Reaching Net Zero

FES 2020: exploring what the net zero target really means

The new, legally binding target of net zero greenhouse gas emissions by 2050 is already driving change across the UK economy. But is it clear what 'net zero' means? How are emissions measured, counted and monitored and is this the same for every sector?

Helen Simpson, one of the ESO's Strategic Insight Leads, explores the uncertainties associated with the target and explains the definition of net zero we will be using in our 2020 Future Energy Scenarios (FES).

Reaching net zero requires a whole society approach. Energy system emissions are just a subset of greenhouse gas emissions produced across the wider economy. Reducing emissions to zero by 2050 is a huge challenge; for some sectors it will be almost impossible. Therefore, there will be some reliance on negative emissions for other sectors to achieve the overall net zero goal. Collaboration and consistency are needed across society to deliver the right results.

In our recently published *'Bridging the gap to net zero'* report, we called out the importance of having a clear and consistent definition of net zero across the whole system, to make sure that decisions across industry and policy are consistent.

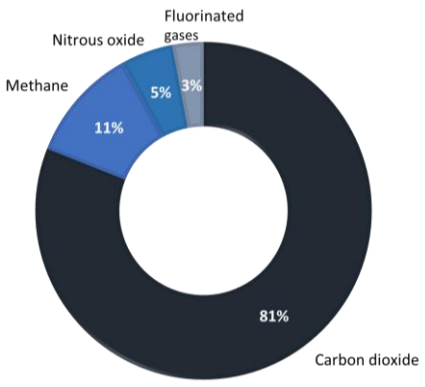
Last year, in our FES 2019 net zero sensitivity we explored a target of 96 per cent emissions reduction by 2050 with existing technologies, the remaining 4 per cent being reliant upon speculative technologies. This aligned with the approach taken by the Committee on Climate Change (CCC) in their 2019 net zero report. This year our FES 2020 net zero target removes the 'hiding place' of speculative technologies and will present three scenarios that demonstrate 100 per cent emissions reduction by 2050 from 1990 levels. This is also aligned with the CCC's latest approach for their 6th carbon budget analysis.

So, what is net zero?

In its simplest sense, reaching net zero emissions requires an overall balance between greenhouse gases being released into and removed from the atmosphere.

Greenhouse gases are most commonly recognised as the following seven gases: carbon dioxide (CO_2), methane, nitrous oxide, and the fluorinated or F gases (hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride). The UK net zero target covers all greenhouse gas emissions, not just CO_2, but it is worth noting that UK emissions are currently dominated by CO_2.

UK Greenhouse gas emissions, by gas, 2018



Source
BEIS: 2018 UK Greenhouse Gas Emissions, Final Figures

Greenhouse gas emissions could be reduced in several ways:

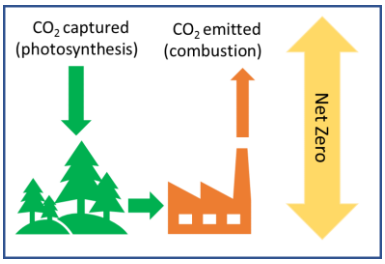
- reducing the gross emissions produced to zero
- using bioenergy so that emissions are offset by biomass growth
- continuing to produce fossil emissions but capturing the greenhouse gases before they are released into the atmosphere
- actively removing greenhouse gases from the atmosphere (negative emissions).

The likelihood is that a combination of these approaches will be needed across the UK society.

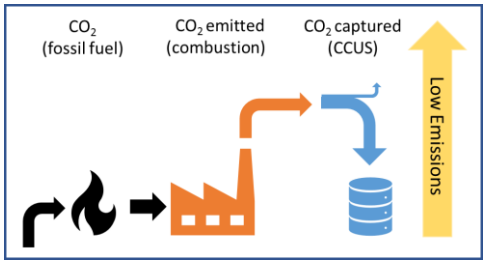
Reaching zero gross emissions

In an ideal world, all sectors would simply make sure that they no longer emit any greenhouse gases by 2050. To do this they would have to switch to using forms of energy that produce no greenhouse gas emissions at the point of consumption (such as electricity or hydrogen), and make sure that these fuels have also been produced via methods which produce no emissions. This is an extremely challenging goal for many sectors by 2050, but for some it is just not feasible.

