CLIMATE JOBS

Building a workforce for the climate emergency

campaign against climate change

This report was written by the Campaign Against Climate Change Trade Union Group (CACCTU). It builds on and develops the earlier work produced by CACCTU, *One Million Climate Jobs* (2014). The editorial group and contributors to this report are trade unionists, environmental activists and campaigners and academics who have collaborated to update and expand the previous work. Most importantly, this updated report is a response to the urgency of the climate crisis and the type and scale of the transition needed to match it.

This report is accompanied by an online Technical Companion, which provides references, modelling and further explanation expanding on some of the issues. The numbered references in each chapter can be found in the corresponding chapters of the online Technical Companion. Go to: www.cacctu.org.uk/climatejobs

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2021 Edition
Published by the Campaign against Climate Change

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Why we need to act – the urgency of now

This report shows how we can cut UK emissions of greenhouse gases to help prevent catastrophic climate change. We explain how this transformation could create millions of climate jobs in the coming years and that the public sector must take a leading role. Climate jobs are those which directly contribute to reducing emissions. This investment will give us better public transport, warmer homes, clean air in our cities and community renewal in parts of the country which have long been neglected. Most importantly, it will give us a chance for the future, avoiding the existential threat of climate breakdown.

We are already seeing extreme weather events caused by the destabilisation of our climate and it is now very clear that no areas are safe from its effects. In summer 2021, floods hit northern Europe, killing over 100 in the Ahrweiler district of western Germany alone. [1] Meanwhile, US cities such as Portland and Seattle which usually have mild summers experienced a record heatwave, leaving hospitals struggling to cope. [2] We've seen devastating wildfires around the world, from Australia to California and Siberia, while warmer waters have led to more severe hurricanes. [3] Those who have done least to cause climate breakdown continue to suffer the worst from its impacts. After years of drought, southern Madagascar has been declared, at the time of writing, to be on the brink of its first famine caused by climate change rather than conflict. [4]

These extreme weather events are a consequence of an increase in greenhouse gases in the atmosphere, which have already warmed the planet 1.1 degrees Celsius above pre-industrial temperatures. This may sound like a small difference in temperature, but it represents a vast amount of energy circulating in the system, destabilising and changing our planet's climate. Scientists are clear that greenhouse gas emissions need to be cut in order to prevent further dangerous warming.

In 2015 governments signed up to the Paris Agreement with the goal of limiting global temperature rises to well below 2 degrees Celsius and preferably

Severe flooding in Cambridgeshire, December 2020. Picture: istock.com/ Alphotographic

> **This "code red for humanity" requires urgent and rapid reductions in emissions to avoid catastrophic climate change."**

1.5 degrees Celsius above pre-industrial levels. The UN Intergovernmental Panel on Climate Change (IPCC) special report of 2018 said that to achieve this would require a cut of greenhouse gas emissions of at least 45% from 2010 levels by 2030, and to reach 'net zero' emissions by 2050.

In 2021, against a backdrop of unprecedented extreme weather events, a further IPPC report raised the alarm even more loudly. Climate change, it says, is widespread, rapid, and intensifying, with some aspects, such as rising sea levels, now irreversible, at least during the present time frame. But the report argues that there is still time to limit climate change with strong and sustained reductions mainly in CO_2 and other greenhouse gases. This "code red for humanity" requires urgent and rapid reductions in emissions to avoid catastrophic climate change. [5]

The UK government has set a target to reach net zero greenhouse gas emissions by 2050, and to achieve 78% reductions from 1990 levels by 2035. But the policies currently in place will not deliver the huge transition needed even to meet the government's own targets. The 2021 progress report of the governments's Climate Change Committee identified with concern that, at most, the policies in place will only reduce a fifth of the emissions required to meet these targets. [6]

But even if the government were on track, the targets themselves do not reflect the UK's share of historic emissions. If the UK were to accept this historic responsibility and make its fair share of the effort to prevent a breach of the critical 1.5°C target, it would have to aim for a rapid transition to a near-zero goal by 2030. This would allow the Global South, which has contributed least to climate change but experiences its worst impacts, to transition and develop whilst also reducing emissions. For climate justice, a transfer of money and technology from the richest parts of the world is also essential. 6

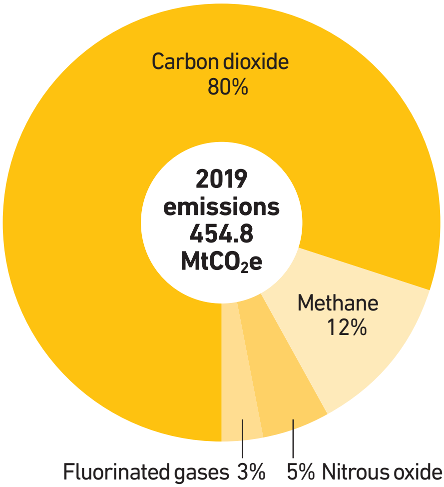
Waking up to the crisis

In 2019 millions of young people and adults around the world took part in climate strikes. Extinction Rebellion also led many people worldwide in direct action protests. This huge rise in climate action, both its scale and in the impact it had, reflects the growing crisis and the continued failure of governments globally to respond with anything like the urgency needed or the policies required that would be capable of delivering huge reductions in emissions.

Despite stark warnings, international agreements and the ever-growing reality of what a changing climate looks like, global emissions have continued to rise.

One of the tactics used to undermine calls for urgent climate action is the argument that we have to choose between jobs and the economy and sustainability. Since the original One Million Climate Jobs report was produced by the Campaign Against Climate Change Trade Union Group in 2008, this argument has been shown to be false many times over. But it is still regularly used by government to justify policies and projects, such as airport expansion or further oil and gas exploration, that break climate targets. These arguments have also found support within some unions.

This updated report draws from and complements a huge body of research and many existing campaigns for the transformation and transition that we need to make and the jobs and livelihoods that can be created if we do. It aims to set out clearly for trade unionists and everyone concerned about the



climate crisis exactly what we should be campaigning for and why we need to urgently break from business as usual.

Time is running out. We can no longer allow year after year to be wasted as an ever more frightening crisis develops. There are alternatives to this failure. Building a workforce to respond to the climate emergency could deliver rapid reductions in emissions and create many well-paid public sector jobs. It's time to mobilise for such a plan.

Building a workforce for the climate emergency: the key messages of this report

A National Climate Service

A key proposal from the original One Million Climate Jobs report was the creation of a National Climate Service, with the government directly employing people to do the work needed to reduce emissions.

The concept of the National Climate Service takes its inspiration from the National Health Service. Despite the challenges and underfunding the NHS currently faces, it is difficult to imagine

> **"It could deliver rapid reductions in emissions and create many well-paid public sector jobs. It's time to mobilise for such a plan."**

how society would have responded to a health crisis such as the Covid-19 pandemic without a nationally co-ordinated, publicly-funded health service. Yet we are facing an even greater crisis, the climate emergency, reliant on the free market and government departments, which consistently fail to prioritise the crisis or to plan any coherent, serious response to it. A National Climate Service would overcome these shortcomings.

Not all of the new jobs will be in the National Climate Service itself: many will be created in in the wider economy. And many more than a million will be needed. This has become very clear as we have put this updated report together: the work required to be done to prevent catastrophic climate change will create a huge number of jobs.

A National Climate Service would play a key role in a Just Transition, so that all workers would be guaranteed permanent, well-paid, trade union protected jobs in work that reduces emissions. It would also guarantee that workers in the old high-carbon sector are retrained with the new skills and knowledge that will be required. We must not underestimate this challenge. The jobs are guaranteed, but ensuring the education and training programmes are in place for that huge workforce must be a significant part of the plan.

A further advantage would be that, just as the NHS provides socially useful work that many take pride being involved in, so will the National Climate Service. It would provide socially useful work that we could take pride in as we decarbonise the economy, address the climate crisis and create a better, safer world for future generations. [7,8]

Public ownership

Alongside the creation of a National Climate Service, it is clear that public ownership of key sectors of the economy is needed in order to make the rapid changes the crisis demands. The market has failed to deliver over many years. In sectors such as transport and renewable energy, which are key to cutting emissions, market failure results from corporations' competition for investment and profit rather than co-ordinating and planning work that can have an impact on the climate. In rail, for example,

competition for lucrative franchises has undermined investment in the green infrastructure we need. 9

In the case of renewable energy, instead of investing in a publicly-owned renewable energy sector, government grants have ended up with private companies. This had not led to the rapid scaling up of this sector or to an expansion of jobs. Direct government investment in a publicly-owned energy system could ensure that a renewable energy industry is established in the UK providing many jobs. 10

Public ownership is vital to transforming our economy in response to the climate crisis. In this report, we have called for public ownership of the energy sector and the grid, of transport, of the plan to retrofit our homes and buildings and, within industry, public ownership of the steel industry and other key sectors.

> **"Public ownership – of the energy sector and the grid, of transport, of the plan to retrofit our homes and buildings and other key sectors – is vital."**

This is the minimum needed to bring about a successful transition, together with a wider economy that is planned in relation to relevant emissions targets and where businesses and industries are regulated to ensure those targets are met.

Many unions already have policies in support of public ownership. Globally, unions have come together to call for public ownership to deliver energy democracy. This is a critical part of the struggle for the transition and for the jobs we need to tackle the climate crisis. 11

Broader societal and economic shifts

In this report, we argue strongly against the vision of a low carbon future which is "business as usual but electrified". We want to create a fairer society; one that understands what is involved in producing the resources we consume – not just in terms of fossil fuels but also in terms of land and water use, mineral extraction, labour conditions and the rights of indigenous peoples. The current climate and ecological crisis is interconnected with social and economic crises. Solutions to the climate crisis need to challenge and reduce existing social and economic inequalities not reinforce them.

At the heart of this updated report is the urgent need to reduce energy use, including the energy embodied in the commodities and products we make, buy and use. There are important infrastructural and society-wide shifts that we can make to achieve this. The mass retrofit programme we propose will insulate homes, greatly reducing energy use as well as fuel poverty, which forces too many people to choose between heating their homes and feeding their families. The shift to a fully integrated public transport system suggested in Chapter 4 will avoid the much greater resource extraction and materials and energy consumption embodied in individual private car use. And shifting to a circular economy to reduce waste will also drastically cut resource use.

The broader societal and economic shifts needed should be understood in the context of the huge and continuing social

> **"The richest 1% are responsible for more than double the emissions of the poorest half of the world's population in the last 25 years."**

and economic inequality that exists in the UK and globally. Many cannot meet their basic needs and around one billion of the world's population do not have access to electricity. [12] In the UK, poverty has risen over the last few years, exacerbated by a decade of austerity and the pandemic. [13]

Inequality lies at the root of the climate crisis. Research by Oxfam International has shown that the global richest 1% are responsible for more than double the emissions of the poorest half of the world's population in the last 25 years. [14] This demonstrates the need to challenge the current neo-liberal free market global economy. An economic model which has produced huge wealth inequalities in favour of the very richest while creating environmental and ecological crisis cannot solve the very crisis it caused.

