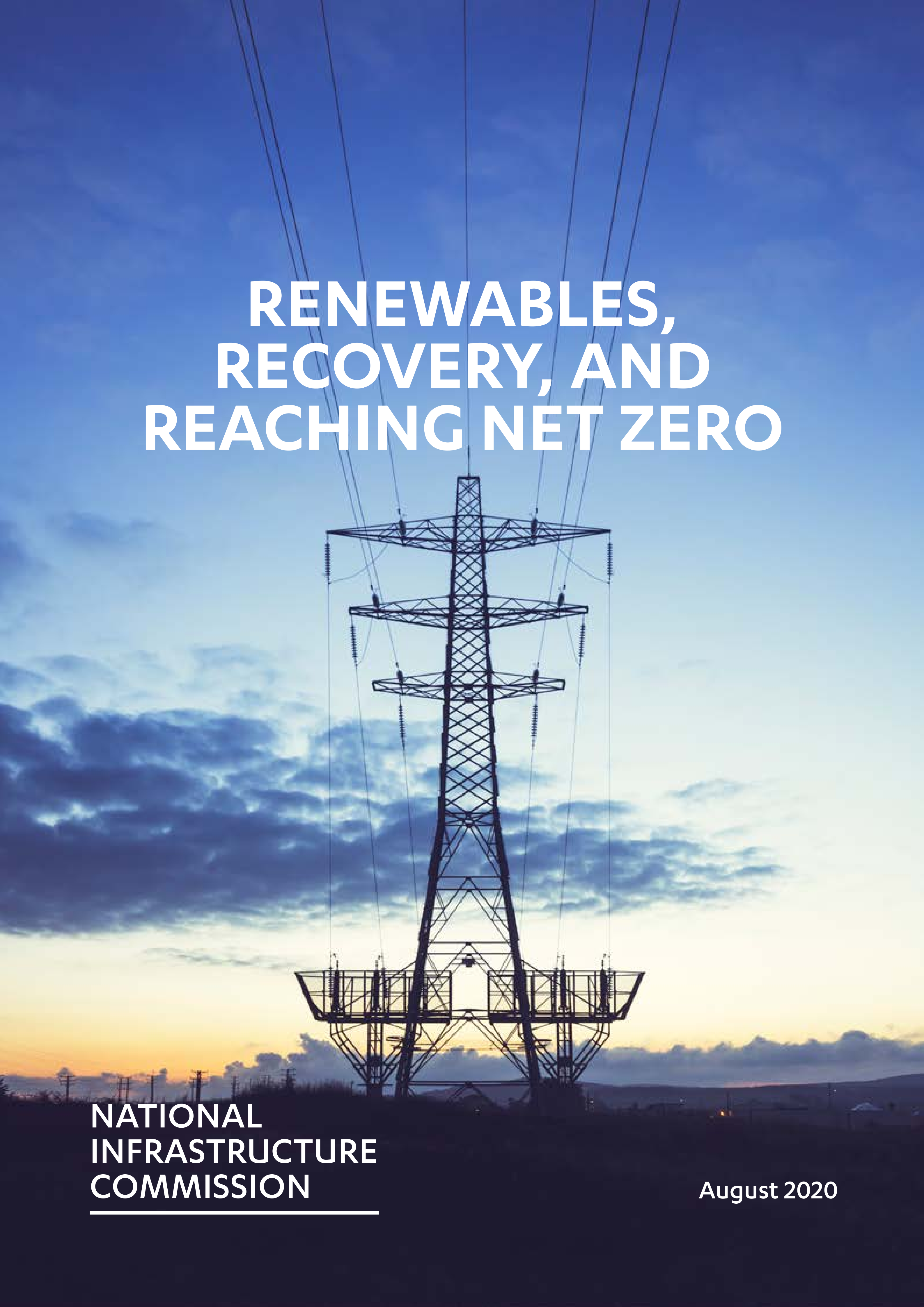
RENEWABLES, RECOVERY, AND REACHING NET ZERO



NATIONAL
INFRASTRUCTURE
COMMISSION

August 2020

Contents

The Commission

The Commission's remit

The Commission provides the government with impartial, expert advice on major long term infrastructure challenges. Its remit covers all sectors of economic infrastructure: energy, transport, water and wastewater (drainage and sewerage), waste, flood risk management and digital communications. While the Commission considers the potential interactions between its infrastructure recommendations and housing supply, housing itself is not in its remit. Also out of the scope of the Commission are social infrastructure, such as schools, hospitals or prisons, agriculture, and land use.

The Commission's objectives are to support sustainable economic growth across all regions of the UK, improve competitiveness, and improve quality of life.

The Commission delivers the following core pieces of work:

- a *National Infrastructure Assessment* once in every Parliament, setting out the Commission's assessment of long term infrastructure needs with recommendations to the government
- specific studies on pressing infrastructure challenges as set by the government, taking into account the views of the Commission and stakeholders, including recommendations to government
- an *Annual Monitoring Report*, taking stock of the government's progress in areas where it has committed to taking forward recommendations of the Commission.

