FINANCING THE ENERGY TRANSITION: DO THE NUMBERS ADD UP?

Gordon Hughes

With a foreword by Lord Frost of Allenton

The Global Warming Policy Foundation
Briefing 68

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Briefing 68, The Global Warming Policy Foundation

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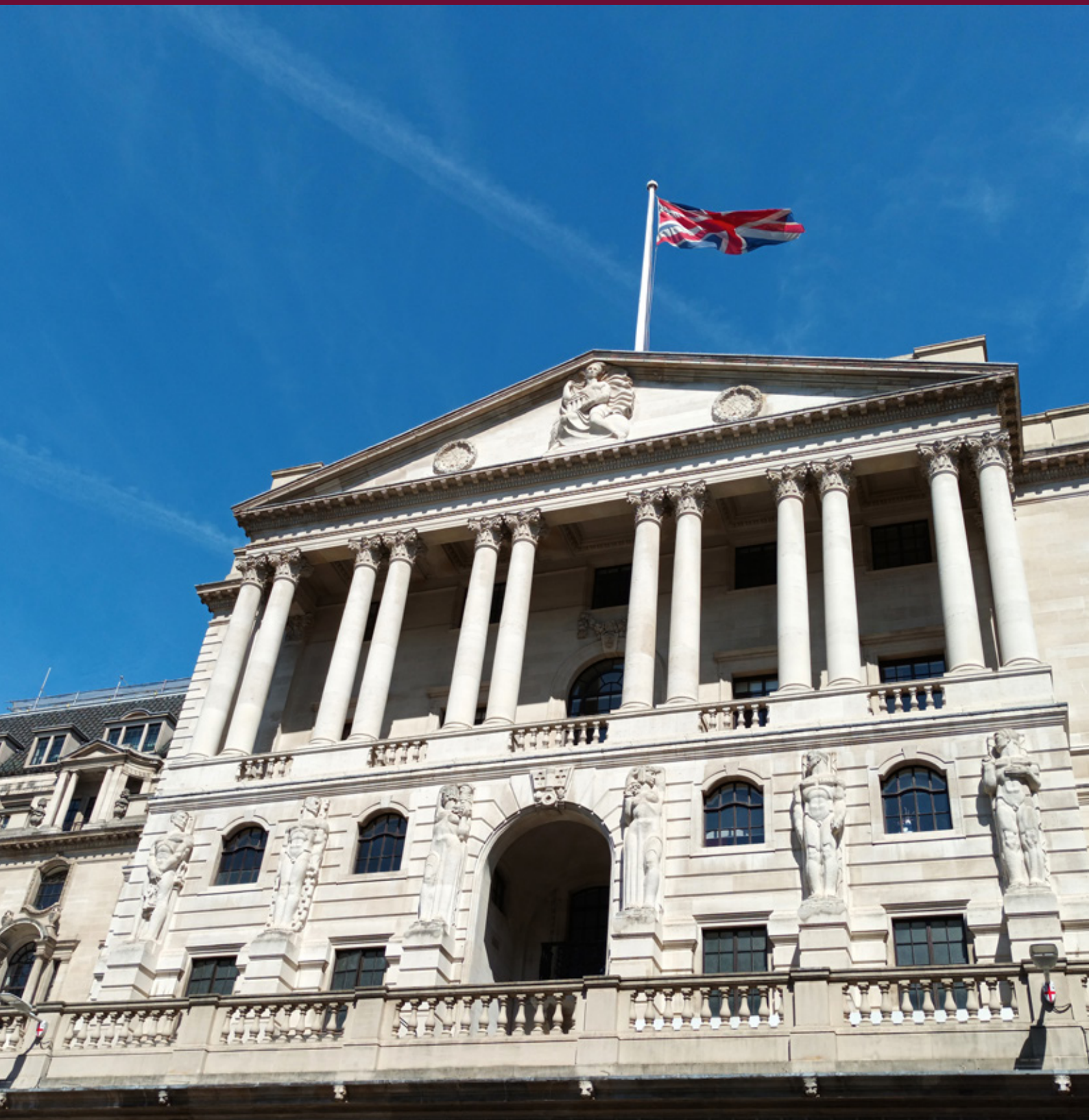

