Oxford Smith School
of Enterprise and
the Environment

Policy brief
Getting a Good Deal on Net Zero

Summary

- **A changed economic context**
  Even if the current high cost environment prevails, a new set of analyses shows the UK can get a good deal on net zero, minimising costs to people and the public purse, with the co-benefits of improved homes, reduced bills, more jobs, and less carbon.
- **Impact on government**
  Additional annual public investment in low-carbon technologies needed from now to 2030 could be limited to £6bn–£8bn per year with a balanced policy mix to crowd in private investment. Our approach is based on calculating the required public funding to close 'gaps' in the Total Cost of Ownership (including capex, opex and carbon taxes, and discounting future costs) over asset lifetimes between 'clean' vs. fossil technologies used in different sectors.
- **Impact on households**
  A well-coordinated household sector transition with heat pumps and EVs could deliver annual savings of ~£105–£380 per household with a car in a high-or-low cost environment. Around 10% of households in our analysis could incur a net cost in a high cost environment.

  80–87% of low-carbon investments will reduce overall costs to consumers over technology lifetimes.
- **Economywide investment**
  Additional annual investment needed to 2030 (across businesses, public sector and households) in a Net Zero scenario is ~25% more than investment that would proceed anyway under existing policies, due to natural turnover of assets (e.g., people buying new cars as old ones expire).

  Adopting net zero technologies will generate billions in savings each year due to lower running costs in power, transport and homes. Factoring in these savings, the 'net' additional annual financing needed economywide (businesses, households, public sector) to 2030 is £18bn–£25bn. This is ~0.7–1% of GDP, or £5-£7 a week per person per year. In contrast, the cost of inaction, estimated by other studies at 1.1% of GDP in 2022, will continue rising.
- **Impact on jobs**
  By 2030, investments to deliver net zero could create 250,000 full-time equivalent jobs.

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A new economic context

The UK's Climate Change Committee (CCC) published its Sixth Carbon Budget advice in December 2020. Since then, a series of shocks have profoundly reshaped the economic environment, notably, soaring inflation due to supply chain disruption during Covid-19 and rising energy prices following Russia's invasion of Ukraine.

The Bank of England raised interest rates to combat inflation, increasing the cost of capital, with uncertainty over future rates. But as clean technologies tend to be much more capital-intensive than their conventional alternatives, they may be disproportionately affected by these increasing financing costs.

The UK may be in a different place to when the Sixth Carbon Budget was set, but the impact of these macroeconomic changes on the cost of net zero is small. After years of slow progress, net zero needs a fresh impetus, and the analysis covered within this brief provides new evidence of the relative low costs and large benefits of rapid action.

The UK can get a good deal on net zero while minimising the cost to the public purse

The UK must reduce its emissions by 68% (from 1990 levels) in its Nationally Determined Contribution for 2030, which is critical to achieving its legally binding 2050 Net Zero target.[1] However, according to the CCC, only 25% of the emissions reductions required by 2030 are associated with credible plans, while around 40% have plans that are either inadequate or have 'significant risks'.[2]

The UK is not going to meet its 2030 statutory carbon targets without increased investment. Current public policy debate has overwhelmingly focused on whether the net zero transition will be 'costly' or not. Our evidence shows that UK households can get a good deal on net zero, at a reasonable cost to public finances to 2030, if we account for the savings that will result from lower running costs from adopting clean technologies, and if a mix of policies is also used to crowd in private investment to alleviate the 'green premium' in financing the upfront cost of clean technologies needed to improve and secure UK homes.

Our analysis shows that the right mix of policies could minimise the upfront costs required for low-carbon technologies, even if the current high-cost environment, with higher real interest rates, were to continue. In fact, **a balanced policy mix such as the one detailed in this brief could halve the public sector support needed to 2030, to between £6bn and £8bn per year,** from £13bn-19bn per year (Figure 1) and crowd in private investment.

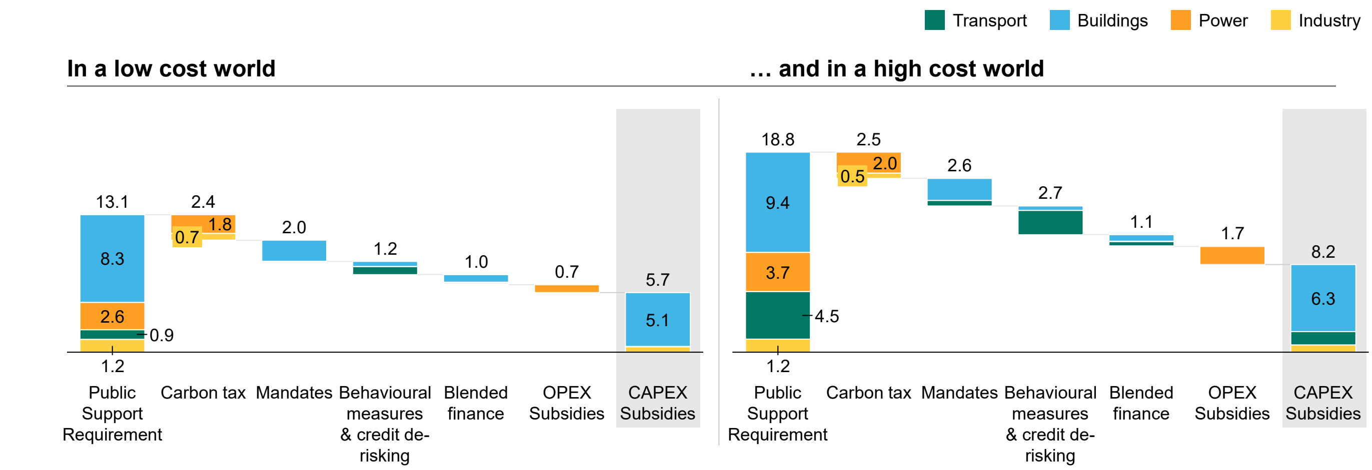
Meeting the 2030 target requires around 25% more investment than current policies will deliver

