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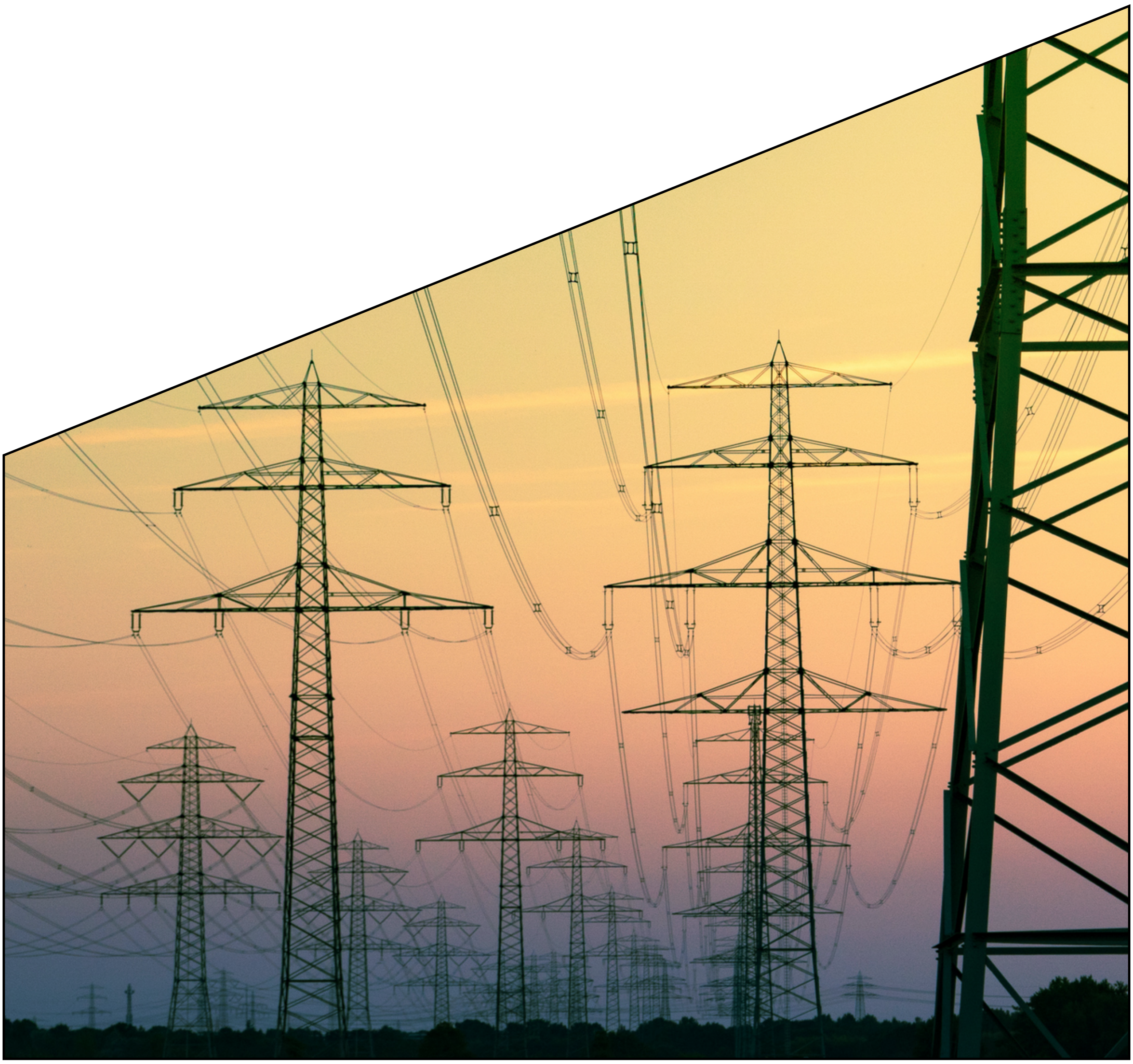
Electric dreams

How can we decarbonise electricity without disadvantaging poorer families?

Jonathan Marshall & Emily Fry

April 2024



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Summary

An energy investment surge is needed

The UK is a low-investment nation. Weak capital spending – the lowest in the G7 since the year 2000 – is holding back economic growth, hitting living standards, and contributing to crumbling public services.

But in one key area – our power system – that has to change. Electricity generation has been the main driver of decarbonisation in the UK to date (accounting for 55 per cent of overall decarbonisation since 1990) but now a three-fold increase in capital spending is needed to meet rising demand. By 2035, around 40 per cent of energy consumed in our homes and in road transport will need to be electricity (up from 22 and 4 per cent today, respectively), before rising to close to 100 per cent by 2050. At the same time, spending on power networks needs to increase by a factor of four to cope with this surge in the volume of electricity. Combined, this required investment in energy supply – which is a pre-requisite for decarbonisation of the wider economy – is larger than that required in any other sector – e.g. road transport, homes, and industry – over the next 15 years.

So, in this paper, we discuss how we should approach this investment surge: what it will cost, how it will be funded, and, ultimately, how it will affect household living standards.

Volatility in interest rates means the cost of investment is uncertain

Instead of squaring up to this investment challenge, current discussions on power sector decarbonisation focus too heavily on the difficulties of building new wind farms, nuclear power stations, pylons and substations, rather than how they are ultimately funded and paid for.

How and when this investment is delivered will, of course, dictate the future cost of energy. But it will do so in a different way than is currently the case as we move from an electricity system that is cheap to build but expensive to run, to one with high upfront costs but very low running costs. For example, at current borrowing costs, capital expenditure accounts for two-thirds (67 per cent) of the cost of energy from an offshore wind turbine, compared with just one-tenth (11 per cent) for a gas-fired power station, where fuel accounts for the vast majority.

This change in composition puts extra pressure on policy design and delivery, and means that longer-term energy prices will be dictated by government choices and by borrowing costs – the latter a function of interest rates – rather than the ups and downs of international commodity markets.

But, although interest rates are not in the gift of any UK government, policies and regulations that play a key role in determining energy prices are. Many of these see low

costs pitted as trade-offs against other factors. For example, the prioritisation of local politics over the need to develop cheap energy sources and network infrastructure, and decisions that add extra costs onto energy generation, are working against the Government's stated aim of having the cheapest wholesale electricity prices in Europe by 2035.

A much bigger issue, though, is that high interest rates make private capital investment in the electricity system more expensive. Compared to how we finance our current consumption – i.e. electricity generated from gas – renewable and nuclear energy bring higher upfront expenditure, which is returned to investors over a longer period. And because power sector investment is largely done by the private sector, where capital costs are a function of returns demanded by investors, then the cost of borrowing is key. In particular, as interest rates have risen, the cost of capital for a typical offshore wind project has also surged to close to 9 per cent. This jump means that nearly half (45 per cent) of the total cost of a new offshore wind project is now due to the cost of capital; for electricity networks, this rises to 55 per cent, given that a greater share of the overall cost is spent on capital, rather than operating costs. If the cost of capital remains at 9 per cent, electricity will cost a third (31 per cent) more per unit generated, and the networks used to transport it cost an extra two-fifths (41 per cent), than in a world where borrowing costs are 4 percentage points lower.

We need to recognise this could impose far too high costs on some lower-income households

To date, there has been a widely held assumption that the power-sector transition will be easy, as rapid falls in the cost of renewable technologies deliver savings to households. But this is a bad way to think about the challenge ahead of us. Economic and policy uncertainty mean that future energy prices are not set in stone, and could be higher or lower than many working assumptions suggest.

But, rather than confront that uncertainty, too often a single price of electricity is used when assessing the impact of net zero on living standards in decades to come. Instead, we should recognise that there are a range of possible future prices, and that – crucially – variations in energy consumption will lead to sizeable distributional impacts on living standards. As such, while it is possible that a net zero electricity system could mean that all households save money on their energy bills in future, there are also plausible scenarios in which – even if policy makers do everything right – some families spend more, not less, than they do today.

We therefore use a simple, stylised scenario to show the impacts of two potential futures. A low-price world illustrates a plausible upside to households; such a scenario would arise from policy and regulation being primarily targeted at pushing down costs, and interest rates falling to a level where the cost of private borrowing is around 5 per cent, comparable to that before the energy crisis. Our second scenario imagines that policy and regulatory strategies focus on priorities other than cost minimisation and that interest rates remain high – with the cost of private borrowing 4 percentage points higher, at 9 per cent.

This high-cost scenario would lead to severe financial strain for low-income households, adding a total of £29 billion to household energy bills per year by 2050. Energy spending for the poorest fifth of households could consume 3.6 per cent more of disposable incomes than it did in 2019 today (while the richest fifth of households would spend just 0.3 per cent more). This is because, in a high-price world, the savings from efficient electrified private transport fail to outweigh the increase in the cost of energy used in the home. More than that, the UK's policy framework would lock households into these high prices for more than a decade, in contrast to the sharp, but brief, price increases during the cost of living crisis.

We need a plan to cope with a high energy cost world

As such, it is entirely feasible that prices in the future are higher than usually assumed – if so, our existing approach to paying for investment will place an unsustainable burden on lower-income families.

Responding by pausing, or slowing, the pace of power sector decarbonisation is not an option: if investment is not sufficient to replace retiring power stations, then we risk an electricity supply crunch appearing in the late 2020s (only one of Britain's eight nuclear power stations will still be generating in 2028, for example). The need for low carbon energy to power the net zero transition at large means that policy makers must plan for – and get ahead of – a world in which energy prices are higher than previously envisioned. Doing so will also help provide macroeconomic stability by reducing exposure to volatile fuel imports which have been a major driver of the UK's recent inflation spike.

In forming this plan, there are three key considerations: keep costs down where possible, a social tariff is the key to a fairer distribution of costs, and billpayer funding may not be enough

Our simple scenarios illustrate that there is a plausible risk that a low carbon electricity system does not deliver savings to households. By recognising this uncertainty, we can start to think about the energy transition in new ways.

The first port of call will be a renewed focus on prices, waking up to the fact that a world of low energy costs is not one in which nothing needs to be done. Instead, we must avoid overpaying by controlling costs where possible.

In the short term, there is a risk of locking in unnecessarily high prices driven by current high interest rates: the bid-limit for developers looking to build offshore wind farm in the next (2024) renewable auction has been increased by 66 per cent, but policy makers must be careful of accepting higher prices too readily, as the impacts will last for more than a decade. Instead, we should ensure that a healthy level of competition maintains cost pressure on bidders, and that auctions are designed such that the lowest possible prices are delivered, so as not to risk undermining the wider transition later.

But wider energy policy could – and should – be more focussed on low costs. Current frameworks that directly increase costs by not opting for the cheapest technologies, and procurement strategies based on bilateral deals that have a history of not delivering value for money, are key examples where changes could be made. Further, mooted plans to fund industrial and social policy – for example, building domestic supply chains or creating new employment opportunities in deprived areas – through levies that will push up electricity prices will lead to higher costs for households too.

But with high interest rates the key driver of higher costs, good policy may only impact prices at the margin. As such, the second consideration is that we may need to look beyond policies that underpin the building of new energy assets – to either the benefits system or energy retail policy – to protect the living standards of lower-income households, and particularly those with higher levels of energy use.

Differences in levels of energy consumption within income bands are high today (higher than across the income distribution) and will remain so in the future, even as the rollout of electric vehicles means that fuel costs feed through into household energy bills, instead of being paid for at the pump. Currently, the average high consumption household spends 165 per cent more on energy at home and in private transport than one with low consumption, a figure that may be largely unchanged (170 per cent) in 2050. This disparity is lower at the top of the income distribution (140 per cent both now and in 2050) than at the bottom, where it will increase slightly from 250 per cent to 280 per cent by mid-century. As well as increasing in size for some, this large variation coming through just one bill in the future will mean it is more visible to households.

This variation will dictate how policy can best respond. The UK's benefits system is currently blind to levels of household energy use; to date, it has responded to unaffordable bills through either fixed payments or by using cold weather as a proxy for periods of high consumption (but without addressing sustained levels of high use). On the other hand, energy retail policy is built around knowledge of household demand, but does not know who is poor and who is not.

