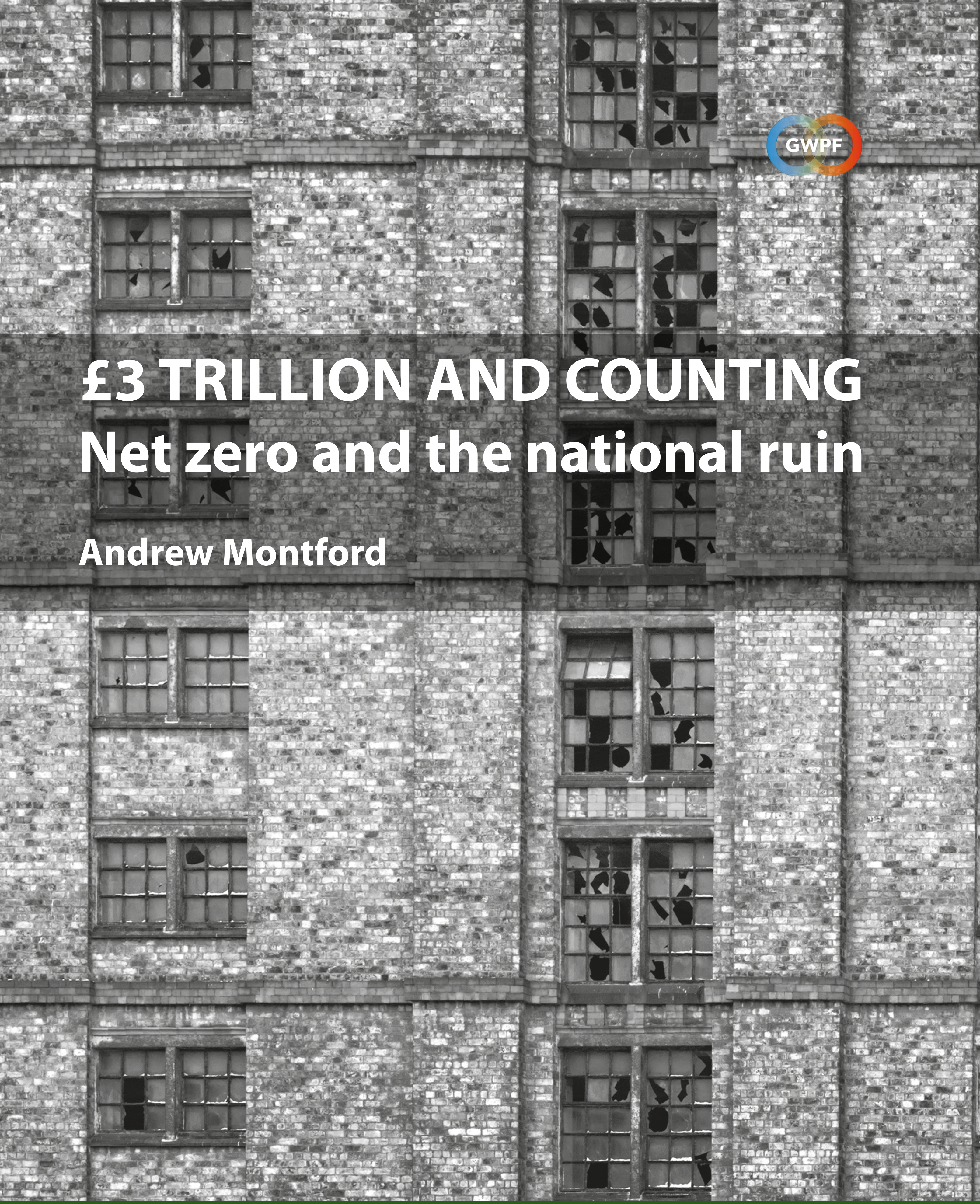


£3 TRILLION AND COUNTING
Net zero and the national ruin

Andrew Montford

The Global Warming Policy Foundation
Note 21

£3 TRILLION AND COUNTING
Net zero and the national ruin

Andrew Montford

About the author

Andrew Montford is the deputy director of the Global Warming Policy Foundation

Introduction

In the summer of 2019, the Committee on Climate Change (CCC) put forward its plans to decarbonise the UK's economy by 2050.[1] The so-called 'net zero' target for UK emissions was nodded through by Parliament a few weeks later.