Public policy debate repeatedly emphasises that large investments will be required to transition the UK energy system to Net Zero. However, much of this includes investments in both high and low-carbon technologies that represent the natural turnover of assets **– that is, investments that would go ahead anyway under current or existing policies,** even in the absence of an additional push for net zero. For example, over the next six years, many households will need to replace cars and will have a choice of internal combustion engine or battery electric vehicles. Similarly, businesses will need to continue investing in energy technologies in order to grow.

The additional annual investment needed by 2030 from

Figure 1: Effect of Balanced Policy Mix on public support required for Net Zero

Average annual low-carbon investment need, 2024-30, £bn



Source: Oxford Smith School Analysis[35] Note: Also see Table 1. Numbers may not add up due to rounding.

businesses, households and government to get back on to a pathway aligned with the CCC's Balanced Net Zero scenario is around 25% more than current policies will deliver.

Of the *total* investment required on average per year from 2024-2030, our modelling estimates that around 75% would be in clean energy technologies. Households account for around two thirds of this, with the remainder accounted for by businesses and government.

If we consider the savings from adopting clean energy technologies with cheaper running costs in power (e.g. utility-scale solar and wind), transport (e.g. electric cars and buses) and homes (e.g. insulation and heat pumps), the additional financing needed from now to 2030 across the public sector, businesses and households would be between £18bn and £25bn per year, depending on the economic environment (low cost, or high cost) (see Figure 2 and Appendix Table 2). This would be equivalent to 0.7-1% of GDP. This equates to £269-373 per person, per year,[3] or £5-£7 a week. Lower-income and vulnerable households could be protected from these costs entirely through support measures.

The vast majority (80-87%) of low-carbon investment will reduce overall costs

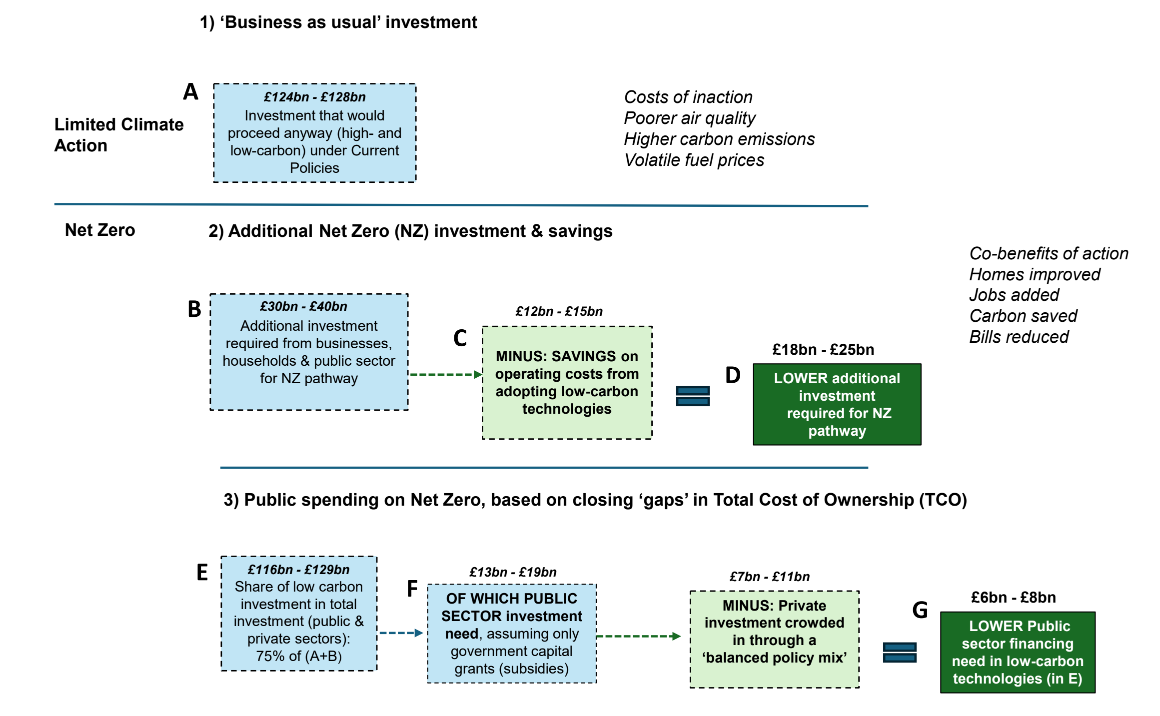
However, the vast majority (80-87%) of these low-carbon investments will reduce overall costs to all consumers over investment lifetimes, relative to continued reliance on fossil technologies, as the lower running costs of these technologies can offset their upfront capital costs. In other words, making these investments now will decrease costs in the medium term. Discounting those savings to the present-day using actor-specific (e.g., business or household) and technology-specific discount rates presents a more accurate picture of whether the transition is saving or costing economic actors.