While the Commission is required to carry out its work in accordance with the remit and the terms of reference for specific studies, in all other respects the Commission has complete discretion to determine independently its work programme, methodologies and recommendations, as well as the content of its reports and public statements.

The Commission's binding fiscal remit requires it to demonstrate that all its recommendations for economic infrastructure are consistent with, and set out how they can be accommodated within, gross public investment in economic infrastructure of between 1.0 per cent and 1.2 per cent of gross domestic product each year between 2020 and 2050. The Commission's reports must also include a transparent assessment of the impact on costs to businesses, consumers, government, public bodies and other end users of infrastructure that would arise from implementing the recommendations.

When making its recommendations, the Commission is required to take into account both the role of the economic regulators in regulating infrastructure providers, and the government's legal obligations, such as carbon emissions reduction targets or making assessments of environmental impacts. The Commission's remit letter also states that the Commission must ensure its recommendations do not reopen decision making processes where programmes and work have been decided by the government or will be decided in the immediate future.

The Commission's remit extends to economic infrastructure within the UK government's competence and will evolve in line with devolution settlements. This means the Commission has a role in relation to non devolved UK government infrastructure responsibilities in Scotland, Wales and Northern Ireland (and all sectors in England).

The Infrastructure and Projects Authority (IPA), a separate body, is responsible for ensuring the long term planning carried out by the Commission is translated into successful project delivery, once the plans have been endorsed by government.

The Commission's members

Sir John Armitt CBE (Chair) published an independent review on long term infrastructure planning in the UK in September 2013, which resulted in the National Infrastructure Commission. Sir John is the Chair of National Express Group and the City & Guilds Group. He also sits on the boards of the Berkeley Group and Expo 2020.

Professor Sir Tim Besley CBE is School Professor of Economics and Political Science and W. Arthur Lewis Professor of Development Economics at the LSE. He served as an external member of the Bank of England Monetary Policy Committee from 2006 to 2009.

Professor David Fisk CB is the Director of the Laing O'Rourke Centre for Systems Engineering and Innovation Research at Imperial College London. He has served as Chief Scientist across several government departments including those for environment and transport, and as a member of the Gas and Electricity Markets Authority.

Andy Green CBE holds several Chair, Non-Executive Director and advisory roles, linked by his passion for how technology transforms business and our daily lives. He chairs Lowell, a major European credit management company and has served as Chair of the Digital Catapult, an initiative to help grow the UK's digital economy.

Bridget Rosewell CBE is a director, policy maker and economist. She served as Chief Economic Adviser to the Greater London Authority from 2002 to 2012 and worked extensively on infrastructure business cases. She has served as a Non-executive Director of Network Rail and Non-executive Chair of the Driver and Vehicle Standards Agency. She is currently Chair of the Atom Bank and the M6 Toll Road.

Professor Sadie Morgan OBE is a founding director of the Stirling Prize winning architectural practice dRMM. She is also Chair of the Independent Design Panel for High Speed Two and one of the Mayor of London's Design Advocates. She sits on the boards of the Major Projects Association and Homes England.

Julia Prescot is a co-founder and Chief Strategy Officer of Meridiam and sits on the Executive Committee of Meridiam SAS. She has been involved in long term infrastructure development and investment in the UK, Europe, North America and Africa. Since 2019 she has sat on the board of the Port of Tyne.

Introduction

The latest analysis for the Commission suggests that 65 per cent of Britain's electricity could be delivered from renewables by 2030 with no material change in cost when compared to the Commission's previous recommendation to deliver 50 per cent renewables.

Accelerating deployment of renewable electricity generation will better position the UK to reach net zero emissions, help to provide long-term confidence in the economy at a crucial time, and won't cost consumers more.

The Commission continues to believe that putting Britain on the pathway to a highly renewable electricity system is the best way to deliver low cost, low carbon electricity. As with all the Commission's work, this latest analysis is robust to future uncertainty. Scenarios have been chosen to represent a range of different potential futures which aids the Commission in making sound policy recommendations.

A renewable electricity system can meet the expected increase in demand for electricity in Britain while keeping costs affordable for consumers. The full arguments for this are set out in *Net zero: opportunities for the power sector*.[1] This latest analysis for the Commission, together with the need to support economic recovery, is reason to move faster and go further than the Commission had previously recommended. Taking today's electricity system with around 40 per cent renewables today to one with 65 per cent renewables in 2030.[2]

The UK needs to act sooner rather than later to tackle the climate crisis, and now is an opportune moment to do so without adding to the cost for consumers. The latest analysis for the Commission suggests that accelerating renewables deployment to 65 per cent of generation by 2030, compared to 50 per cent, would not materially change costs for consumers in the short or the long run. Renewables are now the cheapest form of electricity generation due to dramatic cost reductions in recent years. And the Commission's analysis holds without making optimistic assumptions on further cost reductions.

