National Audit Office

REPORT

Decarbonising the power sector

Department for Energy Security & Net Zero

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Decarbonising the power sector

Department for Energy Security & Net Zero

Report by the Comptroller and Auditor General

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Gareth Davies
Comptroller and Auditor General
National Audit Office

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Key facts

13%

of 2021 UK greenhouse gas emissions were from electricity generation, representing 54 million tonnes of carbon dioxide equivalent ($MtCO_2e$)

2035

year by which the government intends all electricity to be from low-carbon sources, subject to security of supply

40% to 60%

increase in demand for electricity by 2035 as estimated by the government in its 2021 Net Zero Strategy

£280bn to £400bn

cost to decarbonise the power sector as estimated by the government in its 2021 Net Zero Strategy

73%	reduction in emissions from the power sector between 1990 and 2021
Approximately 41%	of electricity in 2021 was produced from natural gas, which will need to be largely phased out or adapted with carbon capture to achieve decarbonisation
Up to 24GW[1]	the government's ambition for nuclear capacity by 2050. The Department for Energy Security & Net Zero (DESNZ) expects all current stations to have retired by 2050. A new station, Hinkley Point C, is currently being built, and DESNZ confirmed an investment decision for a new station at Sizewell C in November 2022[2]
Up to 50GW	the government's ambition for offshore wind capacity by 2030. This would mean overseeing the deployment of three times as much offshore wind capacity in eight years as in the last two decades
Up to £62 million a day	constraint costs since 2018, where electricity generators are paid to constrain their output
Seven	teams (directorates) across three top-level groups in DESNZ responsible for decarbonising the power sector

Notes

1 A watt is a unit of power and there are 1 billion watts in 1 gigawatt (GW).

2 On 7 February 2023, the government announced that the Department for Business, Energy & Industrial Strategy (BEIS) would close, and its responsibilities would transfer to new departments, including the Department for Energy Security & Net Zero (DESNZ). References to DESNZ that relate to events prior to this date therefore refer to BEIS.

Summary

Introduction

1 In 2019, the government set a target to achieve net zero greenhouse gas emissions by 2050. This will require changes across society, from the way people heat their homes to the way they travel. Decarbonising electricity generation is fundamental to the government's net zero strategy because many sectors of the economy, such as transport and heating in buildings, are likely to switch to using electricity instead of fossil fuels such as natural gas. In 2021, the government set an ambition that by 2035 all electricity should be generated using clean sources, subject to security of supply, while meeting an expected increase in electricity demand of up to 60%. This means phasing out polluting types of electricity generation, such as gas-fired power stations and replacing them with a new mix of zero and low-carbon generation, including wind, solar and nuclear power.

2 Switching to clean electricity generation has increasingly become part of the government's plan to ensure there is an affordable and secure domestic energy supply in response to the disruption to international gas supplies that has followed Russia's invasion of Ukraine. In April 2022, the government published the British Energy Security Strategy.[1] This emphasised how accelerating progress towards a decarbonised power sector would, over time, enable a secure supply of electricity and affordable bills. The strategy set out increased government ambitions for transitioning to zero and low-carbon electricity generation during the 2020s, including increased ambitions for offshore wind and nuclear power.

3 In February 2023, the government established the Department for Energy Security & Net Zero (DESNZ), which has overall responsibility for ensuring the government achieves its power sector ambitions.[2] Government has overseen a 73% reduction in this sector's emissions since 1990, although in 2021 greenhouse gas emissions from electricity generation still represented 13% of total UK emissions. DESNZ is developing its plan to achieve the remaining emissions reductions, through a combination of changes across the power system. These include: increasing the amount of electricity generated by clean energy sources; developing the networks that transmit electricity from where it is generated to where it is used; establishing new market arrangements for buying and selling electricity; and encouraging consumers to use electricity in different ways so demand is more synchronised with patterns of supply. DESNZ is also establishing new governance structures and processes to enable it to oversee progress towards its ambitions.