The Caring Economy

As well as the idea of climate jobs, we consider the expansion of low carbon jobs and, in particular, work within the caring economy to play an essential role in transiting to a society best able to care for both people and the planet. These crucial sectors have for decades been run down, hollowed out and undermined through outsourcing and privatisation. They are jobs mainly carried out by women, who also do the bulk of unpaid family care. There should be massive investment in and expansion of the caring economy to improve pay and working conditions, to support those with caring responsibilities and to enable us to live differently and live well.

The role of workers engaged in the care sector has not been addressed in detail in this report but has been covered elsewhere, for example by Green New Deal UK. [15] Unpaid care should also be understood as economic and socially necessary work that must be taken into account as we formulate the changes we need to see in our society and economy as described above.

Challenging greenwashing and false solutions

As the popularity of the argument that tackling the climate crisis can create jobs has gained prominence many who had previously rejected the notion can be found jumping on the bandwagon, from politicians to oil and gas companies. Challenging the greenwash is now an important part of arguing for work to tackle the climate crisis.

It is important therefore to be very clear about what type of jobs, which technologies and strategies, and what broader social changes we need to make to really tackle the crisis we face.

To do this, there needs to be much greater scrutiny of what is being proposed, examining in detail whether it really will help to reduce greenhouse gas emissions or whether it is simply greenwashing leading to "business-as-usual". This means scrutinising the technologies being promoted. Are they technologies that simply lock in continued fossil fuel use and mitigate the greenhouse gases being produced. Or are they genuine contributions to a rapid

transition from fossil fuels, approaches that leave the majority of the world's reserves of fossil fuel in the ground.

This report makes clear which technologies we believe should not be prioritised in the transition we need. We oppose using technologies that lock in business as usual or that have other ecological and climate impacts. As the chapter on energy explains in more detail, this includes nuclear power, biomass for power and for biofuels, and "blue" hydrogen. We reject solutions that extend fossil fuel use and rely on as yet unproven "carbon capture and storage" technology.

Can we afford it?

The Covid pandemic has shown that governments can find huge amounts of money to address a crisis and that doing so is primarily a question of political will. Economic orthodoxy is very fluid in the context of such crises. Things presented as impossible one day become absolutely possible the next, including the state taking a much more direct role in many parts of the economy and bailing out and nationalising failing sectors. Twice within the last 15 years we have seen huge sums of money pumped into the economy in response to crises: during the 2008 banking crisis [16] and during the Covid-19 pandemic. [17]

Analysis by the government's Office for Budget Responsibility (OBR) has suggested that £1.4 trillion would be required to meet the government's current plans for net zero by 2050. The Committee on Climate Change (CCC) suggests the £50 billion a year needed over the next 30 years to meet net zero is affordable. Unions and campaigners have identified the huge amounts of money lost through tax avoidance and evasion, often by some of the richest companies and individuals, which could provide billions for a Just Transition. But to do this, the wealthy must be made to pay their fair share of taxes. [18]

The money is there. What has not been there is the political will. The cost of inaction is vast, both on an economic level – many mainstream economists and businesses believe inaction could result in huge loss of GDP by 2050 if climate change is not addressed [19] – and, of course, in much more fundamental terms. The costs of not addressing the climate crisis are immeasurably greater in the future collapse of a liveable planet for the people, creatures and nature that inhabit it.

We cannot afford not to invest in millions of climate jobs which transition the economy to zero carbon. We encourage everyone who agrees with us to join the campaign to get us there.

Skilling a workforce for the climate emergency

There is a skills crisis. Like the rest of the public sector, further education, which could play such a significant role in teaching and delivering the skills needed for a transition, has been decimated by funding cuts and failed policy initiatives.

The problem lies in the approach of successive governments which is dominated by market-led thinking. The government's Skills for Jobs White Paper, published in January 2021, contained only one sentence on the green economy. This, in the same year as the UK government hosted the COP26 climate talks. The plans prioritise yet again narrow business interests over the demands of students for an education which equips them for the future, in skills and training for the work that could deliver solutions to the escalating climate emergency.

Picture: Guy Smallman

Every job requires green skills. There are jobs in "climate critical" sectors such as energy, transport, retrofitting homes and workplaces, nature conservation and an expansion in agro-ecological approaches to agriculture. To deliver the work and build the type of workforce outlined in this report will require a huge investment in training and skills.

Young workers and those who want to retrain need to be able to access high quality training in the skills they need. Cost and availability of such courses must not be an obstacle to training this workforce.

Further Education (FE) colleges and universities are key to imparting the knowledge and skills required by young people and the existing workforce for a transition to a green economy and coordinating work-based training provision.

An expansion of vocational education and training should not only train young people but should address issues of diversity in employment sectors. Developing an apprenticeship programme can't just be turned on and off like a tap. There needs to be long-term planning, rooted in the training and skills needed for a transformation of the economy, as well as the involvement of young people, teachers and lecturers and their communities.

Vocational education and training is a vital part of the response to the climate crisis. This requires a huge increase in public funding for the FE sector to enable this to happen, reflecting the key role education, training and skills have to play in the transition of our society.

chapter 2

Keeping the lights on with renewables: jobs in energy generation, distribution and storage

To slash greenhouse gas emissions, we must urgently stop burning fossil fuels. Most of the energy we currently use, for electricity generation and in homes, vehicles and places of work, is produced from fossil fuels such as gas and oil. Decarbonising the energy system requires a huge transition to renewable energy and electrification of the system. The challenge is to eliminate fossil fuels from our energy system, including those sectors which have relied mainly on them, whilst generating enough electricity to meet all our energy needs.

This chapter focuses on electricity generation and distribution. However, in this report we also stress that we cannot transition to a fully decarbonised energy system without also drastically reducing the amount of energy we use overall. That means not only a shift to jobs in renewables but also a shift to jobs that directly help to reduce energy consumption in each sector.

The route to zero carbon requires a real commitment to end fossil fuel use now, with joined-up planning and investment. This can only be done through public ownership of energy generation and distribution. The technical challenges include identifying the right energy mix and the best way to store energy to balance supply and demand. Our energy system is a crucial public utility and provides a public good. Delivering an energy system and a workforce for the climate emergency can only be done effectively if the failed market model is replaced.

Greenhouse gas emissions from energy use

In 2019, total final energy consumption in the UK was 1,651 TWh.[1] The total

> “The challenge is to eliminate fossil fuels from our energy system whilst generating enough electricity to meet all our energy needs.”

greenhouse gas emissions (GHG) from this energy consumption in CO2 equivalent (CO2-e) can be broken down by end-user sector. The table below includes both emissions from on-site fuel combustion, for example gas or petrol, and that sector’s share of emissions from electricity generation. [2] These are the greenhouse gas emissions that need to be cut if we are to respond to the climate emergency and transition our energy system to zero carbon.

Why renewable energy?

Table 2 is from a 2017 analysis comparing the lifecycle emissions of different renewable energy sources compared to fossil fuels for generating electricity. [3]

Lifecycle analysis looks not only at the emissions from burning fuels but also at those produced during mining or drilling for materials, transportation, manufacturing components, constructing the installations, and dismantling installations at the end of their lifetime. It shows that even taking all these factors into account, renewable energy produces much lower emissions than fossil fuels.

Newer renewable technologies already have far lower lifecycle emissions than earlier ones and they will continue to improve as the technologies themselves and the manufacturing of key

Table 1

End-use Sector	2019 GHG emissions in Mt CO2-e	Main source of emissions
Transport	136.4	Burning fuel in internal combustion engines
Homes	96.9	Heating, hot water (mainly gas) and electrical appliances
Business and industry	103.4	Combustion for high temperature processes; machinery (excludes non-energy chemicals emissions)
Public buildings	11.7	Heating and cooling, hot water, IT equipment
Total	348.4	
Other	106.3	Energy-related emissions from other sectors, plus non-energy-related emissions such as methane from livestock and waste, and non-energy emissions from industrial processes
Total end-user emissions	454.7	

Table 2

Energy source for electricity generation	Lifecycle emissions in g CO2-e/kWh	Energy source for electricity generation	Lifecycle emissions in g CO2-e/kWh
Offshore wind	18.4	Wave	55.9
Onshore wind	14.4	Solar photovoltaic	50.9
Hydro (run of river)	19.1	Natural gas	446.1
Tidal	33.9	Coal	948.9

components become more efficient. Since most emissions from renewable energy generation are due to the energy used in producing and transporting the infrastructure, these emissions will fall rapidly as more of this energy is itself renewably produced.

Therefore, a serious attempt to decarbonise energy generation requires a huge expansion in wind, solar and water power. These renewable energies and the jobs that can be created are examined below. How much electricity we need and the challenges of energy storage and distribution are also discussed. We also argue that some types of energy, currently being promoted as low carbon and necessary, can be just as damaging as the fossil fuels they are proposed to replace.

Replacing jobs in fossil fuel extraction and generation: Transitioning the workforce

The move to renewable energy will mean that jobs in fossil fuel extraction and energy generation will end. Research that models a pathway to zero carbon by 2050 has found that the number of new jobs created in the UK by shifting to an energy system based only on wind, water and sun and with a range of energy storage technologies would create **563,814 more jobs** than the number lost in fossil fuel extraction and power generation. [4] That's not including the hundreds of thousands of additional jobs needed to slash the amount of energy we use.

A survey of Scottish oil and gas workers [5] found many reported chronic job insecurity and falling wages, and more than half said they would be interested in redeployment to offshore wind or the wider renewables sector. The most frequently cited barrier to making this move was lack of affordable and accessible retraining opportunities.

Currently the barriers to building the necessary skilled workforce to decarbonise our energy supplies include a fossil fuel lobby intent on maintaining the industry's huge profits at the expense of the climate. These industries are lobbying for technologies, branded as part of the energy transition, that prolong our dangerous dependency on fossil fuels, whilst tightening the screws on their workforce with redundancies and more exploitative contracts.

We argue that a National Climate Service can build the kind of workforce we need, so that everyone who needs it, whether experienced workers whose roles have become obsolete or young people new to

From oil to to wind, an example of the transition we need.

Picture: Sean Vernell

the job market, has access to high quality training in the right skills.

The scale of the challenge

In 2020 the UK government adopted a target of net zero greenhouse gas emissions by 2050 and a reduction in territorial emissions of 78% of 1990 levels by 2035. This excludes international aviation and shipping and the emissions produced in manufacturing goods imported to the UK.

The government hailed the announcement of these targets as world leading, but, in reality, they are significantly lower, and with longer timelines, than those needed to limit global warming to below 1.5 degrees Celsius.

The Sixth Carbon Budget report produced by the government's Climate Change Committee sets out advice on how to meet these targets. [6] This report takes as a starting point a remaining global carbon budget which gives, according to the IPCC report [7], only a 50% chance of staying within the 1.5-degree limit – very poor odds given the catastrophic consequences of breaching that limit!

In addition, the proposals laid out in the CCC report allocate the UK a much higher share of the global carbon budget than that needed to meet the UK's historic contribution to greenhouse gas emissions. [8] This unfairly shifts the burden of emissions reductions to countries in the Global South. These countries have not made a historic contribution to our current global temperature rises but suffer the impacts more deeply. The conclusion must be that we must cut emissions far faster and far more deeply than proposed by the UK government and outlined in the CCC report.