It is crucial that the UK maximises the economic benefits of the low carbon transition. In the power sector, the economic recovery from Covid-19 should be market led, with government supporting the conditions for growth. With strong government leadership, the net zero target will help bring a new wave of technologies forward, spurring the UK to replace old carbon intensive technologies with smarter more innovative solutions which can, in turn, drive long-term growth. This analysis does not consider the potential for two such new technologies – hydrogen and bioenergy with carbon capture and storage. The impact these technologies could have in the power sector has previously been considered in *Net zero: opportunities for the power sector*. In that publication the Commission considered the additional benefits these technologies could bring in terms of lowering the overall cost of a highly renewable electricity system.

The government has made a number of positive commitments on renewables deployment. The ambition to deliver 40 GW[3] of offshore wind and the re-opening of Pot 1 contracts for difference auctions for onshore wind and solar[4] will deliver significantly increased deployment rates of renewables. Achieving 65 per cent renewable generation by 2030 can be done if ambitions are realised through an active push from government to generate the private sector investment needed.

It is key that, alongside deploying renewables, the UK continues to drive innovation in the power sector to effectively build a flexible electricity system. Storage technologies, flexible demand, efficient interconnectors, and other innovations are also needed to support renewables and maintain the security of the electricity system. The Commission set out a series of recommendations on increasing electricity system flexibility in its 2016 *Smart Power* report.[5] Good recent progress must continue at pace to deliver these.

1. Summary of approach to analysis

The latest analysis for the Commission looks at the cost impact of accelerating the deployment of renewables faster than previous modelling. The analysis considers the cost of electricity systems that deliver approximately 65 per cent of Britain's generation from renewable sources by 2030.

Aurora Energy Research was commissioned to carry out updated electricity system modelling. The approach taken is the same as was taken for the *National Infrastructure Assessment* and subsequent modelling.

The analysis considers the total system costs of delivering a net zero compatible electricity system out to 2050, not just the costs of each technology in isolation. This involves modelling an electricity system that balances supply and demand for every half hour of the year. The costs presented include the costs of building, connecting and operating each technology, including the wider system impacts they may have. This ensures that the costs of variable or inflexible generation are fully captured.

The modelling considers systems with 60, 80 and 90 per cent renewable penetrations in 2050, but all with 65 per cent of generation in 2030 coming from renewables. In all the Commission's scenarios electricity demand will increase significantly from today's level as sectors switch from fossil fuels to electricity. In all scenarios the increased demand is met by the generation mix modelled. The lowest electricity supply requirements in the Commission's scenarios is 360 TWh in 2030 and 465 TWh by 2050, compared to approximately 355 TWh average from 2015 to 2019.[6] Therefore, the proportion of generation that renewables make up in 2030 can drop by 2050 without retiring any renewable capacity and therefore a scenario which has 65 per cent renewables in 2030 can lead to a system with 60 per cent renewables in 2050; other low carbon capacity would come online to meet the additional demand between 2030 to 2050.

The least cost mix of renewables, between onshore wind, offshore wind and solar, is analysed in the modelling after accounting for current government commitments. The remaining generation is optimised economically based on profit maximisation, within the limits of emissions and operability constraints assumed. This modelling work involves analysing the electricity system for every half hour of the year and aggregating costs for meeting demand throughout.

There are two different electricity demand scenarios assumed. One scenario assumes electrification of heating and the other assumes hydrogen for heating ('greener gas').

The modelling provides the following outputs for each scenario:

- total costs in £2016 of constructing and running the electricity system, averaged over the years 2030 to 2050
- capacity and generation for each type of technology.

Total costs are further broken down into the following five categories:

- **wholesale market costs**: The costs of electricity generation, including a carbon price. The carbon price is set at the value required to meet the emissions constraint under each scenario
- **capacity market costs**: Costs of procuring enough capacity to meet assumed security of supply constraints
- **balancing market costs**: These costs cover the actions required to ensure that the electricity system always balances supply and demand
- **network costs**: The cost of building new network cables to connect and support additional generation capacity
- **subsidy costs**: Any additional cost on top of the above four categories required to deploy the set amount of renewable capacity.

A more detailed overview of the modelling approach used by Aurora Energy Research is outlined in *Net zero: opportunities for the power sector* with the full data and assumptions made available.[7]

As with all the Commission's work, this analysis is robust to future uncertainty. None of the scenarios modelled are intended to be a forecast; modelling the electricity system out to 2050 has too many unknowns to make that a prudent activity. Instead, they have been chosen to represent a range of different potential futures which aids the Commission in making sound policy recommendations.

It is important to focus on the clear trends from the analysis and not to fixate on small modelled cost differences. Policy decisions should not be made on the basis of marginal cost differences over the long term; these are unlikely to be robust decisions. Instead, the Commission has focused on the clear and consistent messages from the analysis, accounting for the uncertainty inherent in considering the future power system in 2050.