The benefits for households: homes improved, bills reduced, carbon saved, and better value for money

Meeting the UK's 2030 net zero targets by implementing a balanced policy mix will bring several key benefits to UK households, which would account for around two thirds of the total low-carbon investment requirement. Recent analysis has shown that UK households receive the least 'value for money' compared to their counterparts in other countries with similar overall levels of prosperity: UK housing is more expensive, smaller, poorer quality and among the oldest housing stock in Europe.[4] Following the rise in gas prices, energy use fell by 10% in 2022, due primarily to lower internal temperatures, rather than better energy efficiency.[5]

We outline the benefits of aligning to net zero for the average household.[6] Technologies to 'green' homes (i.e. through retrofitting insulation and installing heat pumps) carry a premium on their upfront cost relative to their conventional alternatives (e.g. gas boilers), with the age of the UK buildings stock being a key reason.[7] However, our analysis shows that, after accounting for the cost savings from lower bills over their investment lifetimes, the annual cost of a net zero home for the average individual household requiring a heat pump installation could reduce to roughly £120-170 per year under a balanced policy mix in a low cost or a high cost environment.[8] The annual cost for a net zero home for a 'fuel-poor' household (accounting for around 10% of the household distribution used in our analysis) requiring a heat pump installation would reduce to ~£179 per year

Figure 2: Annual average investment requirement across power, transport, buildings and industry to align with the Balanced Net Zero pathway, 2024-2030



Source: See Appendix Table 2

in a low cost environment, but this would be ~£288 per year in a high cost environment, under a balanced policy mix.[9] *Without* a balanced policy mix the cost for a net zero home would ~£550-£850 (Figure 3).

However, switching to an electric car will *save* households money. The costs of electric cars are expected to fall significantly by 2030, supported by rapid cost declines in battery technology.[10] This is on top of running cost savings; by 2030, electric cars will be 60% cheaper to run than conventional cars. **As a result, our analysis shows that the average household with one car could save in the region of £275-500 per year.**

A well-coordinated transition in the transport and buildings sectors could secure net savings of ~£105-£380 per household with a car, in a high cost or a low cost environment, with a (reduced) 'green premium' paid for household net zero technologies offset by operating cost savings from electric car technologies (Figure 3).[11] A small proportion of households could incur a net cost in a high cost environment.

Our analysis looked at different types of households ('archetypes'), covering characteristics such as efficiency, tenure (owned or rented), and households that are fuel-poor versus those that are not. Despite the cost reductions that can be achieved through operating savings and the right mix of policies, there remains a need to ensure that any residual costs do not impose a disproportionate burden on lower-income groups, which also tend to have homes that could be characterised as inefficient and fuel poor.[12]

Our study estimates that, without any additional support, the bottom quintile of households (with less than £15,000 per year median disposable income) could spend 0.8-1.8% of their income per year on net zero home conversion. For the top quintile, however, this would drop to 0.2-0.4% of their income. The cost of net zero home conversion as a share of household income is greater for lower-income households; support will be needed to mitigate the impact of this and ensure they can access the long-term benefits of these upgrades. Although outside the immediate scope of our analysis, there are now numerous studies which establish wider societal co-benefits from decarbonising homes, including better air quality,[13] better outcomes for people's health[14] and improved energy security.[15] **This suggests that there is greater benefit for UK households in aligning to a Balanced Net Zero path by 2030 than in delaying the net zero transition.**

