The challenge of Carbon Dioxide Removal for EU policymaking

Vivian Scott[1], Oliver Geden[2,3]

[1] *School of GeoSciences, University of Edinburgh, United Kingdom*
[2] *EU/Europe Research Division, German Institute for International and Security Affairs, Berlin, Germany*
[3] *Institute for Science, Innovation and Society (InSIS), University of Oxford, United Kingdom*

Most scenarios to meet the Paris Agreement require negative emissions technologies. The European Union has assumed a global leadership role in mitigation action and low-carbon energy technology development and deployment, but carbon dioxide removal presents a serious challenge to its low-carbon policy paradigm and experience.

The majority of decarbonisation scenarios consistent with the Paris Agreement's (PA) objectives of limiting global temperature increase to well below 2 °C and possibly even 1.5 °C envisage vast and sustained deployment of carbon dioxide removal (CDR) [1, 2, 3]. To date, there is no practical implementation of these negative emissions technologies (NETs), and no PA signatory government has committed to substantial research and development or the creation of regulatory mechanisms. While policymakers, informed by the IPCC, seem to have accepted that CDR is necessary to meet the PA's targets, they have avoided indicating who exactly is going to deliver it [4].

Traditionally, the European Union (EU) and its Member States might be expected to take the lead. Recent energy system modelling studies, aiming at cost-optimization with a resulting uneven distribution of mitigation burdens between sectors, suggest that the EU power sector deploys bio-energy combined with carbon capture and storage (BECCS) to reach gross CDR levels approaching 1 Gt CO_2 per year by 2050 [5, 6]. To meet an overall emissions reduction target of 80% by 2050 (compared to 1990) the power sector would reach reduction levels of 152%, while transport, buildings and industry sectors deliver reductions of only 10%, 36% and 65% [5]. Looking out to 2100, below 2° C scenarios from integrated assessment models (IAMs) with country-level data calculate that BECCS in the EU could contribute sustained net negative emissions to global mitigation efforts [4].

The EU appears rather unmoved by such scientific assessments of the need for its energy systems to deliver CDR. There is currently no high-level declaration or roadmap from the European Commission or the Council of the EU that mentions the need to generate negative emissions in Europe. Consequently, CDR is not part of the EU's climate policy regulation yet, such that even if a utility were to build a BECCS installation today, it could not receive extra credits under the EU Emissions Trading Scheme (EU ETS). During the recent renegotiation of the EU ETS Directive, setting the rules for the 2021-2030 period, this has not even been a matter of serious debate. This should not come as a surprise. Transformations of energy systems are usually based not on optimum modelled mitigation pathways but on political and economic considerations. To assess if and how CDR might enter into the sphere of EU energy and climate policymaking we should consider not just how certain CDR techniques fit into existing sets of political preferences, economic interests, national energy mixes and infrastructures, but also how a carbon removal approach would fit into the dominant EU low-carbon policy paradigm and its shaping of the European energy system [7].

Challenged paradigm

CDR potentially confronts and confounds the stable narrative of the EU's paradigm: that emissions reductions 'in line with science' and support for low-carbon energy technologies will eventually help to achieve global climate stabilisation and deliver green growth. This highly institutionalised paradigm creates a powerful European success story of domestic pioneering of renewable energy technologies, energy efficiency and carbon markets, internal emissions reductions (23%, 1990-2016) unmatched by any other major industrialised region, and corresponding leadership in global climate policy.

While CDR does not necessarily challenge the paradigm's core – aiming to avoid dangerous climate change by eliminating emissions – acknowledgement of the need to start deployment of CDR in the 2020s in order to meet long-held global climate targets like the 2 °C threshold means admitting a partial failure and inadequacy of present policy. This potentially disturbs the EU's success story, as it challenges the still widely-held European view that mitigation by development and deployment of low carbon energy technologies alone is on track to deliver global climate stabilization at the internationally agreed level.

Alternatively, given its track record of mitigation action, EU governments and populations might ask why they should carry the burden of pioneering CDR to compensate for relative inaction elsewhere, especially as CDR perhaps brings little promise of climate policy co-benefits (e.g., green growth and jobs [8], air quality [9], decreasing dependency on fossil fuel imports [10])? Here, the overall interpretation of the CDR approach will be critical. Will CDR be seen as convenient to 'vested interests' borrowing from the future or as a rational imperative? Would European society view CDR as a betrayal of climate action or an extension of the EU's current approach? If CDR is presented as separate to mitigation and adaptation as a third dimension of EU climate policy then it will, as a form of geoengineering, create much more criticism than if defined as a subcategory of mitigation [11].

We must also ask about the perspectives of key actors and their responsibilities should the conceptual reference line, presently 80-95% emissions reductions by 2050 as a step to net-zero emissions, be shifted into net-negative territory, e.g. 130% by 2100. This would likely create tensions between EU Member States, and between emissions sectors, as it raises the prospect that the distributed effort between pioneers and laggards [12] be considerably extended.