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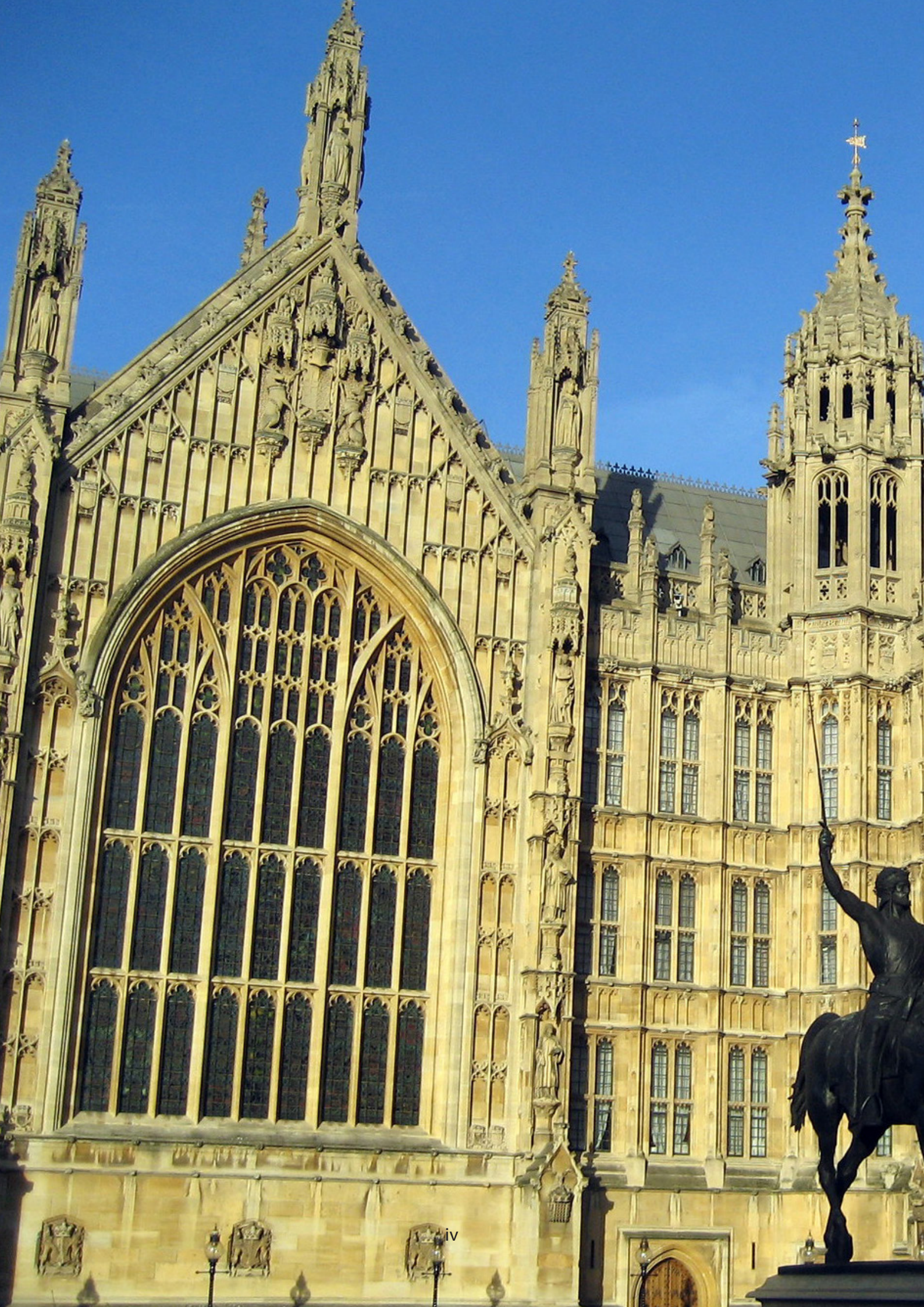
Gordon Hughes is a former adviser to the World Bank and is professor of economics at the University of Edinburgh.



Foreword

By Lord Frost of Allenton

The message in this briefing from Professor Gordon Hughes could hardly be more urgent. It is that the energy transition, as currently structured as part of the broader net zero policy, will lead to another 'policy fiasco'. He rightly says that we are 'posturing about targets that are patently not achievable and might be economically ruinous', and urges a rethink of the strategy before it is too late.

The view of Western governments and of the expert class that supports their Net Zero policies is that the necessary transition can be accomplished at limited cost. The UK's Climate Change Committee argues that the fiscal cost of transforming our energy system will be an average of around 1–2% of GDP per year between now and 2050, and that this investment in new energy technology will actually *improve* the country's growth performance. Believe that if you will.

Professor Hughes is more honest. He points out that independent experts assess the real cost to be at least 5% of GDP for the next couple of decades, and potentially even higher. He notes that we can't find this money by redeploying it from other investment areas, because we already invest, net, almost nothing in assets other than housing. It's clear that we can't borrow such sums without risk of a fiscal crisis. So the only way of doing it is to reduce consumption by 8–10% over two decades – and, even then, only if the necessary funds can be extracted by taxation. This is doubtful when the tax burden is already at its highest point since the war.

Put these propositions to the Net Zero proponents, and you will be told there is no need to worry. Costs will magically come down, new technology will somehow be invented, and we will find ourselves in the new promised land of clean, green, growth that will pay for everything. But they never give any evidence for believing this – and, where we can check what they say, for example in the real costs of wind power, we can see that these cost reductions are simply not happening.

The real world cannot be avoided. As Professor Hughes says, either we must be honest with the people and be clear that they are going to have to pay at a currently unanticipated level, or we must extend the time period for the transition – that is, delay the Net Zero 2050 target, perhaps out till 2070 or 2075. Failure to do either – sadly, perhaps the most likely outcome – will mean that we simply muddle on, pretending we are making progress, spending at high levels, but achieving little. Meanwhile the rest of the world outside the West will look on, incredulous at this unprecedented act of economic self harm.

