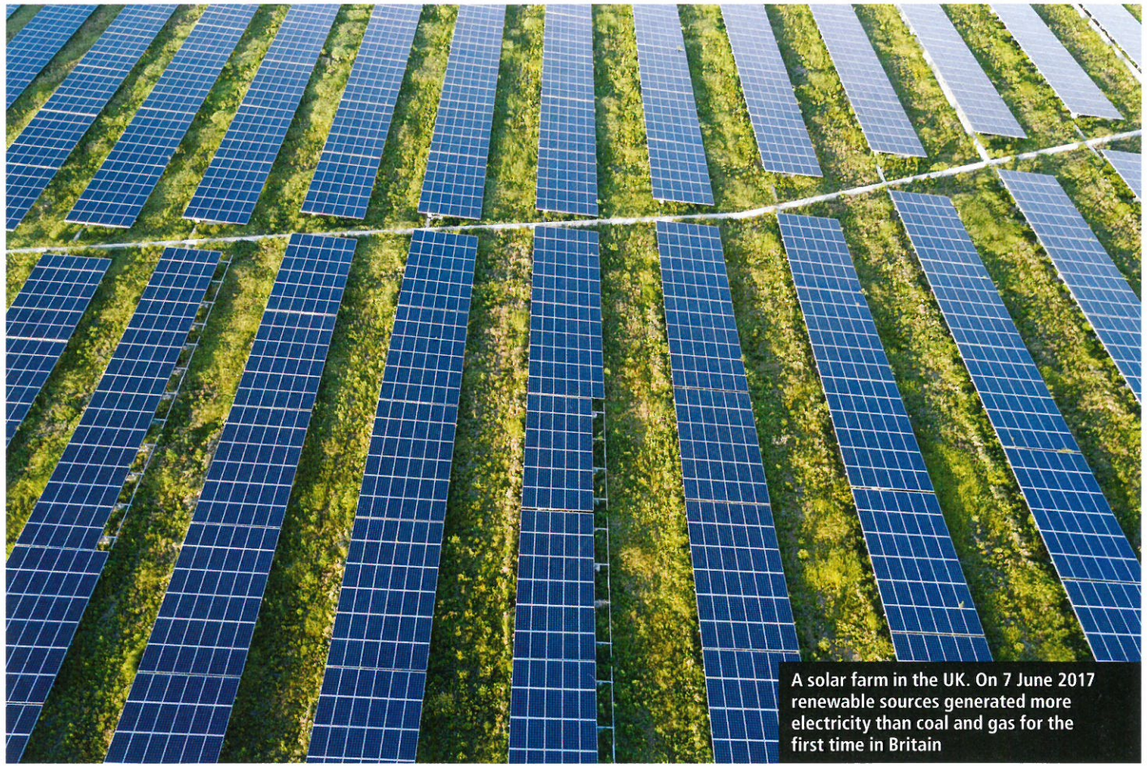
Negative greenhouse-gas emissions

What are negative emissions and how are they impacting on attempts to slow down climate change? Noel Castree explains



A solar farm in the UK. On 7 June 2017 renewable sources generated more electricity than coal and gas for the first time in Britain

The Paris Agreement on reducing greenhouse-gas (GHG) emissions, brokered by the United Nations (UN) in late 2015, has now entered into force. Over 100 countries have signed it, including most of the world's largest GHG-emitting countries.

The aim of the Paris agreement

The aim of the agreement is to avoid so-called 'dangerous climate change'. Governments have tasked themselves with keeping GHG emissions low enough that the atmosphere will not warm more than 2°C above pre-1800 levels. Even this much warming will cause significant changes to the planet's physical geography (which is why the UN would much prefer a 1.5° target to be met). But any warming above 2° will take humans into truly uncharted territory. For instance, scientists predict that sea levels could rise by as much as 9 metres over the next three centuries, posing a serious threat to many coastal cities.

In this context, the agreement is a plan to slow down the change rather than applying the emergency brake. Or, to use another metaphor, it intends to adjust the atmospheric thermostat rather than turn off the heating system altogether.

What is happening to emissions levels?

Since the first UN Earth Summit (in 1992) — when governments began to formally acknowledge that humans are changing the Earth's climate — GHG emissions have significantly *increased* rather than decreased. GHG concentrations are today about 30% higher than they were 25 years ago.

In light of this, people outside government might presume that rapid GHG emissions reductions are now planned, starting in the near future. However, the concept of 'negative emissions' allows signatories of the Paris Agreement to avoid achieving immediate straight line reductions. This Climate Change Update explains the concept of 'negative emissions' and why it has come in for criticism from both climate scientists and those in the world of professional politics and political activism.

Where did the idea come from?

The Intergovernmental Panel on Climate Change (IPCC) is the world's most authoritative organisation when it comes to anthropogenic climate change. Its first reports to governments, back in the 1990s, already indicated the need for drastic global reductions in GHG emissions. Such reductions would be both expensive and technically difficult. This is because the source of the emissions — the burning of fossil fuels in power stations and car engines, the production of cement etc. — was (and still is) vital to daily life in the most developed countries.