2. Results of analysis

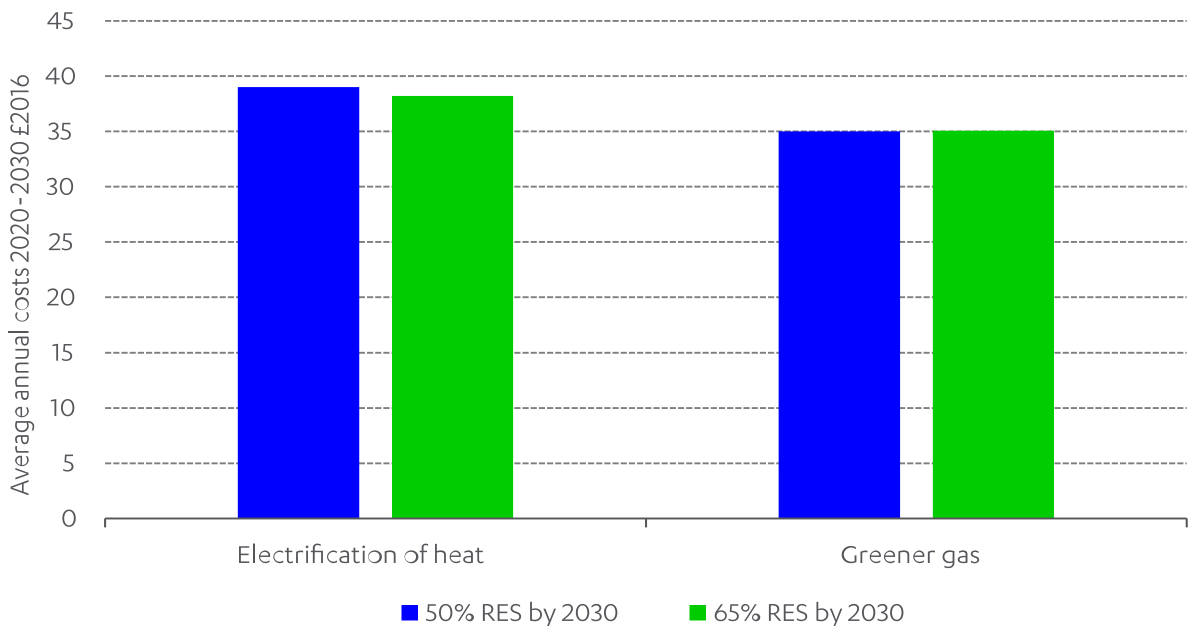
The analysis suggests that there is no material cost impact, either over the short or long term, of deploying renewables faster. Renewables are now the cheapest form of electricity generation due to dramatic cost reductions in recent years. Cost reductions have been greater than was predicted in 2018 when the Commission made its recommendation on what level of renewable generation the government should be targeting.

As set out above, this analysis considers the impact of deploying renewables to achieve 65 per cent renewable generation by 2030. This involves deploying greater levels of offshore wind, onshore wind, and solar over the coming decade than the Commission has previously considered. But doing so will not materially increase costs to consumers, even with conservative cost assumptions for renewable technologies. This will also deliver a lower carbon electricity system sooner, which will benefit the emissions intensity of other sectors that rely on electricity as an input.

Previous analysis for the Commission has suggested that highly renewable systems are likely to be cost competitive with those with higher levels of nuclear. On this basis the Commission previously recommended that the government should ensure that the electricity system is running with at least 50 per cent renewable generation by 2030, putting Britain on the pathway to a highly renewable system. At the same time the Commission recommended that the government should take a one by one approach to nuclear and not agree to more than one new nuclear plant, in addition to Hinkley Point C, before 2025.