Using bioenergy



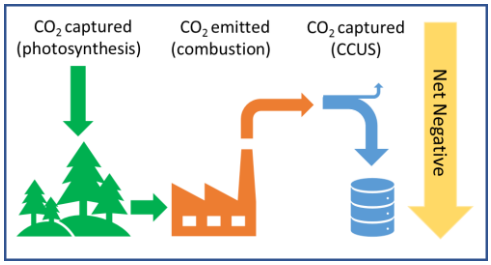
Trees naturally pull CO_2 out of the atmosphere (absorbing it during photosynthesis). This results in carbon being stored in forests, vegetation and in the soil. While the burning of fossil fuels releases carbon that has been 'trapped' underground for many millions of years, when we burn sustainably sourced wood or other bioenergy crops, the CO_2 emitted can be offset by the CO_2 they have absorbed over their life.



Capturing emissions

Another approach to minimising emissions is to capture the CO_2 produced from fossil fuel combustion or other industrial processes before it is released into the atmosphere. Technology exists to do this, known as carbon capture and storage (CCS), however there remains a certain level of CO_2 leakage. Capture rates are expected to range between 95 and 97 per cent across the FES 2020 scenarios. Therefore, using this approach results in low, but not zero, emissions.

Negative emissions



The term 'negative emissions' refers to the removal of greenhouse gases from the atmosphere. But how is this achieved?

Planting more trees (afforestation) or restocking existing areas of forest or woodland (reforestation) is a natural way of achieving negative emissions.

Another approach is to combine CCS with the use of bioenergy, to store away recently absorbed CO_2. For example, if electricity is generated by burning organic matter (biomass) rather than coal or gas, with the resultant CO_2 emissions being captured using CCS, this will result in negative emissions. This process is known as bioenergy with carbon capture and storage (BECCS).

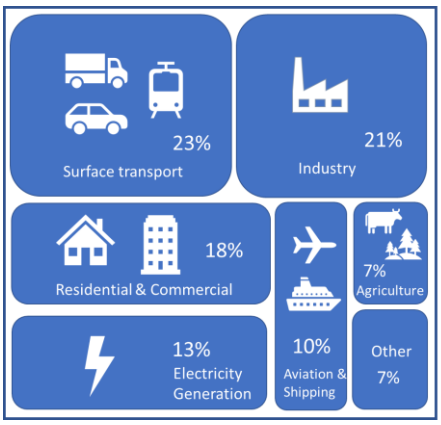
New technology is under development to capture CO_2 directly from the atmosphere. Direct air capture and storage (DACS) involves a chemical process which is used to absorb CO_2 from a flow of air. This remains in the early stages of development; its downside being that it is a very energy intensive process.

Reaching a balance

The negative emissions options explored above offer opportunities to net off residual emissions from difficult to decarbonise sectors such as aviation, farming and certain industrial processes (steel, chemicals and cement production).

As long as enough greenhouse gases can be removed from the atmosphere to balance the residual amount emitted by certain sectors in 2050, net zero across the whole economy can be achieved.

UK Greenhouse gas emissions, by sector, 2018



Source - CCC: UK emissions progress report 2019

How are emissions measured?

Because there are many different greenhouse gases and they differ in how strongly they trap heat and in how long they persist in the atmosphere, it is important to have a consistent way of measuring them. For this reason, they are typically converted into a CO_2 equivalent measure. Each gas is recognised as having a different global warming potential (GWP_{100}) which reflects the energy that a one-off emission of the gas would trap in the climate system over 100 years, compared to a one-off emission of carbon dioxide over 100 years. The CO_2 equivalent (measured in tCO2e) multiplies one tonne of gas by its associated GWP_{100}.

But, having a consistent way of measuring both positive and negative emissions is not enough. It must be clear who is responsible for which emissions in order to avoid gaps or duplication in accounting.

Current UK domestic targets and associated carbon budgets are calculated on a territorial basis, i.e. they include greenhouse gases that are emitted within the geographical bounds of the UK. The term production-based accounting is also used, but it's worth noting that this refers to where the *emissions* are produced, rather than the product itself. So, this means they include CO_2 emitted when we heat our UK homes, drive our cars on UK roads, make items in our UK factories or produce electricity in the UK using fossil fuels. They do not however include emissions from factories in other countries that manufactured goods we have imported for use in the UK. And, they don't include emissions from electricity brought into the UK via interconnectors, that was generated elsewhere. When we model energy supply and demand in FES we cover the geographical boundary of GB, not the UK. However, when calculating the impact of our modelling on decarbonisation targets, we will account for emissions across all sectors and the whole of the UK.

Although the production-based/territorial method of accounting reduces the risk of double-counting and gaps, we recognise there are times when considering the true carbon footprint of a product, and other forms of emissions accounting can be extremely important. For example, current accounting does not consider the international supply chain and changes in the UK can result in emissions being offshored (i.e. increasing reliance on imports).