1 Department for Business, Energy & Industrial Strategy, *British Energy Security Strategy,* 7 April 2022.
2 On 7 February 2023, the government announced that the Department for Business, Energy & Industrial Strategy (BEIS) would close, and its responsibilities would transfer to new departments, including the Department for Energy Security & Net Zero (DESNZ). References to DESNZ that relate to events prior to this date therefore refer to BEIS.

Purpose of this report

4 This report sets out the main challenges that DESNZ faces to decarbonise power. We have assessed the progress DESNZ has made since it set the ambition to decarbonise power by 2035 and examined how well it is set up to oversee future progress. We use offshore wind and nuclear power as examples of zero and low-carbon generation to illustrate some of our points. We recognise that DESNZ has made less progress since 2021 with establishing its long-term delivery plan than it intended because it needed to shift focus to respond to short-term challenges on energy supply and the cost of consumer bills. This report is therefore an early assessment in which we set out potential risks DESNZ needs to manage and make recommendations aimed at supporting DESNZ as it develops its plan. In the future we will assess government's progress with achieving power sector decarbonisation, how well it is managing the risks highlighted in this report, and the value for money of its interventions.

5 This report does not consider the response by DESNZ to recent energy supply and affordability challenges. In February 2023 we published *Energy bills support*.[3]

Key findings

Government faces challenges to decarbonise power

6 Transitioning to a secure, affordable and decarbonised supply of power by 2035 requires a step-change in both private investment and the pace at which new generating capacity is built. In its Net Zero Strategy, the government estimated that £280 billion to £400 billion of public and private investment in new generating capacity will be needed by 2037 to decarbonise the power sector. These costs represent the construction costs for power generation only, and do not include the costs for all aspects of decarbonising the power sector, such as network construction or research and innovation on technologies. Total costs will depend on factors including the location of new generation, the impact of any reforms to the electricity market and the effect of efforts to align consumer demand with supply. DESNZ has set stretching ambitions for the expansion of offshore wind, solar and nuclear power, which require much faster deployment rates than have been achieved before. For example, to achieve its ambition for 50 gigawatts (GW) of offshore wind by 2030, it needs to oversee the deployment of three times as much offshore wind capacity in eight years as in the last two decades (paragraphs 1.8, 1.14 to 1.17 and Figures 2 and 6).

3 Comptroller and Auditor General, *Energy bills support*, Session 2022-23, HC 1025, National Audit Office, February 2023.

7 The power system needs to modernise to accommodate different kinds of electricity generation. Renewables have different characteristics from the fossil fuel power sources they are set to replace. Wind and solar can only generate power when the wind is blowing or the sun is shining so generation cannot be controlled, unlike gas-fired power stations that can be turned on or off quickly to meet changes in demand. Renewables also have a very different economic model from gas-fired power stations, because once built they have relatively low running costs. These lower costs are not currently reflected in the price consumers pay for electricity because current market arrangements for buying and selling electricity were largely developed when gas and coal were the dominant fuels. DESNZ is working on ways to reform the electricity market and is encouraging consumers to use electricity more flexibly so that demand is more aligned to the intermittent nature of renewables, for example through its Smart Metering Implementation Programme (paragraphs 1.11 to 1.13, 1.16 and Figure 9).

8 Decarbonising power requires government to increase its planning and coordination of the power system. Expanding generation while modernising the power system entails several separate but linked changes that rely on a range of public and private sector organisations. Industry stakeholders are increasingly concerned about the lack of a government delivery plan that brings different aspects of power together. The Climate Change Committee recommended in its 2022 Progress Report to Parliament that DESNZ should publish an overarching delivery plan or strategy for decarbonising power.[4] Stakeholders we spoke to said there needs to be a delivery plan that recognises the time required to decarbonise all aspects of the power sector, including expanding generation and developing technologies ahead of 2035 (paragraphs 2.5, 2.8, 2.11 to 2.12 and Figures 4 and 5).

