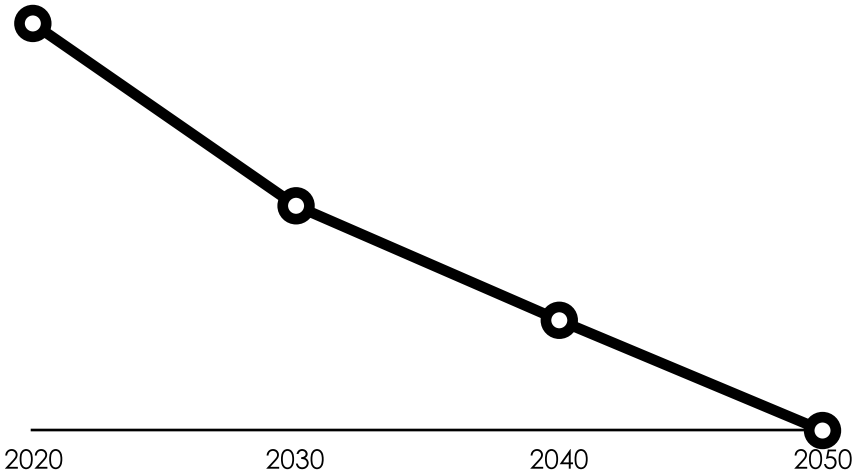
EXPLORING NET ZERO

Energy&Climate INTELLIGENCE UNIT



Negative emissions: why, what, how?

‘Negative emissions’ – taking greenhouse gases from the atmosphere – are likely to be needed in order to stabilise global warming at 1.5 degrees Celsius, the aspirational target to which governments committed in the Paris Agreement.

There are two basic approaches – natural climate solutions (NCS) and negative emissions technologies (NETs). Both have limitations in terms of how much they can be deployed, and may have downsides.

Why ‘negative emissions’?

In order to stabilise global warming at any level, emissions of carbon dioxide, the main greenhouse gas, need to be eliminated; reducing them is not enough. Other greenhouse gases such as methane also need to be constrained.

However, in sectors such as agriculture and aviation, bringing emissions to zero may not be possible. Therefore, the only approach is to draw sufficient greenhouse gases from the atmosphere to balance out emissions that remain – so that emissions reach ‘net zero’.

If negative emissions balance positive emissions over a period of time, global warming should then stabilise. Currently the only greenhouse gas for which negative emissions are feasible at scale is carbon dioxide.

How much is needed, and when?

The Intergovernmental Panel on Climate Change (IPCC) published a landmark report in October setting out what governments need to do if they are to fulfil the Paris Agreement. The IPCC said that meeting the 1.5°C target implies reaching net zero CO2 emissions globally around mid-century, together with major reductions in other greenhouse gases, and that negative emissions will almost certainly be needed.

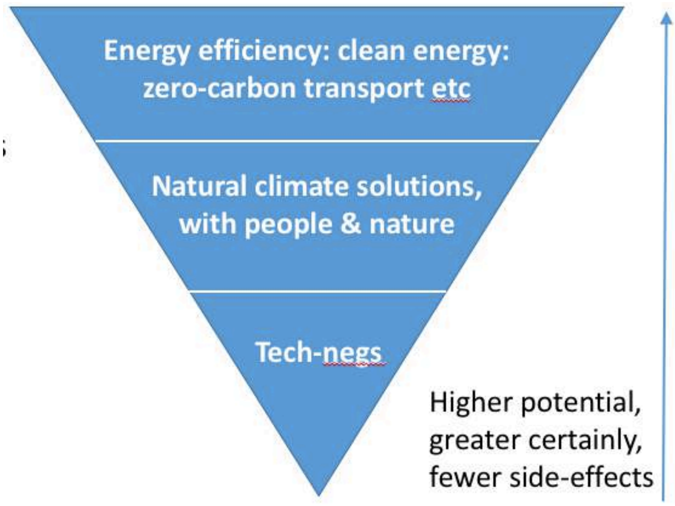
Cutting aviation emissions to zero may not be possible, so 'negative emissions' are needed. Image: Rosedale7175, creative commons licence

How much are needed will depend on how much progress is made in cutting emissions. It will also depend on whether warming releases more greenhouse gases into the air, for example by freeing methane trapped in permafrost.