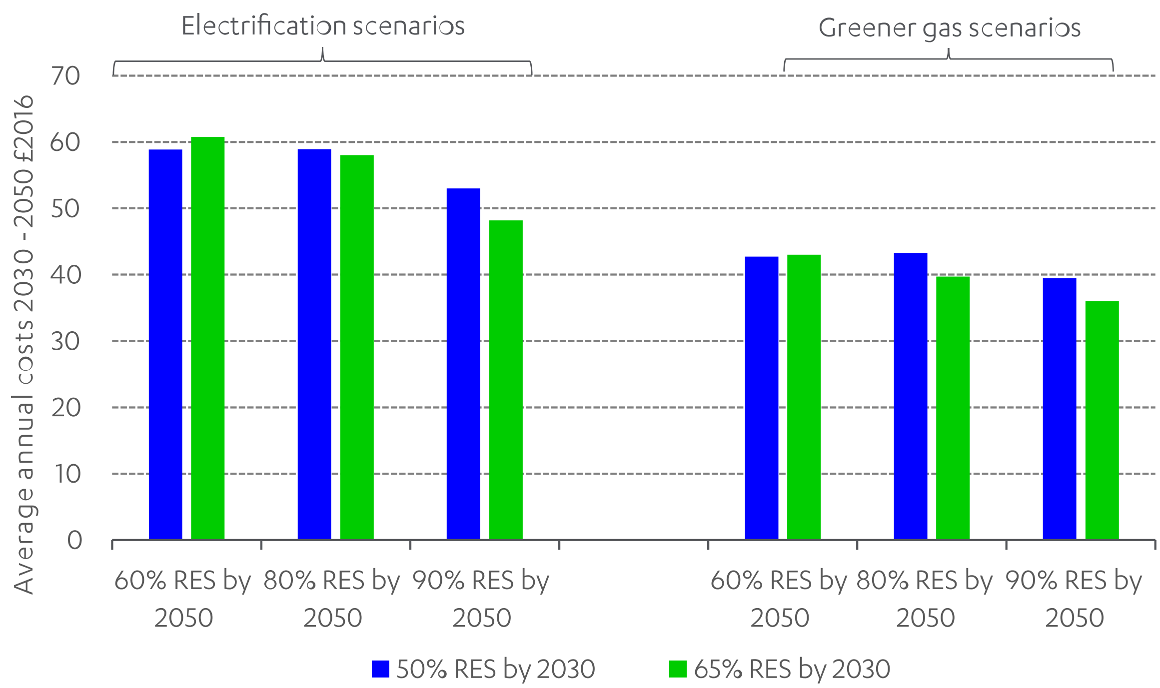
This analysis suggests that deploying renewables faster will not change costs in either the short or the long term. Figure 1 shows that there is no material change in costs over the next decade with annual average electricity system costs between 2020 and 2030 similar in scenarios with either 50 per cent or 65 per cent renewables by 2030. Figure 2 shows the same but for the long term, considering annual average electricity system costs between 2030 and 2050.

Figure 1: Cost impact over the short term (2020 – 2030) of deploying renewables faster[8]



Note: In the x-axis labels RES stands for renewables and consists of offshore wind, onshore wind, solar, hydro power and a very small amount of biomass.

Figure 2: Cost impact over the long term (2030 – 2050) of deploying renewables faster[9]

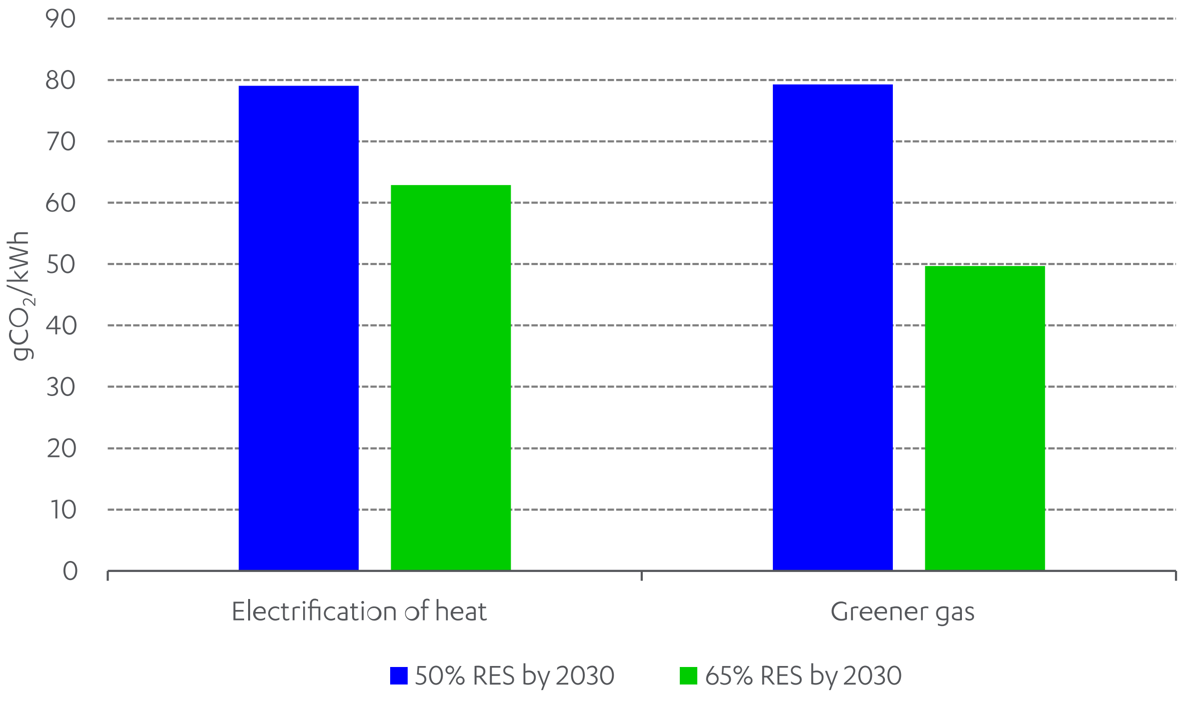


Note: In the x-axis labels RES stands for renewables and consists of offshore wind, onshore wind, solar, hydro power and a very small amount of biomass.

