2021-IP19 – UK Net Zero Strategy: Build Back Greener: Synopsis on hydrogen and CCUS

The Sixth Assessment Report (AR6) of the International Panel on Climate Change (IPCC) reveals that ''Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO_2) and other greenhouse gas emissions occur in the coming decades''. This AR6 statement explicitly signifies the urgency to transition to a low-carbon economy as soon as practically possible. The UK Government's response to this pronouncement is its ambition to make the United Kingdom the birthplace of the green industrial revolution which has been set out in its recently launched landmark net zero strategy. This initiative sets out how the government will deliver on its commitment to reach net zero emissions by 2050 as summarised in Figure 1.

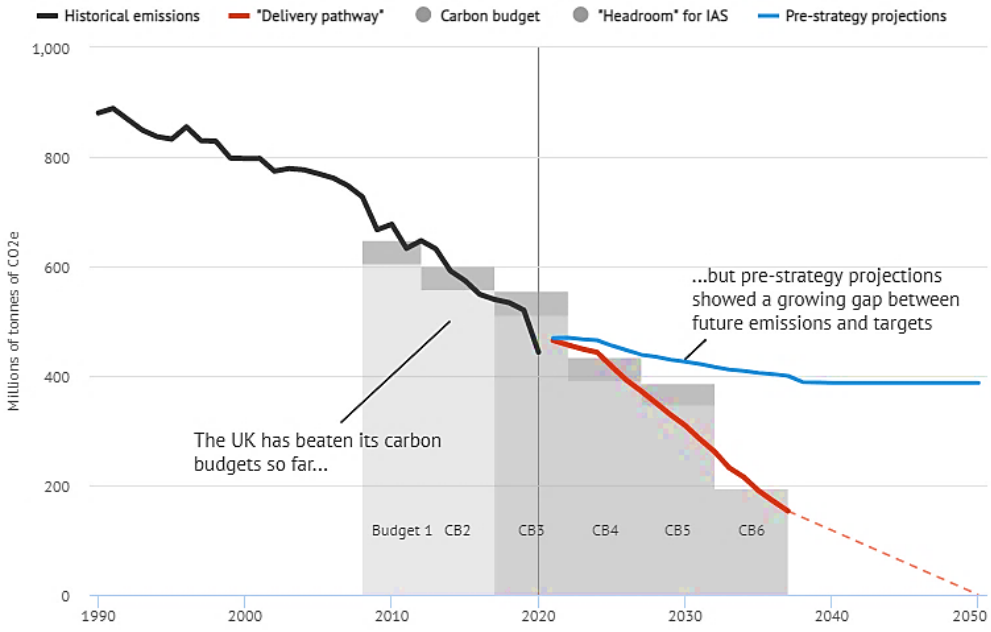

Figure 1 Delivery pathway to the UK net zero strategy.

Note: UK greenhouse gas emissions including international aviation and shipping (IAS). Lines show historical emissions (black), pre-strategy projections (blue) and the strategy's "delivery pathway" (red). Legislated carbon budgets levels are shown in grey. The first five budgets did not include IAS, but "headroom" was left to allow for these emissions.

The delivery of the ambitious strategy is underpinned by the UK's ten-point plan for a green industrial revolution and which designates low carbon hydrogen and carbon capture, usage and storage (CCUS) as key priority areas in the Net Zero Innovation Portfolio. The UK Government is committed to a 'twin track' approach to hydrogen production i.e., electrolytic and CCUS-enabled hydrogen where it aims to produce a 5 GW of low carbon production capacity by 2030 and 10 - 17 GW by 2035. This approach will create a thriving new hydrogen economy and position the UK hydrogen economy for the scale up needed to support net zero by 2050. Delivery of four CCUS clusters is also projected to play a key role towards net zero by capturing 20-30 Mt of CO_2 per year by 2030 and 50 Mt of CO_2 by the mid-2030s (see Figure 2), thus setting the stage for an expanded CCUS scale-up and role for deep decarbonisation of the power and industrial sectors as well as CCUS-abetted hydrogen production.

Figure 2 Diagrammatic scale-up and emission reduction role of CCS by 2035

The path to net-zero will see the power system fully decarbonised by 2035 and could be achieved via a number of scenarios and will accordingly respond to innovation and adoption of novel technologies over time. The UK Government has already set up the Industrial Decarbonisation and Hydrogen Revenue Support (IDHRS) scheme to fund new hydrogen and industrial carbon capture business models having recognised the prominence that low carbon hydrogen and CCUS will play in the decarbonisation endeavour. The net-zero strategy includes an indicative roadmap to 2035, which the government will use as a gauge to ensure that it is on track to achieve its targets. The 2035 roadmap is projected to see at least one power plant CCS facility, four CCUS clusters and large-scale steam methane reformation (SMR) and auto-thermal reformation (ATR) plants deployed.