As an example, the IPCC's Fifth Assessment Report assumes the power sector, already the focal point of European mitigation efforts, would be a frontrunner to generate negative emissions. Extending the logic of distributed sectoral effort, the assumed capacity of the power sector to deliver negative emissions might also be assumed to continue to compensate residual emissions from other sectors deemed too technically or politically challenging to force to reductions of 100% or beyond, e.g. from transport or buildings [5, 6]. However, advancing this agenda from generalised assumptions to practical implementation raises the question of how the EU power sector, and EU governments and their constituencies, might assess specific NETs.

Contentious technology choices

The currently preferred NET implemented in IAM scenarios compatible with ambitious climate targets is BECCS [1]. Bioenergy initially enjoyed strong EU-level support towards deployment, with biomass by far the largest source of renewable energy in the EU, mainly because of its dominant position in transport and heating sectors [13]. However, the generalised enshrining of bioenergy resources to be carbon-neutral has proven premature, and the complexity of

bioenergy accounting, custody and interaction with food production and ecosystem conservation has come under increasing scrutiny and criticism [14]. This applies both to the use of biofuels in the transport sector and biomass co-firing in coal power stations in Member States like the UK, the Netherlands, and Poland [15]. As a result, there are now ongoing efforts at both EU and Member State level to strengthen biomass sustainability criteria and limit its contribution towards future renewable energy targets.

Contrasting the EU's relative success (albeit with questionable benefits) in bioenergy development, efforts to initiate CCS deployment in the EU have structurally and comprehensively failed. . As part of global ambitions coordinated through the G8, in 2007 the European Council set the objective to deliver "up to twelve" commercial scale demonstration projects by 2015. Subsequent EU mechanisms to create and award capital grants were developed [16], but a combination of factors – including the collapse of the EU ETS carbon price, power and industry sector reluctance, societal resistance due to safety concerns and the perception of CCS as a cover for retaining and building new coal power, as well as failure by Member States to co-fund projects – led to widespread project termination [17]. As such, the EU has little near-term prospect for CCS deployment. Furthermore, central to the EU's vision of power decarbonisation is the very high penetration of interconnected variable renewables, a system trajectory that leads away from a requirement for high load factor thermal plants that might be met with BECCS.

Bringing this all together, there is strong divergence between modelled possibilities and practical progress. As such, the delivery of BECCS at scale, being reliant on co-delivery of sustainable biomass with CCS technology and supporting infrastructure, cannot be judged to be politically deliverable in the near- to medium-term.

Future pathways

While the political perspectives for a dedicated EU BECCS or wider CDR policy seem bleak, there are processes that might open new opportunities. Out of countless possible options on how a CDR agenda might advance within the complex system of European climate and energy governance [12] we outline possible developments at three different levels – the EU itself, Member States, and the private sector.

A top-down approach by the European Commission appears politically challenging. Nonetheless, the Paris Agreement requires formal technocratic attention, perhaps through integration of CDR into the renewed low-carbon roadmap 2050 (to be delivered by end-2018), supplemented by plans for corresponding EU-level research funding from 2021. However, in a pattern similar to the political treatment of NETs in global IAMs [4], allowing CDR to become an integral part of EU energy system modelling could follow a merely conceptual motive: to ease national or sectoral mitigation requirements in re-modelled trajectories, enabling the EU to avoid drastic measures in the near- to mid-term while still retaining nominal adherence to 2 °C or even 1.5 °C pathways.

On the Member State level, CDR is not yet an integral part of national energy and climate strategies. However, some Member States, notably Sweden and Portugal, are advancing domestic net-zero decarbonisation targets, an approach likely to be taken up by other climate-progressive governments, in the context of the PA's net zero target [18]. This perhaps invites an agenda of limited CDR development and implementation to offset residual emissions deemed too difficult or expensive to mitigate, probably aligned to key domestic resources and industries. Such an approach could subsequently influence actions at the EU level. Equally

however, Member States lagging behind might see NETs as opportunities to ease their mitigation burdens, all the more if their deployment could be co-financed through EU funds. Since biomass co-firing with coal is seen as a promising route to commercialisation of BECCS [19], Poland might be the Member State with the highest potential. But since Poland is the most prominent and outspoken laggard in European climate policy this could further undermine the political credibility of BECCS.

Lastly, we surmise that small markets could emerge based primarily around communities or companies wanting to go beyond '100% renewable' claims and aiming for 'carbon neutrality' instead. This could conceivably, within a facilitating policy framework, support small-scale direct air capture, extend current emissions offsetting practices to small-scale terrestrial CDR (e.g. biochar or enhanced mineral weathering), or perhaps generate investment in BECCS outside the EU under the PA's Article 6 market mechanisms for internationally transferred mitigation [20]. These activities would be unlikely to achieve technically meaningful scale within Europe, but might usefully provide both early technology development and practical experience of societal and political acceptance of CDR.

