Clean Energy, Nuclear and Fuel Cycle Innovation on the Path to Net Zero

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Department for Business, Energy & Industrial Strategy

Net Zero



- In 2008 the UK set an ambitious goal of decreasing its greenhouse gas emissions by 80% of 1990 levels by 2050; on 27 June 2019 the Government legislated to increase its ambition, committing to net zero emissions by 2050 (i.e. a reduction of 100% compared to 1990 levels).
- The Climate Change Act also sets legally binding interim targets for five-year Carbon Budget periods. In the short-term, policy decisions aim to meet the 4th and 5th carbon budgets (CB4, 2023-27, and CB5, 2028-32) with a requirement for the 6th Carbon Budget to be set during the first half of 2021.
- Under the Paris Agreement, each signatory must publish a Nationally Determined Contribution (NDC) which is a signal of their "highest possible ambition" – and the UK's 2030 NDC will set tone for ambition at COP26.
- While we have made strong progress to date, **UK emissions are currently projected to significantly exceed our legal emissions caps (Carbon Budgets 4 and 5, 2023-32)** and a considerable step change is required.

Net Zero Targets

- Specify which emission sources and which gases are covered (CO₂, all GHGs, or a subset) and when net zero will be reached, *e.g.*
 - Nitrous oxide has GWP-100 of 296
- Each country or organization takes a different approach
 - o EU targets all GHGs by 2050
 - $\circ \quad \mbox{China's net zero plan focuses on balancing} \\ \mbox{only CO}_2 \mbox{ emissions by 2060} \\ \end{tabular}$
 - United States is aiming to reach net zero by 2050, but has yet to specify which gases are covered
- IPCC pathway to limit warming to 1.5°C requires net zero CO₂ around 2050 and all GHGs approx. 2 decades afterwards

Global-warming implications



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Sixth Carbon Budget

- Legislation laid in Parliament to reduce emissions by 78% by 2035 and be enshrined in law by the end of June 2021.
- The CCC identify their recommendation would require a major investment programme, supporting COVID-19 recovery including to scale up low carbon markets and supply chains over the 2020s and early 30s, along with support for behavioural change. This includes:
 - considerable expansion of low-carbon energy supplies, including further growth in offshore wind
 - **take up of low-carbon solutions** as high carbon options are phased out, *e.g.* by the early 2030s all new cars and all boiler replacements are low-carbon
 - less carbon-intensive activities, *e.g.* a national programme to improve insultation and high-carbon meat consumption reducing by 20% by 2030
 - land and greenhouse gas removals, transforming agriculture while maintaining same food levels per head, and 460,000 hectares of new woodland by 2035.



How do we achieve Net Zero?

- Ahead of COP26, ambitious new plans to reduce emissions across key sectors of the economy including an Energy White Paper, Transport Decarbonisation Plan, Industry Decarbonisation Strategy and Heat and Building Strategy.
- A comprehensive **Net Zero Strategy**, setting out the government's vision for transitioning to a net zero economy, making the most of new growth and employment opportunities across the UK will be published.













How do we achieve Net Zero?

Figure 4 Types of abatement in the Balanced Net Zero Pathway



- Reduce Demand
- Improve efficiency
- Low-carbon solutions
 - Electrification
 - H₂

- CCUS
- Low-carbon energy
- Land-use and GGR



Source: BEIS (2020) Provisional UK greenhouse gas emissions national statistics 2019; CCC analysis. Notes: 'Other low-carbon technology' includes use of bioenergy and waste treatment measures. 'Producing low- carbon electricity' requires the use of CCS in electricity generation.



To achieve net zero by 2050, an economy-wide transformation is required

Transport	Business & Industry	Power	Land Use / Natural Resources	Buildings (Domestic)	Greenhouse gas removals
28% of emissions	25% of emissions	15% of emissions	15% of emissions	15% of emissions	
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Department for Transport	Department for Business, Energy & Industrial Strategy	Department for Business, Energy & Industrial Strategy	Department for Erwironment Food & Rural Affairs	Department for Business, Energy & Industrial Strategy Ministry of Housing, Communities & Local Government	Image: System of the system Image: System of the system Department for Business, Energy Department for Environment for Environment & Industrial Strategy Food & Rural Affairs
 Transport Decarbonisation plan: Part 1 announced in March 2020 Ultra-low emission vehicles – £2.5bn for charging infrastructure and extending Plug in-Grants to 2023 Clean Transport Package - £5bn over five years to create a new era for walking and cycling including 4,000 new zero carbon buses Automotive Transformation F und – £10m for the first wave of R&D projects now available 	Carbon Capture & Storage - £800m to establish CCS in at least two UK sites. Red diesel reform, removing the entitlement to use red diesel from most sectors from April 2022 Heavy Industry -£350 million to cut emissions in heavy industry	 Energy White Paper published December 2020 £160 million to make the UK a world leader in clean wind energy Onshore wind and solar projects will be able to bid for contracts in the next Contracts for Difference allocation round planned to open in 2021 More than £100m of innovation and industrial strategy funding into Advanced Nuclear R&D. 	 Nature for Climate Fund - £640m to plant 30K trees and restore 35K hectares of peatland Landmark Environment Bill announced Flood Defences - £5.2bn (over six years) Green Recovery Challenge Fund - £40m to support environmental charities and local authorities Recommitted to planting 75,000 acres of trees every year by 2025 	Green Homes Grant - £2bn to support homeowners and landlords in upgrading the energy performance of their homes Public Sector Decarbonisation Scheme - £1bn to upgrade public sector buildings Social Housing Decarbonisation Fund - £50m for innovative approaches to retrofitting social housing Building techniques - £26m to support advanced new building/construction techniques to cut costs/carbon	£100 million to research and develop Direct Air Capture technologies

Behavioural Change

CCC Carbon Budget 6

Figure B2.2 Role of societal and behavioural changes in the Balanced Net Zero Pathway (2035)



 Low-carbon technologies or fuels, not societal/behavioural changes
 Measures with a

combination of low-carbon technologies and societal/behaviour changes

Largely societal or behaviour changes



Source: CCC analysis.

