AVOID 2
Can we avoid dangerous climate change?

What is the scale and challenge of the energy system transition required to meet long-term climate goals?

Achieving emissions consistent with a 50% chance of remaining below 2°C by 2100 will require large changes in the energy system over the 21st century, including increased use of renewables and significant retirement of fossil fuel generation capacity. Delaying global coordinated mitigation action towards the 2°C goal beyond 2020 would substantially increase the costs of mitigation and require very rapid subsequent rates of decarbonisation.

Latest results

Energy systems modelling is used in the AVOID 2 research programme to investigate what kinds of changes would happen to the global use and supply of energy in scenarios designed to meet a range of long-term temperature goals.

Scenarios generated by three global energy systems models, with the objective of limiting temperature change to 2°C by 2100, all show that **delaying global coordinated mitigation action until 2030 results in greatly increased mitigation costs** relative to the case where action begins in 2020.

Figure 1 shows the global cumulative costs of meeting the higher 2ºC goal over the period 2012-2100 for one of the models, and also the additional costs of technology constraints, including a delay in the deployment of carbon capture and storage or CCS (the "late CCS" scenario) and a limited increase in the use of electricity in the buildings, transport and industrial sectors (the "limited electrification" scenario).

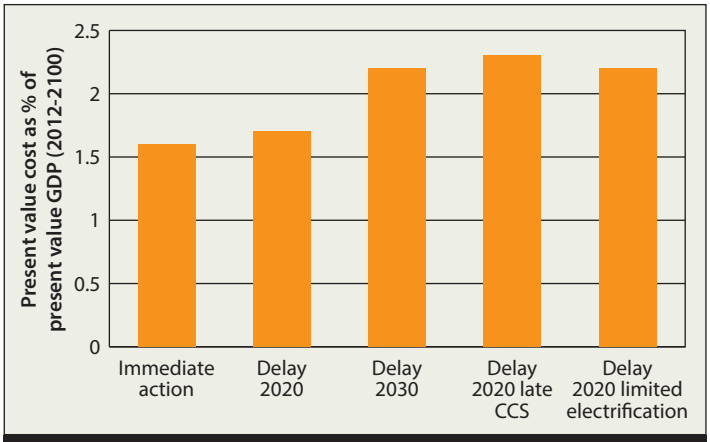

Figure 1: Illustrative 2012-2100 global mitigation cost (as share of global GDP) in a single model (TIAM-Grantham), to meet a 2°C scenario under alternative constraints. Present value cumulative costs in 2005 $, based on 5% discount rate.

Note that these and other similar studies do not include the costs of climate adaptation or damages, which would increase the total costs of these pathways and are expected to be especially significant for large temperature rises above 2°C.

Another way of examining the challenge of mitigation in these scenarios is to consider the annual rate of change in global CO_2 emissions over the first decade after global coordinated mitigation begins, as shown in Figure 2. **Greater rates of decarbonisation depend on more rapid changes in the economy and the energy system**. Delays to mitigation action imply increasing annual rates of decarbonisation. Decarbonisation rates faster than 3% per year have previously been described as "extreme".[1]

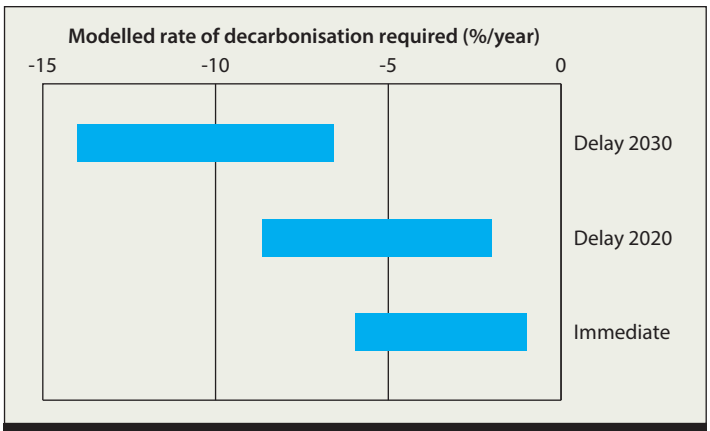

Figure 2: Average annual rate of change of global CO_2 emissions in the first decade after the start of global coordinated mitigation action to remain below 2°C in 2100 begins. 'Immediate' action starts at a reference baseline of either 2010 or 2012 in each model.

[1] M. G. J. den Elzen, D. P. van Vuuren, and J. van Vliet, 'Postponing emission reductions from 2020 to 2030 increases climate risks and long-term costs', Clim. Change, vol. 99, no. 1-2, pp. 313-320, Mar. 2010.

Fundamental changes to the electricity sector over the 21st century see a shift away from fossil fuel generation in all of the model scenarios achieving a 2°C outcome. There is also a significant increase in electricity capacity, since the use of electricity as a final energy source increases from 18% today to between 40% and 66% by 2100 across the models. The fossil fuel share of total electricity generation, currently greater than 60%, reduces to between 2% and 16% across the models by 2100. Of the remaining fossil fuel based power generation, all is used with CCS technologies by 2100.