Remarkably, the CCC said that the costs were 'manageable'.[2] In the Executive Summary, it claimed that:

> …we estimate an increased annual resource cost to the UK economy from reaching a net-zero [greenhouse gas] target that will rise to around 1–2% of GDP by 2050.

Elsewhere, it was explained that resource costs were the difference between the costs and benefits incurred in moving to a net zero world and those in a world without climate change or climate policy.[3]

Although a monetary figure was not published in the Net Zero report or any of the supporting reports, from some of the supplementary information it was possible to discern that the figure involved was £50 billion in 2050. No equivalent figures were presented for the years 2020–2049, although many commentators assumed that it would also be £50 billion per year throughout that intervening period, implying a total cost of £1.5 trillion over 30 years. However, as can be seen in the quote above, the CCC was arguing for lower figures in those earlier years.[4]

Others noted that there appeared to be no proper cost-benefit analysis among the hundreds of pages published by the CCC. Nevertheless, the committee's chairman, Lord Deben belittled suggestions that financial aspects of the net zero project had been neglected, telling the House of Lords:

> I was unhappy to hear those who said that the report was uncosted and unprepared. It has been recognised universally as the most seriously presented, costed effort...[5]

Despite the report being – in Lord Deben's words – 'costed', the CCC has resisted attempts to have its calculations disclosed under FOI legislation. Even more remarkably, it has admitted that it has not actually calculated a cost for the period 2020–2049;[6] there is only the £50 billion figure for 2050 (see Figure 1). The decision to undertake the decarbonisation of the economy is thus – contrary to what Lord Deben told Parliament – *un*costed.

With no official estimate of the costs involved in decarbonisation of the various sectors of the economy having been prepared, this paper brings together the conclusions of two major GWPF

Specifically you requested:

In the exhibits to chapter 7 of the Net Zero report, you give a resource cost for decarbonisation of £50.8 billion in 2050.

I would like to know the resource cost for each year between 2020 and 2049 inclusive.

Our response

We do not hold the information you have requested. The purpose of the net zero report was to establish when the UK should reduce emissions to net zero, which we recommended be legislated for 2050. The focus of our scenario analysis was therefore on whether achieving net zero emissions was feasible in 2050, and what the additional costs would be in that year.

Figure 1: The CCC's response to request for the costs for years 2020–2049.

reports which have attempted to provide such figures for two of the most important emitting sectors, namely the electricity system and domestic housing.

Decarbonising the electricity supply

At the core of the CCC's strategy for decarbonising the economy is the replacement of fossil fuels with zero-carbon electricity, mostly from offshore windfarms. It gives few details of what the detailed composition of the generation fleet would be, although it provides what it says is an example breakdown, and it says the heavy lifting could be delivered by 75 GW of offshore windfarms.

The details are so scant that it would be impossible for anyone to make a meaningful estimate of the costs involved. However, National Grid undertake an annual exercise – the Future Energy Scenarios – to simulate various ways in which the electricity grid might operate in the future to make supply and demand meet. No doubt prompted by the work of the CCC, its report considers how the electricity system might be completely decarbonised, although only as an appendix to the detailed modelling exercise.

National Grid does not cost any of the Future Energy Scenarios, but sufficient detail is given to allow others to do so. This is the aim of the report by Colin Gibson and Capell Aris, entitled *The Future of GB Electricity Supply: Security, Cost and Emissions*. Gibson is a former Power Network Director at National Grid, while Aris is a power systems engineer. Their expertise is therefore unquestionable.