Recent studies conclude that about 11 billion tonnes of carbon dioxide (GtCO2) might need to be sucked from the air each year by mid-century in order to keep global warming below the previously agreed target of 2°C. Greater amounts might be required for 1.5°C. For comparison, global greenhouse gas emissions are now equivalent to around 50 GtCO2.

What are 'natural climate solutions'?

The best-known approach is to plant forests. Trees absorb CO2 from the air as they grow – so, broadly, more trees means more CO2 uptake.



Saving energy or using 'natural' climate solutions, such as planting trees, may have greater potential than more complex negative emissions technologies

Other approaches include:

- restoring peat bogs
- restoring coastal ecosystems, increasing shoreline and marine plants.

There is also significant potential to safeguard carbon that is already in plants and the soil, by:

- avoiding destruction of forests,

peat and shoreline ecosystems
- adopting ‘no-till’ agriculture, which avoids carbon release through soil disturbance
- better wildfire management to avoid burning of trees and plants.

Technologies

The NET with the biggest potential is bioenergy with carbon capture and storage (BECCS). Plant material is burned to generate electricity. The CO_2 is captured and stored underground. More plants are then grown, absorbing CO_2 from the air – this is burned, taking more CO_2 underground; and so on.

Another NET is direct air capture (DAC), where a chemical process extracts CO_2 from the air.

There are also some ‘hybrid’ concepts, which enhance natural processes of carbon dioxide absorption:

- boosting the growth of phytoplankton, tiny plants in the ocean, using iron filings (‘iron fertilisation’)
- creating biochar – charcoal – through pyrolysis (heating) of plant material. Spread on fields, biochar takes carbon into the soil in stable form
- enhancing weathering of rock, a process that naturally carries CO_2 into the ocean.

Technologies that would cool the Earth by reflecting or blocking incoming solar energy, such as putting dust into the atmosphere, are not NETs – they do not absorb CO_2 and do not tackle ocean acidification. They are not considered in the IPCC report.

How much can negative emissions be used?

Natural climate solutions could in principle absorb about 28 $GtCO_2$ per year by 2030. However, factors including competition for land might make the obtainable value much smaller. The European Academies’ Science Advisory Council (EASAC) recently concluded that in practice negative emissions approaches offer limited potential.

Natural climate solutions are faster to implement than NETs, but would be ‘saturated’ over time - for example, forests cannot be planted indefinitely. Planting new forests could conflict with other requirements for land such as growing food; but it could also provide habitat for nature. Mixed forest, which is generally good for biodiversity, absorbs more CO_2 than monoculture.

Deployment of BECCS would also be limited by availability of land. Growing energy crops sufficient for negative emissions of 10 $GtCO_2$ would take up more than one-fifth of the area currently used for growing food. BECCS would do more harm than good – contributing positive emissions – if intact forest were removed to make land for energy crops.There could also be competition for land between NCS and BECCS.

The capacity of biochar and enhanced weathering are small by comparison. The reliability of ocean fertilisation to sequester carbon appears low.

Natural solutions are likely to be cheaper than BECCS, which is estimated to cost $100-400 per tonne of carbon sequestered. For comparison, the EU carbon price stood at €5-10 per tonne for most of its existence, although it has latterly risen sharply to €25. Currently there are no economic mechanisms designed to pay for negative emissions.

Mixed forest absorbs more carbon dioxide than monoculture forests. Image: Andrew Foster, creative commons licence

For the UK

The UK's existing target of cutting emissions by 80% by 2050 means that annual emissions will then be at or below 160 MtCO2e. The Committee on Climate Change, the statutory advisor, has already calculated that emissions could fall further, to 90% - and that achieving net zero for greenhouse gases would need negative emissions in the order of 100MtCO2 per year.

For comparison, one recent estimate put UK potential for natural negative emissions at 166 MtCO2 per year, with one-third – around 55 MtCO2 per year – deliverable at under $100 per tonne. The UK has committed to plant a new 'National Forest' in the Midlands covering 200 square miles and the government has pledged £10m to help restore more than 10,000 football pitches-worth of peatlands in England.

The UK's BECCS capacity has also been estimated at around 55 MtCO2 per year, although this would require biomass imports - the same study calculates the figure at about 30 MtCO2 if only British-sourced biomass is used. Drax power station is setting up a pilot plant.

The Royal Society and Royal Academy of Engineering recently concluded that taking the UK to net zero would need a slightly higher negative emissions figure, 130MTCO2 per year, and that this was 'likely to be achievable'. Reducing emissions further would cut the need for NETs, and so cut the overall cost considerably.

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