The pathway to net-zero is projected to be achieved via a number of scenarios with the exact route to net-zero reliant on the cost, accessibility, acceptability and readiness of key technologies as well as the choices made by the government, businesses and individuals. These technologies will produce about 610 – 690 TWh/year of low carbon electricity in the UK by 2050.

Three Net zero scenarios namely: high electrification; high resource; and high innovation were modelled through the same pace of decarbonisation to demonstrate a range of pragmatic ways in which net zero could practically be achieved with technology and resources currently known. The three modelled scenarios highlight the role that hydrogen and CCUS, amongst other sustainable technologies, will play in a net-zero economy.

2050 Scenario 1: **High electrification** investigates the influence of deep decarbonisation of the electricity system to support the transport, heating, and industry sectors as illustrated in Figure 3.

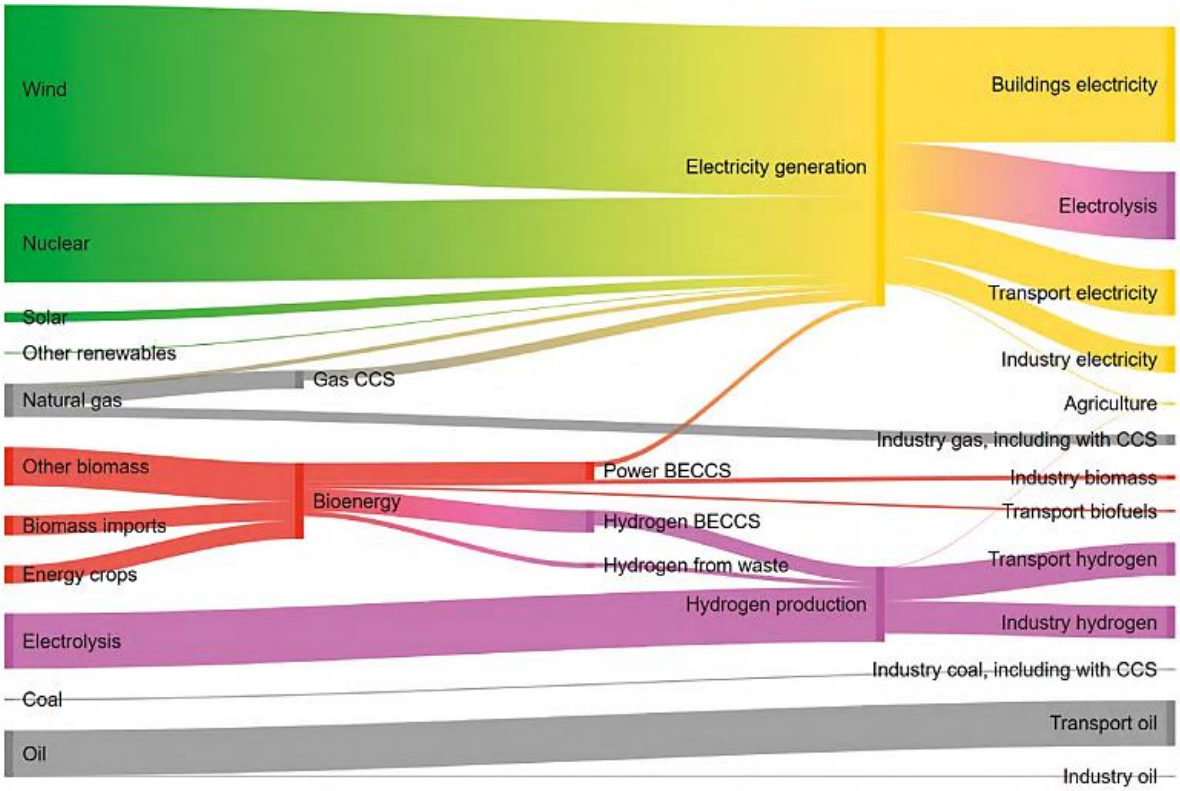

Figure 3 Illustration of the 2050 net-zero pathway of **high electrification scenario**

The high electrification pathway sees the UK generating about 690 TWh/year of electricity (more than twice the electricity today). Despite overwhelmingly electrification via renewables low carbon hydrogen is scaled up to 240 TWh/year, and industry emissions are near zero, largely due to the impact of CCS on natural gas combustion and reformation. Offset of residual emissions in the aviation, agricultural and waste sectors was achieved by bioenergy with CCS (BECCS).