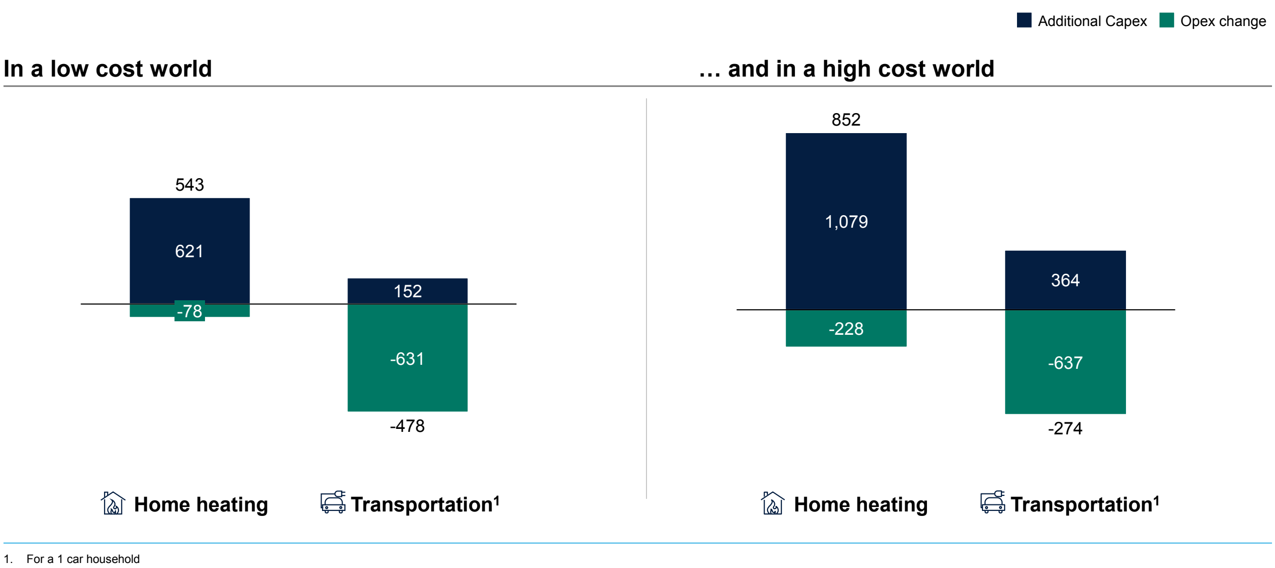
A Balanced Policy Mix: Five policy measures for meeting our 2030 Net Zero milestones at a reasonable cost to public finances

Our analysis assumes that, where a clean technology is more expensive than its carbon-intensive equivalent on a total cost of ownership (TCO) basis, subsidies or other policies are necessary to cover the gap and ensure that the clean technology is cost-competitive. However, as technology advances, green technologies get cheaper, the public support requirement will reduce over time.

In the hypothetical case that the government only uses grants, Net Zero could require an additional £13bn-19bn public sector investment annually to 2030. As shown in Figure 1, a more realistic, **balanced set of measures could reduce this to £6bn-8bn per year.**

Figure 3: 'Green premium' and operating cost saving for the average household for greening their home and transport

Average annual TCO premium of individual household in 2030, £



Source: Team research based on investment estimates aligned with CCC deployment and updated cost information.[30]
Note: Transportation assumes a one-car household. Numbers may not add up due to rounding.

Table 1: Modelled policy levers in the Balanced Policy Mix to 2030

Policy lever	Description	Sector
Carbon price	Carbon prices close TCO gaps by making carbon-intensive technology relatively more expensive.	Power, Industry
Mandates	Manufacturer mandates are assumed for heat pumps, electric cars and electric vans, where the government mandates a proportion of sales from Net Zero technologies. The government is assumed to use mandates and Capex subsidies in a 50/50 blend where mandates exist.	Transport, Buildings
Behavioural measures	Household energy investment decisions are partly driven by cost, but also by a range of non-economic factors. Evidence suggests households may require a higher return on domestic energy investments than their actual borrowing cost. Behavioural measures reduce household barriers to uptake of low-carbon technologies. These can be deployed as public-private partnerships, including information campaigns, support for 'one stop shop' solutions, and marketing of low-cost financing options. Behavioural measures are combined with credit de-risking, which are financing solutions that minimise credit and default risk (for example, on-bill financing of energy efficiency and low-carbon heating solutions). The measures reduce 'myopia', or shortsightedness, in households' investment decisions and reduce the discount rate households use to make investment decisions to the cost of capital faced by households.	All
Blended finance	Blended finance is the strategic use of public funds to 'crowd in' private investment. We consider concessional loans, leaving aside guarantees and other instruments. A concessional loan has two effects: first, it delivers a subsidy since the loan is at sub-market rates; second, it de-risks the investment for private investors, further reducing the cost of capital. This study assumes that blended finance could deliver a 30% reduction in the cost of capital that businesses face.	All
Operating (Opex) subsidies	The government deploys Opex subsidies for utility-scale power (for example, Contracts-for-Difference). They de-risk the technology by providing revenue certainty.	Utility-scale Power
Capital (Capex) subsidies	Capex subsidies (for example, capital grants) cover the remaining TCO gaps. That is, the government directly pays for the portion of the asset that is not cost-competitive.	All

Source: Oxford Smith School Analysis[37]

The balanced policy mix crowds in around £3bn-5bn of investment from households, and £5bn-6bn from businesses, reducing the level of public sector support needed. Mandates deliver between 25% and 27% of the reduction in public support in the buildings sector, which increases private sector investment in heat pumps. Carbon taxes could deliver a further 25-30%, which primarily boosts private sector investment in the power sector. Behavioural measures (i.e. supportive measures that reduce barriers to the uptake of low-carbon technologies) and blended finance deliver between 30% and 35%, which primarily increases private sector investment in the buildings and transport sectors. Opex subsidies cover the rest of the gap to make power sector technologies cost-competitive, and the residual public sector support is made up of Capex subsidies. Under the balanced policy mix, every £1 of public sector support therefore crowds in roughly £1.40 of private investment, with the added co-benefits of this investment, such as reduced carbon, more jobs, and improved homes.