Across all modelled scenarios between 86 and 99 GW of renewables must be deployed by 2030 to deliver an electricity system with 65 per cent renewable generation. This includes 40 GW of offshore wind, 14 – 18 GW of onshore wind, and 29 – 38 GW of solar. Having both wind and solar at scale in the generation mix is beneficial to effectively balancing supply and demand. Due to their varied reliance on weather patterns they generate at different times and are complementary throughout the day and across the year. The analysis assumes that unabated biomass is not generating by 2030 and so does not contribute to the 65 per cent renewables target. This analysis does not consider the role that hydrogen or bioenergy with carbon capture and storage could play in the power sector. In *Net zero: opportunities for the power sector* the Commission considered the additional benefits these technologies could bring in terms of lowering the overall cost of a highly renewable system.

Deploying renewables faster will also lead to achieving a lower emissions intensity power system faster (Figure 3). The power system currently has a carbon intensity of around 190 gCO2/kWh[10]. Both this analysis and the Commission's previous analysis modelled power sector scenarios that are consistent with the UK's net zero target. But deploying renewables faster will help deliver such a system sooner. This could be important for helping faster decarbonisation in sectors that may use electricity to displace fossil fuels, such as transport or heating.

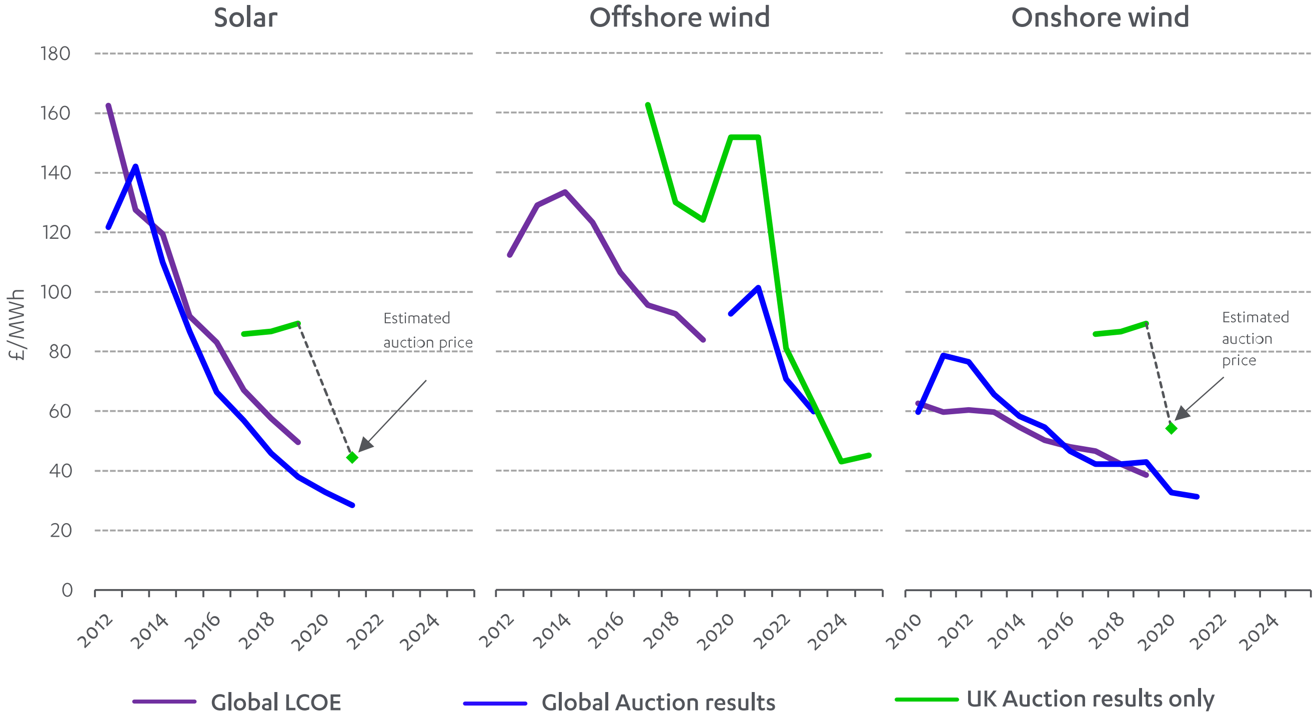
Figure 3: Carbon intensity of modelled scenarios in 2030[11]



Interconnectors will continue to play a key role in efficiently balancing supply and demand and delivering a secure system, something the Commission has discussed at length in *Smart Power* and *Net zero: opportunities for the power sector*.

The Commission has not made overly optimistic assumptions on future renewable cost reductions. Dramatic cost reductions have been delivered in renewable technologies over the last decade all around the world (Figure 4), and renewables are now the cheapest form of generating electricity. Whilst not ruling the possibility out, the Commission is not assuming that these dramatic cost reductions continue.