The scale of the impacts from higher future energy prices will mean that these issues cannot be used as an excuse for inaction. A social tariff – where funding from the tax system allows different families to pay different prices for energy based on qualifying criteria such as incomes, age, or household composition – is therefore an inevitability if we want to ensure that poorer families are protected during the transition, and that support offered can, crucially, be scaled in line with energy demand.

The third concern is whether the current system of privately financing investment which is then repaid through energy bills can be maintained. Calls for taxpayers to fund investment instead, mirroring current debates around water and railways, are not hard to imagine, and, if acted upon, could see the state funding and owning large chunks of the electricity system for the first time in decades.

Tax-funding the entirety of the transition, however, comes with costs too sizeable (£40 billion per year over the next decade) to fit within the UK's strained fiscal position. As such, decisions may need to be made as to where the state balance sheet can be used with the most impact. Of the two broad types of investment – generation and networks – the latter accounts for much less (one third) of the total spending need to 2040, and is more sensitive to borrowing costs, which will be lower if publicly funded.

As such, it seems that the most effective use of state capital would be delivering the thousands of miles of new wires that Britain will need in the next few decades. Crucially, this option would also deliver a much fairer distribution for who bears the cost of investment than the status (billpayer-funded) quo. Moving from a system in which transmission network spending is funded through energy bill standing charges (which places an unfair burden on those on lower incomes) and distribution networks funded through unit charges (which hits those with high levels of energy use) to one where costs are spread more fairly across the income distribution would be more equitable. In fact, using taxpayer funding would see expenditure as a share of income flat across the income distribution instead of a factor of 6 higher for the poorest quintile than for the richest under bill-funded approaches. However, it would come with a different type of delivery risk, as HM Treasury will be weighing up calls to invest in electricity networks alongside calls for investment in schools, hospitals, defence, and other public projects. Moving away from the privately-delivered, billpayer-funded approach is a drastic option, but with the need to invest as paramount as that to protect living standards, policy makers may find themselves with few alternatives.

An effective plan will allow an overhaul of the power sector to happen at pace

The UK's journey to a net zero economy involves a complete overhaul of our power system, requiring large-scale investment at a time of high uncertainty around future costs. Current long-term visions of how this investment will impact household spending tend to assume low costs and upsides for everyone, but it is highly plausible that costs are higher and not everyone is better off.

We need to understand and account for this uncertainty, and plan for how we can deal with a world in which high costs materialise without harming the UK's journey to net zero emissions. Doing so will require a new approach: a core focus on keeping costs down; protecting vulnerable households via a social tariff; and potentially allocating transition costs to taxpayers, rather than billpayers. These should be all options to ensure that the decarbonisation of Britain's electricity grid does not increase pressure on the budgets of low-to-middle income households.

The UK is not investing, but needs to brace for a surge in capital spending on the electricity sector

The UK is a low investment nation. Both public and private investment has been around a fifth lower than that in other advanced economies since the turn of the century, leaving the UK with the lowest investment rate in the G7.[1]

In the past, some have pointed to low investment levels as a feature – not a bug – of a services-dominant economy. Others have suggested that low investment reflects an impressively efficient sweating of its asset base; a justification for low investment in utilities before and after privatisation.[2] But neither of these are true; instead, Britain's low investment is a key determinant of our terrible recent performance on both productivity and economic growth.[3]

One area, though, where this is about to change is in our electricity system. Britain's power sector is the poster child of our journey to net zero; emissions are at their lowest level since the Victorian era, and the share of electricity generated from coal is down from 40 per cent in 2012 to almost zero in 2023.[4] Promisingly, renewable energy – particularly offshore wind, where the UK is a world-leader – now accounts for more than two-fifths (42 per cent) of electricity generation, up from just 3 per cent at the turn of the millennium.[5] To enable this transition, which accounts for more than half (55 per cent) of the UK's total carbon-cutting to date, annual investment in the electricity system more

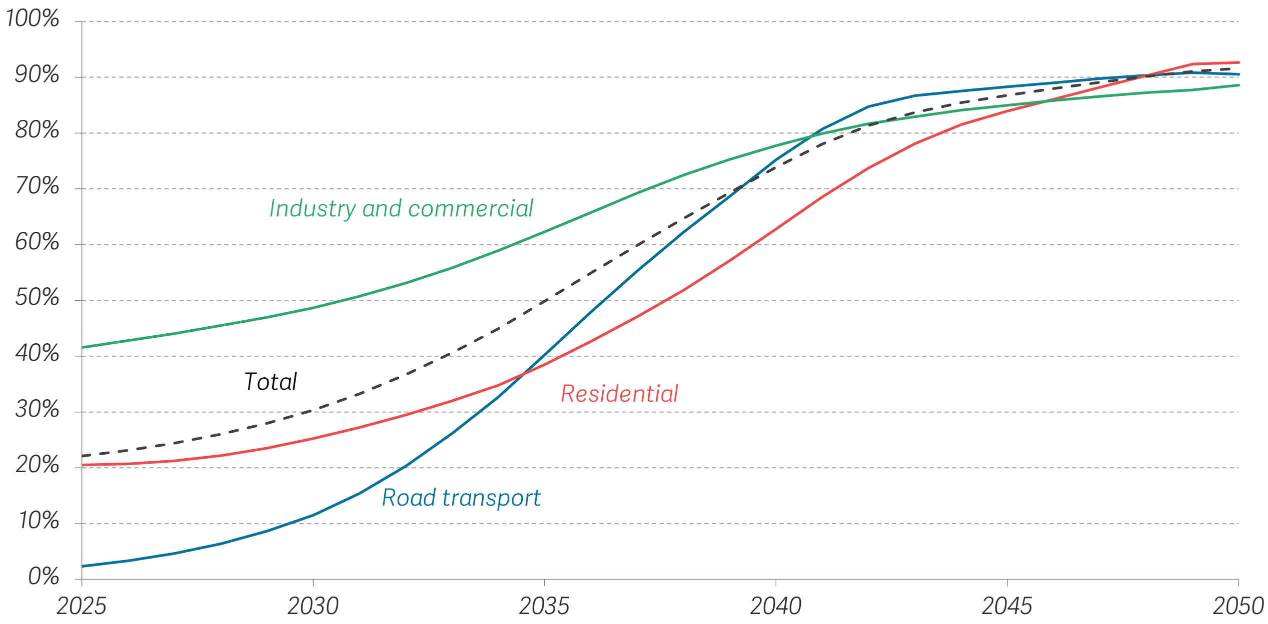
1 Analysis of OECD data. This is calculated as simple averages of the ratio of total gross fixed capital formation (GFCF) to GDP, in current prices.
2 J Vickers & G Yarrow, Economic Perspectives on Privatization, Journal of Economic Perspectives. 5, 1991; P Domah & M Pollitt, The Restructuring and Privatisation of the Electricity Distribution and Supply Businesses in England and Wales: A Social Cost Benefit Analysis, July 2000.
3 P Brandily et al., Beyond Boosterism, Resolution Foundation, June 2023.
4 Analysis of Department for Energy Security and Net Zero, Energy Trends: UK electricity; S Evans & V Viisainen, Analysis: UK emissions in 2023 fell to lowest level since 1879 , Carbon Brief, March 2024. These figures include energy from biomass generation.
5 International Energy Agency, Renewables 2023: Analysis and forecasts to 2028, January 2024.

than doubled (rising by 115 per cent) between 2006 and 2021.[6]

But there is far more to do. The decarbonisation of other sectors of the economy – such as road transport, residential housing, and industry – is reliant on the availability of green electricity. As shown in Figure 1, electricity will go from providing just 4 per cent of energy consumed by road transport in 2025 to 40 per cent in 2035, and rising to 90 per cent in 2050. Likewise, electricity will cater for just 22 per cent of residential energy demand in 2025, but this will be 38 per cent in 2035 and more than 90 per cent in 2050. By 2040, Britain's homes will consume 45 per cent more electricity than in 2025, while road transport electricity demand will increase 13-fold, as heat pumps and Electric Vehicles (EVs) become commonplace.

FIGURE 1: **Decarbonising homes and transport relies on cleaning up the electricity supply**

Forecast share of final consumer energy demand provided by electricity, by sector: GB



NOTES: Figures based on National Grid's 'Consumer Transformation' scenario.
SOURCE: Analysis of National Grid Future Energy Scenarios.

This widespread electrification will not happen without a step change in investment. The UK's Climate Change Committee (CCC) forecasts that investment in electricity production will need to be about three times its current value, up from around £9 billion annually during the 2010s to £30 billion per year during the 2030s (all in 2023 prices; see Figure 2).[7]

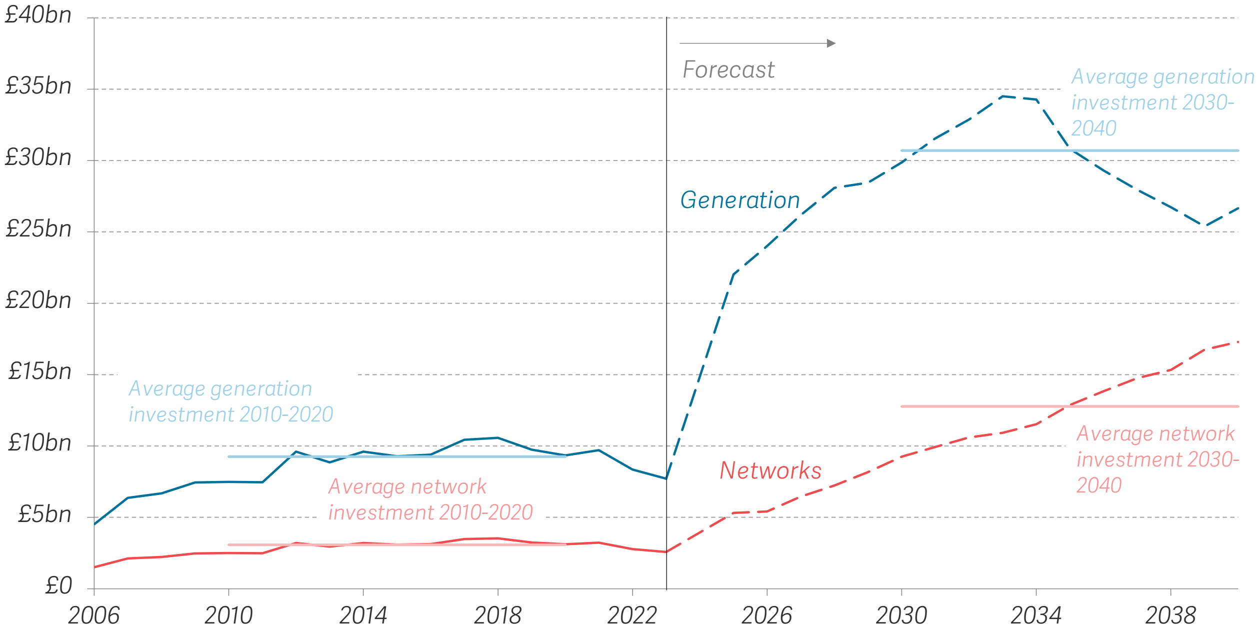
6 Analysis of ONS, Quarterly Acquisitions and Disposals of Capital Assets Survey (QCAS) investment made by energy industries, March 2024.

7 In this note we use 'generation' to account for both the direct generation of electricity, such as that from a thermal or renewable power source, but also for technologies needed to provide sufficient flexibility for a grid based on variable renewable outputs, such as peaking plant, batteries and long-term storage technologies.

Electricity networks are also facing their biggest overhaul since the high voltage transmission grid was established in the 1950s.[8] The Government estimates that £310 billion of network investment needs to take place between 2023 and 2050, entailing a four-fold increase between the 2010s and the 2030s (from £3 billion to £13 billion per year).[9] As such, the total capital spending required by our electricity system is even larger than that estimated to decarbonise homes and transport over the next 15 years.[10]

FIGURE 2: **Investment in the nation's power system needs to increase almost four-fold**

Annual historical and projected total capital expenditure in the electricity sector (2023 prices): GB



NOTES: Additional investment in electricity supply sourced from CCC Sixth Carbon Budget, which is split by electricity networks and generation. To calculate total electricity investment, remaining energy supply investment was split between networks and generation by the share of additional investment in each. Outturn network investment estimated to be 25 per cent of total electricity supply investment – the mid-point between government and CCC estimates. Total investment is smoothed over 5-year periods, with the year as the mid-point.
SOURCE: Analysis of CCC Sixth Carbon Budget, December 2020; ONS, Quarterly Acquisitions and Disposals of Capital Assets Survey (QCAS) investment made by energy industries, March 2024; ONS Consumer Price Indices, March 2024; BEIS Electricity Networks Strategic Framework, August 2022.