Furthermore, the scenario suggested by the Climate Change Committee includes only 70% genuine renewables from wind, water and solar in 2035. The remainder is to come from nuclear, and from sources such as gas with carbon capture and storage (CCS), biomass with CCS (BECCS), and hydrogen produced from methane with CCS. We argue that these technologies carry with them problems that limit or preclude their role. Instead, we argue for a full transition to genuine renewables by 2038, alongside serious measures to slash energy demand in all sectors.

"We must cut emissions far faster and far more deeply than proposed by the UK government and outlined in the CCC report."

How much electricity do we need to produce?

In 2019 total UK electricity supply was 346 TWh, of which 85.4% was from final consumption in buildings, industry and other sectors. The remaining 14.6% was energy industry uses and transmission and distribution losses. Of the total amount of electricity used that year only one quarter was generated from renewables. [9]

In order to transition the sectors which currently rely on fossil fuels to using electricity from renewables, we estimate that we would need at most 1,374 TWh/yr to meet current demand. We think this is a generous estimate and have set out our reasoning in the Technical Companion.

However, if the energy-saving work described in other chapters is implemented, we can reduce demand by about a half, to around 700 TWh/yr, or roughly twice the current supply. Higher levels of generation might be technically feasible but should be avoided where possible because of the resources needed and their impacts on the environment. We discuss the question of resources and materials in more detail in the Technical Companion.

We should be aiming to achieve this target by 2038 rather than 2050, as current government plans propose. This urgency is needed to avoid the rapid approach of climate tipping points identified in the 2021 IPCC report. [10]

The renewable technologies we need

Windpower

By the end of May 2021, the UK had 10,961 wind turbines. They had a total installed capacity of over 24 GW, consisting of 13.7 GW onshore and 10.4 GW offshore, delivering a total of 66 TWh/yr. [11]

In the Climate Change Committee's "balanced pathway", wind is expected to provide 430 TWh/yr by 2050 from a generating capacity of 125 GW. This is a five-fold increase and would deliver more than two thirds of total supply. 95 GW of this is projected to come from a ten-fold growth in offshore capacity. [12] In the shorter term, the goal is 40 GW of offshore capacity installed by 2030.

In contrast to this, we propose a total generating capacity of 196 GW from offshore and onshore wind combined, providing 629 TWh/yr by 2038.

Offshore wind

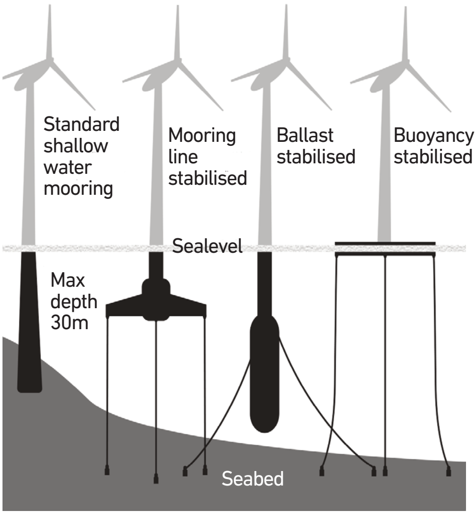
Our proposed scenario would require an increase in installed capacity to 5-6 GW per year, resulting in 100 GW capacity in 2038.

Wind is a huge and important resource for energy generation in the UK. Offshore wind is in plentiful supply and blows most consistently in the waters off the UK.

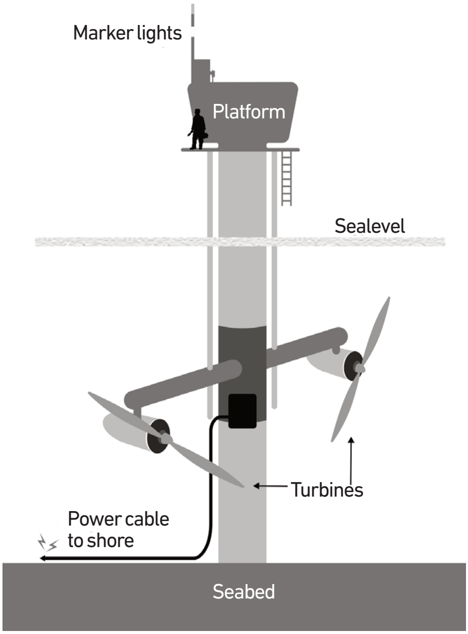
The installed capacity or maximum generating power of one turbine is increasing rapidly. The average capacity of a turbine increased from 2.5 Mega Watts (MW) in 2012 to 7 MW in 2019. There are turbines in development rated at up to 15 MW. [13]

Increased power ratings mean increased size, but larger turbines are a more efficient use of space and materials.

Floating wind turbine



Tidal turbine



This figure shows one of the several different kinds of tidal turbines now being developed. See page 22.

Pictures: Adam Di Chiara

More power can be produced from fewer turbines, reducing the need for foundations and wind farm inter-platform cabling.

Deep water floating turbines

The impact on the marine environment of operating 100 GW of capacity needs to be considered as many thousands more turbines will be competing for shallow waters.

Floating turbines are an alternative to traditional offshore wind turbines. [14] These can be deployed in waters up to 1,000 m deep, compared to a limit of 60 m for fixed bottom turbines, allowing them to be placed in a wider range of areas. Because they can be deployed far out at sea, they can take advantage of higher and more constant wind speeds and can be built much higher and with longer blades. They save on the steel required for fixed bottom turbines, and their installation may be less disruptive to the ocean bed. They would pose far less danger to birds because they would be more widely spaced and away from areas used by high bird populations. A 2018 industry report argues that, with the right investment, the UK could install 50 GW of floating wind power by 2050. [15]

Jobs in offshore wind

Based on a target of 100 GW of installed capacity by 2038, we estimate that a workforce of around 70,000 employed in direct jobs needs to be built. The largest proportion of these jobs, 59%, would be in manufacture and the logistics and engineering roles supplying the necessary materials and other supplies. 24% of jobs would be in operation and maintenance, 11% in installation and grid connection and 6% in other roles (see Technical Companion for details).

> **"Larger turbines not only produce more power but their height also allows them to access higher, more consistent wind currents."**

Manufacture here refers only to components of the turbines. Many additional jobs will also be needed for manufacturing such items as specialist trucks, boats, cranes and other equipment, as well as in the supply chain producing materials for turbines, cable substations and components for associated machinery. We estimate these additional jobs at 60,000.
If manufacturing capacity were established, this would have wider positive economic and social impacts, including jobs in other sectors, potentially in areas that have suffered long term economic depression as a result of previous manufacturing decline.

Jobs in onshore wind

Onshore wind will also play a key role in delivering the renewable energy we need. The challenge for onshore wind is the land needed to scale up to the required capacity. Currently onshore wind requires 2,700 km2 of land to produce 14 GW of power.

A report by the private sustainability consultancy Vivid Economics, which was used to inform the proposals of the Committee on Climate Change, suggests that power produced by onshore wind

Wind is a huge and important resource for energy generation in the UK.

resources could increase to between 96 and 214 GW. It estimates that between 8 and 19% of UK land is potentially suitable for onshore wind development. [16] Our report suggests scaling up onshore wind to the lower figure of 96 GW by 2038, to take into account the need for other important land uses required to tackle the climate crisis, such as reforestation, peatland restoration and solar PV farms.

A more efficient use of land can be achieved by using larger turbines. These not only produce more power but their height also allows them to access higher, more consistent wind currents. In 2012 the average height was 75 m, whilst turbines of up to 260 m are currently being planned, with a production capacity of up to 6 MW each. [17]

To reach a capacity of 96 GW by 2038 means installing turbines to produce an increase of on average 5 GW per year. There are currently 4,400 people employed in onshore wind. [18] We estimate that we would need to increase the workforce to at least 28,000, with a further 14,000 jobs in the supply chain (see Technical Companion). However, figures for current employment vary widely from one report to another and it is possible that future numbers could be very much higher than our cautious estimate.

Solar energy

Although wind power would supply the largest proportion of the energy we need, solar has a substantial role to play. The growth of the solar Industry in the UK has been undermined by lack of government support, so the potential of solar power to meet energy needs is under-developed both in electricity generation and in job creation. Despite its huge potential, in 2019 in the UK, only 10,911 people were employed in solar PV and 9,497 in solar heating and cooling. [19]

The two main technologies for electricity generation from solar energy are solar photovoltaic, known as solar PV – the solar panels commonly seen on domestic roofs – and concentrated solar power. Concentrated solar is a utility-scale solar technology more suited to parts of the world with a lot of strong sunshine. So our main focus in this section is on solar PV.

The Climate Change Committee notes there is potential for 130-540 TWh/yr from 145 to 615 GW of installed capacity of solar power in the UK. [20] However, the CCC does not exploit this potential, setting targets of only 60 TWh/yr in 2035 rising to 85 TWh/yr in 2050. In this report we suggest that 60 GW of large- and medium-scale solar PV farms and 37 GW of rooftop and on-site solar panels could be installed over 16 years, which would increase capacity to 97 GW by 2038.

Challenges of solar power: land use

Land use is a significant challenge for solar PV. The Vivid Economics report suggests 6-11% of UK land is potentially suitable for large-scale solar, but the lower figure, which excludes peat bogs and high-grade agricultural land, provides a better starting point. However, developments in solar cell efficiency mean that solar farms could provide twice

the installed capacity of existing ones with the same land area. Further developments enabling cells to capture more light will increase the number of viable sites for installation, including more rooftops.

Challenges of solar power: resource use and lifecycle emissions

The carbon intensity of solar PV is currently considerably higher than wind power (Table 2). A high proportion of this is a result of the energy needed for manufacturing materials such as steel, aluminum and silicon. This will decline rapidly as the energy supply is decarbonised. Advances in cell technology will reduce emissions intensity further by significantly improving the efficiency of cells. [21] The domestic industry in PV cell manufacture needs to be scaled up significantly, which will also reduce lifecycle emissions through reductions in emissions from transportation.

Concerns have been raised about resource extraction and use, including toxicity of materials, labour rights and environmental degradation. [22] These are important issues. We include a detailed discussion in the Technical Companion, but here we note that regulation and oversight have a key role to play, and stress the importance of strong union organisation.

> "The amount of electricity from solar PV could be increased by floating solar panels on reservoirs."

Reducing the impact on resources also requires a different approach to resource use and reuse. Solar panels have a lifetime of up to 30 years, and almost all the silicon, as well as the glass and metal, can be recycled. [23] Currently the recycling of materials involved in PV cell technology is limited because it is not seen as sufficiently profitable. This needs to change so that all resources are reused and recycled wherever possible. This requires that the work is undertaken as a key part of a publicly run energy system with a National Climate Service which could co-ordinate and plan across the sector. If this is implemented, the recovery and recycling of materials from solar panels will become a significant industry in its own right, employing thousands of workers.

Solar technologies and dispersed generation

One advantage of solar PV is its potential for distributed rooftop and other onsite generation. This can help reduce the load on the grid and even supply energy to it. Used in conjunction with small-scale battery storage, solar PV can contribute to levelling out supply and demand.