Gibson and Aris take the two of the generation system scenarios that get close to net zero carbon emissions and work out how much electricity these would generate in practice, matching this supply against demand for each half hour. In particular, they perform detailed estimates of windfarm generation based on historical weather patterns. They then track surpluses of production through the storage systems and other systems that National Grid posits will be used to balance the grid, and showing how deficits will be made up by extracting power back out of storage or from elsewhere. They then use the standard methodology of levelised cost to work out what all the financial impact will be, including all the energy storage facilities, interconnectors and so on.

The results are extraordinary. In both of National Grid's zero-carbon scenarios, the cost of the electricity generating system per unit of electricity nearly triples. The cumulative cost to 2050 will be around £1.4 trillion more than a grid based on gas generation, amounting to around £50,000 per household. Nevertheless, by 2050, 90 million tonnes of carbon dioxide are being abated each year, but at an annual cost of £100 billion.

Are the cost estimates underlying these numbers reasonable? Given the importance of offshore wind in the National Grid scenarios, the levelised costs involved are of paramount importance. The Gibson and Aris figure for the levelised cost of offshore wind is £169/MWh. Figures much lower than this are bandied about on a regular basis; for example, the Bloomberg New Energy Finance biannual survey of levelised electricity costs says that UK offshore wind has a levelised cost range of £50–60/MWh.[7] However, such numbers appear to be based on turbine manufacturers' 'puff', rather than hard data. Bids into the auctions for Contracts for Difference are also much lower, but there is good reason to doubt that that these are valid indicators of actual costs.[8] The financial accounts of UK offshore windfarms, reviewed by Aldersey-Williams *et al.*, show unequivocally that levelised costs remain in the range £100–150/MWh, although there is a suggestion that they are falling slowly.[9]

But does that mean that the Gibson and Aris figure is too high? In fact this is not the case. The key detail to understanding why revolves around the capacity factor of the windfarm: the ratio of the energy it produces in a year to its capacity – what it could produce if it ran flat out all the time. Typical figures for offshore windfarms are around 40%, although this value is expected to rise as windfarms move further offshore. The CCC says, with wild optimism, that a figure of 58% will be the norm in 2050,[10] but this is to ignore the effects of wear and tear as well as another important

The cost of decarbonising the electricity system will be of the order of £50,000 per household

factor. Windfarms have priority access to the grid, and since the proportion of renewables on the grid is relatively low, the electricity they produce can be used without issue, at least for the majority of the time. However, in order to deliver net zero carbon emissions, National Grid envisage having to build a large amount of overcapacity. In their net-zero scenarios, therefore, generation will often exceed demand when it is windy. Sometimes the surplus can be exported or used to refill energy storage facilities, but sometimes the stores will be overwhelmed, and overseas grids may well have similar problems of their own. In these circumstances, windfarm operators will have to be paid to switch off. In other words, UK customers will pay for electricity that hasn't been produced. Thus while it is possible that windfarms might improve capacity factors to over 50%, this will not benefit consumers, who will simply have to pay the windfarms to switch off. (Windfarm operators don't care, since they are paid whether they produce or not.) The effect on costs will be to reduce effective capacity factors to less than 40%. Note this figure comes directly from National Grid, who give both capacities and the electricity that the grid will take for each generation technology. These low capacity factors reconcile the Gibson and Aris levelised costs to the results of Aldersey-Williams *et al.*, and they simply reflect the fact that in future we are going to spend much more on switching windfarms off than we do today.

It might also be objected that the capital costs of offshore wind are falling. The economist Gordon Hughes has suggested that there has been an underlying decline of 4% per year since 2013, although this is obscured by the fact that operators have incurred higher capital costs as they move further offshore in search of more reliable winds.[11] So while capital costs make up around three quarters of the basic levelised cost, they are only around half of the total cost once the cost of intermittency management is included, so a reduction of 20% in capital costs would give only a 10% reduction in the total cost. Transmission costs are also also likely to be important, but are hard to assess. In summary, offshore wind costs might fall somewhat, but will make little difference to the big picture.