However, the Balanced Policy Mix here is only one of many policy combinations that are possible, and it assumes that the policy mix of the recent past is scaled up to align with the Balanced Net Zero Pathway. Future UK governments have similar options to achieve Net Zero – for instance, the weights on different policies in the mix could change.

Our analysis demonstrates how the public investment need for households could be limited through a mix of policy instruments, across household archetypes. The distribution of operating savings across different household types over time (for example, when property is bought and sold) could vary, contingent on the efficiency of the housing market. For this reason, behavioural measures within the balanced policy mix (for example, information campaigns) are likely to play a key role in delivering efficient outcomes.

The alternative: the cost of not acting

Many argue, with good reason, that the strongest case for acting on net zero is the prohibitive cost of *not* acting. Analysis by the Grantham Research Institute at LSE finds that total climate change damages to the UK will rise from 1.1% of GDP in 2022 to 3.3% by 2050 and 7.4% by 2100, under current policies.[16]

The UK Office for Budget Responsibility in 2021 concluded that "unmitigated climate change would ultimately have catastrophic economic and fiscal consequences for the UK".[17] More broadly, the cost of damage from climate change-related floods, drought, heat waves and other impacts will far outweigh any cost of trying to tackle it.[18] The CCC Advisory Group on costs and benefits of

Net Zero stated in 2019 that "the cost of decarbonisation in decades to come will be a function of the action and investment taken today; the correct answer to the question 'what will it cost?'… depends on what is done now."[19]

These statements are not unsubstantiated: Oxford University research shows climate change will heavily impact the UK, which, along with Switzerland, will see the world's most dramatic relative increase in uncomfortably hot days (a 30% increase) if the world misses the 1.5ºC target and heats to 2ºC.[20] This is a conservative estimate and does not consider extreme events like heatwaves, which would come on top of this average increase.[21] The House of Commons Environmental Audit Committee's conclusive report on Heat Resilience and Sustainable Cooling shows that the UK is unprepared for such changes.[22]

The economic benefits: job creation and regional implications

While investment into electric cars, cleaner power and better homes is a cost to households and affected industries, it is an opportunity for workers active in these sectors. Analyses of economic impacts of the net zero transition often tend to focus on numbers of jobs. While this is a relatable metric, the evidence on labour market impacts of the transition is complex and continuously evolving. The net zero economy will feature a mix of new, different and conventional jobs, with some skills (such as electricians) in higher demand.

There is not yet a universally agreed definition of what a 'green' job is.[23] It is estimated that around 20% of jobs in the UK and 14 European economies can be considered directly and indirectly green, taking a broad, occupation-level definition of the 'greenness' of jobs – sectors with the highest shares of green jobs are utilities, construction, manufacturing, the primary sector and transport; there is some evidence that greener jobs tend to be 'better' jobs in terms of levels of education and wages.[24] Jobs have been classified as 'directly green' when they involve the emergence of new occupations, or alter the skills and knowledge requirement of existing occupations towards 'green tasks', and 'indirectly green' when they support green activity but do not involve any 'green tasks'.[25]

The net zero transition will change the composition of jobs: there will be downscaling or removal of fossil fuel energy generation with an associated displacement of workers, but also a demand for new workers to build and manage new clean energy infrastructure. This necessitates the need to plan ahead for potential skill shortages and unfilled vacancies.[26] The literature also highlights the issue of transience or permanence of jobs: classification of occupations as 'green' or 'brown' overlooks the fact that some roles may be crucial for only part of the transition.[27] A review of evidence in the UK suggests that net zero-aligned investments – in clean automotive, hydrogen and Carbon Capture, Utilisation and Storage, renewable energy, and housing energy efficiency – can create tens of thousands of jobs in the short term, typically in construction and installation.[28] In the medium- to longer-run, job creation opportunities are related to R&D and production of new technologies.[29]

Notwithstanding the above complexities, for this analysis (to 2030) we acknowledge that constructing and installing green investments results in direct jobs, alongside continued employment effects from operating and maintaining new technology and indirect employment effects further up the supply chain. This study uses input-output analysis to estimate the scale of these impacts, while noting that further second-order effects, including broader co-benefits, will also occur.[30]

By 2030, the investments to deliver net zero could create approximately 250,000 full-time equivalent UK jobs above those in our baseline (Current Policies) scenario. These include 'direct jobs' (i.e. 150,000) as well as 'indirect' jobs (i.e. 100,000). This is within the CCC's estimate that Net Zero could create between 135,000 and 725,000 net new jobs by 2030, although it is not directly comparable as we have a narrower scope of net zero than the CCC.[31]

These jobs are the result of the construction and installation of new technologies, which occur in the year of delivery, alongside operational jobs that continue throughout the lifecycle of the investments and beyond 2030. The scale of impact increases with the addition of indirect jobs up the UK supply chain, supporting more than 100,000 extra full-time equivalent jobs.