This whole debate badly needs more honesty and openness. Professor Hughes' paper is an important contribution to it. I hope policymakers are listening.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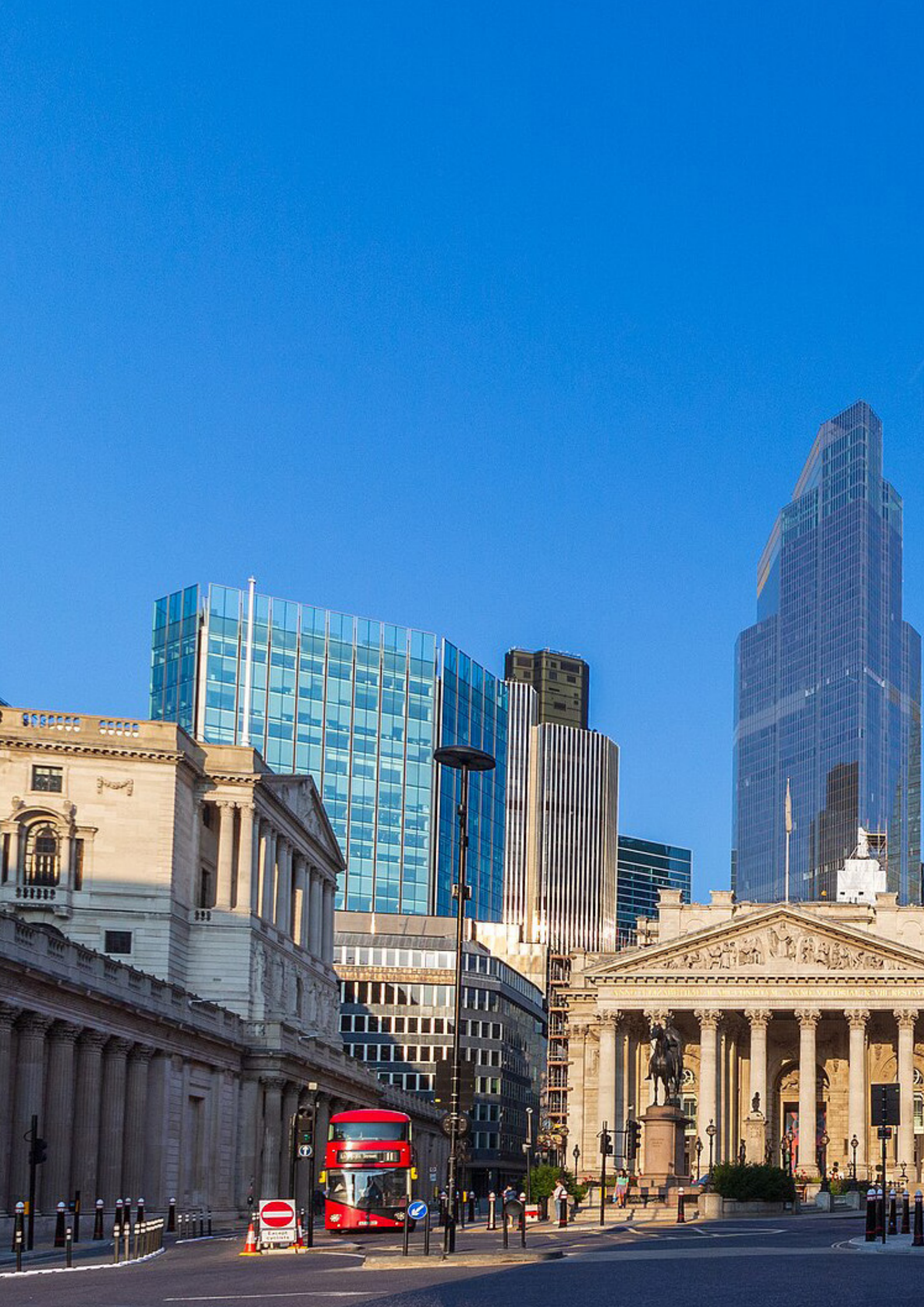
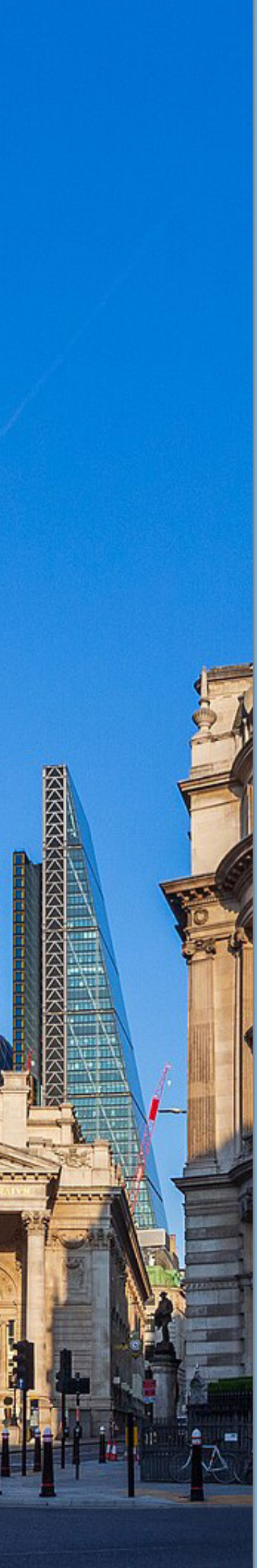
Executive summary

- The UK, along with other European countries, finds itself in a fiscal and macroeconomic trap, with strong pressures for more public spending and a large fiscal deficit. Gross investment has fallen to a level that barely covers the replacement of the existing capital stock. With net migration exceeding 1% of the population, it is well below what is required to maintain capital per head. Without a significant shift of resources from consumption to investment there is little prospect of accelerating economic growth, which is the least painful way of gradually escaping this trap.
- Notwithstanding this trap, politicians insist that the country must implement an accelerated energy transition, involving large investments in capital-intensive technologies for producing and consuming energy. Engineering and other authoritative estimates suggest that the amount of new investment required for the transition will be a minimum of 5% of GDP for the next two decades and might exceed 7.5% of GDP.
- Redeploying existing investment and hoping for economic growth is a recipe for economic stagnation, because new investment in physical assets other than housing is close to zero and cannot sustain current levels of services and economic growth. Equally, the UK is not Japan. Our economic history tells us that there is no chance of borrowing an additional 5% or more of GDP annually for two decades to finance the energy transition.
- In macroeconomic terms, the only viable way of financing the UK's energy transition is a drastic reduction in consumption, to free up resources for the huge level of new capital investment required. Every honest economist knows that, even if they may differ over the sums involved. Realistically, the reduction in private consumption would have to be 8–10% for 20 years. Such a shock has never occurred in the last century outside time of war, and even then never for more than a decade.
- Politicians and other policymakers have not prepared the public for such a shock. The responses to current policies suggest that the public's willingness to pay for the energy transition is low. In an open economy with high levels of economic inactivity, it is probable that taxes and other policy instruments will raise only a fraction of the money expected, due to what are called 'behavioural responses'; that is, tax avoidance, capital flight, increased inactivity and other changes.
- Ignoring the macroeconomic and fiscal constraints will almost certainly lead to yet another long-running policy fiasco along the lines of HS2, with results that achieve little in concrete terms. Rather than pretence and muddle, it would be better to extend the period and pace of the energy transition to match the resources that can realistically be afforded. Setting arbitrary targets with no grounding in financial or engineering reality may be a convenient short-term political strategy, but almost invariably undermines the domestic and international credibility of governments and associated institutions.
- As Abraham Lincoln is said to have observed, 'You can fool some of the people all of the time, and all of the people some of the time, but you cannot fool all of the people all of the time.' UK and European politicians justify their commitment to an accelerated energy transition as setting an example to the rest of the world. However, China, India and Indonesia are among the many countries in the rest of the world whose leaders are not fools and can draw their own conclusions about the realism and consequences of the energy transition as currently pursued. Posturing about targets that are patently not achievable and might be economically ruinous is unlikely to convince anyone, although most will be too polite to point this out.
- If the UK and countries in Europe want to provide an example that might be followed, the first step is to offer a strategy that (a) takes full account of macroeconomic and fiscal realities, and (b) focuses initially on those parts of the energy transition with the lowest investment costs and best return on the resources used. It is obvious to any analyst that neither of these conditions are met by current policies.