As discussed in Box 1, this investment will provide energy for commercial users and the public sector, as well as for households. Heavy industry, such as steel, will be particularly exposed to the economic impacts of decarbonising the power sector, but this lies outside of the scope of this note, in which we focus on the implications for household living standards.

8 National Grid ESO, Beyond 2030, March 2024.
9 BEIS, Electricity networks strategic framework, Appendix 1 , August 2022; analysis of UK CCC, Sixth Carbon Budget, December 2020.
10 Analysis of UK CCC, Sixth Carbon Budget, December 2020.

BOX 1: The implications of a net zero grid for industry

This note examines the implications of decarbonising the power sector for household living standards, but the implications will be felt throughout the economy as a whole.

Non-household consumption currently accounts for two-thirds of Britain's electricity use. Although this fraction is set to fall in the future, as households consume more electricity for heat and transport, non-household energy consumption will remain significant, with more than half of electricity still expected to be used by firms and the public sector in 2050.[11]

Within this grouping, it is the nation's energy-intensive industries who are, and will continue to be, particularly exposed to changes in energy prices. The UK's carbon targets require industrial carbon emissions to reduce by two-thirds by 2035, most of which will be achieved through electrification.[12] But this is not the only challenge these sectors face. Manufacturing industries in the UK already face competitive pressures from high energy prices – in 2022, they were higher in the UK than all EU nations bar Belgium – and are therefore on the hook as future capital spending feeds through into energy costs.[13]

Indeed, the recent energy price spike highlighted the extent to which the UK's strategic manufacturing sectors are at risk from high costs. Profits were more negatively affected for firms in energy-intensive industries – such as manufacturing, accommodation and food services, and transportation – than for those where energy was a smaller proportion of input costs.[14] For example, during 2022-23, the disparity between electricity prices paid by UK steel producers and those in France and Germany jumped to £93 per megawatt hour (MWh), close to triple the £36/MWh gap one year prior, as high gas prices pushed up wholesale costs.[15]

In this note, we focus on how to think about this investment surge: its costs, how it is funded, and its impact on household living standards.

11 Analysis of National Grid ESO, Future Energy Scenarios (FES), 2023.
12 Not all industrial processes are suitable for electrification, with many instead set to be decarbonised by switching fuels to hydrogen or capturing carbon. For more, see: Department for Energy Security and Net Zero, Industrial Decarbonisation Strategy, March 2021.
13 Department for Energy Security and Net Zero, International domestic energy prices, November 2023.
14 S Piton, I Yotzov & E Manuel, Profits in a time of inflation: some insights from recent and past energy shocks in the UK, August 2023.
15 UK Steel, Industrial Competitiveness: electricity prices faced by UK steelmakers, November 2023.

A changing policy landscape and higher interest rates make the cost of investment uncertain

Instead of squaring up to how this investment will be funded, current discussions on power sector decarbonisation focus too heavily on the difficulties of building new wind farms, nuclear power stations and pylons. This manifests in a pre-occupation with short-term issues – planning reform and failed renewable auctions, for example – rather than focusing on the scale of the investment that will shape energy bills for decades. How it plays out, particularly who funds this investment, will dictate the future cost of energy paid by households. Crucially, though, how and when this investment is delivered will dictate the future cost of energy, but it will do so in a different way than is the case in the current system.

In future, the cost of electricity will reflect the cost of capital, not the price of fossil fuels

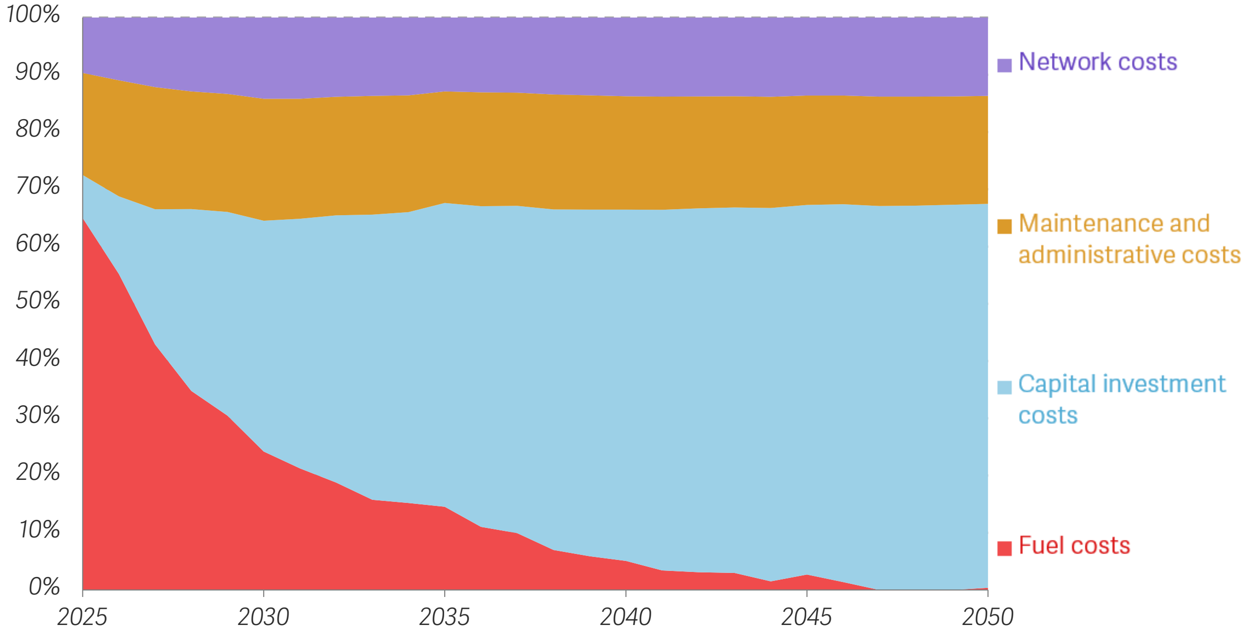
Historically, the power grid has been relatively cheap to build but expensive to run, with electricity prices largely tracking those of coal, and more recently gas (traditionally the main inputs needed to generate electricity). Now, we are creating a system that is expensive to build, but cheap to run. As such, the electricity system of the future will be one in which prices depend on the cost of building assets, rather than the costs of procuring fuels. As Figure 3 shows, between 2025 and 2035, the share of the total cost of running the electricity system that is due to the cost of fuels will fall from 65 per cent to 15 per cent. At the same time, the share of overall costs due to capital investment will rise from 8 per cent to more than half (53 per cent).[16]

The rapidly changing composition of the electricity system, expected to grow from 50 per cent renewables to 90 per cent in the 10 years from 2025 – puts extra pressure on policy design.[17] This is because longer-term energy prices will be dictated by government policy and borrowing costs – the latter a function of interest rates – rather than the ups and downs of international oil and gas markets. For example, at current private borrowing costs of 9 per cent, spending on capital investment accounts for two-thirds (67 per cent) of the cost of energy from an offshore wind farm, compared with just one-tenth (11 per cent) of that from a gas-fired power station, where fuel accounts for the majority.[18]

16 LCP, Impacts and implications of the British Energy Security Strategy – Considerations for REMA, October 2022.
17 Analysis of National Grid ESO, Future Energy Scenarios (FES), 2023.
18 Department for Energy Security and Net Zero estimates offshore wind hurdle rates are 8.3 per cent in 2024. Other analysis, such as that by FTI Consulting, estimates that hurdle rates of 10-12 per cent would be typical for offshore wind projects. Given this range, we take a mid-point of 9 per cent for our analysis. For more, see: FTI Consulting, Bidding Considerations for AR5, July 2023; and: Department for Energy Security and Net Zero, Contracts for Difference: Methodology used to set Administrative Strike Prices for CfD Allocation Round 6, November 2023. In this briefing note, we use the terms 'cost of capital', 'hurdle rates', and 'borrowing costs' interchangeably. These refer to the returns that companies pay to investors through a combination of debt and equity. For the UK government, these borrowing costs are entirely debt-funded through gilts.

FIGURE 3: Within a decade, the main driver of electricity prices will be the cost of capital investment

Forecast of electricity system cost breakdown, by cost type: GB



NOTES: Electricity system cost is the total cost of generating and transporting electricity in a single year. Calculations from October 2022, before the majority of interest rate rises took place in the UK. If these changes were considered, both the capital investment and network costs would likely become a larger share of the electricity system cost.
SOURCE: LCP, Impacts and implications of the British Energy Security Strategy – Considerations for REMA, October 2022.

Past policy choices have helped lower generation costs, but the current approach does not always prioritise cheap energy

Until recently, we were able to count on the cost of most low carbon sources of electricity falling rapidly, even as we built them at pace. For example, in the UK's first Contracts for Difference (CfD) auction in 2014, offshore wind contracts were signed at a strike price as high as £164/MWh of electricity produced (in current prices).[19] By the fourth auction round offshore wind prices had fallen by more than two-thirds to just £51/MWh.[20] This impressive fall was driven by new technologies, more efficient processes, and sound policy, most notably through effective de-risking of private investment through the UK's CfD scheme, as detailed in Box 2.

19 In 2023 prices. Source: Department for Energy Security and Net Zero, Contracts for Difference (CfD) Allocation Round One Outcome, February 2015.
20 In 2023 prices. Source: Department for Energy Security and Net Zero, Contracts for Difference (CfD) Allocation Round 4: results, July 2022.

BOX 2: Fixed price contracts have de-risked investment and driven down renewable costs

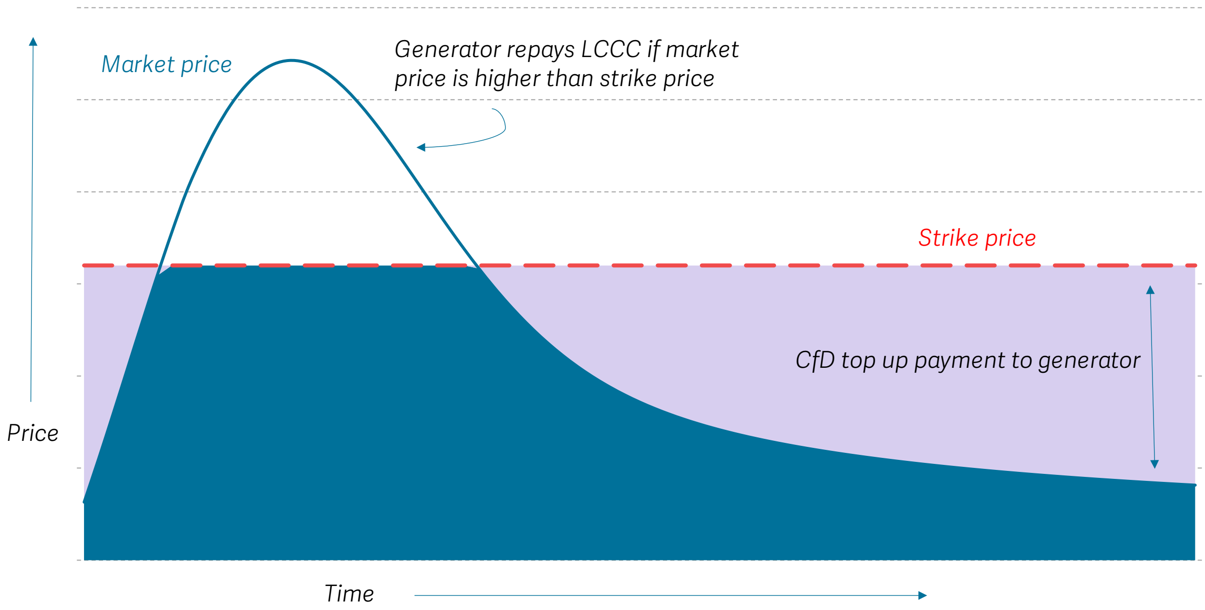
The CfD is the primary mechanism through which new electricity generation is supported in Britain. It works by guaranteeing developers a fixed price for electricity generation, stable over 15 or more years. This removes the risk of market prices falling in the future and makes projects more attractive to the private sector, allowing access to cheaper capital and resulting in lower electricity prices for consumers. Contracts are awarded through competitive auctions, forcing developers to strive for the lowest possible prices, and have underpinned 30 gigawatts (GW) of low carbon capacity since the first contracts were allocated in 2014.[21]

The CfD regime is lauded internationally as a policy success, and it is not hard to see why. The auctions have overseen plummeting renewable prices, inverting the decades-old story of gas being cheap and renewables expensive. And, although the wholesale price of electricity is set by the marginal generator (typically a gas plant) – renewables built under a CfD contract insulate consumers from paying over the odds during gas price spikes, as Figure 4 shows.[22] If the wholesale price of electricity is higher than the CfD strike price, electricity generators repay consumers, limiting the extent to which price spikes are passed through to energy bills. Schemes inspired by the UK have been implemented or are in development in numerous other countries, including an EU-wide scheme as part of its wide-ranging 'Fit for 55' package.[23]

21 Low Carbon Contracts Company, Contracts for Difference in a Nutshell, accessed 15 April 2024.
22 M Grubb et al, Navigating the crises in European energy: Price Inflation, Marginal Cost Pricing, and principles for electricity market redesign in an era of low-carbon transition, UCL Institute for Sustainable Resources, September 2022.
23 Council of the European Union, Electricity market reform, accessed 15 April 2024.