Measures requiring largely societal or behaviour changes needed to reduce demand and improve efficiency. *E.g.*

- Healthier diets
- Reducing growth in aviation demand
- Choosing products that last longer

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Behavioural Change

Climate policy 8 Support all feedback loops Reduce barriers to behaviour change aviour change e lic engagement 6 Support sense of Fairness, Consistency, Leadership and 'we're all in this together' 3 Co-benefits motivate behaviour change Policy **Co-benefits** 1 Social contagion: change 4 'Behavioural externalities' Social proof Co-benefits Shifting norms support policy **Tipping points** change Visibility is key Behaviour change Public engagement Non-governmental organisations S Visible public engagement 2 New products Falling costs (as consumers and as citizens) supports new policy Market / industry

- If the UK is to hit its Net-Zero target by 2050 there • will need to be a substantial and sustainable change in behaviour in the workplace and at home.
- Key factors will be: •
 - Habit changing Ο
 - Climate change education Ο
 - **Digital enablers** Ο
 - Policy Ο

ERP (2021)





Energy Transition



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14 September, 2021

GB Electrical demand has dropped and generation has changed



Daily total gas, all liquid transport fuels, electrical demand

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Underlying data are from National Grid, Elexon and BEIS Figure created by Dr Grant Wilson: i.a.g.wilson@bham.ac.uk Energy Informatics Group, University of Birmingham slidepack available from https://doi.org/10.5281/zenodo.3930970

We need to double electricity generation to meet Net Zero. It needs to be decarbonized, and able to turn on and off quickly.

Current UK energy consumption:



Renewables are intermittent. Today, we manage these fluctuations with gas:



- The cheapest way to ensure we can meet electricity demand in future is to also build a small amount of reliable low carbon power.
- "Gigawatt build" nuclear plants provide baseload contribution (brown above), but do not manage fluctuations well, and cannot be the solution to manage intermittency.
- Gas (blue above) currently manages intermittent fluctuations in electricity demand.

Energy White Paper

THE PRIME MINISTER'S TEN POINT PLAN



NUCLEAR POWER

Nuclear power provides a reliable source of low-carbon electricity. We are pursuing large-scale nuclear, whilst also looking to the future of nuclear power in the UK through further investment in Small Modular Reactors and Advanced Modular Reactors.



GREEN PUBLIC TRANSPORT, CYCLING AND WALKING

We will accelerate the transition to more active and sustainable transport by investing in rail and bus services, and in measures to help pedestrians and cyclists. We will fund thousands of zeroemission buses and give our towns and cities cycle lanes worthy of Holland.



OFFSHORE WIND

By 2030 we plan to quadruple our offshore wind capacity so as to generate more power than all our homes use today, backing new innovations to make the most of this proven technology and investing to bring new jobs and growth to our ports and coastal regions.

SMRs and AMRs – what are they?



confidence they can produce electricity at competitive prices.

Advanced Modular Reactors (AMRs):

A further generation again, using novel fuel types and specifically designed for co-generation



Have been built, but further demonstrators are required to show they can produce electricity at competitive prices.

SMRs and AMRs are space-efficient per unit of energy



One advantage of new nuclear is the potential for co-generation to contribute to Net Zero

65% of energy generated by nuclear is lost as "waste heat".

That wasted energy can be utilised: to heat buildings, to support industrial processes, and to create low-carbon fuels, including hydrogen and ammonia.



Current nuclear generation is not designed to utilise waste heat. While current nuclear generation could be used to create low-carbon fuels, this would be inefficient and expensive.

The next generations of nuclear power – Small Modular Reactors ("Generation III") and Advanced Modular Reactors ("Generation IV") – have been designed in part with co-generation in mind.

To meet Net Zero, we require a range of solutions to decarbonising hard-to-reach sectors, including surface transport, aviation and industrial processes.

What are the options for future nuclear generation?



Advanced Nuclear contribution to Net Zero

SMR Programme

- The Energy White Paper/10 Point Plan made the case for more nuclear, through integrated strategy, with first SMRs by early 2030s.
- Up to £215m to fund a domestic RR SMR design from the Advanced Nuclear Fund.

AMR Feasibility & Development Programme

- 8 vendors selected for funding under Phase 1 to undertake feasibility studies.
- 3 vendors selected for further funding under Phase 2 to undertake further design development: Tokamak Energy, Westinghouse and U-Battery.

Future AMR Programme

 Energy White Paper created the Advanced Nuclear Fund which includes support to develop of an AMR Demonstrator by the early 2030s at the latest.



2050 - "A view"

- In 2050 most of our electricity will come from renewables.
- These are by there nature intermittent.
- The cheapest way to ensure we can meet demand is to also build a small amount of reliable low carbon power.
- Nuclear offers a trade-off between capacity (small) and generation (significant).



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There is a significant challenge presented by Net Zero that is pervasive.



Co-generation will be a long-term opportunity



Nuclear SMR and AMR being developed rapidly to meet clear 2050 need.









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