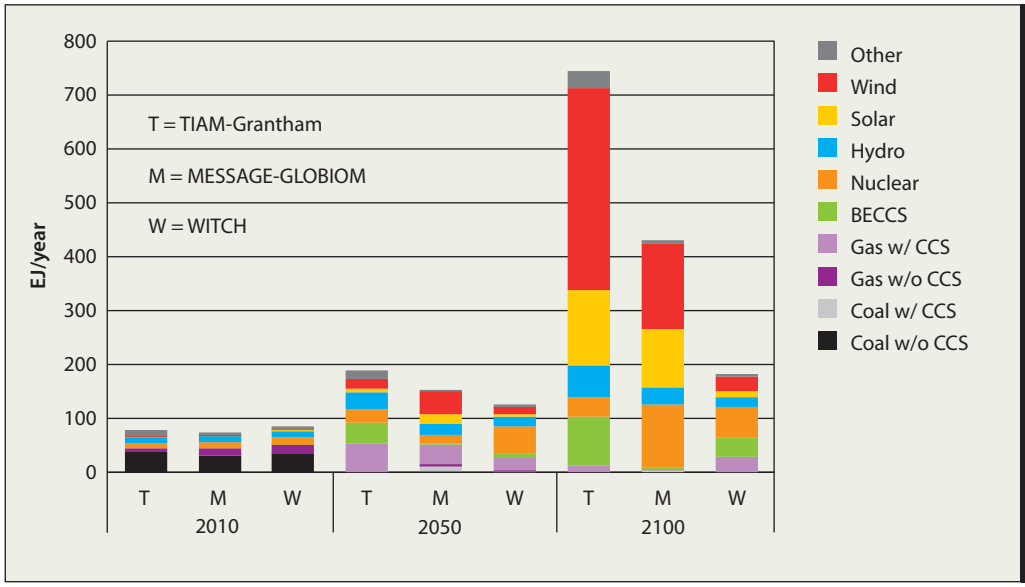

Figure 3: Electricity generation in 2010, 2050 and 2100 for three energy system models (2°C scenario with global coordinated mitigation action delayed to 2020).

Note: There is a wide range of choice in technologies between alternative models. This reflects the different assumptions on technology costs and availability in the models, resulting in a different balance between scale-up of CCS, nuclear, and renewable energy supply technologies and opportunities for cost-effective demand reduction. Increasing penetrations of intermittent renewables will require electricity grid balancing measures (e.g. storage).

As in similar studies, **modelled deep mitigation scenarios make significant use of CCS to achieve targets**. In the models used here, rapid CCS deployment increases from at least 2GtCO_2 capture per year in 2030 to between 13 and 34GtCO_2 per year by 2080 (figure 4).

Where CCS cannot be retrofitted to existing fossil fuel plants, meeting the 2°C goal could result in stranded assets, in particular in the coal sector. In a scenario where global coordinated mitigation action starts in 2020, average capacity factors (actual generation relative to potential) in two out of three models drop to almost zero by 2030, implying the possible early retirement of 1,400GW of still economically viable coal plants – this is equivalent to 80% of currently installed global coal power generation capacity.

Two of the three models used show global net negative CO_2 emissions by 2080. Globally net negative emissions require that more CO_2 is being removed from the atmosphere than added to it; hence this is not just capture of emissions at source, but also includes drawdown technologies such as Bioenergy combined with Carbon Capture and Storage (BECCS). This is consistent with the IPCC low-emission scenario (RCP2.6), in which net negative emissions are required from approximately 2070.

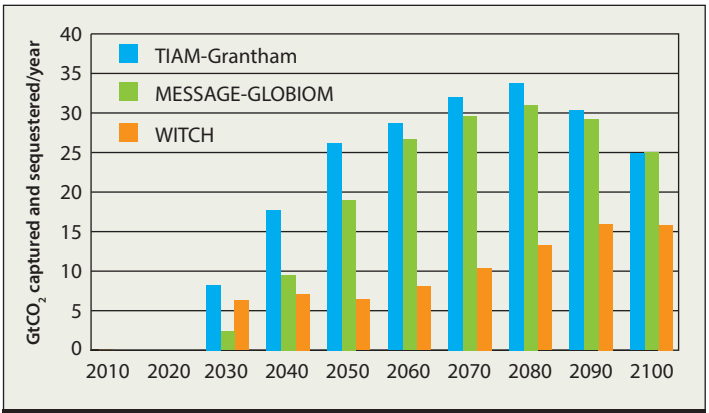

Figure 4: Global CO_2 captured and sequestered annually, 2°C scenario with global coordinated mitigation action delayed until 2020. WITCH has a greater scope for energy demand reduction so does not rely so heavily on CCS (cf figure 3).

Read more

AVOID 2 report C2: *Assessing the challenges of global long-term mitigation scenarios* available on our website *www.avoid.uk.net*;
AVOID 2 policy card C2b: *What contribution can mitigation of non-CO_2 greenhouse gases make towards achieving long term temperature goals?* available on our website *www.avoid.uk.net*;
AVOID 2 policy cards on feasibility of BECCS (forthcoming) will be available on our website *www.avoid.uk.net*.