FIGURE 4: **Contracts for Difference can protect consumers when market prices are high, but come with a cost when prices are low**

Schematic of an illustrative CfD top-up, or repayment, by renewables generators compared with a hypothetical market price



NOTES: LCCC is the Low Carbon Contracts Company – a company fully owned by the government, set up to manage CfD contracts on behalf of the Government. Strike price refers to the price agreed in contracts.
SOURCE: Authors' analysis.

Government policies and regulations will continue to play a key role in the cost of future energy, but many of these pit low costs as trade-offs against other factors. For example, the Government has shied away from building onshore wind farms which can provide cheap electricity, so as to duck contentious local politics, and has chosen a piecemeal approach to building nuclear power stations, swerving all the benefits of continuous fleet rollout and missing out on the power of competition to drive down prices.[24] Mooted plans to deliver industrial and social benefits through CfDs – such as developing new domestic supply chains or growing employment in deprived areas – would also add extra costs onto energy bills.[25] These decisions stand somewhat contrary to the Government's stated aim of wholesale electricity prices being the cheapest in Europe by 2035.[26]

We can't rely on low-cost capital any longer

The UK's impressive progress on renewable energy was built on a foundation of abundant access to low-cost capital during the 2010s. This is no longer the case. Real long-term interest rates are now at levels not seen since before the financial crisis. This shift in the

24 Britain Remade, Revealed: Britain is one of the most expensive places in the world to build new nuclear, December 2023.
25 Department for Energy Security and Net Zero, Introducing non-price factors into the Contracts for Difference scheme: call for evidence, April 2023.
26 Department for Energy Security and Net Zero, Powering up Britain – the net zero growth plan, March 2023.

macroeconomic environment is already weighing on firms, with higher interest rates reducing capital investment by more than 10 per cent by the end of 2023.[27] It is also weighing on public investment: a combination of rising debt interest and the Chancellor's desire for pre-election tax giveaways has led him to seek savings elsewhere: notably in deep cuts to public sector net investment (set to fall from 2.5 per cent in 2024-25 to 1.7 per cent of GDP by 2028-29 – equivalent to a £26 billion decline).[28] The greater cost of borrowing has also been pointed to as the rationale for Labour scaling back its £28 billion per year green spending pledge.[29]

This is significant for our net zero plans, and for the future cost of electricity, because higher interest rates also make private capital investment more expensive. Most of the cost of an offshore wind turbine is spent during the first ten years – building the foundations, procuring steel, and manufacturing turbines and nacelles – with investors shelling out for this upfront expenditure, on the promise that this will be returned, with interest, over a long period. Compared to financing electricity generated from gas or coal, this upfront expenditure is not only higher, but longer time periods between borrowing and creating revenue means it is likely to be paid back more slowly.

We can already see the implications of this for renewables generation, which is particularly sensitive to private borrowing costs. As interest rates have risen, the cost of capital for a typical offshore wind project has surged to close to 9 per cent.[30] During the 2024 CfD auction, policy makers responded to this by increasing the maximum ceiling on bids, thereby reversing the decade-long trend of lower strike prices agreed in CfD auctions.[31]

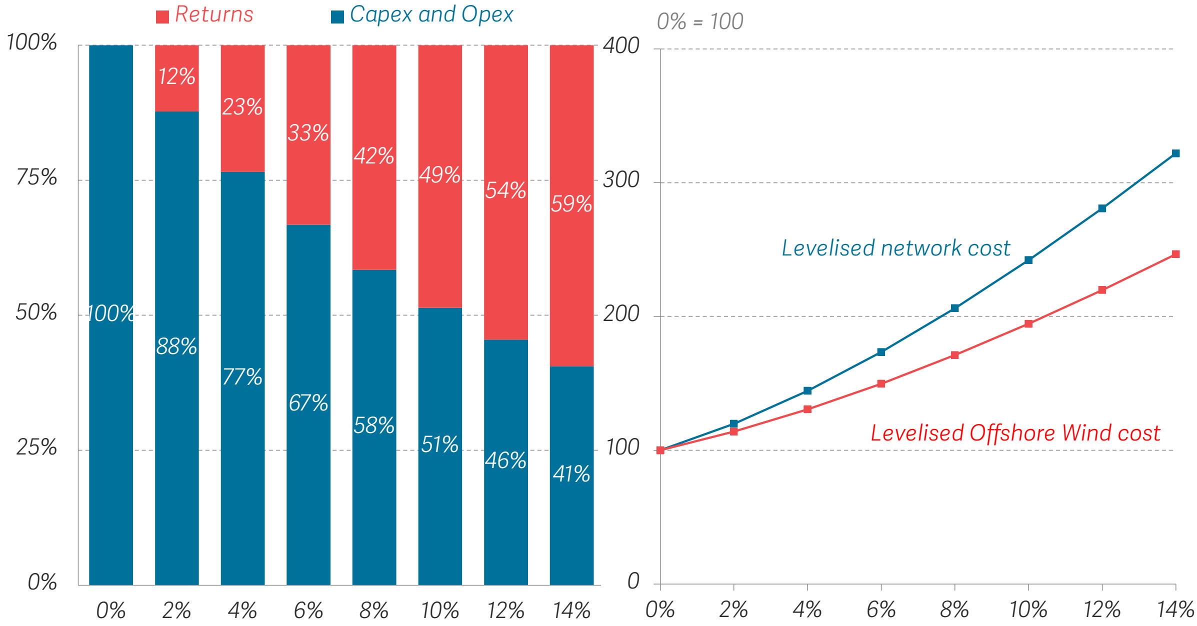
Unpacking this further, Figure 5 shows how the cost of electricity generated from an exemplar offshore wind project, and the cost of delivering network upgrades, increases rapidly as the cost of capital rises. For an offshore wind project financed at a cost of 5 per cent, less than a third (29 per cent) of total project costs would be repaying investors. Factor in a 4-percentage point rise in financing costs – close to the current value – and this figure approaches half of total project costs (45 per cent), pushing the price of electricity generated up by 31 per cent. These numbers are all much larger than for a gas-fired power station, where just 7 per cent of costs are investor returns at 5 per cent borrowing costs, or 11 per cent should the cost of capital increase by 4 percentage points. An increase in borrowing costs of this scale for a gas-powered plant would push up the cost of a unit of electricity by just 3 per cent.[32]

27 Bank of England, Latest Results from the Decision Maker Panel Survey – 2023 Q4, November 2023.
28 C Aref-Adib et al., Back for more?, Putting the Spring Budget in context, Resolution Foundation, March 2024.
29 J Pickard, Labour set to ditch £28bn-a-year green investment target, Financial Times, 8 February 2024.
30 See footnote 18.
31 Prices rose from £44/MWh in the unsuccessful CfD Allocation Round 5 to £73/MWh in CfD Allocation Round 6 (both in 2012 prices). Source: Department for Energy Security and Net Zero, Contracts for Difference (CfD): Allocation Round 6, March 2024.
32 The implications of higher interest rates are starker still for nuclear power stations, owing to their very high investment costs, long build times and longer asset lifetimes. For example, EDF's Hinkley Point C has been under construction since 2018 and is not anticipated to start generating until 2031. These long lead times mean that there is more time for interest to compound, pushing up overall costs. Additionally, very high upfront costs – the cost of Hinkley Point is now estimated at more than £30 billion – mean the impact of higher interest rates is far greater than that for other technologies.

This phenomenon isn't limited to generation, however, and is in fact even more pronounced for upgrading the nation's electricity network. A jump in borrowing costs from 5 to 9 per cent would add two-fifths (41 per cent) onto the cost of new capacity, with 55 per cent of the cost of electricity networks spent on investor returns if borrowing costs reach 9 per cent.

FIGURE 5: The capital-intensive nature of low carbon generators and of network assets mean they are highly sensitive to borrowing costs

Share of total offshore wind project costs spent on capital and operating expenditure vs returns (left panel), and estimated costs of new network and offshore wind capacity (right), at selected borrowing rates: GB



NOTES: Costs refer to levelised cost of electricity, which is a measure of the average net present cost of producing electricity over the lifetime of a generator, and represents the average revenue per unit of electricity generated to recover the costs of building and operating a generator over an assumed lifecycle. All in 2023 prices. Network costs are held at a 7.5 per cent Opex to 92.5 per cent Capex ratio in line with Ofgem's RIIO-2 Transmission Framework (excluding management expenditure).
SOURCE: Department for Energy Security and Net Zero Levelised Cost of Electricity calculator, Regulatory Assistance Project, Bloomberg New Energy Finance; Ofgem RIIO-2 ET Framework data.

These policy and economic headwinds combine to create high levels of uncertainty around the future trajectory of Britain's energy costs. We have enjoyed falling renewable prices in recent years, but policy makers cannot bank on returning to this in the near future. Instead, a better assumption would be that prices are uncertain – they could plausibly be higher or lower than they are today. With this in mind, we consider in the next section the distributional consequences of lower and higher electricity prices.

Future predictions are often too reliant on a single – and low – price forecast, but whether we arrive in a high or low-price world has big distributional consequences

To date, there has been a widely held assumption that decarbonising the power sector will be easy, delivering savings to households off the back of sharp falls in the cost of renewable technologies. This is a reasonable way to think about the past, where decarbonisation has had little discernible impact on energy bills, which comprised a similar share of household budgets in 2019 (before the pandemic and the energy crisis) as in 2012.[33] But this is a bad way to think about the challenge ahead. Heightened policy and economic uncertainty colliding with a need for a surge in investment means that future energy prices could be higher or lower than many working assumptions suggest.

Too often, analyses of future household energy costs do not confront this uncertainty, instead being based on just one price scenario in which historical trends continue into the future. In addition, it is often assumed that all households will benefit equally, regardless of how they consume energy.[34] But whether families are larger or smaller, drive more or less, or live in well-insulated flats or leaky detached homes, means that there is significant variation in energy demand between households. Given the way that future electricity costs are so reliant on the (uncertain) cost of capital, it is now particularly important to consider that there are a range of possible future energy prices, and that variations in energy consumption will lead to sizeable distributional impacts. Crucially, doing so will reveal that there are plausible scenarios in which some families spend more, not less, on energy in the future than they do today.

