climate change policies. This is not necessarily due to the substantive content of the policy. It is likely because the ideological motives of those actors that advocate for these policies are mistrusted (Hoffarth and Hodson, 2016).

Public opinion on climate change has historically been swayed by political mobilization by elites and advocacy groups rather than information-based science advocacy, especially through the news media (Carmichael and Brulle, 2017). The platform through which messages are shared, too, can affect the perception of the message. The 'left' or 'right' ideological orientation of news sources tends to predispose the nature of reporting to frame climate change in terms that adhere with the publication's ideology (Carvalho, 2007, Schmid-Petri, 2017). Distrust in media sources due to perceptions of bias is a known barrier to the public's engagement with climate change (Lorenzoni et al., 2007), while the use of 'right' ideologically aligned news sources has been shown to decrease trust in scientists' understanding of climate change (Hmielowski et al., 2013).

The quantity of media coverage on climate change has a direct effect on the aggregate trends in public opinion about climate change. More media coverage means more concern among the public regardless of whether the coverage is 'positive' or 'negative' (Carmichael and Brulle, 2017). Meanwhile, for individuals with a strong interest and engagement in politics, there is evidence that selection of media sources is increasingly becoming ideologically driven (Davis and Dunaway, 2016) (though this is not the case for non-politically engaged citizens (Garrett and Stroud, 2014, Guess et al., 2018)); online discussions about climate change commonly occur in fora with little diversity of opinion (Williams et al., 2015). These phenomena are linked, as after an issue has been exposed via the media, discussion in social media increases (King et al., 2017). In both cases – seeking ideologically aligned media and participating in online homogeneous discussions – the most engaged and vocal members of the citizenry appear to seek messengers who reflect their own views. The more a member of the citizenry gains an interest in an issue, the more likely they are to perceive balanced media reporting as biased against their interests (Hansen and Kim, 2011) and the more likely they are to seek news sources that reflect and support their position. The implication is that the longer an issue has been in the public discourse via the media, the more likely it is to become polarised.

As public awareness of, and engagement with, negative emissions grows, we can learn from these lessons from climate change and work toward a functional discourse. When engaging with stakeholders and the public, as is essential to developing a governance regime for negative emissions (Bellamy, 2018, Rayner et al., 2013), it is helpful to consider what signals the messenger will send to the audience. If the messenger is a known political figure, the message will be affiliated with their identity group or ideology. A mix of messengers can help avoid ideological bundling, especially when those messengers are not strongly ideologically aligned or identified. Developing strategic alliances with individuals and organisations across the ideological spectrum may counteract some of these trends toward polarisation. Perceiving oneself to have shared interests and identity- and ideological-coherence with a messenger affords more credibility to the messenger, and therefore the message being delivered (Bolsen and Shapiro, 2017, Oldmeadow et al., 2003).

Avoiding recognisably partisan spokespersons is critical to counteract the forces acting to polarise discourse (McDonald, 2016). Engaging with a range of news media sources across ideologies (Carvalho, 2007) and partnering with key political and media elites who cross traditional ideological divides (such as the Green Tea Coalition, which originated out of the Atlanta Tea Party and the Sierra Club to advocate for renewable energy (Downie, 2019)) can assist with challenging the perception that climate change is an issue of the political 'left'.

The same strategy could also steer the negative emissions discourse away from polarisation (Lenzi et al., 2018). Such trans-partisan alliances can also open opportunities for employing framing that leads to meaningful engagement from across the political spectrum. Genuine broad alliances can facilitate development of shared understanding, which will allow for new ways of engaging with negative emissions, rather than following the polarised path laid by the climate change debate.

Looking toward implementation

In this article we have focused on lessons for the high-level public and policy discourse on negative emissions, however as negative emissions projects near implementation we further point to the rich and insightful literature on climate and energy transitions to guide practicalities of just and effective deployment. For example, through attentiveness to the social licence to operate (Bice and Moffat, 2014), procedural fairness (Lacey et al., 2017), public participation (Colvin et al., 2016), justice (Sovacool and Dworkin, 2015), and the economics of regional industry change (Burke et al., 2019). If negative emissions technologies are deployed, this avenue is yet another point for learning from the past to position for a functional future.

Concluding remarks

Based on our reflections on the climate change experience, we propose three key lessons for negative emissions. Critically, ideological bundling should be avoided as negative emissions enter the public discourse, and this can be supported through choosing communication frames carefully and using non-partisan, trusted messengers.

We encourage researchers to continue to pursue rigorous and robust research into the technical and social feasibility of negative emissions, and to consider as a priority the social acceptability of negative emissions, and to be cognisant of the possibility that some technological approaches may be outside of what is considered socially acceptable (following Lacey et al., 2015). At the same time, we urge all with a voice in this emerging discourse to consider the implications of how their research and viewpoints are communicated. For instance, if the risks of a negative emissions technology are shown to outweigh the potential benefits in a particular context or emissions trajectory, it is important that the scientific and governance communities understand and publicly share this information. Therefore it is all the more important that one brush is not used to paint all negative emissions technologies, and the potential risks and benefits of each proposed technology are considered with specificity and in context. This can help achieve open and functional discourse across the disparate approaches.

These insights and arguments are predicated on an assumed willingness across constituencies to engage constructively with the challenges and opportunities presented by negative emissions. Deliberate efforts to seed misinformation by powerful interests may make functional discourse and action on negative emissions beyond reach of the three lessons outlined here (Nisbet, 2009, McDonald, 2016). Policy development will need to include strategies that avoid the creation of lobbies comprised of those whose ideological or material interests will be harmed by negative emissions. Nevertheless, the need for negative emissions presents opportunities for economic innovation and growth. As a result, there is the potential for the negative emissions agenda to engage across the ideological spectrum. Developing the discourse and the emerging negative emissions governance regime in a functional and inclusive way, not polarised, will be critical in mobilising the required resources if the promise of negative emissions advocated by some scholars should prove true and necessary to avoid the worst impacts of climate change.

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