Realising that such reductions were unpopular with political leaders and their citizens, some experts suggested that delaying them might allow governments to focus on long-term environmental goals while avoiding short-term political and economic pain. This would benefit developed countries, already hugely reliant on fossil-fuel energy. It would also help emerging economies that were seeking to improve living standards by likewise using coal, oil and gas in large quantities.

Negative emissions effectively means removing carbon dioxide from the atmosphere, for example by planting trees as 'carbon sinks', or storing carbon dioxide underground or in the sea (carbon capture). This idea was seen as a respectable way to represent a delay in emissions reductions. In a negative emissions world, far more greenhouse gases would be removed from the atmosphere per annum than are discharged into it. It was therefore acceptable to delay emissions reduction, on the assumption that we will make up for this in the future.

The situation today

In 2017, the negative emissions idea remains central to national GHG emission targets worldwide. For instance, Australia's government pledged a 25% reduction in its emissions compared to 2005 by 2030. However, it does not have the technology and policies to drive such a reduction. The present government is assuming that new technologies and the policies of future politicians will produce a dramatic change after 2020. Those technologies and policies, if they come to fruition, will need to do two things very quickly.

- They will need to sequester enough atmospheric carbon dioxide to compensate not only for 2020–30 emissions but also 'excess' emissions for the 2005–19 period.
- They will need to compensate for the warming effects of other greenhouse gases, such as methane, over the period since 2005.

Further reading

Castree, N. (2016) 'Climate change update: Understanding the 2015 Paris agreement', Geography Review Vol. 30, No. 1, pp. 18–19.

Hulme, M. (2015) 'Engineering the Earth's climate: Can we? Should we?' Geography Review Vol. 29, No. 1, pp. 38–41.

The carbon budget

To understand the mathematics of this we need to refer to the world's so-called 'carbon budget'. This is the amount of carbon dioxide, in tonnes, estimated to be 'available' to emit before the 2°C target is missed. Much of the budget has been used by our historical predecessors, especially in 'carbon intensive' economies like the USA, Canada, Japan and the western European countries. Based on current emissions levels the budget, of roughly 1 trillion tonnes, is set to be used up by 2038 according to some experts,. To avoid a 'carbon debt' — that is, a blown budget — there are currently three options.

- **Option 1:** a massive increase in the area of land planted with vegetation would sequester a potentially large amount of carbon dioxide (so long as this green 'carbon sink' keeps being replenished).
- **Option 2:** as renewable energy sources receive more government support and scientific focus they could become more economical than fossil-fuel energy sources. This would mean that much of the oil, coal and gas currently targeted for burning would be left in the ground.
- **Option 3:** new carbon capture technologies would store carbon dioxide emitted from any remaining energy sources, such as burning wood chips.

Together, if implemented at a sufficiently grand scale, these measures would keep the carbon budget from going into deficit.

Can we avoid 'blowing' the budget?

Estimating the emissions reduction impact of all but the first of these is hugely uncertain. Even if greater certainty were possible, implementing all three options on a sufficiently large scale is challenging.

- **Option 1:** experts estimate that a land area up to three times the size of India would need to be planted with specific tree, shrub and grass species to make a sizeable dent in the trillion tonne budget. Implementing such a revegetation project will be extraordinarily difficult: which countries will be involved? how will a non-devegetation policy be enforced? and what economic, social and environmental benefits will need to be forgone by devoting land to revegetation rather than other uses? These are not easy questions to answer.
- **Option 2:** though we already have effective renewable energy technologies, like solar panels, large and powerful businesses continue to make enormous amounts of money by selling or utilising fossil fuels. Meanwhile, the economies of entire countries (such as Saudi Arabia and the USA) rely upon the export or import of fossil fuels. This creates huge resistance to switching en masse to renewable sources. It is hard to predict when, and with what mix of low-carbon energy sources, such switching might occur.
- **Option 3:** carbon capture and storage technologies are still at an experimental stage. It is unclear whether breakthroughs will allow enough carbon to be captured (e.g. from future biomass power stations) and safely stored underground forever.

For these reasons, some critics regard the negative emissions concept as a way for national governments to excuse inaction on climate change. Others, by contrast, see it as a useful way for governments to buy time while they lay the ground for more dramatic technical and policy changes down the line.

Either way, if the planet's atmosphere continues to warm up — in 2015 it was already more than 1°C warmer than pre-1800 — this might open the door to so-called 'geoengineering' solutions. These aim to cool down the planet quickly, not by removing GHG gases but by reducing the amount of thermal radiation reaching the Earth's surface (see Mike Hulme's article 'Engineering the Earth's climate: Can we? Should we?' in Geography Review Vol. 29, No.1). Such technologies pose a variety of physical risks and, for critics, can be an excuse for governments not to commit to a 'post-carbon' transition of the world's countries.

Conclusion

The stakes of political inaction are very high indeed. Today's in/decisions will have consequences for hundreds and thousands of years into the future. Even if the carbon budget is not exceeded, scientists give us only a 66% chance of not going beyond the 2°C target (and that target may be 0.5° too much anyway). We must hope the idea of negative emissions is not a fantasy destined to prevent the policy action it is supposed to facilitate.

Noel Castree is a professor of geography at The University of Manchester.