To illustrate this uncertainty, we use a simple, stylised model to show the impacts on household living standards of two such futures. First, we illustrate a low-price world, where government policy and regulation target low costs, and interest rates fall to a level such that the cost of private borrowing is around 5 per cent, comparable to that before the energy crisis.[35] Our second scenario imagines that policy and regulatory strategies focus on priorities other than cost minimisation and interest rates remain high – pushing the cost of private borrowing up by 4 percentage points to 9 per cent (comparable to the cost of borrowing faced by developers in 2024).[36] For each scenario, we illustrate the impacts on living standards for households across the income distribution, comparing

33 J Marshall & A Valero, The Carbon Crunch: Turning targets into delivery, Resolution Foundation, September 2021.
34 Valuable analyses by HM Treasury, the National Infrastructure Commission, and the consultancy firm DNV all look at the impacts of energy bills in the future, but are based on a single price level. See: HM Treasury, Net Zero Review final report, October 2021; National Infrastructure Commission, Energy and fuel bills today and in 2050, July 2018; and: DNV Energy Transition Outlook 2024, February 2024.
35 For example, see: H Edwardes-Evans, INTERVIEW: Capital cost hikes pressure UK offshore wind developers: K2 Management, S&P Global, March 2023; and: T Hansen et al., Five grand challenges of offshore wind financing in the United States, Energy Research & Social Science, Vol 107, January 2024.
36 Department for Energy Security and Net Zero, Contracts for Difference: Methodology used to set Administrative Strike Prices for CfD Allocation Round 6, November 2023.

2050 with 2019 (we use 2019 data to give 'typical' consumption, because data since then will be distorted by the Covid-19 pandemic or the 2022-23 energy crisis). We discuss how these scenarios are constructed in Box 3.

BOX 3: Modelling assumptions for low and high-price scenarios

To understand the impacts of future electricity prices, we used a simple model to account for household energy consumption across the income distribution. This accounted for use within the home and in private vehicles, and compared usage in 2019 with estimates for 2050. Current energy consumption for residential heating, cooking, appliances and lighting was calculated using data from the English Housing Survey, Ofgem's price cap methodology and the UCL Smart Energy Research Laboratory. Expenditure data was converted to actual energy consumption by calculating standing charges at the time, removing them from expenditure, and converting remaining spend in line with prices under the relevant energy price cap. Annual private vehicle mileage per household was derived from the National Travel Survey, converted to litres of petrol using CCC efficiency conversions for petrol cars, and weighted by household size.

Median consumption values were used for each equivalised after housing costs income quintile, with incomes derived from Households Below Average Income microdata.

To project forward to 2050, levels of energy consumption were deemed vto be unchanged, except for when converting gas consumption in heating to electricity in a heat pump, where a coefficient of performance of 3 was used. Energy in private transport was converted from petrol to electricity, and the efficiency of each was assumed to improve over time in line with Department for Transport (DfT) estimates. No further advances in heat pump efficiency were assumed, nor improvements to building energy efficiency. We used estimates of heat pump uptake from the CCC's Balanced Pathway, and the projected share of road miles driven in electric cars from the DfT's Road Transport Demand Model.

Current energy price data was taken from Ofgem's price cap methodology and DfT's weekly road fuel price indices. For future price scenarios, the 'low price' scenario was taken from the Treasury Green Book. For the higher-price alternative, it was assumed that CfD-backed generation would account for 80 per cent of demand. The price is based on CfD allocation round outcomes, and analysis of data from the Department for Energy Security and Net Zero's Levelised Cost of Electricity calculator, which shows the impact of varying interest rates, construction and infrastructure costs, and network charges for connection and use of system.[37]

Household incomes were projected forward using the OBR's long-run economic determinant baseline projections, holding the distribution constant.

Finally, this exercise only considered annual running costs (or energy bills). No fixed costs for new heating systems or private vehicles were included.

Under the low-cost scenario, expenditure on home and private vehicle energy is estimated to fall materially, with households across the income distribution spending significantly less than they did in 2019. Figure 6 shows that all households would spend 1-2 per cent of their incomes on energy in 2050, equating to cash savings of between £250 and £1,000 per household (in 2024 prices).

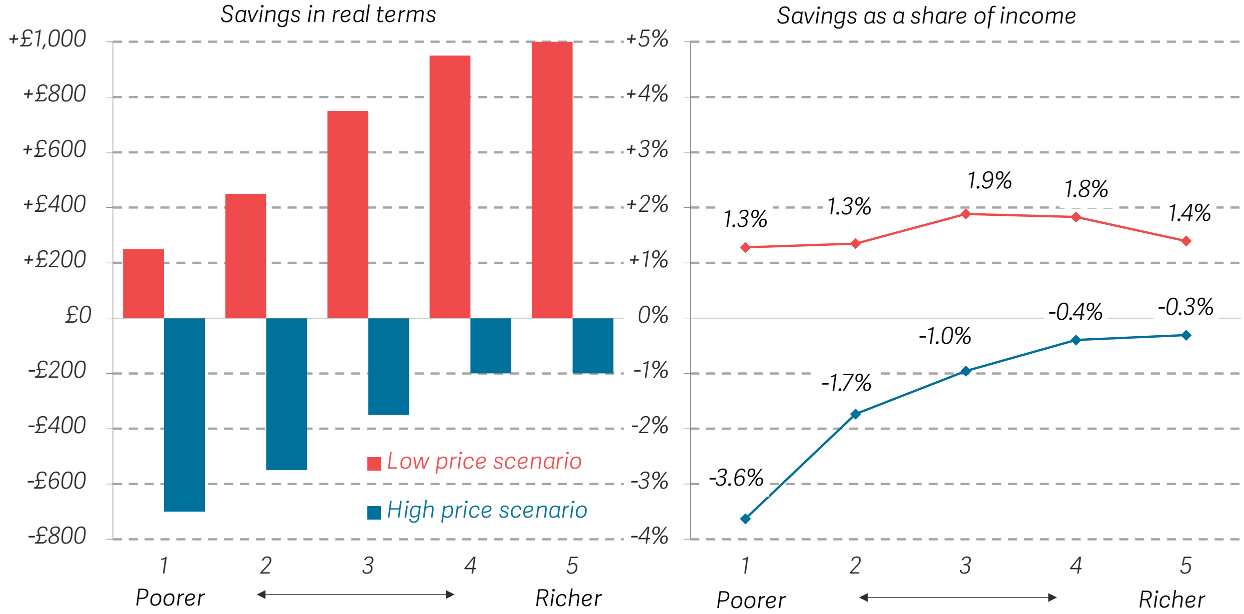
On the other hand, a future powered by higher-priced electricity could add £29 billion to household energy bills per year by 2050 (compared with low-prices in 2050). This would cause severe financial strain for low-income households: energy spending for the poorest households could consume 3.6 per cent more of incomes than it did in 2019 – a 40 per cent increase in real-terms, compared with 2019. In contrast to low-income households, however, spending by richer households would remain largely unchanged between 2019 and 2050, spending just 0.3 per cent more of incomes. Worryingly, in contrast to the sharp, but relatively brief, price increases during the cost of living crisis, the UK's policy framework – in which prices are agreed and fixed for the duration of long-term contracts – would lock households into these high prices for several years.

Here, of course, the choice of baseline is important. Box 4 shows how, compared with current energy prices, households across the income distribution are all set to benefit in 2050, even if in our high-cost scenario.

37 Department for Energy Security and Net Zero, Electricity Generation Costs (2020), August 2020. Inputs for the LCOE model were derived from: Department for Energy Security and Net Zero, Contracts for Difference: Methodology used to set Administrative Strike Prices for CfD Allocation Round 6, November 2023; Department for Energy Security and Net Zero, Electricity Generation Costs 2023, first published August 2023, updated November 2023; and: ONS, Consumer price inflation, UK: February 2024.

FIGURE 6: A world of cheap electricity brings benefits for everyone, but poorer households will be disproportionately impacted if prices are high

Modelled savings on total energy expenditure compared to 2019 as a share of disposable income, by equivalised after housing costs income quintile (in 2024-25 prices): GB, 2050



NOTES: Figures compare annual energy spending in 2019 with estimated spend in 2050 under a high-price and low-price electricity cost scenario (excluding fixed costs). This reflects heat pump and EV uptake outturns and forecasts for 2023, as well as the prices households faced. See Box 3 for more information.
SOURCE: RF Analysis of DfT, National Travel Survey; Climate Change Committee Sixth Carbon Budget; Living Costs and Food Survey; English Housing Survey; DWP, HBAI; HM Treasury, Green Book; UCL SERL; MCS Foundation; DfT Road Transport Demand Model data.

We can shine more light on the drivers of this disparity by disaggregating total expenditure figures into energy consumed in the home and in private vehicles, which we do in Figure 7. Our modelling suggests that, in a future powered by low cost electricity, a small uptick in residential energy expenditure is more than compensated for by big savings in transport costs. On the other hand, should prices follow those in our high-priced scenario, a sizeable increase in spending on energy in the home – especially for poorer households – will exceed savings from transport. Although our estimates come from a fairly simple model, the results are in line with other work showing that cheaper motoring is set to deliver the majority of savings across the entirety of the net zero transition (surface transport comprises 70 per cent of all operational cost savings to 2050, according to CCC modelling).[38]

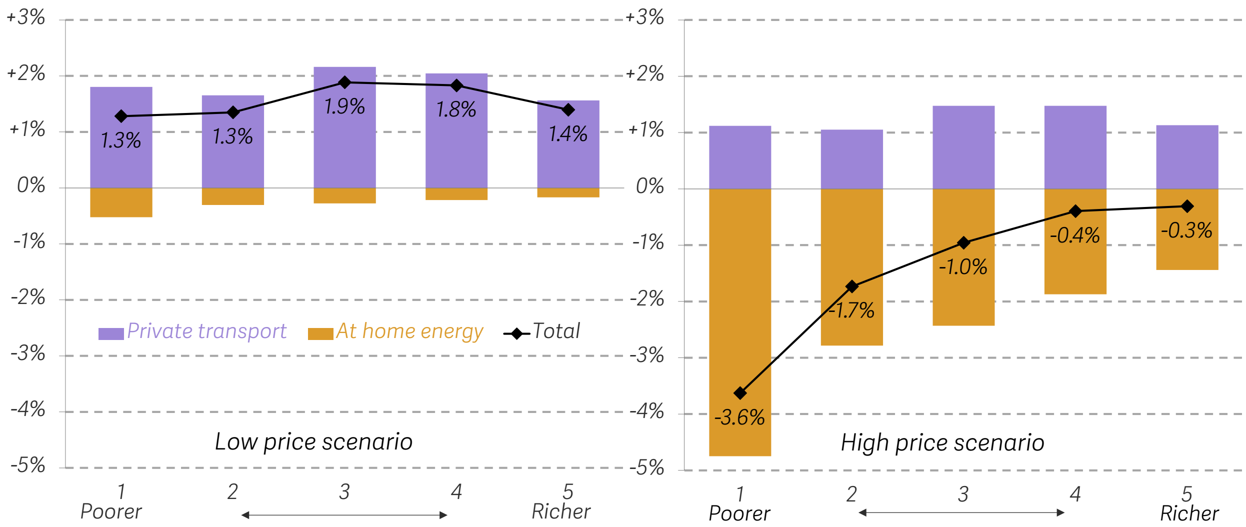
These results are perhaps counterintuitive, because heat pumps are slightly more efficient than gas boilers. The fact that residential energy expenditure is set to rise reflects in part that gas is currently artificially cheap compared with electricity: more than a quarter (25.5 per cent) of an electricity bill in 2021 were environmental and social obligations, compared to just 2.5 per cent of a gas bill.[39]

38 Analysis of Climate Change Committee, Sixth Carbon Budget, December 2020.
39 Ofgem, Breakdown of a gas bill & Breakdown of an electricity bill, August 2021.

Most significantly though, households are more vulnerable to changes in the cost of energy used in the home than to the cost of energy used in private transport. This is because households (and particularly lower income households) spend a greater proportion of their incomes on home energy consumption compared with private vehicle energy consumption. For example, home energy comprises 70 per cent of low-income household's energy budgets in 2019, rising to 85 per cent in 2050 as the relative improvements in EV efficiency outweighs the relative improvements in heating efficiency. Low income households therefore benefit less from low cost electric vehicles.

FIGURE 7: **In a high electricity-cost scenario, the extra cost of heating homes would outweigh the savings to households of private electric vehicles**

Savings on total energy expenditure compared to 2019 as a share of income by mode of consumption, by equivalised after housing costs income quintile (in 2024-25 prices): GB, 2050



NOTES: Figures compare annual energy spending in 2019 with estimated spend in 2050 under a high-price and low-price electricity cost scenario (excluding fixed costs). See Box 3 for more information.
SOURCE: RF Analysis of DfT, National Travel Survey; Climate Change Committee Sixth Carbon Budget; Living Costs and Food Survey; English Housing Survey; DWP, HBAI; HM Treasury, Green Book; UCL SERL; MCS Foundation; DfT Road Transport Demand Model data.