Estimates vary widely about how much electricity could be generated in this way. The Centre for Alternative Technology suggests that covering 15-20% of the UK's roof area could provide 90 GW of capacity. [24] A more conservative figure of 37 GW from 25% of UK rooftops is given in the Vivid Economics report. Powerroll, manufacturers of an innovative solar PV film, suggest that covering 25% of industrial rooftops could provide 37 GW of capacity. [25]

This suitability for small-scale generation has resulted in a small but significant proportion of solar capacity already being owned by private householders, businesses, community groups, housing associations and local authorities.

This pattern for the development of solar across the UK reflects the failure of government policies to develop a significant solar industry to match capacity. Initially solar installation was encouraged through a feed-in tariff – a guaranteed payment to private householders and businesses to sell energy to the grid. This meant higher electricity bills were subsidising the private owners of solar panels. The feed-in-tariff was then withdrawn leading to the collapse of businesses in the small-scale solar PV sector.

Given the important role envisaged for small-scale generation and storage in the wider energy system, it would make more sense for the scaling up of rooftop solar, undertaken as public works as part of a planned publicly owned energy system.

Jobs in solar energy

We propose that 37 GW of rooftop and on-site installation could be installed over 16 years up to 2038, alongside the programme for retrofitting buildings. Most of the jobs required for installing solar panels would be additional to those we have calculated for the retrofit programme.

Government policies have led to a failure to develop a significant solar industry to match capacity.

In addition, we argue that 60 GW of large- and medium-scale solar PV farms should be installed, which would increase total capacity to 97 GW by 2038. That would be an average of 5 GW per year with the creation of at least 90,000 jobs in manufacture and installation. The amount could be increased by floating solar panels on reservoirs, which would also reduce water loss through evaporation.

Although the labour intensity of solar PV will certainly fall as technologies advance and solar cells become more efficient, it is worth noting that as of 2019 there were very few UK jobs in manufacturing solar panels, the majority being in installation and construction of solar farms. [26] This means that if an industry in manufacture could be built up, the number of jobs could easily be maintained or increased. Also, over time, the number of jobs in repair and maintenance and especially in recycling will grow.

Solar thermal, heat pumps and storage tanks

Solar thermal technologies can play an important role in space and water heating rather than generating electricity. Solar collectors on rooftops use the energy from sunlight to heat water which is then stored in a well-insulated tanks for later use or used to pre-heat rooms to reduce the electricity needed during peak hours. This can work effectively even in colder seasons. Large solar collectors can significantly reduce electricity demand in some industries.

In addition, thermal stores are now available, called thermal batteries, which can store a large amount of heat energy in a much smaller volume of space than a hot water tank.

Solar collectors can also be integrated with PV panels, creating a system which provides both electricity and hot water, and also improves the efficiency of the PV cell by keeping it cool. [27]

It is difficult to assess how many jobs could be created in this area. In 2019 only 9,497 people were employed in solar heating and cooling. Given the vital importance of reducing energy demand and improving energy storage, we argue that thermal technologies have an important role and that we can develop local industries to manufacture as well as install them. We can assume that the job numbers would at least double to 20,000.

New jobs could also be created to install and maintain heat pumps. The Heat Pump Association says that the number of installers will need to be scaled up from less than 1,000 in 2019 to over 44,000 in 2035. [28] However, many of these jobs are already accounted for in our chapter on buildings retrofit, so here we add only 20,000.

Water power

Water power hardly figures in the current government proposals, despite its huge potential to create low carbon energy and jobs. Water power could contribute to overcoming the challenge of intermittent energy associated with wind and solar, and we think it should become an important part of the renewable energy mix. If harnessed, it could provide energy over a considerable portion of each day at predictable times. Tidal stream and wave energy in particular are promising technologies that need to be developed. Public ownership of our energy sector is needed to ensure the investment needed.

Because water power technologies are still in development, it is difficult to predict how quickly they can be scaled up. Our timeline to 2038 is tight, so we have gone with cautious estimates of 8 GW from tidal and wave energy combined and a further 3 GW from hydropower, providing a total 28.3 TWh/yr by 2038. In the longer term, we can expect tidal and wave power to expand rapidly, perhaps replacing some older wind farms and employing some of the workers from that sector.

Tidal stream turbines

These are similar to wind turbines but submerged under the sea in areas where the tides create strong natural currents. Underwater turbines can produce much more energy more consistently than wind turbines because the density of water is much greater than that of air and the tides are very constant. (See diagram, p.16)

Tidal stream turbines create relatively little disruption to the ecosystem around them. However, very powerful turbines could alter the water dynamics causing disturbances to marine ecology. More

research is needed on the optimum size, design and environmental impacts of such turbines.

A 2018 report by energy consultants Catapult estimates a potential of 15 GW of energy from tidal streams but suggests that tidal stream technology producing no more than 1 GW will be deployed by 2030, generating almost 4,000 jobs. [29] Though starting from a low base and with further development needed, we think that tidal stream technology could be scaled up to produce 4 GW by 2038, creating 16,000 jobs.

Tidal barrages

Tidal barrages are the most efficient way to harness tidal energy. They are often located in estuaries, with the barrage secured to the sea floor while the top sits just slightly above the high tide water level. Turbines are located along the bottom of the barrage. During an incoming tide, water flows over the turbines as the water rises, then flows back through the turbines as the tide goes out, generating electricity. However, tidal barrages can have a significant impact on the surrounding ecosystem, preventing fish and other marine creatures passing through and also impacting water movement, resulting in loss of intertidal habitat. [30]

A variation of the tidal barrage is the artificial tidal lagoon. At appropriate sites, these would be less disruptive to ecosystems. However, the only application for an installation in the UK, in Swansea Bay, was turned down by the government in 2018 despite the 2017 publication of a government initiated independent report arguing in favour of this technology. [31] If the tidal lagoon had gone ahead, it would have provided over 530 GWh of electricity per year and supported 2,232 jobs in manufacturing and construction.

"If the Swansea Bay tidal lagoon had gone ahead it would have provided over 530 GWh of electricity per year and supported 2,232 jobs in manufacturing and construction."

Tidal fences

These may have either vertical or horizontal blades installed together like a fence. They are submerged entirely underwater in inlets and fast-moving streams. They have far less impact on the surrounding ecosystem than a tidal barrage as they interfere less with the movement of the water.

We think that by 2038 we can create 5,000 new jobs in tidal barrage and tidal fences combined.

Wave power

Wave energy can be captured by a variety of means, the most common being the wave energy converter, which allows waves to flow into a chamber and back out, compressing and decompressing air in the top of the chamber which propels a turbine. Wave energy is reliable and consistent and will therefore have an important role to play in the renewable energy mix once deployed on a significant scale. Research and development is needed to determine the most efficient design.

The Catapult report cited above estimates a UK potential of 23 GW of wave energy but only 1 GW installed by 2040 with up to 8,100 jobs. [32] With the right policy support, we think this could reach 2 GW by 2038, requiring 16,000 jobs.

Hydroelectric power

As of 2019, hydroelectric power stations in the UK accounted for 1.88 GW of installed generating capacity. This includes four conventional hydroelectric power stations and more than 1,500 small hydroelectric schemes [33], most of them less than 5 MW capacity. [34]

There are also four pumped storage hydroelectric power stations providing a further 2.8 GW of installed electrical generating capacity. [35] These are a way of storing electricity by using it to pump water from a lower to a higher level, and then releasing it to run downhill and turn turbines at times of high electricity demand.

Sites for hydroelectric dams have to be very carefully selected, as the flooding of large areas to create reservoirs can result in a lot of methane, a powerful greenhouse gas, being released from rotting vegetation. Impacts from large schemes can include loss of farmland, water shortages downstream, fluctuations in river levels downstream impacting local ecology, a reduced carbon sink as vegetation is lost, and in some instances forced displacement of entire communities.

Run-of-river schemes without reservoirs, and small-scale schemes generally, have less impact. For these reasons the potential for additional hydroelectricity power stations in the UK is very limited, estimated at 146 to 248 MW for England and Wales and up to 2.6 GW for Scotland. Whilst relatively small scale, the fact that

Abandoned test site for tidal energy at the Fall of Warness in the Orkney Islands. Picture: Matjaz Krivic / Climate Visuals Countdown.

> **"The current market model of a privately owned energy system encourages waste and prioritises solutions lobbied for by the big fossil fuel players."**

generation can be started and stopped quickly makes hydroelectricity useful for matching supply to varying demand.

In 2019 there were 1,900 people employed in hydropower in the UK, and it is possible this could be doubled with a combination of small- and larger-scale installations. We estimate 1,000 new jobs in this sector.

The power grid: energy efficiency, load spreading and storage

One of the most challenging issues for a decarbonised energy sector based on renewable energy is matching supply with demand. Demand for electricity varies throughout the day and according to the season. It can vary between 20 GW, often occurring in the early hours of hot days in August, and 60 GW, usually in the early evening of the coldest days of the year in January or February.

The grid also has the challenge of managing fluctuations in output depending on weather conditions as more wind and solar energy come on stream, often termed intermittency. The peaks and troughs in the supply of renewably produced electricity often do not match the peaks and troughs in demand. Not only must electricity be available to meet peaks in demand, but if supply exceeds demand parts of the grid can shut down.

These issues have underpinned the continued use of natural gas to rapidly increase and decrease supply for grid balancing. When renewable energy supply exceeds demand, suppliers may be paid to stop generating – known as "curtailment" payments. Ending fossil fuel use in our energy system requires different and better ways of matching supply to demand without wasting renewably produced energy and without relying on continued use of fossil fuels.

The CCC envisages continued use of gas and the use of carbon capture and storage, CCS, to decarbonise the electricity produced from gas and from other sources such as biomass or hydrogen derived from natural gas. [36] We are critical of this approach and these technologies for reasons explained in the sections below.

The key to balancing supply and demand lies instead in a combination of reducing energy demand, finding ways to spread the demand, and developing energy storage systems that can store renewably produced electricity to be used when needed.

The current market model of a privately owned energy system encourages waste and prioritises solutions lobbied for by the big fossil fuel energy market players, regardless of other solutions which may be more effective in creating a decarbonised system. A national grid under public ownership is crucial to enabling a full and rapid transition to renewable energy. A priority focus needs

to be on development of energy storage systems to enable supply to match demand.

Demand reduction and load spreading in the home

One of the biggest challenges is the fluctuations in demand for domestic energy. Our homes account for about 27% of UK energy consumption and are a major source of the daily and seasonal peaks and troughs in demand.

In the Buildings chapter, we show how energy use can be significantly cut by insulating homes. The use of storage heaters, insulated water tanks and thermal batteries, and using electrical appliances such as washing machines at off-peak times can help even out the load on the grid. Batteries can store energy from rooftop solar panels for use during peak hours or for feeding into the grid. Charging electric vehicle batteries at off-peak times and feeding into the grid at peak times can also play a role, alongside the shift to public transport. [37]

Batteries and smart grid technologies

Batteries are a key technology in this area. Batteries store electrical energy as chemical energy, and rapidly convert it back into electricity when needed. The most common battery available today, currently used in electric vehicles, relies on lithium and other environmentally and socially damaging minerals such as cobalt, which is mostly mined in the Congo using child labour. [38] There are, however, developments in battery chemistry focusing on minerals less environmentally and socially costly and that are more suited to grid-scale storage.