Conclusions

While the above suggests possible routes for limited progress, the hard-won and solidified EU low-carbon policy paradigm should be expected to struggle to adapt to the near- to mid-term scientific imperative for structured CDR development. Short of exogenous events forcing a paradigm shift, the integration of NETs into active rather than assumed policy will most likely prove a pragmatically tortuous, incremental and gradual process.

This invites increased scrutiny of the practicality and pertinence of the timelines presented in modelled scenarios, in which research and development of NETs is imminently commenced leading to successful delivery within little more than a decade from now. This timeframe would appear ambitious just for achieving the pre-requisite goal of adapting EU political perspectives towards CDR.

This is not to criticise the important role of scenarios to quantify the immense and immediate scale of the mitigation challenge, and to explore possible pathways of energy system transformations. However, the extensive selection of NETs (notably BECCS) as a specified 'backstop technology' against the backdrop of disappointing practical experience and passive political aversion is increasingly problematic [21]. If, despite the overwhelming evidence of its value to achieving low-stabilization climate targets, even climate policy leaders like the EU and its most progressive Member States are reluctant to commence actions to deliver their share of global CDR in a timely fashion, it is perhaps advisable to develop a more conservative assessment of the timelines and scales assumed worldwide.

There remains clear imperative to explore NETs, and the EU should seek to support their research, development and demonstration, examine how they might be deployed through integration into policy and accounting frameworks, and seek cooperation in this effort with other leading forces in low-carbon energy transitions, e.g. California. However, in parallel, caution should be exercised in facilitating the continued conceptual usage of NETs [5, 6]. Steps to achieve this could include the following. First, European and national mitigation targets for the second half of the century should initially be limited to net-zero [18]. Second, greater scrutiny and justification should be applied to policy or model choices to designate specific sectors (e.g. transport, agriculture, industry) to have residual emissions that need to be offset via CDR (presently predominantly biomass with CCS in the power sector). Third, limit

ceilings below the theoretical model boundaries should be set on the inclusion of NETs in energy system models exploring deep decarbonisation scenarios [3]. These could be either fixed limits (e.g. restricting the EU bioenergy resource, in tCO_2/yr) to the present level over immediate decades, or made dependent on technology development or socio-political signals (e.g. only Member States with active development of commercial-scale operating CCS facilities and supporting CO_2 transport and storage infrastructures [22] should be able to select BECCS). While the results of applying such limitations would not be comforting to EU policymakers or industry, they would better reflect real-world experience, and in doing so help minimise the risk of false policy optimism as to the ability for CDR to be rapidly achievable and scalable.

Acknowledgements

The work of V.S. is supported in part by the UK Natural Environment Research Council GHG Removal Programme (NE/P019749/1).

Competing interests

The authors declare no competing interests.

References

1. Smith, P. *et al. Nature Clim. Change* 6, 42–50 (2016).
2. Peter, G.P. *Nature Clim. Change* 6, 646–649 (2016).
3- Van Vuuren, D.P. *et al. Nature Energy* 2, 902–904 (2017).
4. Peters, G.P. & Geden, O. *Nature Clim. Change* 7, 619–621 (2017).
5. Solano Rodriguez, B., Drummond, P. & Ekins, P. *Clim. Policy 17*, 93–110 (2016).
6. Bollen, J. and R. Aalbers. *Biomass-Energy with Carbon Capture and Storage Should Be Used Immediately* (CPB Netherlands Bureau for Economic Policy Analysis, 2017).
7. Burns, T.R., Calvo, D. & Carson, M. *Paradigms in public policy: Theory and practice of paradigm shifts in the EU* (Peter Lang, 2009).
8. OECD. *Towards Green Growth* (OECD Publishing, 2011).
9. West, J.J. *et al. Nature Clim. Change* 3, 885–889 (2013).
10. Duscha, V. *et al. Energy Policy* 95, 314–323 (2016).
11. Heyward, C. *Political Sci. Politics* 46, 23–27 (2013).
12. Fischer, S. & Geden, O. *Moving Targets: Negotiations on the EU's energy and climate policy objectives for the post-2020 period and implications for the German energy transition* (German Institute for International and Security Affairs, 2014).
13. European Commission. *Renewable Energy Progress Report*. COM(2017) 57 final.
14. Bosch, R., van de Pol, M. & Philp, J. *Nature* 523, 526–528 (2015).
15. Roni, M. S. *et al. Renew. Sustain. Energ. Rev.* 78, 1089–1101 (2017).
16. Scott, V. *Energy Policy* 54, 66–71 (2013).
17. Scott, V. *et al. Nature Clim. Change* 3, 105–111 (2013).
18. Pye, S. *et al. Nature Energy* 2, 17024 (2017).
19. Sanchez, D.L. & Kammen, D.M. *Nature Energy* 1, 15002 (2016).
20. Honegger, M. & Rainer, D. *Clim. Policy* 18, 306-321 (2018).
21. Geden, O. *WIREs Clim. Change* 7, 790–797 (2016).
22. Stewart, R.J. *et al. Greenhouse Gases Sci. & Tech.* 4, 481-494 (2014).