2050 Scenario 2: **High resource** explores the influence of extensive utilisation of low carbon hydrogen in the economy and sees its generation at about 500 TWh/year. The role of CCS in this scenario is significant and includes gas and bioenergy CCS-abetted power generation and CCS-enabled hydrogen production for the building, transport, industry and power sectors. The economy in this scenario is largely decarbonised via CCS-enabled hydrogen and CCS-abetted power as illustrated in Figure 4.

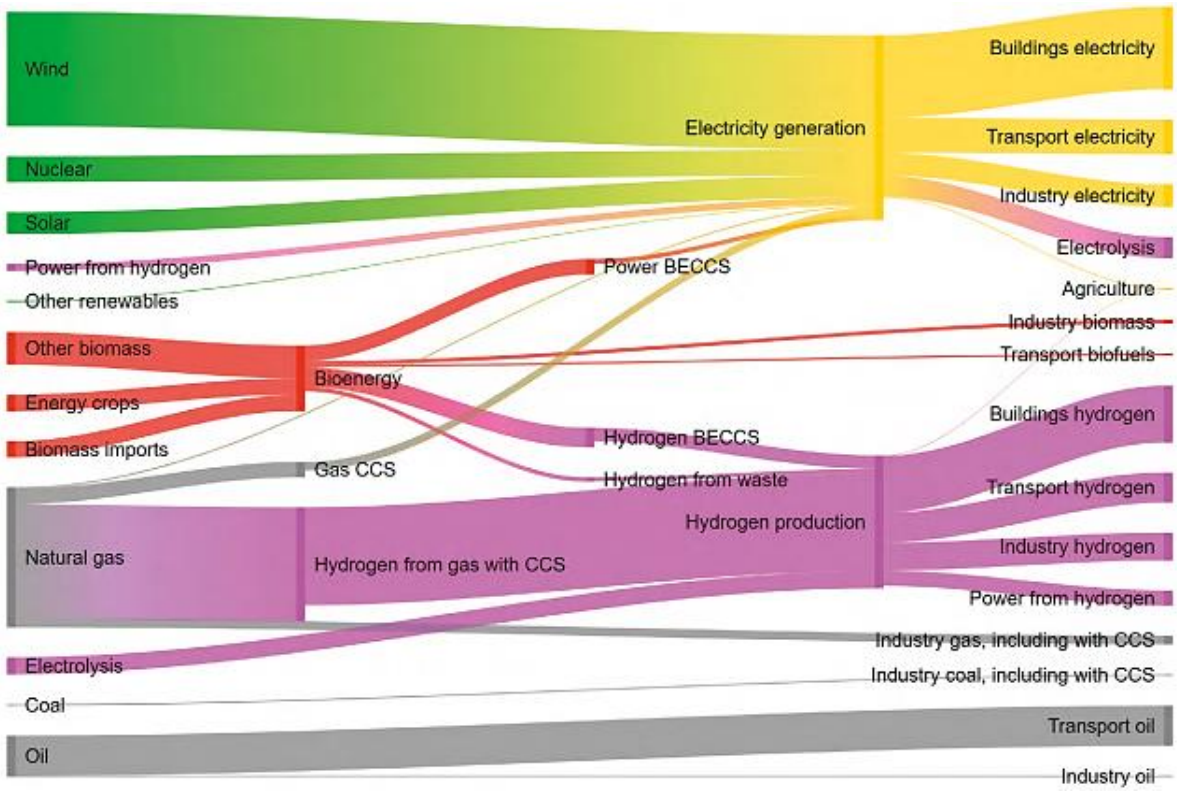

Figure 4 Illustration of the 2050 net-zero pathway of **high resource scenario**

2050 Scenario 3: High innovation investigates a pathway in which innovations support deep decarbonisation of the economy via optimistic pathways that include ultra-high CO_2 capture rate, negative emission technologies and very low residual emissions in the aviation sector. This enables the deep decarbonisation of end use sectors, such as transport, buildings, agriculture and industrial dispersed sites, to be scaled down. Scenario 3 sees the decarbonisation technology pathway between high electrification and high resource scenarios as illustrated in Figure 5.