High capacity batteries will need to be integrated into the electricity network, either at power stations or in the wider transmission and distribution network, to store large quantities of energy for peak-time distribution.

In 2020 the UK had only 1 GW of utility scale battery storage, with another 13.5 GW in development. [39] In comparison, analysis commissioned by energy suppliers Good Energy suggests that moving to 100% renewables will require the availability of 140 GW of power from batteries and other storage. [40]

The capacity of the electricity grid – the long distance electricity transmission cables and more local distribution cables

> **“The capacity of the electricity grid – the long distance electricity transmission cables and the more local distribution cables – will need to be increased to cope with peak power demand.”**

– will need to be increased to cope with peak power demand. The amount of grid upgrading needed can be reduced by including more dispersed storage within local distribution systems or within individual homes and buildings.

As well as utility scale battery installations, therefore, most analyses see domestic, small-scale and local storage playing an important role. The Good Energy report proposes domestic battery storage capacity ranging from 23 to 55 GWh, storing electricity for use during peak periods. To make this work, smart grid technologies are needed that can integrate sources of supply and storage.

The development of a smart grid has usually been viewed in commercial terms, requiring incentives for households and businesses to buy into the technologies. This approach is too slow and too piecemeal to deliver the smart grid technologies we need. A grid run as a public service would prioritise this work and be able to manage it far more efficiently, whilst ensuring that costs do not fall unfairly on low-income households.

Other energy storage systems and technologies

Existing battery technologies work for short-term storage, but we also need more ways of storing energy for longer periods to ensure sufficient supply during winter months. Possible solutions include liquid air, compressed air, or hydrogen produced by electrolysis of water using surplus renewably-produced electricity. Liquid metal batteries using non-rare elements also offer the prospect of long-term storage. These various options are discussed in more detail in the Technical Companion.

Jobs in the grid and energy storage

Estimates for jobs in storage are hard to find despite storage being such a critical element in the energy system. Jobs are needed in research and development, grid management, manufacture, installation, recycling and more. The Renewable Energy Association, in a useful though already outdated overview of storage technologies, suggests that if 2 GW of energy storage were deployed by 2020, the industry could create jobs for up to 10,000 people in the UK. [41] However, much more storage than this is needed, up to at least 140 GW by 2050, according to the Good Energy report.

Job estimates are difficult to derive as they depend on the mix of technologies used for storage. However, we would suggest that, at a minimum, there is a potential for at least 20,000 jobs in this area over the next decade. In addition, there will be significant work in developing and reinforcing the grid to carry more power. This could require another 30,000 workers.

A note on green hydrogen

Hydrogen from electrolysis of water, using surplus renewable energy, could be one solution for long-term energy storage. This is generally known as "green hydrogen", which differs from "blue hydrogen", which is produced from methane and relies on carbon capture and storage to remove the CO2 that the process produces (see below).

Producing green hydrogen requires a lot of energy, and using it, as some in the industry have suggested [42], to replace natural gas for heating and hot water would add significantly to the amount of renewably-produced electricity we would need to generate. Many commentators agree that we should limit production to

> "Use of nuclear energy will exacerbate the unresolved problem of long-term storage of dangerous nuclear waste."

no more than that needed to prevent wastage of renewably produced electricity and ensure sufficient long term energy storage to cope with periods of high demand. [43] In addition, its use should be prioritised for hard-to-electrify sectors such as heavy transport or industrial processes that require very high temperatures.

What technologies have we left out and why?

Much of the challenge of transitioning the energy system relates to the need to balance the grid and ensure a continuous supply of electricity. The Climate Change Committee suggests a goal of 70% of intermittent renewable energy by 2035, with another 20% from sources providing a steady stable supply, termed "firm" sources. Their report recommends 10% of firm energy be nuclear, the remaining 10% to be provided by dispatchable sources, those that can be turned on or off according to demand. The report identifies the main sources of dispatchable energy as gas and biomass with CCS, as well as hydrogen or synthetic fuels.

There are serious problems associated with the technologies proposed in this scenario, and we have not included these technologies in the plan proposed in this report. Here, we briefly consider the reasons for this, with more detailed explanation provided in the Technical Companion.

Nuclear energy

Most of the UK's nuclear generating capacity is coming to the end of its life, and the government proposes replacing it with a new generation of small fast breeder reactors. These plans promise to be enormously expensive, would take many years to implement and carry significant health, safety and environmental dangers.

Nuclear energy relies on uranium-235, which is a scarce resource. Uranium mining and processing has significant environmental impacts and poses health dangers for workers involved in the process. Fast breeder reactors, able to produce more fuel from the more abundant uranium-238, are still in development and are unlikely to be ready for deployment in the energy sector in the next 20 years. They have additional safety risks and strengthen the existing links between nuclear energy and the military as the plutonium they produce can be extracted and used for nuclear weapons. [44]

Continued use of nuclear energy will exacerbate the unresolved problem of long-term storage of dangerous nuclear waste. There is constant risk of catastrophic nuclear accidents causing widespread contamination and serious health impacts for workers and the wider public.

Nuclear power is promoted as a reliable and firm energy source that can "keep the lights on" when energy from wind and sun is not sufficient to meet demand. [45]

There is a constant risk of catastrophic nuclear accidents. Picture: istockphoto.com / coastalrunner

In reality, a flexible system based on a mix of generating sources and storage makes this approach unnecessary. Nuclear cannot "power up" and "power down" quickly, therefore adding to the problem of matching supply and demand. [46]

Nuclear energy is often regarded as having the lowest lifecycle emissions of all generating technologies. Analysis shows, however, that it has a significant greenhouse effect due to the large amount of water vapour released by nuclear power stations. [47] Crucially, nuclear power plants take many years to build and come online. Planning for a new generation of nuclear plants therefore carries a massive climate cost in the shape of the emissions that could be saved by getting the wind, water and solar systems built at speed. [48]

Carbon capture and storage, "abated" gas and "blue hydrogen"

Carbon Capture and Storage (CCS), or Carbon Capture Utilisation and Storage (CCUS), is central to many zero emissions scenarios and has the support of some trade unions. We have rejected its use at the scale currently being suggested and for most of the purposes currently being proposed. We explain why below.

CCS relates to capturing the CO2 that is emitted when fossil fuels or biomass are burned to generate electricity. The CO2 is converted into liquid form, transported by pipeline or tanker and 'stored' deep underground or under the seabed. This is also proposed as the main method for dealing with CO2 emissions produced by industry.

CCS is also intended for use in the production of so-called blue hydrogen. This is hydrogen produced from natural gas, which is mainly methane, using a method called steam methane reforming. [49] A by-product of this is large amounts of CO2, which in theory is then captured and buried. Proposed uses for blue hydrogen include replacement of natural

gas for domestic heating and hot water, as well as uses in industry and transport. CCS is also proposed as the main method for capturing emissions produced by industry.

The large number of plans for CCS would build in continued use of fossil fuels and high carbon industrial processes and would require huge volumes of space for storing the billions of tonnes of CO2 which would be emitted. However, CO2 stored in this way can leak back to the surface, and even if only 1% a year leaked out, the cumulative impact of this over the years would be immense. In addition, current CCS projects usually target only 90% of CO2 emissions and in practice have fallen far below even this target.

Research by the Tyndall Centre for Friends of the Earth Scotland [50] has concluded that CCS, if it worked at all, could not be deployed on a significant scale until well into the 2030s, whereas we know that the biggest cuts in emissions need to happen within the next decade. Yet CCS has been seized on as a catch-all for carrying on business as usual rather than confronting the urgent task of eliminating greenhouse gas emissions. The prospect of this deeply flawed technology for decarbonising gas in the future underpins strategies that will lock us into a prolonged dependency on fossil fuels.

> **"Some technologies proposed in the Climate Change Committee's scenario have serious problems associated with them."**

Plans to replace natural gas with hydrogen for heating and hot water are of this kind. These plans are initially dependent on the large-scale development of blue hydrogen, with the prospect of it being replaced in the future by green hydrogen, produced from water using renewably-produced electricity. In reality, it is most unlikely that sufficient renewably-produced electricity will be available to produce green hydrogen on this scale, so reliance on blue hydrogen with continued gas extraction will be locked in.

CCS has not been proven at scale and relying on the future possibility of removing carbon emissions is a highly dangerous strategy for energy that is likely to delay the rapid scaling up of renewables and the drastic cuts in energy consumption that are needed. Instead of a rapid move away from fossil fuels, infrastructure is being planned that maintains the use of fossil fuels, such as gas, and other fuels, such as bioenergy, which will damage vital ecosystems.

Bioenergy

Energy produced from biomass is known as bioenergy. Biomass is a broad term covering organic carbon based materials.

When forests are logged it takes longer for the original amount of carbon stored to be recovered, especially where clearcutting is practiced.

Here we focus on the use of wood as a replacement for fossil fuels in power stations, and crops grown to produce so-called biofuels to replace petroleum based fuels in transport.

Trees and plants store carbon as they grow, and when they are burned, this carbon combines with oxygen in the air to produce CO2 emissions, just as when coal or gas is burned. Burning wood emits at least as much and usually more CO2 than burning coal per kW of energy. However, supporters of wood as a fuel in power and heat plants claim that it is carbon neutral because the emissions released will be balanced by the carbon that is absorbed as new trees are grown in its place.

This very misleading. It takes many decades for new trees to grow and absorb equivalent amounts of CO2. When forest ecosystems are logged it often takes even longer for the original amount of carbon stored in vegetation and soils to be recovered, especially where clearcutting is practiced. Even if the amount cut is replaced by new growth, this is only new growth that would have happened anyway if the forest had been undisturbed – not additional growth to compensate for the stored carbon that has been lost. The net effect is always an increase in emissions. 51

Much of the wood used for burning comes from biodiverse forests which are part of a complex ecosystem of plants, animals and carbon-rich soils, vital for helping to regulate the climate not only by sequestering carbon but also by helping to regulate rainfall and storm cycles. If the wood comes from new plantations it means rich ecosystems being replaced by a single crop storing far less carbon than what it displaced.

"DRAX power station burned imported wood pellets equivalent to 127% of the UK's total wood production for 2019, to generate less than 1% of the UK's total energy demand."

Biomass uses vastly more land than solar or wind to produce a given amount of energy. In 2019, DRAX power station, the world's biggest biomass power plant, burned an amount of imported wood pellets equivalent to 127% of the UK's total wood production for that year, to generate less than 1% of the UK's total energy demand. [52]

Crops used to produce gas or liquid fuels for heating and transport require huge amounts of agricultural land, meaning that they displace vast amounts of food crops, leading to higher food prices and pressures on food supplies. Alternatively, agriculture expands into natural ecosystems, including tropical forests cleared for palm oil and soya plantations. [53] We cannot afford to use land in this way when the pressure on land for food crops and for carbon sequestration is so great.