The cost to the UK economy is, as noted above, likely to be of the order of £1.4 trillion pounds by 2050. Consumers will pay some of the cost through higher prices for goods and services, but a significant amount will come to them through higher energy prices in their homes. What makes this worse is that the CCC also envisages a wholesale switch of domestic heating from gas to electric. This is potentially therefore the double whammy to end all double whammies. The only conceivable way to prevent it is to reduce the demand for heat by insulating the housing stock. This is the subject of the next section.

Housing

Professor Michael Kelly's paper considers the cost of decarbonising domestic heat through retrofitting of insulation. Kelly, an engineer and former chief scientist at the Department of Communities and Local Goverment, has observed that decarbonisation of domestic heat can be achieved through reductions in demand (through insulation programmes) or through replacement of fossil-fuel based heating systems (gas and oil) with ones driven by (zero-carbon) electricity.

In his paper, Kelly sets out the findings of a major pilot programme he instituted while working in Whitehall to see what level of decarbonisation of domestic heat could be achieved through insulation and at what cost. The government therefore funded a programme of retrofitting insulation to social housing. But as Kelly explains in his paper, the results were very disappointing:

> ...with an average spend of order £85,000, the average reduction of CO_2 emissions achieved was only 60%...

If emissions reductions of, say, 80% were to be delivered, it is clear that much more money would be required. At £135,000 per property, the cost would run to £4 trillion. Assuming that cost reductions would be achieved as the market developed, Kelly speculates that this might fall to £2 trillion, or around £70,000 per home.

If emissions reductions of, say, 80% were to be delivered, it is clear that much more money would be required. At £135,000 per property, the cost would run to £4 trillion.

When Kelly explained his findings in the aftermath of the publication of the CCC Net Zero report, Lord Deben was fiercely critical, telling the House of Lords:

> The Global Warming Policy Foundation talked about a figure reached by suggesting that to retrofit every house in Britain would cost £150,000 per house. Of course, you can produce any old figure you like if you start with rubbish figures in the first place.[12]

This was a remarkable position to take, given that Kelly's figures represent hard data. Moreover, his estimates are supported by others. In 2016, the Energy Technologies Institute said that the cost of deep retrofits was 'in excess of £2 trillion',[13] which would be around £70,000 per home, while in 2018, the Institute of Engineering and Technology published figures of £80–90,000 per home.[14] Since then, the *Guardian* has described a recent project in the UK, which delivered 50% reductions in heating bills in some small flats in Nottingham at a cost of £85,000 per property.[15] Kelly's data therefore appear to remain valid today. It is clear that only a tiny fraction of households would be able to afford such a cost, and it is therefore infeasible that the country could produce major reductions in demand for heat through insulation programmes.

Although it is hard to be sure, it seems that the CCC concurs, despite Lord Deben's protestations in Parliament. While its report on decarbonising housing[16] says repeatedly that government should encourage retrofitting of homes 'so they are low-carbon, energy efficient and resilient to a changing climate', in fact the committee is only envisaging a reduction in heat demand of 15% by 2030.[17] In a footnote elsewhere in the Net Zero report it says that the costs for bringing most of the housing stock – of older vintage – up to the zero-carbon standard are 'prohibitively high'.[18]

What does this mean for consumers?

From this analysis, it seems clear that for the majority of the housing stock, only relatively small improvements in insulation levels are affordable. This much, everyone seems to agree on, and it is no suprise therefore that National Grid incorporate reductions of demand for heat of 10–26% in their net zero scenarios.[19] Kelly's data suggest that retrofits on this scale this might cost £15–30,000 per dwelling, a total of perhaps £0.5 trillion.

The bulk of the work of decarbonisation therefore has to be delivered by decarbonisation of the electricity supply. This means getting off gas central heating and using electricity instead. However, electrical heating is already much more expensive than gas and, as Gibson and Aris make clear, the price of electricity is going to rise.