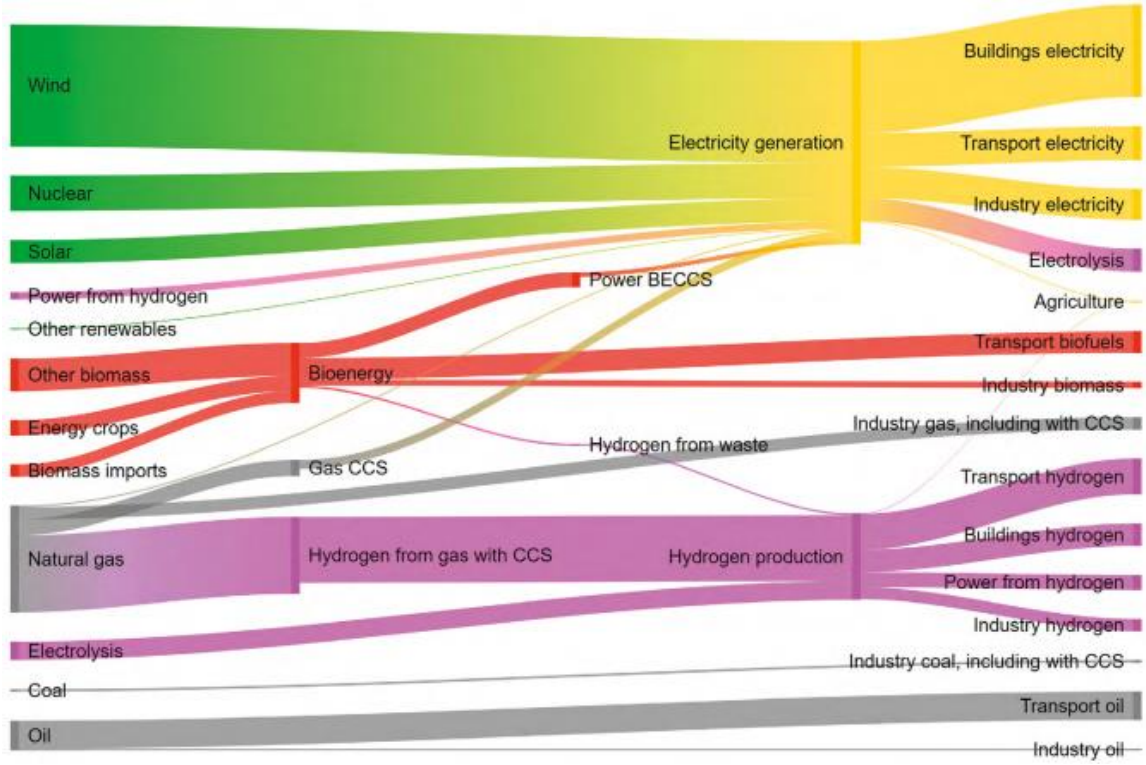

Figure 5 Illustration of the 2050 net-zero pathway of **high innovation scenario**

A net-zero economy by 2050 appears to be implausible without low carbon hydrogen and CCUS based on the three modelled scenarios discussed above.

The UK government is currently ensuring that steps are taken to bring forward low-carbon technologies to decarbonise the electricity system that include CCUS-enabled power. This is to be carried out by the Dispatchable Power Agreement (DPA) business model, which seeks to bring forward at least one power CCS plant in the mid 2020's. The government's cluster sequencing for CCUS via the £1 billion CCS Infrastructure Fund (CIF) is aimed at providing the industry with the confidence required to deploy this technology at pace and at scale. Initial beneficiaries of this fund are set to be the Eni-led HyNet North West and the BP-led East Co_2ast Cluster which aim to capture up to 10 and 27 Mt of CO_2 per year, respectively, in the 2030s.

The UK government has published its Hydrogen Strategy, which sets out how the government will stimulate progress in the 2020s, to deliver the production capacity planned by 2030 and position hydrogen to help meet the government's Sixth Carbon Budget and net zero commitments. This will be achieved by establishing the flagship Net Zero Hydrogen Fund, and finalising the Hydrogen Business Model and the twin track strategy, all in 2022.

The transition from a fossil-fuel intensive economy to a low carbon enterprise with hydrogen and CCUS offers an immense oppurtunity and has been recognised by academia, industry and policymakers as a means to decarbonise the UK economy. This has resulted in these key technologies having a prominent role in all possible options considered for a net-zero UK by 2050.

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