The additional jobs are concentrated in the Maintenance & Repair, Financial intermediation, Transport equipment and Transportation sectors, reflecting the operational need of new technologies which will by necessity be delivered domestically, and the UK's comparative advantage in the financial sector.

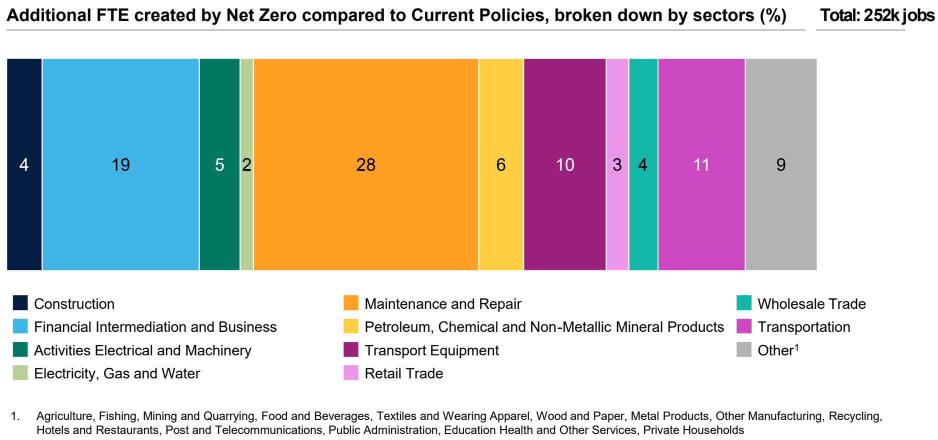
An initial assessment considers the distribution of employment effects, assuming that the additional investments are spread equally across the UK's existing areas of economic activity (i.e. investments are mapped to areas of existing employment within given sectors). This allows the distributional impact to be considered, while recognising that the *actual* impacts will vary according to the location of final investments.

For investments in housing, these assumptions are likely close to the reality of delivery, as retrofitting will take place across the UK roughly according to the distribution of households. However, for some sectors, such as Carbon Capture and Storage, investments will likely be more localised, driving job creation in particular areas of the UK. If capital investments were targeted to specific regions, job creation impacts could be greater. Jobs in Maintenance and Repair are spread throughout the UK, creating over a quarter of additional jobs in all regions outside of London. However, some existing sectors are already highly clustered, with financial intermediation in particular heavily focused in London, with approximately 40% of all new jobs in London in this sector.[32]

How we derived these results[33]

Situated between the CCC's Sixth and (expected) Seventh Carbon Budget analysis, our study explores the incidence of investment and cost across government,

Figure 4: Percentage of additional FTE jobs created by Net Zero compared to a Current Policies Scenario, by sector



Source: Oxford Smith School Analysis[32]

business and households. We look at the cost to the UK of meeting its Net Zero 2030 milestones in two future alternative pathways: i) a turn back to a 'low cost' environment, with continued cost decreases in clean technologies, and low financing costs as the world experienced prior to 2022, or ii) a 'higher for longer' cost environment, where financing costs remain above the post-2008 trend, as the world is currently experiencing.

We quantify the investment needs and economic costs for different levels of climate ambition and the two different cost environments, from the perspective of 'real-world' actors making investment decisions. Our baseline, a Current Policies scenario, considers the deployment of technology aligned with existing, stated government policies, while a Net Zero scenario aligns with the Balanced Pathway in the Sixth Carbon Budget.[34]

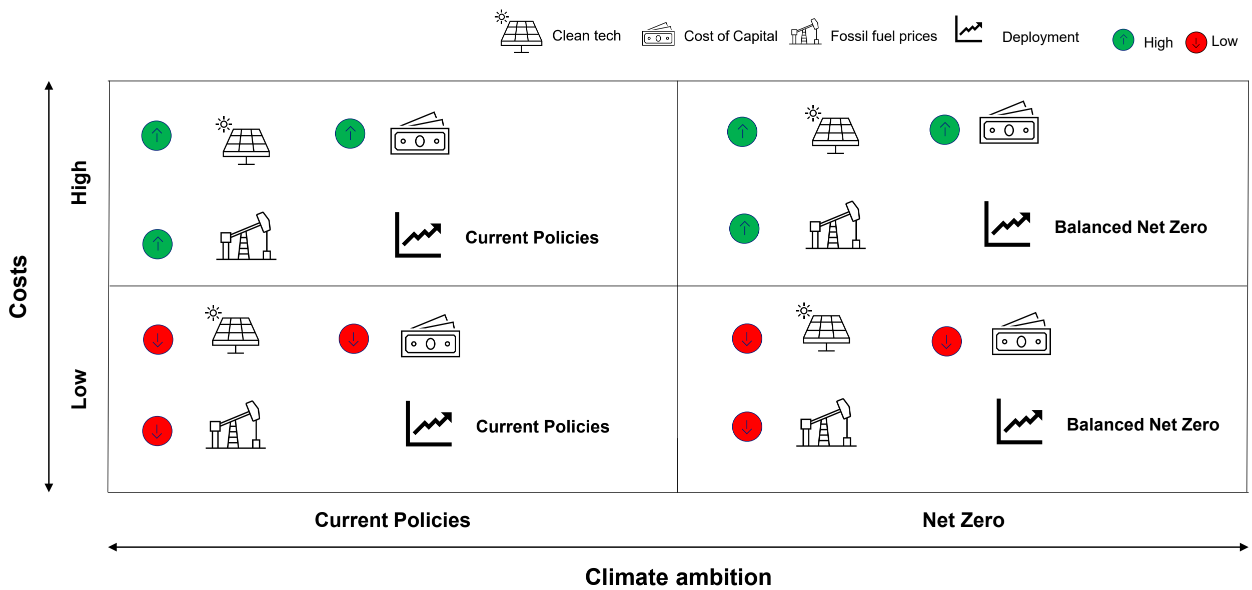
We have a set of analyses in three parts, which are linked by our underlying Scenarios.