Introduction

Several pieces of news over the last month have highlighted an issue that politicians and promoters of Net Zero throughout Europe have been very reluctant to discuss. Among them is the decision by the Labour leadership in the UK to row back from their commitment to spend £28 billion per year of public money on 'green deal' projects. More recently, the finance minister of France has signalled that the state-controlled electricity company EDF cannot afford to finance the development of nuclear power plants in the UK alongside other such plants in France. The German government has been under great stress following a decision by the constitutional court that it cannot redirect €60 billion of special funding, allocated for the pandemic, to cover the costs of various green programs. These and other pieces of news have a common thread: the difficulty – or, perhaps, impossibility – of paying for the energy transition within current macroeconomic and fiscal constraints.

Pressures on non-energy investment and public finances arising from the energy transition are a part of the broader fiscal and economic picture in most West European countries. In the UK there is concern about low or non-existent productivity growth due, it is argued, to low levels of investment in business assets as well as transport, social and other infrastructure. Housing investment has lagged far behind population growth. Even more pressing are demands for more current spending on health, education and social care to cope with a growing but ageing population. In several European countries there is pressure to sharply increase defence spending, because the perceived threat from Russia has increased and trust in the extent of support from NATO has declined.

Even without the energy transition, there is no money to invest in economic growth, and no money without economic growth. For more than a decade, the UK has borrowed heavily to finance public spending, while also cutting public investment to a minimum. While there is a strong temptation to continue this strategy, the combination of higher interest rates and increasing concerns about the ratio of public debt to GDP may impose greater constraints in future. In particular, the strategy offers no obvious prospect of higher economic and productivity growth, so the constraints on public spending may become ever tighter.

For clarity, in this paper I have used the term 'energy transition' to refer to those aspects of the Net Zero agenda that cover all aspects of decarbonising energy production and use, including transport, industry, services, housing and infrastructure. We have a reasonable idea of what the energy transition encompasses and how its costs might be estimated. On other aspects of Net Zero, such as diet, types of agriculture, and lifestyles, there is little agreement on either what is required and whether the public is willing to adopt many of the proposals that are floated. The energy transition is broader than the German term *Energiewende*, which focuses on the phaseout of nuclear power and the shift to reliance on renewable generation.

In this rather dismal context, the energy transition poses an almost intractable challenge. Its core feature is the replacement of technologies with low capital costs and high operating costs (to pay for fossil fuels) with alternative technologies that, in most cases, have very high capital costs and minimal operating costs. Burning hydrogen might be considered similar to burning natural gas, but the costs of green hydrogen are almost entirely the embedded capital expenditure to deliver the renewable generation, electrolysis, storage caverns and pipelines required. In macroeconomic terms, the energy transition involves writing off a significant portion of our existing capital stock and replacing it with new capital that costs anything from five to ten times as much per unit of output or customer served.

Think of the comparison between (a) a combine-cycle gas turbine, which costs £0.8 million per megawatt of capacity, and (b) an offshore wind farm, which costs at least £3.5 million per megawatt of capacity and requires 1.7 times as much capacity to produce the same output. The wind option requires about 7.5 times the amount of capital per unit of electricity – and that is without any allowance for the costs of managing the intermittency of wind production. Adding in the cost of batteries is likely to double the amount of capital per unit of electricity.

This example is extreme, but whether it is transport or heating or any of the other ways in which we use energy, the impact of the energy transition on the scale of the capital stock required to support modern life and economic activity is a huge increase. Despite much chatter and public boasting, countries in Europe have barely started on this transition.

To date, the major impact of policies has been to replace coal by renewables in the generation of electricity. This was always the easiest step, simply because the generation capacity involved was old, and technologically outdated as a result of the switch to gas generation from the 1990s onwards. The big changes to domestic heating, transport and industrial energy have barely begun in most European countries.

Arguably the main exception is Norway, which has the great fortune to enjoy massive hydro resources, developed over decades. The partial exception is France, which chose to develop nuclear power on a large scale and electrified parts of its economy because of its limited endowment of fossil fuels. However, many of those plants are ageing and the costs of replacing them will be high.

In the remainder of this note I will focus on macroeconomic numbers for the UK, because the likely next government has made commitments to accelerate the energy transition without acknowledging or, perhaps, appreciating the nature of the issue. The UK is not untypical of other European countries, so the same conclusions apply elsewhere, subject to any adjustments for the longer transitions contemplated in some countries.

The energy transition

Engineering-based estimates of the total capital cost of the energy transition in the UK run from 100% to 150% of GDP, which is about £2.6 trillion in current prices. Politicians and bureaucrats claim that the transition, at least in the electricity sector, can be completed by 2035 or even 2030.

Such claims are typical of initial announcements for many large projects in the UK. These bear no relationship to the ultimate time and cost required to deliver what is usually a modest part of what was announced. The archetype is, of course, HS2, but the Institute for Government has emphasised that this is typical of the problems that beset large-scale infrastructure development in the UK.* Any reader familiar with other European countries knows of similar white elephant projects such as Berlin Airport or Stuttgart Railway Station in Germany.