9 DESNZ has not yet established a delivery plan to decarbonise power because it has prioritised responding to recent energy sector challenges. In April 2021, DESNZ created an energy portfolio office, which is responsible for creating a delivery plan for power decarbonisation and coordinating the work of the DESNZ directorates responsible for different energy programmes including renewables, nuclear power and networks. DESNZ planned internally to prepare a first draft of its delivery plan with key decision points, risks, mitigations and interdependencies by October 2022, in support of a vision of how a fully decarbonised power sector will be achieved by 2035. During 2022, DESNZ prioritised developing and implementing responses to recent record-high energy bills and it therefore scaled back its work on coordinating long-term power sector decarbonisation. It told us it still has more work to do to develop a delivery plan (paragraphs 2.2 to 2.4).

4 Climate Change Committee, *Progress in reducing emissions, 2022 Report to Parliament*, June 2022.

Risks to DESNZ that stem from a lack of planning

10 The lack of a delivery plan means DESNZ cannot be confident its ambition to decarbonise power by 2035 is achievable. Many of the changes necessary to achieve decarbonisation rely on technologies that are not yet available or not yet ready to scale up to the level needed. A key example is technology to enable the power system to meet demand at times when there is little wind power. DESNZ is supporting the private sector to develop a range of solutions to this issue, such as hydrogen power and energy storage. However, it has not established a 'critical path' to 2035 to understand when it will need to make decisions about which technologies to adopt and roll out to stay on track. For example, DESNZ considers that achieving decarbonisation by 2035 requires new generation, including wind, solar and nuclear, to deploy at, or close to, the maximum level which is technically feasible in that time. However, there are several significant challenges, such as securing investment and identifying locations. Establishing an overall delivery plan would help DESNZ understand the resilience of its plans to setbacks and identify in advance the alternative pathways that it could take if required (paragraphs 1.13, 2.3, 2.4, 2.6, 2.9, 2.15 and Figures 7 and 8).

11 There is a risk that without a delivery plan, decarbonising power while maintaining security of supply will cost consumers more. There will be ways of sequencing the different changes required to decarbonise power that help to avoid unnecessary costs. For example, ensuring network capacity keeps pace with expanding generating capacity could avoid the risk of paying wind farms to shut down. If generators cannot access the grid, generation exceeds network capacity, or generation exceeds demand, then costs arise to consumers as generators are paid to constrain their output. While these 'constraint costs' typically vary (between £0 and £62 million a day since 2018), the annual total costs have recently increased, alongside the growth in offshore wind capacity. A clear delivery plan could also increase the confidence of investors to fund new infrastructure, which could reduce their costs of capital. In the past we have highlighted how a lack of clarity and changes in policy direction from government can affect investor confidence, increasing their required rate of return, and ultimately increasing costs for energy consumers (paragraphs 2.7, 2.11 to 2.13 and Figure 12).

12 Without a delivery plan DESNZ cannot fully understand when costs could be highest and the potential effect on taxpayers and consumers. Over time a decarbonised power system should have lower operational costs because it is typically more energy efficient. However, substantial upfront investment is required. The Climate Change Committee, which advises government on progress against its climate targets, has predicted that the capital investment required for building infrastructure to decarbonise power will increase in the 2020s, but should be in decline from 2035 onwards as the required build-rate falls and the costs of these technologies decreases. Typically, the costs to build, maintain and operate the power system are passed on to consumers' bills, which have recently reached record-highs because of global fuel prices (paragraphs 1.3, 1.15, 1.16, 2.16 to 2.18 and Figure 10).

13 DESNZ has more to do to manage portfolio performance, costs and risks of transitioning to a decarbonised, secure and affordable power system. While DESNZ has been reporting internally on its progress to decarbonise the power sector, it has not yet established a set of system-wide measures to track progress and costs, which could enable it to identify when it is off-track against expectations. It is also developing its end-to-end portfolio risk management framework. Risk management processes exist for programmes within the portfolio, and some significant risks are escalated for review by the energy portfolio office, energy board or net zero boards. However, not all risks are aggregated across the portfolio and there is no portfolio-wide view of the top risks to decarbonising the power sector (paragraphs 2.17 and 2.24 to 2.27).

