

EASAC (2017) 'Negative emission technologies: What role in meeting Paris Agreement targets?' - Relevance to Ireland

At the Royal Irish Academy, we champion research and promote awareness of how science enriches our lives and benefits society. As we believe that good research needs to be promoted, sustained and communicated, we bring academia, government and industry together to address issues of mutual interest, and in doing so, we contribute to public debate and policy formation.

As a Member of the European Academies Science Advisory Council (EASAC), the Royal Irish Academy welcomes this latest EASAC report: *Negative emission technologies: What role in meeting Paris Agreement targets?* EASAC is the collective voice of the National Academies of Science of the EU member states, Norway and Switzerland, providing independent scientific advice for policy-makers in the EU's institutions, member states and Europe generally.

The EASAC report on negative emission technologies (NETs) finds that they have 'limited realistic potential' to halt increases in the concentration of greenhouse gases in the atmosphere at the scale envisioned in the Intergovernmental Panel on Climate Change (IPCC) scenarios, and suggests that rather than assuming that future technologies will be able to remove large amounts of carbon dioxide from the air, the focus should instead be on strengthening mitigation measures. The report therefore recommends that parties concentrate on rapidly reducing greenhouse gas emissions, better controlling deforestation and soil degradation, and developing viable business models for carbon capture and storage implantation.

This report is significant to Ireland's stated ambitions to become a competitive, low-carbon, climate-resilient and environmentally sustainable economy by 2050. Ireland is a party to both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, and supports initiatives within the framework of both the Paris Agreement and the United Nations Sustainable Development Goals. Ireland's commitment to reducing greenhouse gas emissions is reflected in the *National Policy Position on Climate Action and Low Carbon Development (2014)*, the *Climate Action and Low Carbon Development Act, 2015*, and more recently, in Ireland's first statutory *National Mitigation Plan*, and *National Adaptation Framework*, published in July 2017 and January 2018 respectively. As envisaged by Ireland's National Policy Position, the evolution of climate policy in Ireland will be a dynamic, iterative process, based on the adoption of a series of national mitigation plans and national adaptation frameworks over the period to 2050, and the new findings of the European Academies Science Advisory Council are subsequently worthy of Ireland's attention and consideration.

This Briefing Paper by Dr Alwynne McGeever and Professor Mike Jones, MRIA, discusses the terrestrial NETs options reviewed by the EASAC report, and their relevance in an Irish context.



The Authors

Dr Alwynne McGeever

Dr Alwynne McGeever completed her Ph.D. in 2016, with a thesis on the population dynamics of Pine and Elm trees in Europe. She is currently a postdoctoral researcher at Trinity College Dublin. Her main research interests are in tree population dynamics, climate change, bioenergy crops and biodiversity conservation. Currently, her main research project considers the potential for negative emission technologies in Ireland. Her work focuses on modelling yield and greenhouse gas emissions of bioenergy crop production under present and future climate scenarios.



Professor Mike Jones, MRIA

Professor Mike Jones was elected as a Member of the Royal Irish Academy in 2003. He is Emeritus Professor of Botany at Trinity College Dublin. His main research interests are in plant ecophysiology which involves the study of climate-plant interactions, particularly the effects of changing climate, on agricultural and natural terrestrial ecosystems. Currently his main research interest is in assessment of national greenhouse gas emissions from land use in Ireland and the potential for negative carbon emissions in order to achieve greenhouse gas emission reductions at the national level. He is currently subject editor of *Global Change Biology* and *GCB-Bioenergy*. He is chair of the Academy Committee on Climate Change and Environmental Sciences and was appointed a member of the EASAC Environment Steering Panel in November 2016.



Disclaimer: The views and opinions expressed by authors are their own and do not reflect the position of the Royal Irish Academy.

Introduction

In 2015 at the Conference of Parties, the Paris Agreement was ratified with the target of limiting global average temperature rise to “well below 2°C” over pre-industrial levels, to avoid dangerous climate change. The most recent Intergovernmental Panel on Climate Change (IPCC) report (IPCC 2014) provides possible pathways for achieving this temperature target, using Integrated Assessment Models (IAM). The vast majority of the IAM pathways for the 2oC target depend on the wide scale availability and use of Negative Emission Technologies (NETs). NETs refer to any mechanism that successfully removes carbon dioxide from the atmosphere and stores it outside the atmosphere. The international community therefore might expect the availability, wide scale deployment and successful delivery of NETs within the next 30-50 years.