Biofuels are being presented as a key fix to decarbonise transport. The airline industry is heavily promoting aviation biofuels, which are likely to be produced from palm oil as well as soybean oil and other virgin plants oils, widely recognised as a leading cause of deforestation, biodiversity loss and human rights abuses. Most of these fuels are in the early stages of development, yet this reliance on highly questionable future technologies is being used to justify the continued expansion of aviation which will increase emissions significantly over these next vital years.

Increasingly energy from biomass is pushed as a technology that will in future remove carbon from the atmosphere. This is known as BECCS, Biomass Energy with Carbon Capture and Storage. Supporters of BECCS argue that, in addition to the supposed carbon neutrality of biomass, the use of CCS both in power and in biofuel refineries will capture and store emissions, making biomass a carbon reduction technology.

Image: www.biofuel watch.org.uk

Except for the capture of CO2 from ethanol fermentation, BECCS technologies have never been proven even at the scale of a small demonstration plant. [54] Even if it was proven to capture

CO2 efficiently, it would not compensate for the loss of natural carbon storage through destruction of mature ecosystems, nor for the loss of land for food-growing. The reliance on CCS yet again builds in a pathway dependent on unproven future technologies, impeding the necessary urgent scaling up of genuine renewables and measures to reduce energy demand.

A possible scenario for a UK energy mix, with job estimates

Although it is difficult to produce an exact plan, we can be certain that *Building a Workforce for the Climate Emergency* demands a huge transition in our energy system, which involves a number of key features. The energy system transition must be rapid and in place by 2038 with 100% renewable energy. The renewable energies that should form the basis of our energy system are wind, solar and water power. From these sources, sufficient electricity must be generated to meet our existing electricity demand plus the additional demand currently met by fossil fuels. Reducing energy demand is vital and our proposals for doing this are spelt out in other chapters.

If there were a clear focus on this transition, those currently working in fossil fuel energy generation and extraction could be retrained and guaranteed jobs in the new industries. In addition, hundreds of thousands of new jobs could be created.

We think energy demand can be reduced to around 700 TWh/yr and that we can generate more than this amount of electricity from renewables, though a large amount of storage capacity will also be needed to match supply with demand.

This electricity will be virtually emissions-free at the point of generation. There are currently significant emissions associated with the construction of the installations, but since these come mainly from the burning of fossil fuels for energy we will be eliminating them at increasing speed as the transition to renewables progresses.

A possible scenario by 2038 is presented in Table 3. It is ambitious but we need to be if we are to prevent climate catastrophe. We think this is a credible scenario for generating the electricity we need and creating thousands of skilled well paid jobs, but it is not the only one possible.

Rapid technological developments which increase capacity in one area may mean we need less capacity in another. The offshore tidal stream and wave technologies are an example of an area in which capacities far greater than those shown in our scenario are theoretically feasible. However these technologies are currently underdeveloped.

Technological developments in storage will also affect how much extra capacity or "headroom" we need to build in to our energy system. In our scenario, we allow enough generating capacity to supply significantly more electricity than is needed in a year, but this could be reduced if there is sufficient storage

capacity to meet peak demand.

In every case, judgements about the best balance of technologies should be made on the basis of what uses least resources and is least environmentally disruptive. To achieve this we need to break with the failed market model and move to an integrated publicly owned energy system capable of managing this ambitious but absolutely essential work.

Table 3

Energy source	Installed capacity by 2038 in GWs	Estimated capacity factor	Average energy generated in TWh/yrs	Jobs in 2019 where known	Future jobs
Offshore wind	100	40%	351	7,200 (ONS) Direct only	Direct 70,000 Indirect 60,000
Onshore wind	96	33%	278	4,400 (ONS) Direct only	Direct 28,000 Indirect 14,000
Solar PV	97	11%	93	10,900	90,000
Solar thermal	Thermal energy			9,500	20,000+
Heat pumps				1,000	20,000+
Tidal stream (offshore)	4	35%	12.3	800 total for tidal stream, tidal barrage/ tidal fence and wave	16,000
Tidal barrage/ tidal fence	2	25%	4		5,000
Wave	2	30%	5		16,000
Hydroelectric (not including pumped storage)	3	Various – depending on type	7	1,900	3,000
Grid operation, reinforcement and storage (including pumped storage)	50+	N/A	N/A	Various	50,000 +
Total for manufacture, deployment, O&M			750.3	34,000	297,000
Ancillary and supply chain jobs					200,000

Glossary: Keeping the Lights on with Renewables

This chapter and the online Technical Companion use some technical language, concepts and terms that readers may not be familiar with, and this glossary is included for reference. Figures quoted for energy consumption are 2019 figures, reflecting usual energy consumption patterns before the impact of lockdowns during 2020-2021.

Power

The rate at which energy is generated, or converted from one form into another (eg wind energy converted into electricity, or electricity converted into heat).

We express power in kilowatts (kW)

1,000 kW = one megawatt (MW)

1,000,000 kW = one gigawatt (GW)

1,000,000,000 kW = one terawatt (TW)

Energy

The amount of energy which is generated in a given time, or stored in a particular form, is expressed here in kilowatt hours (kWh). This means the amount of energy which is generated in an hour by a device with a capacity of 1 kW, running at full capacity.

1,000 kWh = one MWh

1,000,000 kWh = one GWh

1,000,000,000 kWh = one TWh

In other contexts, you may see energy expressed in different units. We have avoided these here to make it easier to compare data.

Capacity

The maximum rate of generation/energy conversion of an installation under ideal conditions. Often termed “installed capacity” or “nameplate capacity”. This is the figure most often referred to by government and industry sources to describe progress in installing renewables, but it can be misleading as no technology generates at full capacity except in rare conditions.

Capacity factor

This is the ratio of the actual energy output over a given period of time to the theoretical output if running at maximum capacity for that same period of time.

Calculating energy output

The amount of energy generated in a year by a given installation is the nameplate capacity multiplied by the capacity factor multiplied by the number of hours in a year. For example, a 3 MW turbine with capacity factor 0.4 (40%) produces 3 x 0.4 x 8766 = 10,519.2 MWh/yr, or about 10.52 GWh/yr.

Efficiency

The ratio of energy input to output – eg, what proportion of the light energy striking a solar cell is converted into an electric current. Improving efficiency is key to reducing embodied emissions and increasing the capacity of installations

Embodied emissions

The emissions associated with the production of a material or product, including extraction, transportation, manufacture and construction.

Embodied energy

The energy use associated with the production of a material or product, including extraction, transportation,

>>>

Glossary

>>> manufacture and construction.

Lifecycle emissions

Embodied emissions plus the emissions produced by the product or installation in use (eg by burning fuel) and its maintenance and decommissioning.

CO2 equivalent

Greenhouse gases (GHG) are often measured in grams, kilos or tonnes of carbon dioxide equivalent (CO2-e). Carbon dioxide (CO2) equivalent is a measure of how much a gas contributes to global warming, gram for gram, relative to carbon dioxide, over a hundred year period.

Although CO2 is the main greenhouse gas, there are other important GHGs such as methane, nitrous oxide and fluorinated gases.

Although they exist in much smaller quantities, these other gases are far more potent. Methane comprises about 16% of greenhouse gases, and has a CO2-e value of 25, but as this is concentrated within about 10 years of its being emitted, its global warming potential is extremely high in the short term (about 84 times more than CO2, gram for gram, over 20 years).

A large proportion of methane is produced by the oil and gas industry, and will be eliminated as we eliminate the use of fossil fuels; however, a large proportion also comes from agriculture, as does nitrous oxide. Fluorinated gases are mostly associated with industry.

Territorial emissions

Emissions associated with energy generation and distribution, fuel burning in buildings and transport, industry and manufacture, within the geographical borders of the UK

Consumption based emissions

Emissions associated with consumption of materials and goods, including those associated with imported goods, where the emissions were actually produced elsewhere. Emissions from producing goods for export are excluded.

chapter 3

Warm homes, healthy workplaces: climate jobs in buildings

This chapter is about jobs in retrofitting (upgrading) homes and other buildings to reduce their energy use and change the type of energy they use, and also building new ones that use less energy. This will significantly cut carbon emissions, as well as tackling the scourge of fuel poverty and the many physical and mental health problems caused by cold and damp homes and unhealthy work environments. This work has never been more urgent as we face an escalating climate emergency. This sits alongside a huge and ongoing jobs crisis, of low pay, precarious employment, often poor working conditions and long hours – now made worse by thousands of COVID-related job losses.

A mass retrofitting programme will need a large, skilled workforce in every part of the country, mostly additional to the numbers currently employed in the building trades. We argue that the majority of climate jobs – that is, jobs that directly help reduce carbon emissions – need to be public sector jobs. A National Climate Service (NCS), like the National Health Service, will need to be established to ensure the work needed to tackle the climate crisis can be done at the scale and pace needed, using public funds to create well paid, skilled and unionised public sector jobs.

A National Climate Service would ensure that workers in high emissions sectors were retrained for new technologies or for climate jobs in other sectors, alongside other unemployed or precariously employed workers and new entrants to the labour market. In the case of buildings retrofit, the focus of this chapter, the challenge for the National Climate Service will be to recruit enough workers to a sector which needs to grow very rapidly, whilst ensuring they are all equipped with the necessary level of training to do the job properly. This chapter sets out what we see as an ambitious yet realistic approach to this vital work.

> **"Heating our homes currently uses between 300 and 370 TW hours per year. We can cut this by around half within the next 10 years, and by even more in the years following."**

These workers will draught-proof and insulate homes and other buildings so that they use far less energy and are more comfortable and healthier to live in. This must include adequate ventilation to ensure good indoor air quality and help prevent aerosol transmission of viruses like COVID-19. They must also ensure buildings can cope with the heatwaves, heavy rain and high winds that will become more common due to the climate change already happening.

Where appropriate they will also install local renewable heat and energy sources in buildings and on roofs. Together with renewable electricity from the grid, these will, over time, replace gas boilers and other fossil fuel heating for most buildings.

The goal is to make most buildings all-electric, but it will be a difficult challenge to meet the energy demand for buildings, for transport and for industry, all from renewable electricity. Fortunately, though, we can drastically reduce the amount of energy needed in our buildings.

This work, the types of jobs and training needed and how this could be carried out is our starting point. Later in the chapter we will look at the work needed to electrify our homes and buildings. Throughout we examine the impact on the urgent need to reduce emissions and on the quality of our home and workplaces.

Homes

In 2019 (ie the last year before the COVID-19 pandemic), energy used in homes – including electricity generated in power stations – accounted for 21% of the UK's greenhouse gas emissions, or 95.3 Mt CO_2e. [1] And almost two-thirds of this is caused by burning fuel directly in the home, mostly gas for heating and hot water.

Energy efficient electrical appliances, and those which use less water (eg for showers and washing machines), can dramatically reduce energy use. More savings can be made by insulating pipes, recovering heat from waste water, and making use of solar heat [2] (*see section below on Electrification and Renewable Energy on site*). But by far the biggest savings come from slashing the amount of energy we need for heating. Heating our homes currently uses between 300 and 370 TW hours per year. We can cut this by around half within the next 10 years, and by even more in the years following. [3]

To do this we need to draught-proof and thoroughly insulate the buildings and replace inefficient boilers with new heat sources. In the next few paragraphs, we outline the main aspects of retrofitting which could cut energy use, reduce CO_2 emissions and create jobs that will play a key role in tackling the climate emergency as well as improving quality of life for all.

