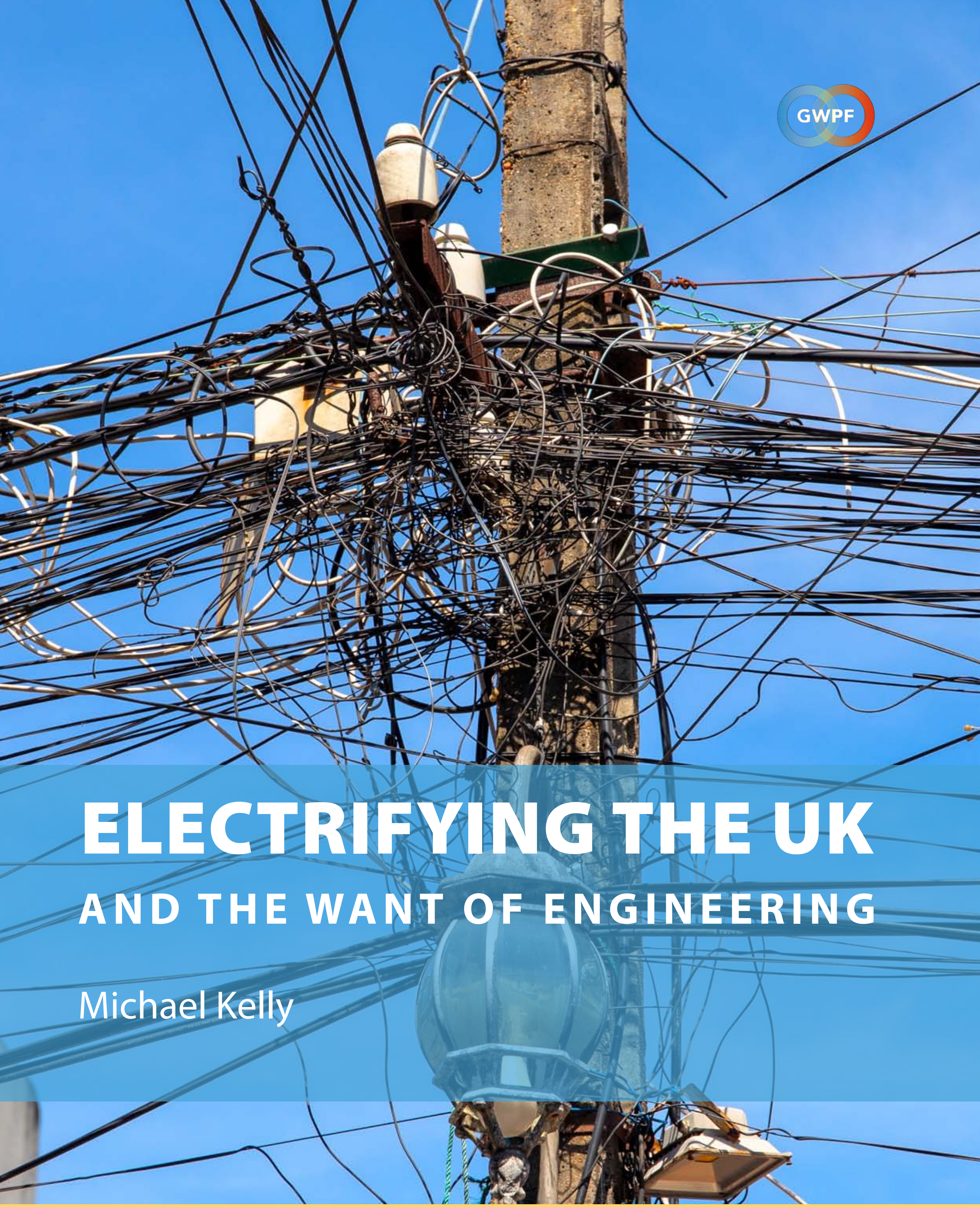

ELECTRIFYING THE UK

AND THE WANT OF ENGINEERING

Michael Kelly

The Global Warming Policy Foundation
Essay 11

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Essay 11, The Global Warming Policy Foundation

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About the author

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The scale of the task

Consider Dinorwig Power Station, the biggest hydropower energy-storage plant in the UK.[2] If all UK cars were battery powered, the nine gigawatt hours of energy stored behind the dam would be capable of recharging the 60 kWh batteries of about 150,000 small cars, or about 0.7% of the UK fleet. We are clearly going to need an extraordinary amount of electricity to convert all personal transport to batteries, even without considering the trucks and vans used in all the logistics that keep our supermarkets, high-streets, and industrial sites stocked.