Examples of NETs include afforestation, Bioenergy with Carbon Capture and Storage (BECCS), enhanced weathering and Direct Air Capture with Carbon Capture and Storage (DACCS). The carbon dioxide can be removed either biologically such as with afforestation and BECCS, or it can be removed via other chemical reactions such as with enhanced weathering and DACCS. The removed carbon dioxide can be stored organically in forest biomass or as soil organic carbon, or by being injected into suitable geological formations (CCS).

EASAC Report

The recent EASAC report, 'Negative emission technologies: What role in meeting Paris Agreement targets?' (EASAC, 2017a), assesses the feasibility and likelihood of NETs options being delivered at scale, as indicated by the IPCC IAMs (IPCC, 2014). EASAC found that NETs had “limited realistic potential” and are unlikely to achieve the emission removals required to align with the 2oC temperature limit. EASAC (2017a) reviews the challenges and potential of different NETs options. NETs carbon dioxide removal methods vary in efficiency and resource requirement, and different storage options vary in long term security and technical availability. Considerations for NETs deployment must include relative carbon removal capacity, cost, readiness, vulnerability to re-release of captured carbon, vulnerability to future climate change, biodiversity risk, energy penalty and land pressure.

Implications for Ireland

Ireland's current emission targets are to reduce emissions by 20% of 2005 levels by 2020. Currently Ireland's emissions continue to rise and are unlikely to meet this target, with projections indicating a shortfall of 9% (EPA, 2017). If Ireland could deploy and scale up NETs options it may be able to achieve significant nett emission reductions by offsetting emissions with carbon dioxide removal. However, as indicated by the EASAC report, it is unlikely NETs will be ready and effective in time to deliver this. The following will consider the terrestrial NETs options reviewed by the EASAC report and outline their relevance in an Irish context.

Carbon-Friendly Agriculture:

Ireland's current policy position is to pursue carbon neutrality in the agriculture sector (DCCAE 2017). One way to achieve this may be to offset agricultural emissions by removing carbon dioxide from the atmosphere through land use and management. This may be achieved through enhancing organic carbon stocks in Irish soils, afforestation and bioenergy crops. However, difficulties exist in verifying changes in soil carbon stocks. EASAC (2017a) call for additional research into the potential capacity in European soils to store additional carbon.

Afforestation:

EASAC (2017a) highlights afforestation and reforestation as one of the most readily available and familiar NETs options with relatively low costs to deliver at scale. However, the key limitation identified is the very large land area required to remove enough carbon dioxide to be effective, likely imposing significant competitive pressures on food production. Another reason for concern is the insecurity of the removed carbon stored in the forest biomass, which could be re-released into the atmosphere by fires or harvesting (EASAC 2017b).

The deployment of afforestation in Ireland is already well established and features heavily in existing climate change mitigation policy. To maximise removal of carbon dioxide, restrictions are needed regarding minimum stand age, to ensure a nett gain of carbon, and harvesting protocols to protect stored carbon and ensure its permanence (Naudts et al. 2016). Issues such as the permanent nature of compulsory re-plant forestry, the lack of land control and management required, as well as the replacement of traditional practices are all challenges for successful uptake by farmers (IFA 2016). There are additional concerns about the impacts of afforestation on biodiversity, and on the environment generally from the primarily mono-culture blanket forestry currently being deployed (Kelly 2015).

Enhanced Weathering:

Enhanced weathering refers to the spreading of crushed silicates on the land to accelerate their chemical breakdown which results in the removal of carbon dioxide from the atmosphere through the formation of bicarbonate (Beerling et al. 2016). EASAC (2017a) find a lack of pilot-scale projects available to test the practical potential for enhanced weathering to deliver carbon dioxide removal at a significant scale. They also raise concerns about the logistical and cost implications of mining, crushing and transporting that material at the scale required. The main barrier is the supply of low carbon energy (for mining, processing and transport) to ensure it has nett negative emissions.