Considerable optimism is required to believe that the energy transition can be achieved within 20 years. That would involve devoting a minimum of 5% of GDP to fund the investments required, but crash programs to develop infrastructure tend to drive unit costs up sharply, because of shortages of necessary skills and other resources. HS2 has suffered in that way. It is very likely that the energy transition – a much bigger program – will experience similar cost inflation. Again, based

* https://www.instituteforgovernment.org.uk/explainer/hs2-costs

on ample experience, it would be reasonable to increase the expected cost by 50% or more to allow for the consequences of attempting delivery on short timescales.

Lest it be thought that these cost estimates are too high, an organisation associated with the EU is reported as stating that achieving the EU's 2030 emissions target will require an investment of 5.2% of GDP or €813 billion per year up to 2030.† The same article reports that the European Commission has estimated that investments from 2030 to 2050 to meet the EU's net-zero targets for energy and transport will be *€1.5 trillion per year*. Adjusting for population, those figures translate, for the UK, to about £105 billion per year to 2030 and £195 billion per year from 2030. Since the European Commission has a long history of drastically underestimating the costs of its environmental policies, it may safely be assumed the eventual cost of the energy transition in the UK and Europe is likely to exceed these estimates by a significant margin.

The UK's Climate Change Committee originally suggested in 2019 that the cost of meeting the Net Zero goal would be 1–2% of GDP over about 30 years. Little detail was provided, and their assumptions have not stood up well to detailed scrutiny. The key elements seem to be (a) an extraordinarily optimistic view of cost reductions driven by technological change, and (b) a misinterpretation of bids for CfD contracts for offshore wind generation. Since these assumptions have not been borne out, it is better to plan on the basis of current real costs rather than hypothetical costs in some possible future.

To assess the implications of spending 5% of GDP annually on the energy transition, we must turn to the key source of data on the UK's national income – the Blue Book 2023.‡ This reports that gross capital formation in tangible assets (thus excluding software and intellectual property) was £327 billion in 2022, or just over 13% of GDP. Of this total, 34% represented new dwellings excluding land, 36% was other buildings and structures, and 30% was all other tangible assets.

In crude terms, the investment required for the energy transition is nearly 40% of gross UK investment in tangible assets. If investment in housing is not affected, since there is already extreme pressure on housing supply, the energy transition would absorb nearly 60% of all tangible investment other than housing. UK economic growth has been profoundly disappointing for more than 15 years. The LSE Centre for Economic Performance recently concluded that average annual growth in the UK's productivity fell by about 2 percentage points between 1995–2007 and 2007–2019.§ About of a third of the decline was due to reduced investment. Most of the rest was due to a slowdown in improvements in the efficiency with which assets and skills are used, a factor that is often linked to investment.¶

Sadly, gross investment figures give a picture that is far too optimistic, because they take no account of capital consumption. This is the need to replace assets as they age and fall out of use. Net investment in tangible assets – after deducting capital consumption from gross investment – was only £42 billion in 2022, or less than 2% of GDP, of which more than 80% was accounted for by net new investment in housing. For practical purposes, gross investment in 2022 outside the housing sector was entirely used to replace old and outdated assets. Replacing old assets by newer ones may increase efficiency and productivity, but it provides no basis for sustained economic growth.

Such replacements may contribute to the energy transition, but there is little chance that a large part of the annual 5% of GDP that must be spent on capital investment to sustain the transition can be found by redirecting other capital expenditure. Offices, factories, health and educational facilities and all of the equipment and machinery they contain must be replaced or modernised, whether or not the energy transition proceeds. New lifts, medical scanners, furniture, food-processing and IT equipment are required to maintain output from existing industrial and service businesses. If they are not replaced, total

† https://www.euractiv.com/section/energy-environment/news/extra-e406bn-needed-annually-to-hit-eus-2030-climate-target-report/

‡ https://www.ons.gov.uk/economy/grossdomesticproductgdp/compendium/unitedkingdomnationalaccountsthebluebook/2023

§ https://cep.lse.ac.uk/pubs/download/special/cepsp41.pdf

¶ Known as growth in Residual Total Factor Productivity.

productivity and aggregate GDP will start to fall, and the rate of decline will accelerate as replacement is delayed.

On top of this is the fraught issue of migration. Official projections suggest an average UK population growth of 0.3% per year from 2020 to 2040. These numbers are completely at variance with reported migration, which is running at over 1% of the UK population each year. The average ratio of the net capital stock to total output for the UK has been over 4 since 2010.** It follows that 4% of GDP must be invested every year in new (not replacement) capital to maintain the average capital per head, if migration and population growth remain above 1% per year. The UK is not close to achieving that goal, and thus the amount of capital per head is falling quite rapidly. Just maintaining the amount of capital per head will eat up an amount of investment equivalent to that required for the energy transition.

Currently the UK is in a macroeconomic trap, with low investment and low productivity, alongside significant population growth. All of the proposed solutions envisage more investment, whether on housing or infrastructure or industrial capital, without providing any indication of where the extra resources will come from. Population growth due to immigration and the energy transition simply tighten the screws of the mismatch between available investment resources and the demands on the overall investment budget.

Escaping the trap

There are, in essence, three stories about how to escape the macroeconomic trap.

1. Redeploy existing investment and, most important, allocate a much higher share of future economic growth to fund the energy transition.
2. Relax the investment budget constraint by squeezing domestic consumption via higher taxes and other levies on disfavoured forms of consumption.
3. Relax the investment budget constraint by a combination of borrowing and foreign investment.

None of these stories is very plausible, but some are sillier than others.

Redeploying existing investment

The first story – redeployment of current investment and the proceeds of economic growth – is the silliest of all. The current political variant focuses on 'green growth' – the idea that green technologies will miraculously allow the UK's economy to grow much faster than it has over the last 15 years. It is a variant of the recurring argument that 'green jobs' will replace employment in industries damaged by the promotion of renewable energy. That argument flew in the face of the evidence when I examined it a decade ago,†† and nothing since has changed the reality. Spending lots of money on green investments and activities will, of course, generate jobs and incomes, but the opportunity cost of lost jobs and growth in the rest of the economy is significantly higher.