The CCC thinks that electrical heat can best be delivered through heat pumps. These machines use electricity to extract heat from the ground or the air. Because they are able to extract more energy than they use to drive the pump, there is a 'gain', typically over 2 (for an air-source heat pump) or around 3 (for ground-source). That means for each kilowatt hour expended on driving the pump, 2 or 3 kWh are extracted. This has obvious benefits for the resulting bills, but since electricity is already four times the price of gas in per-joule terms, it is clear that heat pumps remain uncompetitive when mains gas is available. And, as we have seen, electricity prices are going to rise sharply. If system costs will nearly triple, as suggested by Gibson and Aris, a conservative estimate of the effect on retail elecricity prices would approach a doubling. Modelling by this author suggests that the reduction in electricity demand from using heat pumps and retrofitting of limited insulation measures will be outweighed by the price increases. Moreover, heat pumps have much higher capital costs. An air-source heat pump would come in at around £7,500. Depending on the lifespans achieved this could amount a cost of £600 per year more, of similar order to the average heating bill today.

So by 2050, the fuel cost of heating a home will have risen, regardless of any reduction in demand produced by heat pumps and insulation programmes. Consumers will also have had to pay for those insulation programmes, at a cost of perhaps £20,000 per household. And they will be spending an the equivalent of £600 per year in extra capital costs. Over the 30 years to 2050, that would amount to over £60,000 per household, with a cumulative cost to the nation of over £1.3 trillion.

And the rest

In summary, the extra costs of decarbonising the two sectors covered by this paper are as shown in Table 1. Annualising these figures over 30 years – the same basis as used by the CCC – gives a value of £96 billion per year, nearly twice what Parliament was told it would cost to decarbonise the whole economy. And this difference comes from examining just the power and housing sectors. Decarbonisation of other sources of emissions – notably transport and industry – is likely to require spending of similar order. It's therefore clear that the costs will surpass £3 trillion.

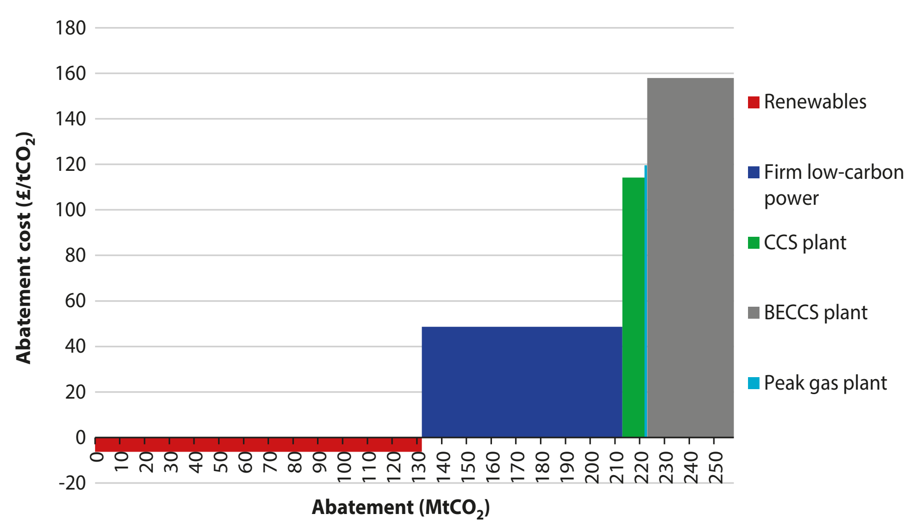
Table 1: Cost summary

	Cost to the nation £ trillion	Cost per household† £
Electricity system	1.4	50,000
Domestic heat*	0.9	32,000
Total	2.3	82,000

* Capital cost only, to avoid double counting electricity costs. †Averaged over 28 million households.

The difference is extraordinary and deserving of explanation, but it is difficult to arrive at any conclusions while the CCC refuses to release its calculations to public scrutiny. There are some hints in the CCC report, however. Consider, for example, their Figure 2.7, reproduced here as Figure 2.

Figure 2.7. Marginal abatement cost curve for deep emissions reductions from the power sector in the Further Ambition scenario



Sources: CCC analysis based on Wood Group (2018) *Assessing the Cost Reduction Potential and Competitiveness of Novel (Next Generation) UK Carbon Capture Technology*, CCC (2018) *Hydrogen in a low-carbon economy*, Imperial College (2018) *Analysis of alternative heat decarbonisation pathways*.
Note: Abatement from 'negative emissions' from BECCS is not counted in the power sector, nor are the costs.