CCS:

EASAC (2017a) raise concerns over the slow progress, and the withdrawal of projects, in developing carbon capture and storage (CCS), due to a lack of economic incentive. For two NETs options (BECCS and DACCS), 'off the shelf' CCS is required. Ireland has two options in this regard (1) export its captured carbon to existing or future carbon storage facilities (such as in Norway and Iceland), or (2) develop indigenous infrastructure to store carbon offshore. There is large uncertainty about the storage capacity in Ireland due to the paucity of geological data. The Kinsale gas field is the most likely first suitable storage site, but would require an investment of c. €80 million to be properly assessed (CSA Group 2008).

BECCS:

BECCS removes carbon dioxide from the atmosphere through bioenergy crops or forestry, burning the biomass produces energy (re-releasing the carbon dioxide), the re-released carbon dioxide is captured from flue gasses and injected into suitable geological formations for storage. Similar to afforestation, EASAC (2017a) raise concerns about the land area required to provide bioenergy at scale for BECCS to be effective.

Trade-offs exist for expanding bioenergy crops in Ireland between emission reductions, energy demand, eutrophication and biodiversity (Murphy, Devlin, and McDonnell 2014, 2013; Bourke et al. 2014; Stanley and Stout 2013). Future policies should endeavour not to undermine existing policies in these areas (Burrascano et al. 2016). Additional barriers to expanding bioenergy crops include

- Cultural preferences in the agricultural community towards food production (Doran 2012) and hesitance to adopt energy crops because of a low financial return (Clancy et al. 2008; Clancy et al. 2011)
- The off-putting long-term commitment required with uncertain market and policy (Clancy et al. 2009). Miscanthus normally takes two years to establish and willow takes four (Styles and Jones 2007).
- Uncertainty about yields and reliable production in an Irish climate (Clancy et al. 2009, 2012)

DACCS:

Direct air capture is “an industrial process that captures carbon dioxide from ambient air, producing a pure carbon dioxide stream for use or disposal” (Keith 2009), (Ishimoto et al. 2017). EASAC (2017a) recognises the promising demonstration of direct air capture in several pilot studies in Europe. The main limitations are the equipment size and the significant energy cost of running a direct air capture project. Key research priorities are to develop more efficient sorbents and reduce the energy requirements. In the Irish context, DACCS is currently prohibitively expensive and requires high energy input to operate and therefore would need a low carbon energy supply.

Conclusion

In conclusion, EASAC (2017a) provide a useful review of NETs options with many insights that are directly transferrable to an Irish context. They conclude that immediate effective emissions reductions should be the highest priority in pursuit of the global temperature limit, and caution that over-reliance and misplaced optimism in NETs may lead to insufficient emission reduction action and significantly increase the risks of dangerous future climate change. In Ireland, the NETs option currently most familiar, feasible and affordable to deploy is afforestation. However, land area requirements and the long-term security of the removed carbon dioxide limit afforestation’s realistic potential to effectively offset national emissions. NETs options that have more permanent storage, such as BECCS and DACCS, are currently unavailable in Ireland due to cost, lack of infrastructure and technological immaturity. While developing NETs options in Ireland continues to be of significant national interest, EASAC (2017a) find that NETs will not ‘compensate for inadequate mitigation measures’.