First, we estimate the cost implications of Net Zero and characterise the cost of the transition deriving from the current and potential future cost savings or cost premiums from adopting specific low-carbon technologies focusing on the Power, Transport, Buildings and Industry sectors.

Specifically, to estimate these premiums or savings in relation to public sector investment requirement, we use the TCO, or lifetime cost of a technology, taking its capital cost (Capex) as well as operating (Opex) costs and carbon taxes, and discounting all future costs using a technology-specific and actor-specific (e.g., household-specific) cost of capital.

Clean technologies are cost-competitive when their

Figure 5: Four modelled scenarios



Source: Oxford Smith School Analysis[36]

TCO is lower than that of a conventional technology that serves the same purpose. If a technology is not cost-competitive, then it is cost-increasing for the investor, resulting in a ‘green premium’ for delivering the transition.

Where clean technologies are not cost-competitive, our modelling estimates the potential public finance requirement to fill the gap between the TCO of clean technologies vs. their fossil alternatives. The hypothetical benchmark is that, without a balanced policy mix, the government would provide direct capital (Capex) subsidy support to fill the public finance gap. It can use supplementary measures to reduce the public sector cost (especially the level of Capex subsidy needed – see Appendix Table 2) and crowd in private investment.

Our approach differs from traditional methods used to quantify public expenditure. Whereas traditional approaches tend to sum all existing and planned initiatives for a given year, we derive, under different policy assumptions, the required public finance number to fill a TCO gap. Our approach does not incorporate spending for R&D subsidies, rather, we use a scenario-based methodology that takes the path of costs as given – for instance, we assume that battery technologies will diffuse globally. Our sectoral scope is narrower than some other analyses, and focuses on the energy system, and primarily on mitigation. The balanced policy mix assumes widespread changes that would limit government expenditure (e.g., manufacturer mandates for heat pumps, and Government’s central projection for rises in carbon prices for Power and Industry) required to achieve net zero.

Second, in a separate analysis, we also estimate how the economic impact of the net zero transition varies across households in terms of the additional costs for different types of households that would need to install heat pumps and/or retrofit homes, and decarbonise their modes of transport, and highlight where support may need to be provided to low-income and other vulnerable households, including to overcome non-monetary barriers such as the effort, time and information required to switch to net zero technologies. We try to build a granular and realistic picture of household costs and savings, using the TCO with household-specific discount rates for different household archetypes.

Third, the study employs input-output modelling to estimate the impact net zero investments have on job creation, considering the sectoral employment effects that take hold and their potential regional distribution.

Conclusion

Our modelling and analysis provide strong evidence that, even in a changed macroeconomic environment, UK citizens can get a good deal on net zero. With the right mix of policies we can minimise the cost to people and the public purse with added the co-benefits of improved homes, reduced bills, more jobs and less carbon. The question now is whether policymakers can rise to the challenge and grasp the opportunity while it still exists.

Appendix Table 2: Annual average investment requirement across power, transport, buildings and industry to align with the Balanced Net Zero pathway, 2024-2030

		Low-cost environment (£bn)	High-cost environment (£bn)
A	Investment in energy system that would go ahead anyway (both high- and low-carbon) under current policies	124	128
B	AAdditional investment required across public sector, businesses and households to get on track for 2030 targets and align to the CCC’s Balanced Net Zero	30	40
C	Savings on operating costs from adopting low-carbon technologies (in relation to B: capex minus opex)	12	15
D	**Additional investment required across public sector, businesses and households to get on track for 2030 targets and align to the CCC’s Balanced Net Zero after accounting for operating cost savings (B-C)**	**18**	**25**
E	Share of low-carbon investment in total [75% of (A+B)]	116	129
F	Public sector investment needed in low-carbon technologies (in E) calculated based on the difference or ‘gap’ in Total Cost of Ownership for replacing ‘dirty’ with clean technologies assuming government only uses capital grants (i.e. subsidies)	13	19
G	**Reduced public sector investment needed in low-carbon technologies (in E) based on a Balanced Policy Mix (i.e. policies that reduce the amount of capital grants needed)**	**6**	**8**

Source: Oxford Smith School Analysis[37]

Endnotes

1 Climate Change Committee (2020). Sixth Carbon Budget.

2 Climate Change Committee (2023a). 2023 Progress Report to Government.

3 Based on a UK population of approximately 67 million as per the ONS.

4 Resolution Foundation (2024) Housing Outlook Q1 2024.

5 Zapata-Webborn, E., Hanmer, C., Oreszczyn, T. et al. (2024) 'Winter demand falls as fuel bills rise: Understanding the energy impacts of the cost-of-living crisis on British households', Energy and Buildings, Vol. 305, 113869.