Clockwise from top: external wall insulation detail (LHC) wood fibre insulation installation (Alex Jelly/openecoho mes.org) and an external wall insulated home in Langlee, Scottish Borders (Changeworks).

Start with a survey and a plan

The first step should be to send in well-trained and certified National Climate Service energy assessors to determine what work can be done on each dwelling.[4]

Each individual house needs careful assessment and planning before refurbishment. Any retrofit work – whether done all at once or in stages – needs to take into account the whole house and make sure the work done in one area doesn't lead to new problems. For example, when sealing homes to avoid heat loss, problems with condensation, or with overheating in summer, must also be avoided.

In many areas, the work can be done efficiently on a street-by-street basis. A team of National Climate Service building workers can put up scaffolding along a row of houses, go in as a team and do all the necessary jobs in one go. The work can be phased so that the worst stock, and the localities where fuel poverty is a serious problem, can be prioritised.

Roofs

In houses, insulation can usually be added easily to loft spaces, which are particularly vulnerable to losing heat. Many houses already have some loft insulation, but at least eight million[5] have much less than is needed.

Climate change means roofs in particular come under pressure as heat increases and rainfall gets more intense, so a retrofit is an opportunity to prepare for the future in every way.

Windows

Windows lose a lot of heat, both directly through the glass and through the gaps around the frames. There are still about two million homes with single glazing, and many older buildings have draughty window frames. Solutions include plugging air gaps, draught-stripping windows and installing triple-glazed windows or adding "secondary glazing".




From left to right: Diathonite insulating limehemp plaster (Ecological Building Systems); insulation keeps the heat indoors, people who insulate their loft notice the difference in their comfort and in their fuel bills; solar PV can be incorporated into a home in the form of PV roof tiles.

Walls

Many houses built since the 1930s have cavity walls, some of which have been filled with insulation. However, many such installations have failed because gaps in the insulation have created a cold bridge, allowing parts of the wall to cool and causing condensation, resulting in mould and damp. In such cases, the insulation must be removed.

New insulation will usually need to be applied inside or outside to provide the level of insulation needed. In most cases, breathable materials should be used, that keep warmth in but let water vapour find its way out instead of getting trapped in the wall where it can feed mould growth.

Applying insulation outside usually works better and can allow the walls inside to absorb heat and help to keep temperatures stable in winter and summer. Applying it inside can preserve the outside appearance of the house, though there will be a small reduction in room size.

In either case, insulation needs to be installed with great care. The tragedy of Grenfell reminds us of the importance of thorough training, inspection and enforcement of standards, as well as of the need to use the best and safest materials. This is a further reason why we advocate doing this as a public service with directly employed labour rather than leaving it to cost-cutting private contractors and unaccountable outsourcing chains.

> **"For this to work at the necessary scale and speed, it must be – like the NHS – free at the point of delivery."**

A note on insulating materials

Currently, the main types of insulation used are plastic foams (made from oil) and mineral wool. Both are responsible for heavy CO2 emissions during manufacture, and the foam products especially emit other dangerous pollutants and are extremely flammable. Plastic, oil-based products were at the heart of the Grenfell tragedy.

There are alternatives that are non-toxic, more fire-resistant than plastics, and capable of allowing water vapour to "breathe" through – important when lining older buildings. Materials such as hemp and wood-fibre can be grown as crops or recycled, providing more jobs in the supply chain, and capturing and locking up carbon for the lifetime of their use.

Whilst starting with the best and safest of the materials we have now, we need to ensure that we build up those supply chains rapidly alongside the roll-out of the retrofit programme. (*We discuss this subject in more detail in the Technical Companion*.) 5

Floors

Timber "suspended" floors in older houses can be upgraded by including an insulating layer within their structure. For concrete floors, insulation can be added on top if the rise in floor level is acceptable. Otherwise, the floor must be removed and replaced with an insulated timber or "green concrete" floor. In flats (above ground floor), heat loss through the floor is unlikely to be a problem.

Ventilation

In sealing our homes against heat loss, it is vital to consider ventilation – both to prevent damp developing and to ensure healthy air quality (especially important for control of contagious diseases like COVID-19).

Correct ventilation firstly means installing windows that can be opened. For some homes, though, high quality fan systems can be installed, which can also be made to recover the heat from stale air as it is expelled.

Cooling homes

As the climate changes, overheating in summer becomes more of an issue. Insulating homes and making them more airtight can lead to real problems if we don't have effective ways of keeping them cool.

Sunshades, shutters or screens may be needed to keep sun out on the hottest days, and other forms of seasonal cooling could be installed, such as ventilation chimneys (removing the warmest air) and

"active cooling" – moving the heat from inside to outside the building – powered by renewable energy.

How do we get the job done?

For this to work at the necessary scale and speed, it must be – like the NHS – free at the point of delivery. The current piecemeal approach relying on a hotchpotch of loans, grant funding and financial incentives for homeowners is both discriminatory and immensely inefficient.

The failure of the Green Homes Grant shows this clearly. Complicated, and managed by a private US company that delayed or failed to pay out to thousands of householders and installers, less than 5% of the grants were made before the government pocketed the remaining cash and scrapped the scheme entirely.

To make a mass retrofit programme work, planning needs to be done in a transparent and accountable way. Local councils, as partners of a National Climate Service, are best placed to coordinate this as they are democratically elected, have a direct relationship with local residents, and already know a lot about the local housing stock through their existing responsibilities.

To build the necessary trained workforce, a huge expansion of high-quality training will be essential, requiring partnerships between councils and local FE colleges.

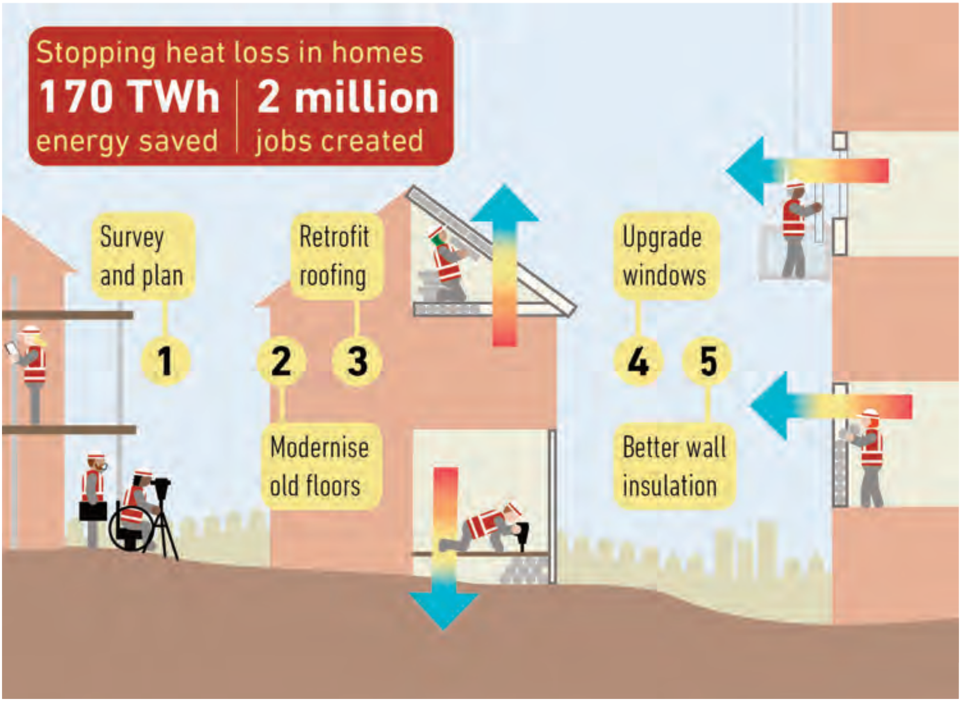


Illustration: David Sewell

Good training courses and apprenticeships crucially depend on the availability of suitable work experience on high-quality projects, both for new trainees and for upskilling existing tradespeople. And courses can only recruit if potential trainees know there is a good secure job at the end.

Where councils still own housing stock, they can, with the right funding, start large-scale schemes on these homes quickly, which in turn supports the development of local supply chains for materials and components, generating further high-quality local employment. Housing associations can play a similar role, in collaboration with councils.

For privately owned homes and in areas of mixed tenures, local authorities can still identify the work that needs doing on each property and engage with homeowners, tenants, landlords and community groups to enable an efficient street-by-street approach to the retrofit works. For this to work, it must be accompanied by rigorous statutory standards for private rentals to ensure uptake in this sector and funding to LAs.

At the same time, pioneering work in retrofit is already being done by community interest businesses, cooperatives, third sector organisations, housing co-ops and community groups seeking to reduce their own energy consumption. These would retain their independence but can be supported where appropriate to scale up, provide high-quality unionised employment, offer good apprenticeships and participate in training opportunities.

Standards

There are a variety of approaches to standards in low emissions construction and retrofitting. Passivhaus, for example, has a standard of 15 kWh per m2 per year for heating in new homes and 25 kWh per m2 per year (the "EnerPHit" standard) for retrofit. This compares with an average of 140 kWh/m2/year for existing UK homes. [6] (*See Technical Companion for more detail on standards*.)

We will take this as our gold standard for NCS retrofits, achieving an average reduction of more than 85% of the energy used for heating. But we know we won't achieve this for all homes, and in practice we need to aim for the best outcome possible for each home. In addition, we need to consider what approach will bring the biggest emissions savings as quickly as possible, whilst opening the way to even further reductions over time.

How many jobs could be created?

We suggest that to do the work, we will need to build a workforce of around two million direct jobs *in homes retrofit alone* by 2030. Recruiting and training such a large workforce will be a challenge, but what we can achieve will increase year by year. We have set out a detailed plan for gearing up in the Technical Companion.

Apart from the energy assessors, retrofit designers and building project managers, and the carpenters, plumbers, electricians and other building workers needed, we will need administrators to make these projects work. They will need to plan the programmes, liaise with residents and ensure that homes are ready for work when the builders arrive, that the energy efficiency of the home is monitored after completion and that snags are dealt with and learned from.

> **"To do the work, we will need to build a workforce of around two million direct jobs in homes retrofit alone by 2030."**

The strategy

To strip back an old house or flat and weatherproof and refurbish it to the highest possible standard of energy efficiency might take four skilled workers six months. [7] Even if we already had a large enough trained workforce, it would take more than 20 years to bring all UK homes to that standard.

But some things – like loft insulation, draught stripping, new windows – can be done much more quickly and make a big difference to energy losses. Tackling these simpler measures first – beginning with the worst housing – will also mean rapid reductions in fuel poverty.

So we propose a twin-track approach for a National Climate Service. For the majority of homes, we prioritise the simpler measures that can be done relatively quickly. This does not mean a one size fits all approach – every home will be assessed to determine what will be of most benefit, whilst also identifying what will need to be done later.