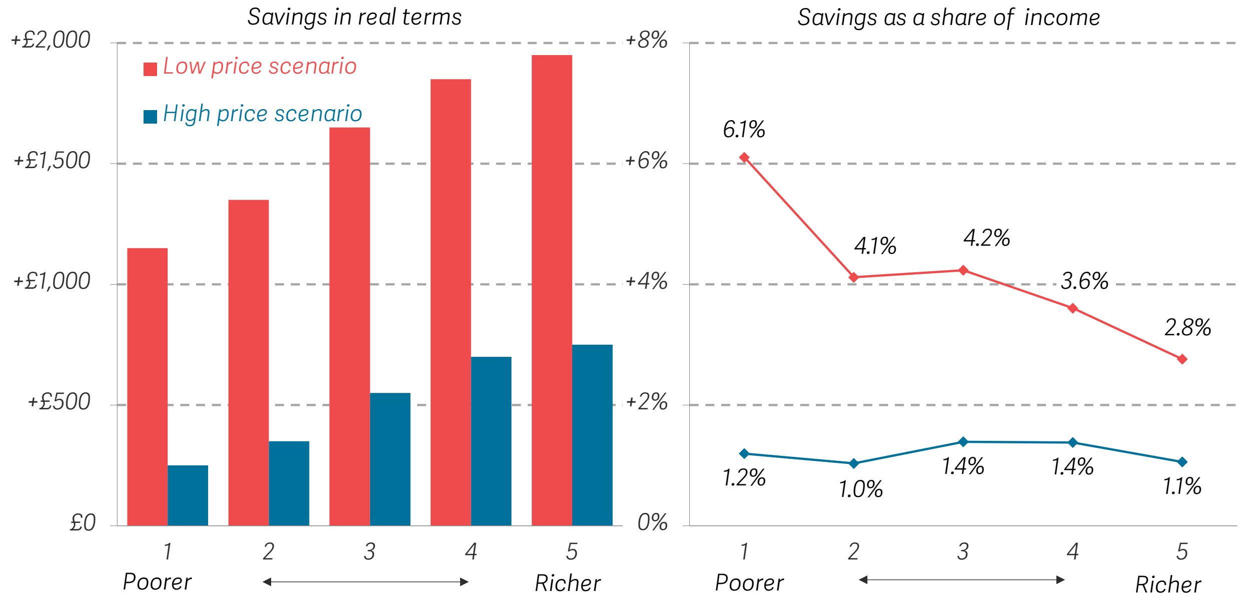
BOX 4: All households will save money in our 2050 scenarios compared to the 2023 European energy crisis

The choice of baseline energy prices really matters. Other work uses 2019 as a baseline to avoid changes in consumption fuelled by behavioural change during the pandemic or steep increases in prices resulting from the energy crisis.[40] However, many will look to compare to the current situation instead.

When we compare energy spending in 2050 to that experienced in 2023, all households are likely to be better off, even if prices are high. Figure 8 illustrates that the high price scenario in 2050 results in both real terms savings of between £250 and £750 compared with consumer electricity and gas prices in 2023, corresponding to between 1 and 1.5 per cent of after housing costs (AHC) incomes.[41] In a low-price future, households can expect to save as much as £1,000 to £2,000 in 2050 – equal to 6 per cent of disposable incomes for low-income households – compared with energy spending in 2023.

FIGURE 8: **Even in our high-cost 2050 scenario, all households will save money compared to the European energy crisis**

Savings on total energy expenditure in 2050 compared to 2023 in real terms (left panel) and as a share of income (right panel), by equivalised after housing costs income quintiles (in 2024-25 prices): GB



Notes: Figures compare annual energy spending in 2023 with estimated spend in 2050 under a high-price and low-price electricity cost scenario (excluding fixed costs). This reflects heat pump and EV uptake outturns and forecasts for 2023, as well as the prices households faced. See Box 3 for more information.
source: RF Analysis of DfT, National Travel Survey; Climate Change Committee Sixth Carbon Budget; Living Costs and Food Survey; English Housing Survey; DWP, HBAI; HM Treasury, Green Book; UCL SERL; MCS Foundation; DfT Road Transport Demand Model data.

40 The impacts of higher energy prices on household consumption are yet to be fully understood, however initial data shows that residential gas demand was 13 per cent lower in 2022 than in 2019, and 19 per cent lower in 2023 than in 2019. Analysis of Department for Energy Security and Net Zero data.

41 Here, we hold consumption levels fixed, although increase the use of heat pumps and electric vehicles from 2019 levels in line with projections.

While no baseline period is perfect for this analysis, it is arguable that 2019 is less imperfect than 2023. Comparing household energy spending in 2050 with that during the energy crisis does not represent a 'typical' period for electricity prices: consumer energy prices remained close to twice their 2019 levels in 2023.[42] Although prices in the 2020s are likely to change from year to year, using 2019 prices as our baseline allows us to compare with a period of relative stability.[43]

This exercise adds some much-needed colour to how future energy prices could impact household living standards. The historical trend of ever cheaper renewable energy means that a low-priced world has been a respectable working assumption. However, this can no longer be taken as a given.

Once we recognise that price uncertainty has increased, we can think about the energy transition in new ways, with a focus on protecting the lowest-income households from bearing unfair costs. Part of this should include a realigning of government policy so that it takes cost reduction as its primary aim. But this can only go so far. Achieving the low-price scenario that we examined above would also require a dose of good luck in the form of interest rates falling, something outside of any UK government's control. As such, we must take the risk of high prices seriously, and think carefully about how to mitigate their impacts on lower-income households.

Higher prices shouldn't mean slower progress in decarbonising the power sector

We have shown above that our current approach for paying for power sector investment could lead to untenable distributional outcomes if we end up in a high interest rate, high cost world. But responding by pausing or slowing the pace of power sector decarbonisation is not an option. Scaling investment in the power sector is a prerequisite for the net zero transition at large, underpinning decarbonisation of transport, homes and industry, but it is also key to mitigating sizeable near- and long-term risks. In particular, large parts of our current generation capacity is set to retire this decade – by 2028, the UK's nuclear fleet will have fallen from eight power stations to just one – exposing Britain to a potential supply crunch if they are not urgently replaced.[44]

A clean power system will also bring macroeconomic benefits. First, it will also reduce our dependency on imported fossil fuels, and therefore our exposure to international energy

42 Analysis of Ofgem Price Cap and UCL Smart Energy Research Laboratory data.
43 Ofgem, Retail price comparison by company and tariff type: Domestic (GB), March 2024. Total fuel bill ranged from £950 to £1,350 (in 2024 prices) between 2012 and 2019.
44 National Grid ESO, Future Energy Scenarios, 2023; and: Department for Energy Security and Net Zero, Energy security strategy, March 2024.

shocks. The UK is a net energy importer, importing £17 billion more gas than we exported in 2023 (in 2019 – pre-energy crisis – this figure was £4.5 billion).[45] These imports are a significant contributor to our large current account deficit, and leave the UK exposed to terms of trade shocks feeding through into domestic price inflation.[46] Generating more energy domestically – and especially at fixed prices – will insulate the UK from volatile international oil and gas markets, thereby curbing the ability of fossil fuels to drive up inflation: of the peak of 11.1 per cent inflation during the 2022-23 energy crisis, 70 per cent was due to energy prices or sectors with high energy intensity.[47]

Instead of thinking that we should cut back investment if the cost of capital rises, we must instead look to both existing and new approaches to mitigate the downsides of a world in which energy prices are higher than previously envisaged.

Policy makers need to plan for the worst to avoid untenable pressure on low income households

By thinking differently about the future, recognising uncertainty and not taking lower prices for granted, it becomes clear that we need to be ready to implement measures to protect living standards. In forming this plan, there are three key considerations: keep costs down where possible, a social tariff is the key to a fairer distribution of costs, and billpayer funding may not be enough.

Policy needs to keep costs down where it can

Of the headwinds facing the electricity sector, it is those caused by policy where the government has the most agency, and as such the first port of call should be a renewed focus on lower costs.

The key short-term risk here is that of overpaying for energy contracts. Pressure in supply chains and high borrowing costs have led to the Government increasing the bid limit for the next (2024) renewable energy auction, up by 66 per cent for offshore wind, for example, allowing companies to ask for higher prices.[48] But policy makers should be wary of accepting these higher costs too readily, or for a sustained period of time as, once signed, prices will be locked in for at least 15 years. Despite calls to allocate a very high budget to this auction in order to procure more capacity, a considered approach

45 Analysis of HMRC, UK Trade Info: Build an overseas trade data table, March 2024.
46 Although countries can run successful growth strategies with large current account balances (e.g. the US), the UK not only has the second largest current account deficit in the world, but it has been in deficit for 40 years, which can present macroeconomic risks. See: IMF, External Balance Assessment (EBA): Data and Estimates, August 2022; and: M Carney, A Fine Balance - speech by Mark Carney, June 2017.
47 ONS, Contributions to the 12-month rate of CPI(H) by import intensity, March 2024.
48 Department for Energy Security and Net Zero, Boost for offshore wind as government raises maximum prices in renewable energy auction, November 2023.

would balance the need to encourage firms to accept lower profits (to keep a lid on costs) with that for a rollout at a pace cognisant of the rising demand for clean energy. Acting too hastily in one direction would lead to higher prices that risk undermining the transition in years to come, while the other would leave the UK hooked on high carbon fuels for longer than needs be.

But there are more energy policy levers at play than just auction design.

One of the most extensively debated energy policy choices is the near-decade-old decision to curb the development of onshore wind and large-scale solar in England, on the grounds of unpopularity among local communities.[49] During this time, onshore wind has benefitted from significant technological progress, such that it now outcompetes all other forms of generation on cost. Government analysis shows that an onshore wind project commissioned in 2025 would deliver electricity at a cost of £38/MWh, less than the £44/MWh for offshore wind and significantly lower than £114/MWh for a new gas plant.[50]

As a result, it has been estimated that Britain entered the 2022 energy crisis with a 'gap' in onshore wind capacity that had to be generated from gas, resulting in an extra £5 billion in electricity costs across the economy.[51] This outcome led to higher bills for everyone, but it was those on the lowest incomes that were hit particularly hard – spending an extra 0.6 per cent of annual incomes on higher-priced electricity from gas, compared to 0.1 per cent for the richest – as Figure 9 shows. So, the benefits of lower-cost electricity are clear to see.

49 Department of Energy and Climate Change, Ending new subsidies for onshore wind, June 2015.
50 Department for Energy Security and Net Zero, Electricity Generation Costs 2023, August 2023. Note that quoted prices for gas power plants include carbon prices which, at the time of writing, are significantly higher than those in operation. Figures quoted are in 2012 prices, in line with the Government's preferred way of referring to CfD auction results.
51 S Evans, Analysis: UK's gas imports would be 13% lower if it had not 'cut the green crap', Carbon Brief, October 2022. This cost would be apportioned in line with electricity demand, with around one third falling to households, an average of £60 per household.

FIGURE 9: The poorest families are feeling the brunt of decisions to stall onshore wind development

Annual additional expenditure on electricity bills as a share of household income resulting from stalling onshore wind development in England, by equivalised after housing costs income quintiles: GB, 2022-23

NOTES: Figure based on aggregate savings of £5.1 billion in 2022-23, apportioned in line with the share of residential electricity consumption and median electricity consumption within income deciles. Assumed that energy consumption figures for households in Scotland and Wales are in line with those in England.
SOURCE: Analysis of Carbon Brief, English Housing Survey, ONS Households Below Average Incomes data.