The current 'green growth' variant of this story has a major flaw in addition to the obvious point that it hasn't worked up to now. Even under the most favourable assumptions, self-sustaining green growth can only be achieved if there is a period of heavy investment to generate the economies of scale and learning that will underpin future technologies and industries. The models simply assume away the basic macroeconomic trap and jump magically into the payoff stage. In our world, unicorns, if they exist, are not discovered via that route.

Conceptually and practically, the idea of green growth for the UK is a muddle. Most of the spending on the energy transition is required for either:

- non-traded items, such as construction, infrastructure and services
- industrial goods, including power systems and electrical engineering, for which the UK has no manufacturing base and no prospect of developing one.

The development and sale of intellectual property associated with new technologies may be a source of future incomes, but countries like Germany, France and Japan are much better placed to benefit from such opportunities. For the UK,

** https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/timeseries/mo9r/capstk

†† https://www.thegwpf.org/publications/gordon-hughes-the-myth-of-green-jobs-2/

environmental spending is fundamentally a form of consumption, improving the country's quality of life but not a significant generator of income from the rest of the world.

Squeezing domestic consumption

The second story – raising the investment budget by forced public saving is technically possible, but seems politically unattainable. The current Labour leadership has gone through agonies before abandoning a commitment to spend £28 billion per year on a green deal. That sum is a little over 1% of GDP, and could be financed by raising the standard rate of VAT from 20% to 25%. Clearly, they concluded it was impossible to sell an increase in the tax burden of that magnitude to a reluctant electorate. Remember the sum under discussion is only one fifth of the estimated average cost of the energy transition.

While the energy transition attracts a great deal of media attention, the revealed willingness of those who would have to pay for it to bear most of the costs appears to be quite low. Commitment to the energy transition is a classic 'luxury belief', held most strongly by those who are sufficiently well-off not to worry about the costs, and those who have no skin in the game. Indeed, at least some of those who promote the transition most strongly are among those who expect to gain from the business opportunities created by spending large sums on alternative energy technologies.

The bigger problem is that the prospects for public expenditure and taxation in the UK are dire, with only minimal allowance for the costs of the energy transition. The tax burden is close to a peacetime high, and there is a large fiscal deficit. Future projections rely on unrealistic assumptions about fiscal drag and squeezing existing expenditures to cope with the strong upward pressures on spending due to population growth and ageing. It is unclear how commitments to spend more on housing, defence and infrastructure can be met.

A small part of the cost of the energy transition can be found by using current spending and replacement capital investment appropriately, but it is pretence to believe that this will have more than a marginal impact. The fundamental trap remains that the energy transition requires a high level of *new* capital investment, in circumstances where governments are already spending far too little on infrastructure, and businesses far too little on capital equipment.

The alternative to public investment has been reliance on mandated private investment, funded by levies on energy prices. Unfortunately, that model has major flaws, as illustrated by an example from outside the energy sector.

Recently, there has been much focus on the poor performance of water companies (both private and public) in managing sewage and associated pollution. Setting aside the usual tendency to find scapegoats, the core issue concerns the balance between spending on environmental improvements and the level of wastewater charges. For more than a decade, regulators have been under pressure to ensure that charges do not increase faster than the expected rate of inflation. This followed nearly two decades during which real charges increased substantially to comply with EU directives. Since improvements in operational efficiency are modest, that stability could only be achieved by limiting capital investment in replacement and new infrastructure.

This example shows that reliance on mandated and very large capital investments, underwritten by levies and infrastructure charges, is neither politically nor socially sustainable. In any case, the balance sheets of the companies that would be required to carry out such investments are not adequate to carry the risks involved. Again, the water industry illustrates this point. Some of the companies are notorious for having overloaded their balance sheets with debt, with drastic consequences when interest rates rose. However, in practical terms, the debt-to-equity ratios of water companies are not high by the standards of regulated utilities in other countries.

The UK has sought to keep down charges for infrastructure services by squeezing the regulated cost of capital and, implicitly, increasing reliance on debt relative to equity. That is not consistent with expecting shareholders to bear all operational and financial risks. Utilities can only operate with high debt-to-equity ratios if the public, either as bill-payers or taxpayers, bear most of the risks of the business. Squeezing the cost of capital worked while interest rates were falling or very low. However, the recent increases in rates, combined with higher levels of debt, mean that the effective cost of capital for private

infrastructure operators is likely to be significantly higher in future.

Any government wishing to promote the energy transition must take responsibility, in one way or another, for the financial and political costs that will be incurred. Whether it is choices between competing demands for public services, or reductions in household living standards, there is no escaping the impact of the transition on electorates who have given no indication that they are willing to bear the costs involved. Indeed, until now all they have been told is that there are few or no trade-offs required, and technology will somehow, magically, solve everything.

Borrowing and foreign investment

The third story – reliance on borrowing and foreign investment – is far less plausible in 2024 than it might have seemed in 2019. The popular idea of MMT – Modern Monetary Theory, but known more colloquially as 'the Magic Money Tree' – is that countries with their own currencies can issue as much money as needed to cover public deficits, thus borrowing either from their own populations or from the rest of the world. This would seem to give governments such as the US or the UK considerable leeway to fund the energy transition.

Unfortunately, there is a large 'but'. The argument only holds up while there are unemployed resources in the economy or foreign lenders are willing to extend unlimited funds at low interest rates. Even if those assumptions were plausible in 2019, no one believes them in 2024, after a period of high inflation caused by demand exceeding supply in many countries (as well as when measured globally). The idea of unconstrained fiscal deficits and borrowing is a product of the period of low interest rates following the 2007–09 financial crisis and the impact of China's industrial growth. That period ended abruptly following the pandemic in 2020.

The story that the energy transition might be underwritten by public deficits, funded out of borrowing and foreign investment, can be described in optimistic or harsh terms. The optimistic version is that the financial and productive return on the investments required for the transition is sufficiently high to sustain confidence that government borrowing can be serviced, and that the economy will not run into resource constraints. The harsh version is that such government borrowing is simply a Ponzi scheme, through which sums owed to early lenders are paid out of monies borrowed from later ones.