Figure 2: The CCC claims that almost half of the power sector's emissions can be removed at negative cost.

It suggests that almost half of the power sector's emissions can be removed at negative cost, which is clearly a nonsense given the very high levelised cost of offshore wind, as discussed above. Gibson and Aris's observations about the cost of dealing with intermittency suggest further flaws in the CCC analysis.

Finally, the CCC's Technical Report also says:

> A gas-based electricity system that generated 645 TWh per year of electricity demand in 2050 would cost around £46 billion/year to build and run, whilst producing 225 $MtCO_2$ of emissions. Our estimates suggest that reducing emissions to 3 $MtCO_2$ would cost an additional £4 billion/year.[20]

There is no explanation of how these figures are arrived at, leaving the abiding impression that the calculations are crude and simplistic. However, it is clear that their starting point is not the electricity system of today.

Conclusions

If we accept the figures shown in this paper, it is implausible that the cost of decarbonisation to net zero – running to several thousand pounds per household per year – will prove acceptable to voters. Much of the problem can be put down to the absurd cost of offshore wind power and dealing with its intermittency, but the wholesale cost of electricity is only a third of the price paid by customers; delivering electricity to customers is an expensive business. Even if electricity could be produced for free, decarbonisation of domestic heat would leave customers considerably out of pocket.

Perhaps more importantly, however, the costs far outweigh any reasonable estimate of the damage done by a tonne of carbon dioxide: Gibson and Aris suggest the cost of decarbonising the electricity system is £1.4 trillion, yielding emissions reductions of 2 $GtCO_2e$. So even if the cost is discounted, each tonne of abatement would still cost hundreds of pounds, far more than any reasonable estimate of the cost of the damage done by greenhouse gases, typically £30 or £40/t.

The conclusions are therefore rather stark: any attempt to decarbonise the power system in the way envisaged by the CCC and National Grid is futile and will do more harm than good. And any attempt to decarbonise domestic heat – either through insulation or electrification –will be disastrous too. That said, the alternative scenarios developed by Gibson and Aris suggest paths that are more likely to be successful, if only partially so, and not on the timescales demanded. Their nuclear scenario, in particular, might lead to a fundamental change, particularly if the small modular nuclear programme is retrieved from its current position in the long grass; Allam cycle gas turbines might also bring about a transformation of the energy landscape.[21,22] But there should be no doubt that renewables represent a monumentally expensive dead end. The madness must stop.