References

- Beerling, D. J., Taylor, L., Banwart, S. A., Kantzas, E. P., Lomas, M., Mueller, C., Ridgwell, A. and Quegan, S. 2016. "Defining the 'negative Emission' Capacity of Global Agriculture Deployed for Enhanced Rock Weathering." *AGU Fall Meeting Abstracts* 21 (December).
- Bourke, D., Stanley, D., O'Rourke, E., Thompson, R., Carnus, T., Dauber, J., Emmerson, M. et al. 2014. "Response of Farmland Biodiversity to the Introduction of Bioenergy Crops: Effects of Local Factors and Surrounding Landscape Context." *GCB Bioenergy* 6 (3): 275–89.
- Burrascano, S., Chytrý, M., Kuemmerle, T., Giarrizzo, E., Luysaert, S., Sabatini, F.M., and Blas, C. 2016. "Current European Policies Are Unlikely to Jointly Foster Carbon Sequestration and Protect Biodiversity." *Biological Conservation* 201 (September): 370–76.
- Clancy, D., Breen, J., Butler, A.M. and Thorne, F. 2008. "The Economic Viability of Biomass Crops versus Conventional Agricultural Systems and Its Potential Impact on Farm Incomes." In *107th EAAE Seminar. Spain: Modelling of Agricultural and Rural Development Policies*.
- Clancy, D., Breen, J., Butler, A.M., Thorne, F. and Wallace, M. 2009. "A Discounted Cash Flow Analysis of Financial Returns from Biomass Crops in Ireland." *Journal of Farm Management* 13 (9): 595–611.
- Clancy, D., Breen, J., Moran, B., Thorne, F. and Wallace, M. 2011. "Examining the Socio-Economic Factors Affecting Willingness to Adopt Bioenergy Crops." *Journal of International Farm Management* 5 (4): 25–40.
- Clancy, D., Breen, J.P., Thorne, F., and Wallace, M. 2012. "A Stochastic Analysis of the Decision to Produce Biomass Crops in Ireland." *Biomass and Bioenergy*, International Conference on Lignocellulosic ethanol, 46: 353–65.
- CSA Group. 2008. "Assessment of the Potential for Geological Storage of Carbon Dioxide for the Island of Ireland." Sustainable Energy Authority Ireland (SEAI).
- DCCAIE. 2017. *National Mitigation Plan 2017*. Department of Communications, Climate Action and Environment.
- Doran, M. 2012. "Biomass Resource in the Island of Ireland." International Centre for Local and Regional Development.
- EASAC. 2017a. "Negative Emission Technologies: What Role in Meeting Paris Agreement Targets?" EASAC policy report 35. European Academics Science Advisory Council.
- . 2017b. *Multi-Functionality and Sustainability in the European Union's Forests DRAFT*. European Academies' Science Advisory Council.
- IFA. 2016. "IFA Concerned about Falling Afforestation Figures given Their Importance in Climate Change Strategy." *Irish Farmers' Association* (blog). April 12, 2016.
- IPCC. 2014. "AR5 Synthesis Report (Fifth Assessment)." Intergovernmental Panel on Climate Change.
- Ishimoto, Y., Sugiyama, M., Kato, E., Moriyama, R., Tsuzuki, K. and Kurosawa, A. 2017. "Putting Costs of Direct Air Capture in Context." SSRN Scholarly Paper ID 2982422. Rochester, NY: Social Science Research Network.
- Keith, D. W. 2009. "Why Capture CO₂ from the Atmosphere?" *Science* 325 (5948): 1654–55.

- Kelly, F. 2015. “An Taisce Submission Re: Public Consultation on the Draft Environmental Requirements for Afforestation (2016).” An Taisce.
- Leake, B. 1986. “The Geology of SW Connemara, Ireland: A Fold and Thrust Dalradian and Metagabbroic-Gneiss Complex.” *Journal of the Geological Society* 143 (2): 221–36.
- Murphy, F, Devlin, G. and McDonnell, K. 2013. “Miscanthus Production and Processing in Ireland: An Analysis of Energy Requirements and Environmental Impacts.” *Renewable and Sustainable Energy Reviews* 23 (July): 412–20.
- . 2014. “Energy Requirements and Environmental Impacts Associated with the Production of Short Rotation Willow (*Salix* Sp.) Chip in Ireland.” *GCB Bioenergy* 6 (6): 727–39.
- Naudts, K., Yiyi C., McGrath, M.J., Ryder, J., Valade, A., Otto, J., and Luysaert, S. 2016. “Europe’s Forest Management Did Not Mitigate Climate Warming.” *Science* 351 (6273): 597.
- Stanley, D. A., and Stout, J. 2013. “Quantifying the Impacts of Bioenergy Crops on Pollinating Insect Abundance and Diversity: A Field-Scale Evaluation Reveals Taxon-Specific Responses.” *Journal of Applied Ecology* 50 (2): 335–44.
- Styles, D. and Jones, M.B. 2007. “Current and Future Financial Competitiveness of Electricity and Heat from Energy Crops: A Case Study from Ireland.” *Energy Policy* 35 (8): 4355–67.

Further information

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For further information on this submission please contact Mr. Craig Skerritt, Programme Manager for Policy and International Relations, Royal Irish Academy. Email: c.skerritt@ria.ie.