The trade-off between local politics and wider benefits is also playing out in our electricity network, which has not been built at a pace sufficient to cope with rising demand.[52] Ensuring that inefficiencies in the power grid today become a thing of the past will require pylons and substations to actually be built somewhere, and care must be taken not to give undue weight to suggestions of more expensive (if perhaps less visually obtrusive) alternatives that will push up energy costs for everyone.[53]

A second issue affecting future costs concerns nuclear power. The majority of projections of the UK's future electricity supply include a significant role for nuclear power, yet the Government's long-term nuclear programme is based on negotiating deals for bespoke projects bilaterally with developers. This piecemeal approach both limits the power of competition to force prices down, and fails to capitalise on economies of scale and learning that comes with building fleets instead of individual units. As such, the UK has been labelled the second-most expensive country in which to build nuclear power stations; costs are

52 This lack of capacity means that those looking to connect new sources of demand are routinely being informed of a ten-year wait to connect to the grid, leaving projects in limbo and costs mounting up, while housing developments, new data centres and other sources of electricity demand are unable to progress as local networks are not capable of delivering the energy they need. For more, see: Department for Energy Security and Net Zero, Connections Action Plan, November 2023. For examples on grid capacity delaying demand-side connections see: J Tapper, Capacity crunch on National Grid is delaying new homes in UK by years, The Observer, 10 March 2024; and: C Gallardo, UK's power struggle gets real as data centres plea for energy reforms, Sifted, December 2023.

53 For example, the cheapest way to deliver new electricity network capacity is to use pylons, which are relatively inexpensive compared with other options, such as underground cables or those under the sea. However, pylons do come with visual impacts, frequently leading to political resistance from affected communities.

more than double those in South Korea, where a fleet approach has been successfully deployed.[54]

Finally, the continued use of energy policy to deliver industrial and social policy goals also means costs are higher than they would be were these targets funded differently. Social policy costs have long been added to energy bills, with the Warm Homes Discount first introduced and levied on bills in 2011, but a recently proposed move to introduce mechanisms that value wider benefits – such as building domestic supply chains or creating new employment opportunities in deprived areas – into renewable auctions will lead to higher prices for households.[55] The issue here is not that the targeted policy goals aren't desirable – spreading high-skilled jobs around the country will strengthen local economies, and make the UK less reliant on imported components – but with energy prices such an important factor in living standards, a better approach may be to fund them outside of household bills.

We may need to look to welfare and energy retail policy to insulate poorer households from high costs

The key lesson from the discussion above is that policy makers should try to keep costs down wherever possible. But with high interest rates the key driver of higher costs, good policy is only likely to impact prices at the margin.

As such, the second consideration is that we may need to look beyond conventional energy policy – to either the benefits system or to energy retail policy – to protect the living standards of low-income households, and especially those with higher levels of energy use (Box 5 adds colour to previous RF research on this issue).

54 Britain Remade, Revealed: Britain is one of the most expensive places in the world to build new nuclear, December 2023.
55 Department for Energy Security and Net Zero, Introducing non-price factors into the Contracts for Difference scheme, April 2023.

BOX 5: Who are low-income high-energy users, and what drives high consumption?

The majority of discussion on how energy consumption differs across households focuses on increasing energy use as we move up the income distribution. While this is certainly true – households in the richest decile currently consume 15 per cent more electricity and 22 per cent more gas than those in the bottom decile – using this problem statement as a base for policy overlooks the fact that variation within income bands is much higher than across them.[56]

Understanding what drives high levels of energy consumption, and how these drivers vary by household income, is therefore key to understanding why certain groups are particularly at risk from high energy prices. As such, Figure 10 shows the results of a dominance analysis of the factors driving high energy use – that is, how much each observed characteristic can independently account for a household being in the top third of combined gas and electricity consumption. It shows that, for most households, inefficient housing is the main driver of high energy demand – accounting for half of the variation that our data can explain for low-to-middle income households. As we move up the income distribution, however, floor area and dwelling type increase in importance, together accounting for more than half (54 per cent) of the variation explained by our model for the highest income quintile.

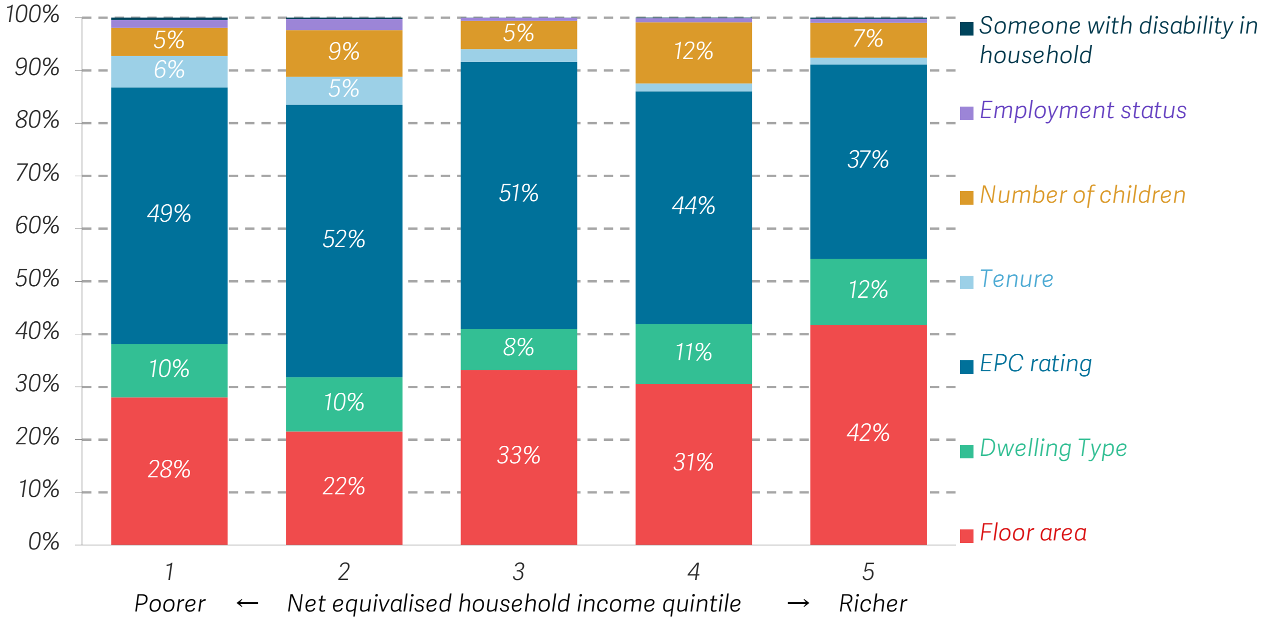
These findings are important for how policy can best respond. Poorer families in badly insulated homes are less likely to be able to afford the upfront costs of improvements, and in many cases will be living in rented properties and therefore be lacking the agency to do so.[57] On the contrary, richer households are far more likely to be able to shoulder the cost of efficiency upgrades, while higher energy bills that result from opting to live in a larger home should not be a worry for the state.

56 Analysis of English Housing Survey data. For a more detailed discussion on within income band consumption variation, and its impact on low-to-middle income households, see: M Brewer et al., A Chilling Crisis, Resolution Foundation, August 2022; and: HM Treasury, Net Zero Review Final Report, October 2021.

57 A Anis-Alavi et al., Hitting a brick wall, Resolution Foundation, December 2022.

FIGURE 10: **Inefficient homes are the main driver of high energy consumption in poorer households, but for richer families it is bigger homes**

Proportion of the variance of high energy consumption that is explained by selected factors, by after housing costs income quintile: England, 2021-22



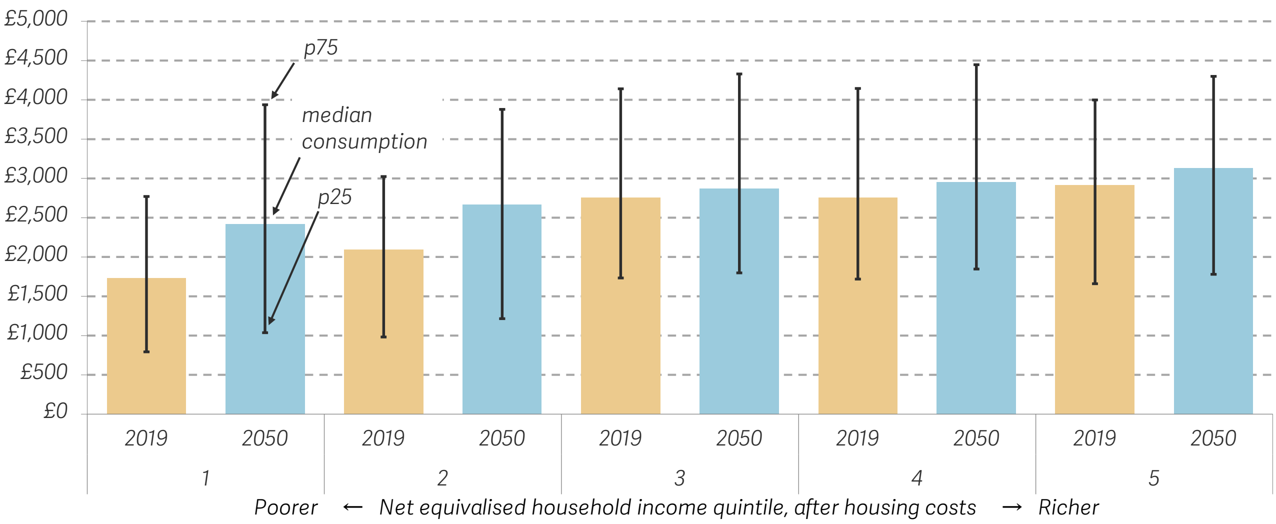
NOTES: This chart uses a decomposition method called dominance analysis to assess the explanatory power of each factor. The method runs a linear regression with each possible combination of explanatory variables and compares the change in the amount of variance explained for each household income quintile. The dependant variable is a binary outcome of whether a household has high energy use, which is defined as those with energy use in the top third of all households. The independent variables are whether anyone in the household has a disability or long-term illness, whether anyone in the household is unemployed, the number of children in the household, the type of tenure, the energy efficiency (EPC rating) of the household, the dwelling type (flat, terrace, detached etc.), and the floor area.
SOURCE: RF analysis of DLUHC, English Housing Survey.

Within income-band variations in energy consumption are high today, and will remain so even as all households replace petrol and diesel in cars and gas in boilers with electricity. Currently, an average high-consumption household (defined here as one at the 75th percentile of combined gas, electricity and petrol/diesel consumption) spends 165 per cent more on energy per year than one with low consumption (i.e. at the 25th percentile). This average figure will remain largely unchanged (increasing marginally to 170 per cent in 2050).

However, this disparity is bigger at the bottom of the income distribution than at the top, and will remain so as households decarbonise their energy use. In the lowest income quintile, a high-consumption household consumes 250 per cent more energy than one with low consumption (set to increase to 280 per cent by 2050) while the current p25-p75 gap of 140 per cent in the top income quintile will be unchanged by mid-century (see Figure 11).

FIGURE 11: **High levels of within income-band variation on energy spending will persist in the future**

Annual expenditure on energy in the home and in private vehicles, at selected consumption percentiles, by equivalised after housing costs income quintiles: UK, 2019 and 2050



NOTES: Figure compares annual energy spending in 2019 and 2050 under a high-price electricity cost scenario (excluding fixed costs). See Box 3 for more information.
SOURCE: RF analysis of National Travel Survey, Climate Change Committee Sixth Carbon Budget, Living Costs and Food Survey, English Housing Survey, HBAI, Treasury Green Book, UCL SERL, MCS Foundation, DfT Road Transport Demand Model data.

As well as increasing in size for some, this large variation on spending coming through just one bill for electricity (compared to the status quo where car fuel costs and residential energy bills are separate) will mean it is more visible to households[58]. As such, it is this variation in consumption – and therefore exposure to potential high prices – that should dictate how policy responds.