6 Smith School (2024a). Delivering Net Zero: A Stocktake – Report, Oxford Smith School of Enterprise and the Environment; Smith School (2024b). Technical Annex – Delivering Net Zero: A Stocktake, Oxford Smith School of Enterprise and the Environment.

7 DESNZ. (2023). Heat and buildings strategy. Department for Energy Security and Net Zero.

8 This for an 'Efficient' household archetype – households requiring a heat pump installation, but not a deep retrofit. Our study examined a number of household archetypes based on tenure (owned or rented), efficiency, and fuel poverty. 'Efficient' households made up a significant proportion of households in our analysis. See Smith School (2024a; 2024b).

9 This is for a ' Fuel Poor, Efficient' household archetype in our analysis which requires a heat pump installation. Based on our Total Cost of Ownership (TCO) approach, 'Fuel Poor' household archetypes have higher discount rates (supported by literature) and therefore a higher cost, post-policy. See Smith School (2024a; 2024b).

10 Climate Change Committee (2020).

11 Based on estimates for 'Non Fuel-Poor, Efficient' households. See Smith School (2024a).

12 In our analysis which broadly aligns with the CCC's 6th Carbon Budget, 'Fuel-Poor' household archetypes account for around 13% of our distribution; 3% are classified as 'Inefficient, Fuel Poor' which lie beyond the scope of this analysis. Based on our Total Cost of Ownership (TCO) approach, 'Fuel Poor' household archetypes have higher discount rates (supported by literature) and therefore a higher cost, post-policy. Further research is needed to investigate detailed intersections of household and car archetypes. Also see Smith School (2024a; 2024b).

13 For instance see Royal Society (2021). Effects of net-zero policies and climate change on air quality.

14 For instance see Carmichael, L., Prestwood, E., Marsh, R., Ige, J., Williams, B., Pilkington, P., Eaton, E. and Michalec, A. (2020). 'Healthy buildings for a healthy city: Is the public health evidence base informing current building policies?' ,Science of The Total Environment, Volume 719, 137146.

15 For instance see Baker, W., Acha, S., Jennings, N., Markides, C., and Shah, N. (2022). 'Decarbonising Buildings: Insights from across Europe', Grantham Institute – Climate Change and the Environment, Imperial College London.

16 Grantham Research Institute (2022) . Policy brief - what will climate change cost the UK? Grantham Institute.

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20 Miranda, N.D., Lizana, J., Sparrow, S.N. et al. Change in cooling degree days with global mean temperature rise increasing from 1.5 °C to 2.0 °C. Nat Sustain (2023). https://doi.org/10.1038/s41893-023-01155-z

21 See Smith School News www.smithschool.ox.ac.uk/news/switzerland-uk-and-norway-dangerously-unprepared-keep-people-cool-if-global-15oc-target-missed

22 See committees.parliament.uk/publications/43103/documents/214494/default/

23 Valero, A. Li, J., Muller, S., Riom, C., Nguyen-Tien, V. and Draca, M. (2021). Are green jobs good jobs? Lessons from the EU and UK to inform labour market transitions. LSE Grantham Institute and CCCEP.

24 Valero et al. (2021).

25 Valero et al. (2021).

26 Bücker, J., del Rio-Chanona, R.M., Pichler, A., Ives, M.C. & Farmer, J.D. (2023). 'Employment dynamics in a rapid decarbonization of the power sector'. INET Oxford Working Paper No. 2023-28.

27 Bücker et al. (2023).

28 Valero et al. (2021).

29 Valero et al. (2021).

30 Smith School (2024b).

31 Climate Change Committee (2023b). A Net Zero Workforce.

32 See Smith School (2024a) for jobs impacts by region.

33 See Smith School (2024b) for full methodology, inputs, assumptions and limitations.

34 The scope of our analysis includes the following CCC sectors: Buildings, Manufacturing and Construction, Electricity Generation, and Surface Transport sectors. Other CCC sectors, for example, Aviation, Shipping, and Agriculture do not feature. The sectors covered are collectively the energy system and represent 92% of all the investment required to decarbonise the UK over this time period (2024-30), according to the CCC.

35 Smith School (2024a). Delivering Net Zero: A Stocktake – Report, Oxford Smith School of Enterprise and the Environment; Smith School (2024b). Technical Annex – Delivering Net Zero: A Stocktake, Oxford Smith School of Enterprise and the Environment.

36 Smith School (2024b).

37 Smith School (2024a; 2024b)

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