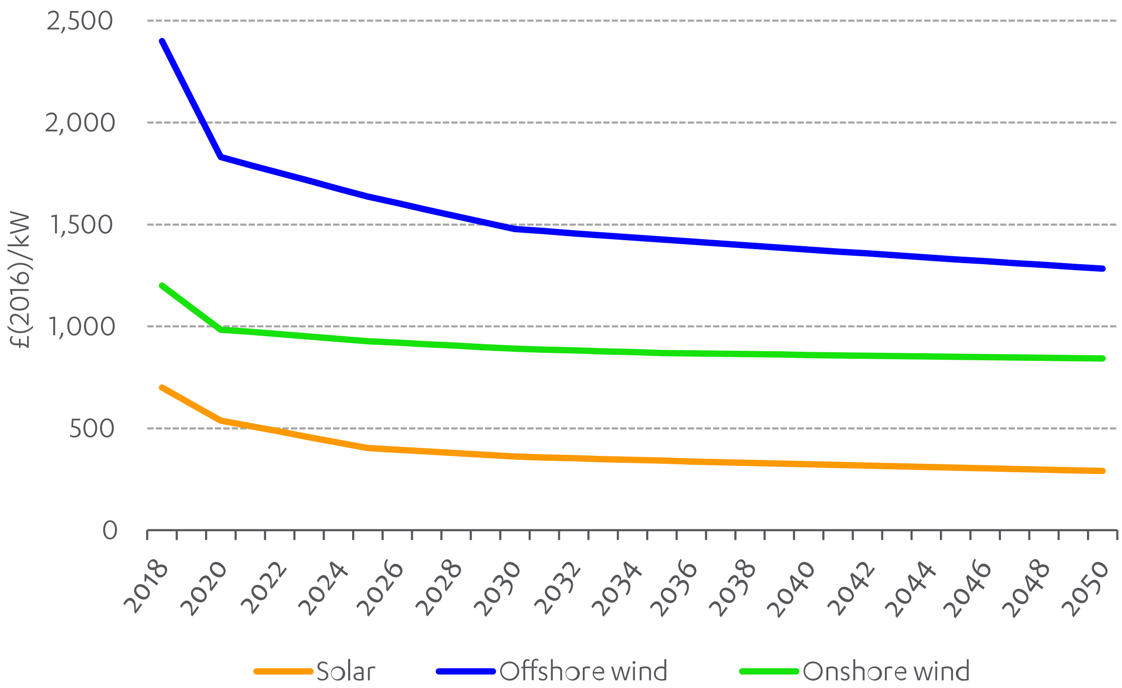
Figure 4: Cost and price reductions of renewables in Britain and across the globe (£2016)[12]



Note: LCOE stands for levelized cost of electricity. LCOE is used to compare different methods of electricity generation on a consistent basis. It therefore reflects difference in utilisation rates and the expected lifetime of different generation plant.

In fact, as Figure 5 demonstrates, the Commission is assuming that most cost reductions in renewables have already been achieved. This could prove to be a pessimistic assumption and current trends could continue. But that only means that deploying renewables would be an even cheaper option for the country.

Figure 5: Assumed cost curves for offshore wind, onshore wind, and solar[13]



It's important to consider not just the cost of generating electricity but the system wide impacts that different forms of generation have, and the Commission's analysis does just that. Figures 1 and 2 show the whole system cost of deploying renewables, including the costs of providing back-up, balancing and curtailment. Even with these additional system requirements that are needed to support renewables, the cost competitiveness of renewable technologies remains clear.

Accelerating renewables deployment to achieve 65 per cent of generation by 2030 will not close down different options for a future electricity system. The Commission believes that it is prudent to leave as many future options on the table whilst taking the needed near term actions to deliver a lowest cost net zero electricity system. To achieve net zero significant additional electrification will be needed, regardless of the future pathway for the UK's heating infrastructure. The lower bound for electricity generation in 2050 in the Commission's analysis is 465 TWh, compared to approximately 345 TWh today.

3. Delivering on increased ambition

To achieve this increased ambition, the Commission recommends that government should set out a pipeline of annual contracts for difference auctions with estimated budgets that offshore wind, onshore wind and solar can all compete in.

The government has a ready-made policy instrument to deliver renewable power, the contracts for difference (CfD) auctions. A CfD is a government guaranteed contract that gives the awarded generator a fixed revenue stream for the electricity it generates. The CfD has been a successful policy instrument over the last five years, playing a significant role in reducing the cost of renewables.

It is key that clear timelines and budgets are announced for future auctions. This will help deliver investor certainty and allow industry, including the supply chain, to take the necessary steps in planning their response. This will contribute to higher quality, lower cost, projects being developed.