While large amounts of rhetoric have been expended on the issue, what ultimately matters are some basic questions of fact rather than opinion. What are the probable returns on energy transition investments? Are they higher or lower than the returns on other investments in infrastructure or productive capital – investments that may be 'squeezed out' by the energy transition? Does the economy have a large margin of unemployed or under-employed resources that could be mobilised by the energy transition? Are foreign lenders willing to finance large imports of capital equipment required without significant increases in borrowing costs or high prices for the investment goods? Are domestic lenders willing to finance a large increase in domestic debt rather than using an increase in the money supply to finance the acquisition of foreign assets?

The answer to each of these questions is almost certainly 'no', at least for the UK. Still, there is a counterexample: Japan has incurred and manages to sustain a level of government debt relative to GDP that is unparalleled when compared with other countries, even though much of its public spending on infrastructure and other investment has been quite unproductive. It has experienced deflation rather than inflation, even though levels of unemployed resources have typically been very low. Is Japan the exception that proves the rule? A country and economic system that is so unusual that no-one else can use it as a model?

The UK is nothing like Japan. It invests a far lower share of GDP, and the opportunity costs of investing in the energy transition are likely to be very high. The economy has limited unemployed resources, and we know that prices and costs rise rapidly in the face of excess demand. A relatively large proportion of government debt is owned by foreign investors. Those who hold government debt, whether domestic or foreign, are readily willing and able to sell that debt to invest in overseas assets. We have seen regularly over the last 50 years that the UK government cannot assume that it can finance large fiscal deficits without the cost of borrowing rising.

Even if Japan provides a case in which the

assumptions of MMT might be valid, they are certainly not applicable in the UK. There is little or no chance that the UK government can finance the energy transition by borrowing and foreign investment without that having a large negative impact on the rest of the economy.

The ratio of public debt to GDP was close to 100% at the end of 2023, up from less than 40% in 2008. The general government deficit rose to 6% of GDP in 2023, and there are limited prospects for eliminating that deficit in the next five years. It would require an enormous act of faith – or, maybe, folly – to believe that markets would finance energy-transition expenditures that might add 50% or 100% of GDP to public debt, as well as allowing government to fulfill political commitments to fund improvements in public services, without any substantial increase in the tax burden.

The numbers do not add up

Hence, returning to the original question, the clear answer is that the numbers do not add up. The UK is not investing enough even to maintain the level and quality of its capital stock per head of population, let alone to undertake a large program involving heavy investment in energy production and networks, as well as modifications in housing, buildings, and public infrastructure. The legacy of the pandemic policies and high rates of migration have created a fiscal situation in which level and quality of public services is likely to decline in future, unless there are large improvements in both capital and labour productivity.

The UK is caught in a fiscal trap which, to those of us of a certain age, has too many reminders of circumstances 50 years ago. The leadership of the government-in-waiting gives every appearance of not really understanding how severe the economic constraints on their programs are likely to be. Their followers probably don't care, but are likely to become rapidly disillusioned when they realise that the 'austerity' of the early 2010s – in essence disappointed expectations of growth in public spending – was nothing like what happened in the second half of the 1970s.

The evolution of the HS2 project illustrates just how bad the fiscal situation is. It is a poorly conceived, designed and implemented project, but that is nothing unusual for flagship public projects. It isn't even very expensive – of the order of £6–7 billion per year over 20 years at 2023 prices, or less than 0.3% of GDP for the full project, which ought to be easily within the compass of a rich developed country. Governments do not cancel a major part of such projects, except under extreme financial pressure. For HS2 the problem is that the cost of continuing to build the whole project is almost equal to total new investment in tangible assets other than housing.

The remaining choice

The cancellation of the second phase of HS2 demonstrates that the government feels unable to commit to a major public investment that would cost less than 0.8% of public spending. That decision illustrates the severity of the fiscal trap the new government will face. The belief that the state can afford to push ahead with an energy transition that would cost nearly 20 times as much over 20 years is plainly absurd on the evidence available. What is left is a choice:

- *Either:* The government and its partners could set out to persuade the public that the (large) sacrifice required to implement the energy transition is both necessary and feasible. That exercise must be based on full and realistic information. The pattern up to now has been reliance upon a combination of empty rhetoric, extreme optimism and deception. Such behaviour is self-defeating in the longer term. An investment program that relies upon sacrifices for more than two decades cannot be sustained if it is not founded on reality and public trust. 'Blood, sweat and tears' is not an appealing political slogan, but without it the energy transition will be undermined by the vagaries of public discontent within a few years.
- *Or:* The time period allowed for the energy transition could be extended to match both the real willingness to pay of the general public and the rate at which capital equipment is normally renewed. This would disappoint those who believe that an accelerated transition is essential. On the other hand, it would allow the transition to proceed at a rate and in a manner that is consistent with a budget of, perhaps, 1% of GDP over a period of a 40 or 50 years. Economic models show that the cumulative cost of the energy transition will be reduced by adopting a time frame that matches the replacement cycle for energy infrastructure and development periods for complex technologies.

Accelerated timetables increase costs, often by a large amount, and often fail.

Since the UK state is almost invariably both incompetent and indecisive, neither of these options will be followed. We will suffer from the usual combination of drift and waste, with a half-hearted pretence that the energy transition is proceeding. Little will be achieved, but at great cost. Again, the HS2 project provides a clear illustration of the likely outcome after 10 or 20 years: £50–60 billion spent on a white elephant railway line from nowhere central to nowhere central.

Unfortunately, muddle and PR are not an escape route from the fiscal trap in which the UK finds itself. In the 1980s, the country benefited from two pieces of good luck: the development of North Sea oil and gas, followed by the global explosion of the financial sector. While luck may be random, the capacity and willingness to take advantage of it is not. The political and policy-making classes in the UK give every appearance of hoping that something, anything will materialise to enable them to change the current path of declining GDP per person.