An obvious response to high energy prices would be to look to the benefits system. However, there are limits to how welfare policy can successfully intervene – it is currently blind to actual levels of household energy consumption, and responds to unaffordable bills through either fixed payments or by using cold weather as a proxy for periods of high consumption (but not addressing sustained high levels of energy use). As such, it is not set up to account for different levels of energy use between different households. On the other hand, energy retail policy is built around knowledge of household demand, but does not know who is poor and who is not.[59]

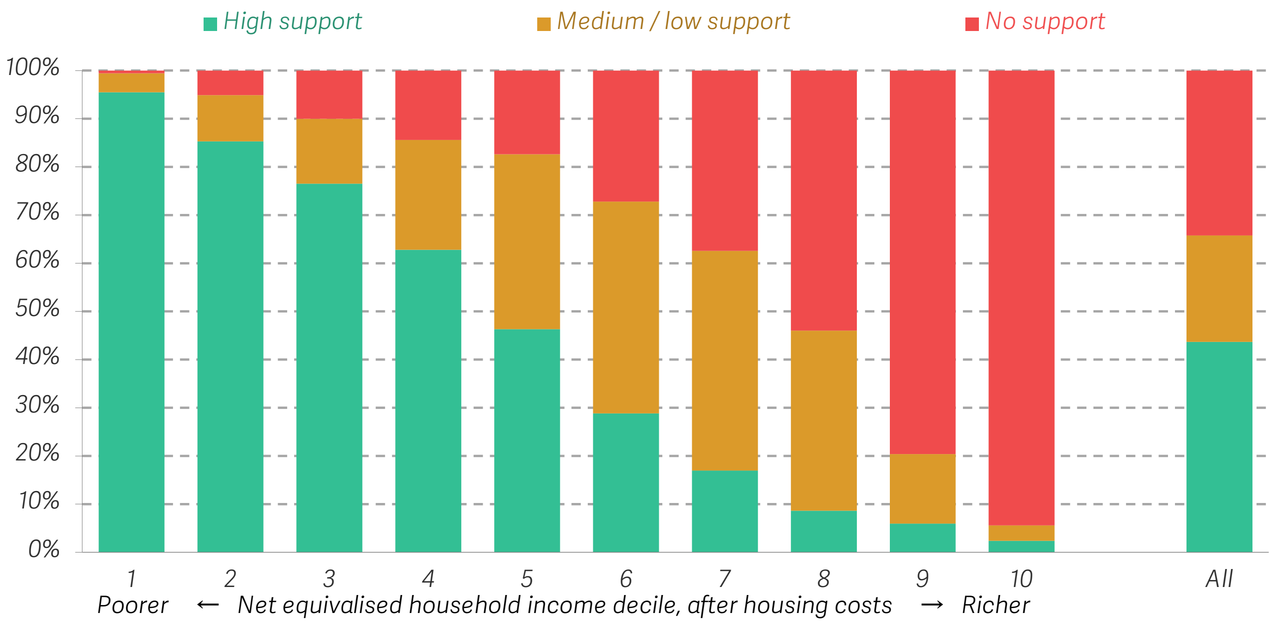
58 Those households without off-street parking might continue to have two bills.
59 For a deeper discussion, see: M Brewer et al., A chilling crisis: Policy options to deal with soaring energy prices, Resolution Foundation, August 2022.

But the scale of the impacts from higher future energy prices will mean that these issues cannot be used as an excuse for inaction. As such, it seems inevitable that calls for a social tariff, where different families pay different prices for energy based on qualifying criteria such as incomes, age, or household composition, will grow. In fact, it is the only tangible option if support offered is to be scaled in line with energy demand.[60]

An example of how a social tariff can be designed to ensure that low-to-middle income households avoid sizeable reductions to their living standards is presented in Figure 12. Under this illustrative tariff, households where anyone receives means-tested benefits or no adult earns more than £25,000 would receive high support, and those where no adult earns more than £40,000 per year would receive low-to-medium levels of support. Households where an adult earns more than £40,000 per year and who receive no means-tested benefits would receive no support.[61] Obviously these levels of support can be varied over time to ensure living standards are not unduly impacted.

FIGURE 12: **A social tariff can be tailored to support poorer households from high energy bills**

Proportion of households eligible for support with high energy costs via an illustrative social tariff, by equivalised after housing costs income deciles: GB



NOTES: For more detail on the design and implementation of a social tariff see: M Brewer et al., A chilling crisis: Policy options to deal with soaring energy prices, Resolution Foundation, August 2022.
SOURCE: Rf analysis of IPPR Tax-Benefit Model and DWP, Households Below Average Income.

60 A social tariff would also provide incentives for lower income households to further electrify their energy demand, through cheaper unit prices for electricity that would also improve the economics of heat pump or electric car uptake. When compared to other options for energy support that vary with consumption, such as a rising block tariff where only a certain amount of consumption is charged at a lower rate before prices rise, a social tariff would, crucially does not disincentivise higher income households from adopting heat pumps or electric vehicles which increase their electricity use.

61 These support bands could, and should, vary depending on the extent to which energy prices are a driver of reductions in living standards. For more details see: M Brewer et al., A chilling crisis: Policy options to deal with soaring energy prices, Resolution Foundation, August 2022.

We may need to fund investment through taxpayers instead of billpayers

The third, and by far most drastic, concern is whether the current model – whereby investment is financed privately and repaid through energy bills – can be maintained, or if investment should be funded directly by taxpayers instead. This debate mirrors current discussion around the water industry and railways; if acted upon, it could see the state funding and owning large chunks of the electricity system for the first time in decades, and break with widely held assumptions that the power sector transition will be largely financed privately.[62]

However, tax-funding the entirety of the transition would come with costs (around £40 billion per year over the next decade) too sizeable to fit within the UK's strained fiscal position. As such, it is worth thinking about where the state balance sheet could be best used with the most impact.

In particular, of the two broad types of electricity sector investment needed – generation and networks – it is the latter that stands out as being more appropriate for direct government funding. First, estimates of overall spending needed by 2040 are much lower for networks than for generation (£13 billion per year from 2030-40 for networks, compared with an average of £30 billion per year for generation, as we saw in Figure 2), so the sums involved should prove less traumatic for the public finances. Second, as Figure 5 showed earlier, network costs are more sensitive to the cost of borrowing than those of generation, allowing the state to get more 'bang for buck' from using cheaper public borrowing: a 4 percentage point fall in the cost of capital (equivalent to the difference between long run UK gilts and bonds issued by network companies) would save 29 per cent on costs.

Potentially most importantly, though, is that using state funding to pay for investment allows for a much fairer distribution of who bears the costs. Figure 13 shows how the costs of £1 billion of bill-funded investment is spread across the income distribution if funded through standing charges, as is currently the case for transmission network investment, or through unit charges, as is currently the case for investment in the distribution network. Standing charges are applied at a flat rate to all households, regardless of energy consumption or incomes, and therefore funding investment in this manner consumes a greater share of budgets for poorer families. Investment outlay funded through unit charges will see those who use more energy pay more, but will place an unfair burden on lower-income households with high levels of energy use. Figure 13 also shows how these costs would be shared across the tax base instead, with a more equitable distribution: costs as a share of income will be flat across the income distribution.

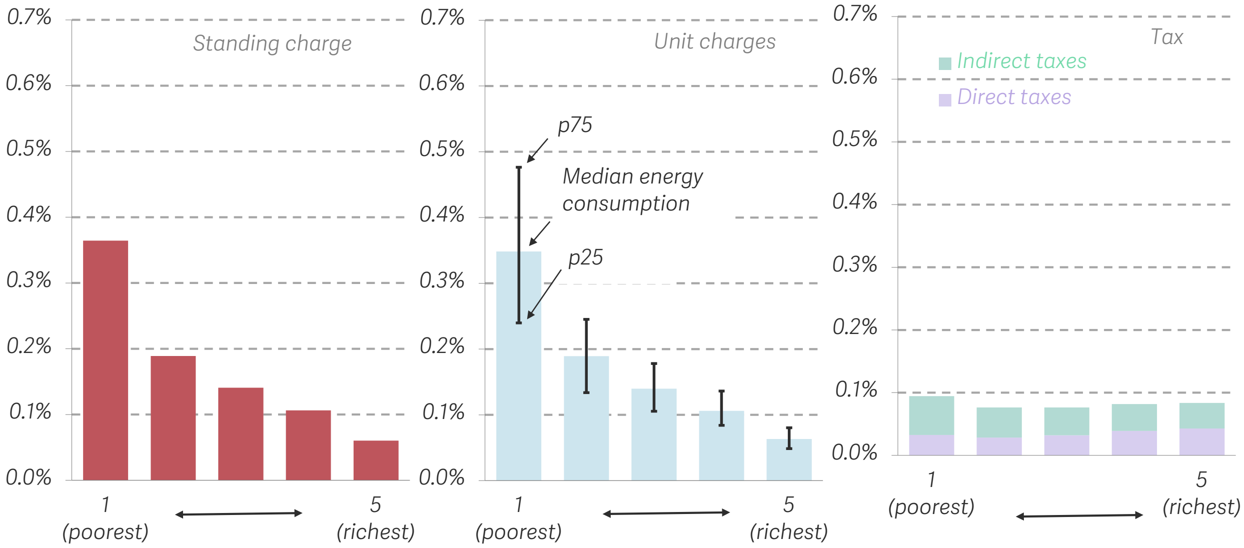
62 See, for example, Office for Budget Responsibility, Fiscal Risks Report, July 2021.

Further, a tax-funded approach would help smooth inequalities that are likely to result from a (much needed) push to anticipatory investment – or, in other words, a strategy in which energy infrastructure is constructed in expectation of demand materialising, rather than in response to it.[63] Anticipatory investment is widely regarded as essential to a smooth and low-cost energy transition, but has been historically rebuffed by the regulator on grounds of fairness.[64]

An everyday example of this is the need to strengthen local, low voltage networks as electric car use grows. Eventually, most households will make use of this infrastructure, but in the short term the costs of this infrastructure will be funded by all household's energy bills, with low income households paying more as a share of their disposable income than high income households, whether they drive an electric car or not. Employing taxpayer resources to fund these upgrades instead would be much fairer.

FIGURE 13: **Funding investment through the tax system would lead to a much flatter burden on households across the income distribution than using energy bill standing charges or unit charges**

Share of annual household expenditure needed to fund £1 billion of investment via standing charges (left panel) or via unit charges at selected consumption levels (centre panel), or through the tax system (right panel) by equivalised after housing costs income quintile: GB, 2024



NOTES: Figures show £1 billion of investment, apportioned to households in line with current share of total electricity demand. Consumption percentiles based on combined gas and electricity use.
SOURCE: RF analysis of ONS effects of tax and benefits on UK household income, English Housing Survey, Department for Energy Security and Net Zero, ONS Households Below Average Incomes data.

63 For more detail see: Ofgem, Consultation on the Early-Stage Assessment for Anticipatory Investment, May 2023.
64 Department for Energy Security and Net Zero, Strategy and Policy Statement for Energy Policy in Great Britain, May 2023.

However, leaning on the tax system would bring a different type of delivery risk, as energy investment is forced to compete with other public spending needs, such as that in schools and hospitals, or with different governments' ambitions for the size of the state, or of the stock of outstanding government debt. Upending more than 40 years of energy policy, in which billpayer funding and private delivery has been prioritised, represents a drastic option, but with the need to invest as paramount as that to protect living standards, policy makers may find themselves with few alternatives.

Conclusion

The electricity sector is no stranger to wider investment issues that are holding the country back. But with the UK's journey to net zero contingent on deep and rapid decarbonisation of the power system, the sector requires an urgent step change in capital spending. This challenge, however, comes at a time of great uncertainty over costs, with strong headwinds from both high interest rates and policy and regulatory decisions.

This increases the scale of the challenge ahead of us if we are to decarbonise the electricity sector and others that are dependent on clean electricity. Slowing or pausing investment is not an option, and so policy makers need to ensure that the needed upgrades can be made without unduly impacting household living standards. The best possible outcome – where interest rates fall and policy focuses on lowering energy costs – will see all households benefit from lower energy spending in the future, but if low prices cannot be delivered then it will be those on lower incomes who will find themselves under pressure. As such, governments should be planning how best to respond.

This paper outlines three potential approaches that could be in play in a world in which higher prices stick around: a core focus on keeping costs down; protecting vulnerable households via a social tariff; or even allowing the transition costs to fall to taxpayers instead of billpayers. All should be options considered by this and future governments to ensure that the decarbonisation of Britain's electricity grid does not increase pressure on the budgets of low- and middle-income households.

The Resolution Foundation is an independent research and policy organisation. Our goal is to improve the lives of people with low to middle incomes by delivering change in areas where they are currently disadvantaged.

We do this by undertaking research and analysis to understand the challenges facing people on a low to middle income, developing practical and effective policy proposals; and engaging with policy makers and stakeholders to influence decision-making and bring about change.

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