Notes

1. https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/
2. Net Zero report, p. 9.
3. 'Resource costs are estimated by adding up costs and cost savings from carbon abatement measures and comparing them to costs in an alternative scenario: generally a hypothetical world with no climate action or climate damages...The total resource cost of the measure in 2050 will be the sum of its annualised capital costs plus in-year operating costs and cost savings (on the same basis - annualised capital cost savings and in-year operating cost savings).' Net Zero Technical Report, p. 16.
4. Later in their response to the FOI request (shown in Figure 1), they reiterate this point.
5. Lords Hansard, vol 798, 26 June 2019, col 1091. http://bit.ly/2Xdmrbi.
6. https://www.theccc.org.uk/wp-content/uploads/2019/12/041219-FOI.pdf
7. Brandely, T. 2H 2019 LCOE Update, Technical Report, Bloomberg New Energy Finance, 22 October 2019.
8. Hughes G (2019) *Who's the Patsy? Offshore wind's high-stakes poker game*. Note 18, Global Warming Policy Foundation.
9. Aldersey-Williams J *et al. Energy Policy* 128 (2019) 25–35. Dr Aldersey-Williams has noted (pers. commun.) that the anomalously low LCEO for the West of Duddon Sands windfarm, as reported in his paper, is in fact erroneous. It should be double the figure shown.
10. Net Zero Technical Report, p. 27.
11. Hughes G, et al. *Offshore Wind Strike Prices: Behind the Headlines*. Briefing No 26, Global Warming Policy Foundation, 2017. Hughes (pers. commun.) says that the rate based on Aldersey-Williams' data is in line with his earlier calculation, at 3–4%, depending on the method used to calculate the trend.
12. Lords Hansard, vol 798, 26 June 2019, col 1092. http://bit.ly/2Xdmrbi.
13. *Housing Retrofits –A New Start.* Technical report, Energy Technologies Institute, 2016. https://d2umxnkyjne36n.cloudfront.net/insightReports/Housing-Retrofits-A-New-Start.pdf.
14. IET, *Scaling up Retrofit 2050*, Institute of Engineering and Technlogy 2018, p. 14. https://www.theiet.org/media/1675/retrofit.pdf.
15. Vaughan A, Dutch eco initiative halves energy bills in first UK homes, *Guardian*, 7 January 2019, https://www.theguardian.com/society/2019/jan/07/dutch-eco-homes-idea-arrives-in-uk-and-cuts-energy-bills-in-half-nottingham-energiesprong.
16. *UK Housing: Fit for the future?* Technical Report, Committee on Climate Change, 2019. https://www.theccc.org.uk/publication/uk-housing-fit-for-the-future/.
17. See p. 13.
18. Footnote to Table 1.1, p. 42.
19. Usman Bagudu (National Grid), pers. commun.
20. Net Zero Technical Report, p. 46.
21. Dawson, A. (2018) *Small Modular Nuclear: Crushed at birth*. GWPF Briefing 33. https://www.thegwpf.org/content/uploads/2018/09/Dawson2.pdf.
22. Montford A. (2020) *Reducing Emissions without Breaking the Bank*. Note 20, Global Warming Policy Foundation.

About the Global Warming Policy Foundation

The Global Warming Policy Foundation is an all-party and non-party think tank and a registered educational charity which, while openminded on the contested science of global warming, is deeply concerned about the costs and other implications of many of the policies currently being advocated.

Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

The key to the success of the GWPF is the trust and credibility that we have earned in the eyes of a growing number of policy makers, journalists and the interested public. The GWPF is funded overwhelmingly by voluntary donations from a number of private individuals and charitable trusts. In order to make clear its complete independence, it does not accept gifts from either energy companies or anyone with a significant interest in an energy company.

GWPF NOTES

1	Matt Ridley	A Lukewarmer's Ten Tests
2	Susan Crockford	Ten Good Reasons not to worry about Polar Bears
3	Ross McKitrick	An Evidence-based Approach to Pricing CO_2 Emissions
4	Andrew Montford	Climate -- Public Understanding and Policy Implications
5	Andrew Montford	Consensus? What Consensus?
6	Various	The Geological Perspective Of Global Warming: A Debate
7	Michael Kelly	Technology Introductions in the Context of Decarbonisation
8	David Whitehouse	Warming Interruptus: Causes for the Pause
9	Anthony Kelly	Global Warming and the Poor
10	Susan Crockford	Health Polar Bears, Less Than Healthy Science
11	Andrew Montford	Fraud, Bias and Public Relations
12	Harry Wilkinson	UK Shale Developments
13	Peter Lilley	The Helm Review and the Climate-Industrial Complex
14	Constable and Hughes	Bubble or Babble?
15	Patricia Adams	The Road from Paris: China's Climate U-Turn
16	Mikko Paunio	Saving the Oceans: And the Plastic Recycling Crisis
17	John Christy	The Tropical Skies: Falsifying Climate Alarm
18	Gordon Hughes	Who's the Patsy? Offshore Wind's High-stakes Poker Game
19	Ray Bates	What Caused Hurricane Lorenzo?
20	Andrew Montford	Reducing Emissions Without Breaking the Bank
21	Andrew Montford	£3 Trillion and Counting: Net Zero and the National Ruin

For further information about the Global Warming Policy Foundation, please visit our website at www.thegwpf.org.

The GWPF is a registered charity, number 1131448.