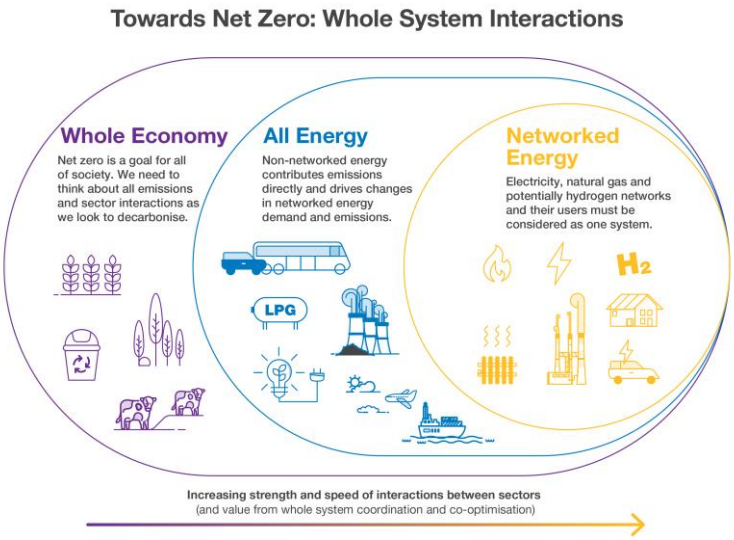
Another weakness in current accounting relates to international aviation and shipping. With territorial accounting, it is not clear who accounts for emissions from planes/ships as they travel between countries. Currently, the UK targets include emissions resulting from domestic flights (i.e. those that both take-off and land in the UK), but not international ones (that take off in the UK, but land outside it).

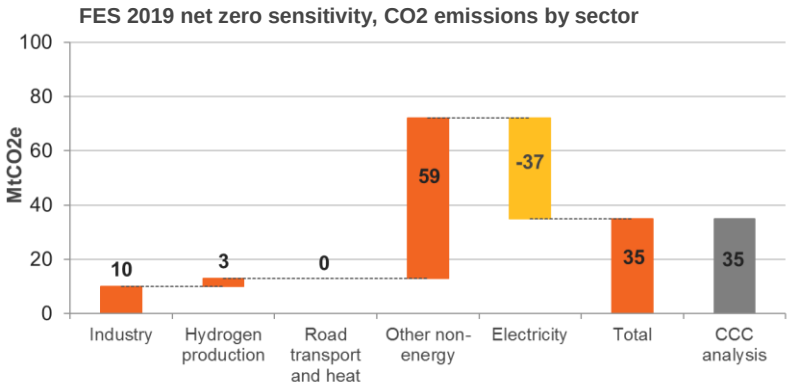
The CCC recommendations in May 2019 asserted that the net zero target *must* cover the whole economy, including international aviation and shipping. They suggest that these emissions should be based on the fuel taken on board planes and ships before they leave the UK (known as 'bunker fuels' methodology).

In FES, based on consultation with stakeholders, we will follow the standard UK methods of emissions accounting laid out above, and align with the CCC recommendations on aviation and shipping to include emissions from bunker fuels. This is because consistency across the industry is considered essential.

Net zero is a whole system target

Net zero is a whole system challenge in which the energy system plays an important role. Whilst the net zero target removes the 20% "hiding place" of the previous goal (80% reduction in emissions from 1990 levels), the concept of negative emissions could still allow many sectors to assume that their emissions will be offset by others and therefore that they don't need to fully decarbonise (for example, electricity generation using BECCS).





Last year, our FES 2019 net zero sensitivity analysis recognised that even if road transport and heat could reach zero emissions by 2050, some sectors are much less likely to reach this target (such as aviation, farming and some industrial processes). Therefore, we included the use of BECCS for generation of electricity so that negative emissions of -37 MtCO2e in the energy sector could balance these 'hard to decarbonise' sectors and enable the whole UK economy to achieve net zero.

This analysis also assumed that 4% of emissions (35 MtCO2e) would be removed by emerging, as yet unproven technology such as DACS. This is also the approach that was taken by the CCC's 'speculative' net zero scenario.

In order to develop our FES scenarios, we use our expertise and stakeholder engagement to conduct deep analysis on the GB energy system. We also consult with stakeholders to understand the emission pathways for non-energy sectors (e.g. farming). This means we can ensure our FES scenarios are credible and integrated with a whole-of-society net zero target for 2050.

Knowing the best assumptions to make for non-energy sectors enables us to more accurately model the scale of negative emissions required from the energy sector. Our FES 2020 scenarios will illustrate credible pathways to 100 per cent emission reduction by 2050, which clearly call out 'what we must believe' across the whole UK economy and society to enable this to happen.