Where will all this new clean green electricity come from? Something of the order of 70% of Britain's entire existing electricity-supply capacity will be needed if we are to remain a mobile society. When we get coded messages from the Climate Change Committee, implying that we will have to rethink the extent to which we are going to be able to travel in future, it is the implausibility of meeting that vast gulf in energy sources that is motivating them to question our lifestyles.

And if we are to decarbonise the economy – so-called 'net zero' – we are also going to have to electrify the heating of buildings too. At present, this is mostly done cheaply and efficiently with natural gas. Converting everyone to heat pumps is going to bring about another huge surge in electricity demand. To repeat the earlier question, where will all this new electricity come from?

It is sometimes objected that we can charge battery cars at night, when demand is low. But the current day–night variation in electricity demand is of itself too small to handle the extra load, so charging at night is at best a partial solution. Another suggestion is that we can charge cars during the day, when solar power is high. But in the absence of storage, this would mean charging them from mid-morning to mid-afternoon on sunny days, wherever they happen to be. This is implausible too, and would be unreliable if we could make it happen.

It's even worse for heat. The average energy used per day in transport is relatively constant through the year, but heating is highly seasonal, with demand 6–8 times higher in winter than in summer. The gas grid can cope with the extra demand simply by releasing a faster flow of gas. Today, modern solar and wind farms have generated as much as 25% of our electricity needs in midsummer. Absent fossil fuels and without some form of very-large-scale electricity storage technology, renewables would need to reliably produce the order of 250% of today's peak winter demand to cope with electrification of both heat and transport if heat pumps are universally installed. Without them, the figure is 400%. Neither scenario seems particularly likely.

And getting the electricity to where it is needed is going to be similarly problematic. The electricity grid will require upgrading from top to bottom. A typical house in the UK draws 1 kW of electrical power, averaged over the year, rising to 2–3 kW when the house is occupied with active people, and with peaks of the order of 5 kW in winter. If we are to electrify the economy, we will be adding electric vehicle chargers and heat pumps to almost every home. A fast EV charger for a car draws 7 kW, perhaps for 6 hours, and a heat pump needs 3 kW, potentially for much of the day. But the cabling and substations in most suburbs were sized and installed before these technologies were even thought of. So while there is sufficient headroom for electrification of a few households, the whole distribution system will need to be upgraded if demand grows. This work will be extraordinarily expensive, but without it there will either be regular brownouts, or drivers will have to be told where and when they can charge their batteries.

Cost and inconvenience

Next time you stand for 90 seconds filling your petrol tank, you might think of the enormity of what is happening in energy terms. Chemical energy is entering your tank at a rate of typically 17 million Joules per second, or 17 megawatts – equivalent to the total energy given off by 17,000 one-bar electric heaters! Petrol is extraordinarily energy dense. But unfortunately for their proponents, electric vehicles are much less convenient, and recharging a car can take many hours. And before anyone suggests that rapid chargers can address this problem, it should be noted that these still take a long time and their use significantly reduces battery lifetimes.

And given that 40% of UK cars do not have a garage and are parked on the street, there is also the problem of where people will be able to charge them. Cars used by commuters will need charging points, either on streets near their homes or at their places of work, or both. As many local authorities have bylaws preventing electric cables from crossing pathways, how will suburban commuters be assured that they can charge their cars? And the cost will be extraordinary. It is already the case that supermarkets installing multiple charging points in their carparks can find themselves having to pay as much as £0.25M towards upgrading the local substation.

The many problems with batteries

When you raise the question of the futility of attempts to electrify the economy and the cost of renewables, someone always raises the subject of battery storage. An Extinction Rebellion protestor recently promised me that the back-up electricity for major UK hospitals would be provided by batteries by 2025. However, a brief glance at the numbers shows that this cannot be true. The £45 million battery installed by Elon Musk outside Adelaide, South Australia, can power that city for 30 minutes. It would power the emergency wards (20% of total demand) of Addenbrooke's Hospital in Cambridge for 24 hours on a single 80–20% discharge. Back-up is currently provided by two 1500-kVA diesel generators, which run for as long as fuel is available and cost £250,000. So if you wanted to be able to cover a week's power outage after a major storm, it would cost around 1300 times as much using batteries as it would with diesel generators. The idea is ludicrous, and it would be equally foolish to apply batteries anywhere else on this scale.