Moreover, using a CfD will allow government to mobilise private capital when the public sector balance sheet is tight and do so quickly. Large scale deployment of infrastructure sends a clear signal to other infrastructure investors that they should have confidence in the UK economy. This is integral to an effective recovery plan. There may also be some short-term stimulus impact from more jobs in the sector if the economy is experiencing an output gap.[14]

There is currently a sizeable pipeline of renewable projects and has previously deployed renewables at rapid rates, so increasing the ambition is feasible. Available information suggests that there is close to 32 GW of offshore wind, 12 GW of onshore wind and 9 GW of solar PV in the pipeline.[15] Renewable project construction times are shorter than some other large infrastructure assets, so much of this pipeline can be deployed over the coming decade. Offshore wind farms can be built in around eight years, onshore wind pre development and construction time is shorter at around six years, and solar takes approximately just one year to build.[16] Moreover, historical peak rates of deployment for each technology are near or above what is now needed in each year to 2030 (Table 1).

Table 1: Deployment rates needed[17]

	Capacity installed in 2020 (GW)	Annual average deployment rate needed (GW per year)	Peak annual deployment rate to date (GW)
Onshore wind	14	up to 0.4	2.8 in 2016
Offshore wind	10	3	2.2 in 2017
Solar	13	1.6 – 2.5	4.1 in 2015

It is important that due consideration is also given to the impact that deploying renewables at this scale could have on communities and environments. Government has taken recent welcome steps in setting up an Offshore Transmission Network Review. Attention must also be given to the full range of local and environmental impacts that deploying renewables may have, with barriers identified and overcome.

The Commission continues to recommend that government better incorporate the whole systems costs of generators into the CfD auctions, as far as is possible. It is important that generators are responsible for both the costs and benefits they impose on the system, such as those related to where they situate. Some sites impose costs, for example due to the need for new transmission infrastructure, or benefits, for example if local weather conditions complement those elsewhere. Over time, the different costs and benefits of new generation should increasingly be reflected in the auction process, allowing the lowest cost system to be developed. However, calculating these impacts is very complex, and in practice a mixture of pricing and other mechanisms will need to be used to ensure total system costs are reflected in the bid price. As the generation mix evolves, it will be essential that both technological and spatial diversity are maintained across the system.

Endnotes

1 National Infrastructure Commission (2020), **Net zero: opportunities for the power sector**
2 The Department for Business, Energy & Industrial Strategy (2020), **Energy Trends: UK Renewables**, Chapter 6
3 Prime Minister's Office (2019), The Queen's speech: **background briefing notes**
4 Department for Business, Energy & Industrial Strategy (2020), CfD for low carbon electricity generation: **consultation on proposed amendments to the scheme**
5 National Infrastructure Commission (2016), **Smart Power**
6 Calculated from Department for Business, Energy & Industrial Strategy (2016) **Digest of UK energy statistics 2017**, Department for Business, Energy & Industrial Strategy (2017), **Digest of UK energy statistics 2017**, Department for Business, Energy & Industrial Strategy (2018), **Digest of UK energy statistics 2018**, Department for Business, Energy & Industrial Strategy (2019), **Digest of UK energy statistics 2019**, Department for Business, Energy & Industrial Strategy (2019), **Digest of UK energy statistics 2020**
7 National Infrastructure Commission and Aurora Energy Research, **Technical Annex: electricity system modelling**
8 Ibid
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10 National Grid ESO (2020), **National Carbon Intensity Forecast**
11 National Infrastructure Commission and Aurora Energy Research, **Technical Annex: electricity system modelling**
12 Data for global LCOE and global auction results is taken as the weighted average from IRENA (2020), **Renewable Power Generation Costs in 2019**. Data for UK auctions is taken from Low Carbon Contracts Company, **CFD Register** results of the three contracts for difference auction rounds, as well as the final investment enabling decisions contracts. Recent auctions have not included onshore wind or solar and therefore estimates have been used. Cost estimates for strike prices for onshore wind auctions in 2020 are from Arup (July 2017), **Enabling Investment in Established Low Carbon Generation**. Estimates for solar auction prices are taken from Cornwall Insight analysis in Solar Trade Association (2020), **Contracts for Difference for Low Carbon Electricity Generation: Consultation on proposed amendments to the scheme**. Onshore wind and solar auction result estimates are in line with projects being deployed in the UK on a merchant basis without a contracts for difference.
13 Data for 2018 is taken from Department for Business, Energy & Industrial Strategy (2016), **Electricity Generation Costs**. Data for 2020, 2025, 2030, 2035, 2040, 2045, and 2050 are taken from Aurora Energy Research **assumptions log**. Other values are an interpolation between these points.
14 UK Energy Research Centre (2014), **Low carbon jobs: The evidence for net job creation from policy support for energy efficiency and renewable energy**
15 Regen (2020), Unlock renewables for a green recovery – **technical appendix**
16 Department for Business, Energy & Industrial Strategy (2016), **Electricity Generation Costs**
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August 2020