Risks for DESNZ to manage when implementing its delivery plan

14 The ability of DESNZ to respond to changes in the external environment depends on the quality of its power sector insights and the extent to which it can operate and manage resources in an agile way. While DESNZ needs a delivery plan, it will need to remain flexible because new technologies could emerge that alter the most cost-effective pathway towards a decarbonised power system. There is also uncertainty about whether existing technologies can be deployed at the speed required to achieve the 2035 ambition. DESNZ has a model of future power generation it can use when considering which pathway might be optimal and making choices such as investing in more generating capacity or investing in energy storage. However, this model is only updated annually and therefore can quickly become out of date. Recent volatility in gas prices, for example, reduces the accuracy and usefulness of the model for policy decisions. DESNZ plans to increase its capacity and capability to manage progress towards decarbonisation and has set up a resourcing group to help move resources between DESNZ and other public bodies to prioritise activities and fill net zero roles (paragraphs 1.8, 2.6, 2.8, 2.20 to 2.22, 2.29 and 2.32).

15 The government intends to create a new organisation to coordinate the power system but has not clarified what its roles and responsibilities will be. DESNZ intends that the Future System Operator will advise government on policy decisions that balance decarbonisation with maintaining a secure supply of electricity and ensuring the system runs efficiently. This might include, for example, advice on the best location to build new wind farms. Government's ambition is for the Future System Operator to be established in 2024. DESNZ has not yet set out how it would work with the Future System Operator, and the extent to which the new organisation assumes responsibility for some coordinating activities (paragraph 2.28).

Conclusion

16 Decarbonising power is the backbone of the government's plan to achieve net zero. Although power sector emissions have reduced significantly over the past three decades, DESNZ cannot be complacent about the challenges involved in decarbonising further while continuing to ensure a secure supply that meets the predicted electricity demand increases. This will require substantial investment in new capacity, alongside system-wide modernisation, and needs a joined-up approach to ensure changes happen in sequence and with coherence. The longer DESNZ goes without a critical path bringing together different aspects of power decarbonisation, the higher the risk that it does not achieve its ambitions, or it does so at greater than necessary cost to taxpayers and consumers. While the recent energy crisis has understandably delayed DESNZ's progress in establishing a longer-term delivery plan for decarbonising power by 2035 it has reinforced the importance of ensuring that plan is resilient to external shocks.

Recommendations

17 In developing its delivery plan for power decarbonisation, DESNZ should:

a **establish how it will ensure the system is resilient to prolonged periods of low generation from renewables**. This should include considering the potential costs and benefits of maintaining some carbon-emitting power generation (such as unabated gas), while still achieving net zero across the economy;

b **within 12 months, review plans for achieving its ambitions for offshore wind and nuclear power expansion**. Where DESNZ determines that these ambitions are unattainable it should develop alternative options that enable it to achieve its broader power sector ambitions, such as investing in demand-side flexibility; and

c **ensure it has understood the main links between different aspects of decarbonisation and sets out in advance how these will be managed**. This should include how to determine the best sequencing of changes and investment, such as ensuring how network capacity keeps pace with expanding generation.

18 In developing arrangements to oversee progress against its plan, DESNZ should:

d **review the capability of its modelling to refine and update the most cost-effective system-wide approach to achieving net zero, including power sector decarbonisation**. It should consider, for example, the location of new generation, the impact of revisions to market arrangements and the potential role for greater demand-side flexibility. Where it identifies gaps in its modelling DESNZ should consider alternative sources of information to enable it to identify and respond to significant changes which might affect the most cost-effective pathway towards decarbonisation;

e **establish a set of clear measures of overall progress, and some interim milestones towards power sector decarbonisation**. It should report progress against these measures and milestones annually to Parliament, along with an explanation as to how this performance information has been used to determine any significant changes to its overall plan; and

f **establish arrangements to understand and respond to system-wide risks and opportunities, to ensure its plan is resilient to setbacks, disruption and future uncertainty**. This will involve having an overview of the cumulative demands on, for example, workforce, materials and investment across the system.