Net Zero and the associated energy transition has become the equivalent of a security blanket. An amorphous cloud from which, magically, some large boost to the UK's economic prospects over the next two or three decades will emerge, with the consequence that the constraints imposed by the country's fiscal trap will be greatly relaxed or disappear.

This hope or belief that something will turn up ignores the fundamental economic difference between what happened in the 1980s and the energy transition. Both the North Sea and the financial sector were classic resource discoveries in economic terms. They provided a substantial boost to GDP at a relatively low ratio of invested capital to the increase in net output or value-added. While people may recall the huge costs of oil rigs, pipelines and terminals, in reality the bulk of the additional income took the form of what economists call 'resource rents'. This was unearned income, most of which accrued to the state, although some benefited businesses and those employed in the sector.

In contrast, the energy transition is a highly capital-intensive re-orientation of the economy. There are no new resource rents to give a boost to national income. For the immediate future, earning an adequate return on investment in the sector depends upon a high level of support from either taxpayers or, through subsidies, consumers, so the resource rents – valued at world prices as they should be – are negative.

To illustrate the point, consider the example of steelmaking. In Britain, the Port Talbot blast furnaces are being closed after receiving large subsidies, because they are not economically viable in a world steel market dominated by low-cost producers in China and India. They are to be replaced by an electric arc process that will also not be viable at current or future electricity prices. Other steel producers in Europe are planning to switch to hydrogen-based processes which, even under the most favourable circumstances, will also be unviable at world market prices. In the steel industry, the technological options under the energy transition all generate negative resources rents from the perspective of the national economy. We may choose to accept that penalty as the cost of protecting the environment, but that is a form of consumption and not a source of unearned income.

In summary, the UK – like other European countries – is in a fiscal trap. We are spending too little on the investment required to maintain and increase our physical capital stock to keep up with population growth. The pressures on public services to look after the increasing share of the population that is elderly, disabled or otherwise unwilling or unable to work mean that the share of public spending allocated to investment has been squeezed. The tax burden has increased, while the fiscal deficit means that the ratio of public debt to GDP has grown to 2.5 times its level 15 years ago. There are significant risks if it continues to increase. By any criteria, these macroeconomic trends are neither satisfactory nor sustainable in the medium term.

Against this background, the country's current and prospective leaders have committed to an accelerated energy transition that will involve new investment in physical assets amounting to a minimum of 5% of GDP – and perhaps double that – even though current new investment in physical assets is less than 1% of GDP. To make matters worse, the new capital is likely to generate negative resource rents – that is, it will increase

consumption or decrease aggregate income - when properly valued. However it is financed, the energy transition will involve a substantial reduction in household incomes and consumption for a population that has neither been prepared for such a shock nor agreed to it.

Conclusions

The prospects of financing the energy transition by either redeploying existing capital spending or borrowing are effectively zero. As a result, the costs will fall directly or indirectly on household consumption unless government consumption is squeezed too. Since household consumption is only 60% of GDP, the impact will be to reduce it by more than 8% over the whole period of the transition. That is not a recipe for political tranquillity over the next two decades, and especially if the burden is distributed unevenly, as is all too likely.

Applying Stein's Rule, that anything that can't continue won't continue, any observer with an iota of common sense will realise that the energy transition won't happen over the period and on the scale currently promised. The sad aspect of this is that such failures invariably lead to vast amounts of muddle and wasted resources. The outcome will be certainly worse than adopting a timeframe and a strategy for the transition that is consistent with a plan for financing the investments required that is feasible and has broad public consent.

Many will dispute or play down the facts and logic I present. So be it. Before dismissing the case that I have made, readers should ask *cui bono* – who benefits? There are very strong private and commercial interests that will benefit from the huge programme of spending and taxes required to finance the energy transition. They may adopt the clothing of environmental concerns, but a crucial question is 'Where does the money go?'.

I have studied, taught, written about, and advised on issues of environmental policy and environmental economics for nearly four decades. It is not necessary to believe in the overriding primacy and urgency of the energy transition or Net Zero to have a sincere and sound commitment to environmental issues and human welfare. The obsessive focus of public debate on one issue, to the exclusion of rational argument about costs and other consequences of such policies, is a disgrace for politicians, advisers and the media.

All politics and policymaking is about choices, often complex and contentious. Net Zero and the energy transition are presented as being a necessity that does not involve large costs. The 'necessity' part of the argument is patently untrue – we can choose to set a target date for the energy transition of 2040, 2050, 2060 or beyond. That is exactly what China, India and many other countries are doing.

The issue of costs is a little more complicated, because the argument relies upon a deliberate confusion between initial or transitional expenditures and average costs in the long run. For the avoidance of doubt, the average cost of using renewable energy is generally higher than reliance on fossil fuels. But even if the average cost of using renewable energy were low, the argument entirely neglects the very large initial capital investments required for the transition. This money must be found from somewhere. The belief that a country can simply incur debt of 100% of GDP to finance the transition ignores economic and financial reality.

This is why the term 'energy transition' is so important. We have inherited a capital stock and an economy, built over more than a century, that relies upon fossil fuels. To replace that capital stock to use renewable energy instead is a project that involves huge expenditures as well as social and economic dislocation, plus the sacrifice of a portion of our national income.

The shorter the transition, the greater will be the cost in terms of other economic and social objectives. We will forego investments in housing, infrastructure, and business capital. We will spend less on education, caring for the disabled and the elderly, improving security, treating illness, reducing mortality, and many other things that we value collectively or individually.

The fiscal and macroeconomic trap in which the UK and European countries find themselves is inexorable, and such choices cannot be avoided. Rhetorical commitment to Net Zero does not change facts and financial constraints. The sooner this is recognised and addressed, the better the outcome is likely to be for both general welfare and the environment.

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People are naturally concerned about the environment, and want to see policies that protect it, while enhancing human wellbeing; policies that don't hurt, but help.

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