Moreover, as anyone who owns a mobile phone knows, batteries are a frustrating technology. When electronics first became portable in the early 1970s, zinc-carbon batteries were common. All the research over the fifty years since then has given us the lithium-ion battery, which has six times the electrical energy stored per unit volume. But this is still more than forty times less energy dense than petrol. This has important ramifications. It is often pointed out that electric motors are more efficient than internal combustion engines, and this is true; there is a factor of three involved. But the low energy density of batteries means that much of this advantage is lost in having to carry around a heavy battery. The power pack for a Tesla weighs half a tonne and occupies much of the floor pan of the car: for the same 600-km range in a petrol car, you would need 48 litres of petrol, weighing just 36 kg.

And the size of the battery means that they require huge quantities of materials in their manufacture. If we replace all of the UK vehicle fleet with EVs, and assuming they use the most resource-frugal next-generation batteries, we would need the following materials:[3]

- 207,900 tonnes of cobalt – just under twice the annual global production;
- 264,600 tonnes of lithium carbonate – three quarters of the world's production;
- at least 7,200 tonnes of neodymium and dysprosium – nearly the entire world production of neodymium;
- 2,362,500 tonnes of copper – more than half the world's production in 2018.

And this is just for the UK. It is estimated that the manufacturing capacity for EV batteries would have to increase more than 500-fold if we want the whole world to be transported by electric vehicles. The vast increases in the supply of the materials described above would go far beyond known reserves. If there are shortages of batteries, electric cars will be idled, and internal combustion engines taken out of mothballs on a large scale.

Finally, it is worth considering the environmental impact of these materials; some of them are decidedly toxic when mined, handled and processed. It is also worth considering what is going to happen to batteries, and the renewable energy systems that power them, at the ends of their useful lives. While much is made of the problem of nuclear waste, just forty Hinkley Point nuclear power stations could deliver the electricity we need, and remarkably they would produce *less* hazardous waste per kilowatt of power than wind and solar power farms.[4]

Where are the engineers?

Put simply, we lack the ability to provide the infrastructure required to deliver electric cars and electric heating on the scale required by 2050. The plan to do so appears to be unachievable, with basic materials requirements representing the show-stopper.

But we are trying to do it anyway. How has this happened? The 2008 Climate Change Act created the Committee on Climate Change and gave it enormous power to oversee the decarbonisation of the UK economy. An unelected body, the committee displays many of the worst features of the administrative state. It has been grossly negligent in turning a blind eye to the complexity of electric vehicles and the related issue of the enforced switch to electricity for domestic heating. Committee members don't have to face the consequences of their policies from voters; politicians, who do have to face the voters, hide behind the committee in order to duck accountability.

It is this failure of the UK's political machinery that I believe is to blame for the situation in which we find ourselves. We have set out to decarbonise the economy without anyone having thought through all the engineering issues, let alone put a cost on the exercise. Recent work from colleagues at the Global Warming Policy Foundation, the only estimates published to date, suggests that the total will exceed £3 trillion, or around £100,000 per household.[5] It took a decade of belt-tightening to get us out of the economic downturn of 2008. The present virus-induced downturn is much more serious, and the belts will need to be tightened much further and for longer. It is clear that we will not be able to afford the costs of the net zero transition for decades, if ever. To attempt to plough on would be madness; indeed, it would directly sabotage the UK economy, and without any measurable effect in terms of actually averting any climate change. When the penny drops and the progress towards all-electric UK is halted, we will be reminded of Ozymandias. The rest of the world can look at Britain and choose whether to laugh or weep. One thing it shouldn't do is emulate us. Surely now is the time for a root and branch cost-benefit review by independent engineers who have no skin in the game of electrifying the UK economy.

Concerning the target of a Net-Zero Emissions Economy for the UK in 2050, the views of the Climate Change Committee and me are inconsistent. This cannot be allowed to stand since at present major misinvestments are being made which will on the one hand make sense, or on the other sabotage our economy in pursuit of an unachievable pipedream. I issue a direct challenge to anyone to comprehensively discredit my report by pointing out errors of facts, data, or logic in coming to my conclusions.   GWPF will publish a serious takedown, but not any marginal quibbling.

Notes

1. https://www.realclearenergy.org/articles/2020/03/18/electric_motors_versus_internal_combustion_engines_486956.html

2. The power station is capable of generating a maximum 1,700 megawatts for a period of 5.3 hours as the dam is emptied, for a total of 9 gigawatt-hours of electrical energy. After that the dam must be refilled before continuing.

3. https://www.nhm.ac.uk/discover/news/2019/june/we-need-more-metals-and-elements-reach-uks-greenhouse-goals.html

4. https://dailycaller.com/2017/07/01/solar-panels-generate-300-times-more-toxic-waste-than-nuclear-reactors/

5. See https://www.thegwpf.org/cost-of-net-zero-will-be-ruinous-new-reports-warn/ for an introduction to four interrelated papers on costing some of the net-zero policies.

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.

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