Meanwhile we start on the "deep retrofit" of other homes, including those where damp and lack of maintenance has caused damage. The teams doing this work will also be gaining valuable experience. All retrofits will need to be followed up by monitoring the energy efficiency of the building while it is in use, so that if the savings are less than expected, the reasons can be identified, rectified and learned from.

In terms of energy savings, this approach could see:

- 27 million homes improved to better than Energy Performance Certificate (EPC) C standard, with the energy required for heating reduced by at least 50% (more for the worst stock).
- Two million homes improved to higher "EnerPHit" or equivalent standards, where the energy required for heating is slashed to less than 20% of typical levels.
- Once this is done, the (now experienced) workforce goes on to further upgrade the remaining homes to the same higher standard, over perhaps a further 20 years.

Picture: Sean Vernell

Public buildings and businesses

We turn now to non-domestic buildings – office buildings, hospitals, shops, restaurants, warehouses, schools and many more. These buildings differ a great deal from one another in the ways they use energy. The use of some buildings may also change in the future due to changes in work patterns and public health requirements. Non-domestic buildings (excluding factories) are estimated to contribute between 15% and 27% of greenhouse gas emissions in the UK. [8]

Offices

For offices, overheating is often a major problem. People and IT equipment generate an enormous amount of heat, and lots of glass can add to this problem in sunny weather. As a result, many buildings are air conditioned, using huge amounts of electricity. Air-conditioning installed or used wrongly could also increase risks of transmitting COVID-19 and other infections. But the same buildings can leak a lot of heat and feel cold in the winter.

Even with low energy light fittings, around 15% of energy in commercial buildings is still used for lighting, sometimes during the day when poorly designed windows have to be shaded to reduce glare.

Computers have become more efficient but servers (in offices and in cloud warehouses) are using more energy than ever before. [9]

One case study in Germany reports that energy use in an office building was reduced dramatically, from 600 to 100 kWh/m2/year. [10] This was done by installing “2+1” (triple-glazed) windows with built-in blinds to reduce glare and allow better use of natural light, external wall insulation, and a better air conditioning system with heat recovery. The new heating system has storage tanks which can be night cooled in the summer to help cooling overall.

Not all retrofits will have such dramatic results, but we think it is possible to reduce existing office energy use by more than 50% overall, to an average of 100 kWh/m2/year. [11]

Local renewables can then help provide the remaining energy. The large roof spaces of many public and commercial buildings provide scope for large solar panel arrays, and may also be able to supply surplus energy to the grid.

Schools and colleges

Retrofitting school and college buildings is just the kind of large-scale project that can help support training and boost local supply chains, enabling the retrofit sector to expand more rapidly and create even more jobs. The shoddy buildings and vast sums of public money sucked into corporate pockets under PFI schemes clearly demonstrate the advantages of a National Climate Service employing direct labour for retrofitting schools and other public buildings.

> **“Retrofitting school and college buildings is just the kind of large-scale project that can help support training and boost local supply chains.”**

Targeting schools also has the advantage of creating a healthier environment for learning [12] and helping students learn about energy efficiency. National Climate Service energy assessors can work with school staff and students to cut energy use in schools. They can then identify needed improvements to the building fabric (*see also note* [13]).

Stabilising temperatures and avoiding overheating is particularly important. Sunshading for windows, ventilation systems and “thermal mass” or night cooling systems can all help with this. Good ventilation is of course vital for both learning and infection control.

Electrification and renewable energy on site

We’ve described how we can cut the amount of energy buildings use. Now we look at how we can supply the remaining energy, using electricity where possible. The more we can generate on site, the less demand we place on the grid, leaving more electricity for other uses. (*Please see the Technical Companion for more detail*.)

Heating our homes: heat pumps and other options

For some homes, heat pumps can provide sufficient heating using the low-level warmth in the ground or air. But they should only be installed after a thorough assessment of the building to ensure they can produce enough heat, and with with low electricity demand. Most often, work on the energy efficiency of the building fabric will be needed first.

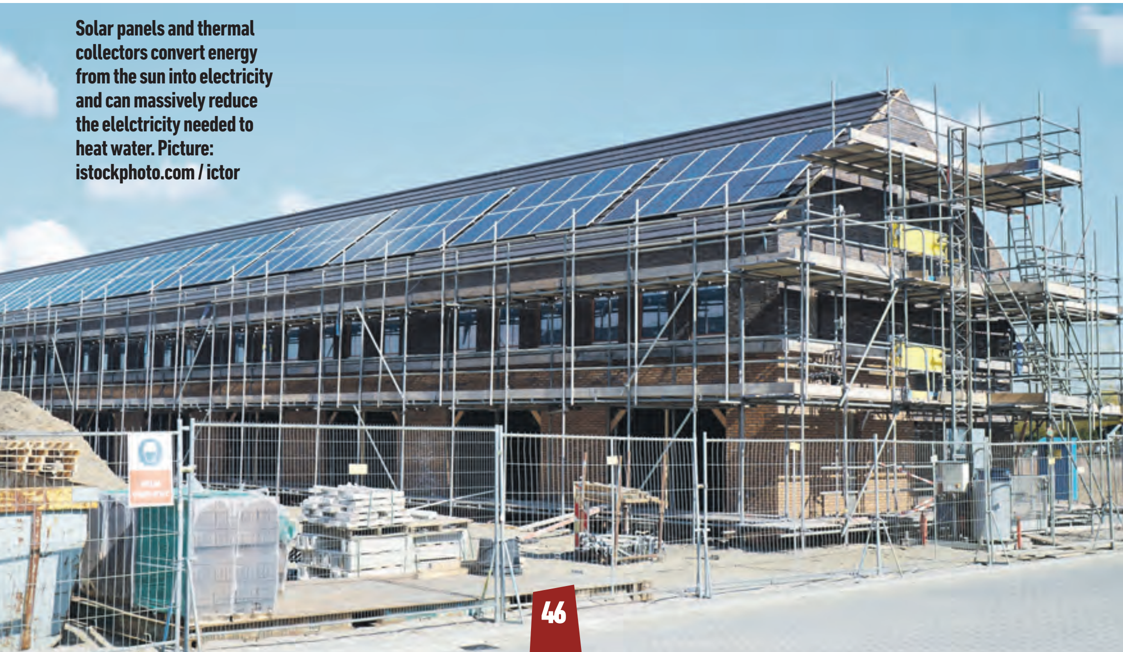
To work well, heat pumps need to be carefully installed and the heat needs to be delivered by underfloor heating or extra-large radiators. Ground source heat pumps are most efficient but need at least some garden space for the coils to be buried in. In areas of denser housing, a group or terrace of houses or a block of flats can be served by a communal system.

"Air-source" heat pumps can work well for more homes, but still need careful siting.

District heating

In district heating (and cooling) networks the efficiency of sharing heat and energy across a local area means savings in energy per home, provided the area is compact and the pipework well lagged.

In Southampton, "Geothermal" energy - heat collected from a mile below the earth – provides heat and electricity for public buildings and over 1,000 homes. [14] A similar scheme is being planned in Bristol using an old mine shaft and warmth from



Solar panels and thermal collectors convert energy from the sun into electricity and can massively reduce the elelctricity needed to heat water. Picture: istockphoto.com / ictor

sewer pipes. These schemes can be near-zero carbon depending on heat source.

Solar panels

Mounted on or built into roofs, and sometimes walls, these convert energy from the sun into electricity. To work efficiently they need to face south, south-east or south-west. They need transformers to convert the electricity to a usable voltage, and either an arrangement with the grid or a method of storing energy when it isn't needed (*for more on solar panels see chapter on Energy*).

Hot water

Solar thermal collectors mounted on roofs can massively reduce the amount of electricity needed to provide hot water in buildings. A solar collector uses the sun's rays to heat a fluid which is then pumped to a heat exchanger inside a water tank, where the heat is transferred into the water. Over the course of a year it will meet about 50% to 60% of a typical home's hot water needs.

A note on hydrogen

We do not support current industry proposals for a large-scale conversion of domestic gas supplies to hydrogen. However, this is a complex topic and we refer readers to the chapter on energy in this pamphlet for a more detailed discussion.

New buildings

At least 80% of existing homes will still be in use in 2050, so retrofitting them is a high priority. For existing housing stock, renovation should be preferred to demolition and replacement, which generally has a much higher emissions cost and frequently results in the loss of affordable homes and displacement of working-class communities.

> **"We also need to build at least 235,000 new affordable homes a year, most of which should be owned and built by local authorities."**

There is also a good deal of scope for retrofitting empty buildings for social housing, as well as schemes to enable councils to take over and retrofit empty homes. Compulsory Purchase Orders have a significant role to play in making the best use of existing housing stock.

However, to solve the shortage of affordable housing – we also need to build at least 235,000 new affordable homes a year, most of which should be council homes, owned and built by local authorities and let at genuine council rent. (*See note* [15] *and Section B in the Technical Companion for more detailed discussion*.)

It is vital we regulate to ensure that these new homes and other buildings are built to near-zero carbon energy standards. As with existing buildings, the key thing is ensuring the highest insulation standards for the building fabric. Merely lowering emissions by supplying more renewably generated energy is not an adequate solution. [16]

It is far easier to cut emissions in new buildings. We can use materials with lower "embodied" carbon – emissions caused by the production and transportation of materials. Locally produced materials can create jobs as well as minimising transport emissions.

Again, the ideal model would be local authority direct labour organisations, drawing on local supply chains with good standards of employment. The skills and training needed will be similar to those needed for low emissions retrofit. So it makes sense for at least some of the newbuild jobs to be integrated into a National Climate Service, including those concerned with planning, assessment and monitoring of performance. The overall number of jobs in construction will of course be greater, reflecting the higher standards required.

The workforce needed to retrofit our homes and buildings

Jobs

(*Section B of the Technical Companion sets out in full the data we have used and how we have calculated these estimates*.)

We estimate that over the next 10 years the retrofit programme will create the following jobs:

- 2,000,000 workers retrofitting homes
- 200,000 workers retrofitting other buildings
- 20,000 building energy assessors
- 20,000 surveyors or architects to become retrofit designers and project managers
- 20,000 support staff to help plan and administer the work
- 40,000 workers providing on-site renewable energy

That's a total of 2,300,000 workers over 10 years.

Of this number, we estimate just over 300,000 are already working on building refurbishment of some sort.

So the number of additional jobs created by the buildings retrofit programme we estimate to be **2 million**.

In addition, there will be approximately **1.5 million** new jobs in the supply chain, providing materials and equipment, and approximately **200,000** extra jobs building new homes.

There will also be jobs in construction training and education and additional building inspectors, which are not included here.

Not all these jobs can be created at once, so we have set out in the *Technical Companion* how the numbers can be grown over a 10-year period.

After that, this skilled and experienced workforce will continue until all buildings have been brought to the highest achievable standard of energy efficiency and make use of on-site renewable energy where possible.

Emissions cuts

Along with the switch to renewables in the grid, this will reduce emissions from buildings by around **95%**.

chapter 4

Creating a green, affordable and accessible network for all: climate jobs in transport

Introduction

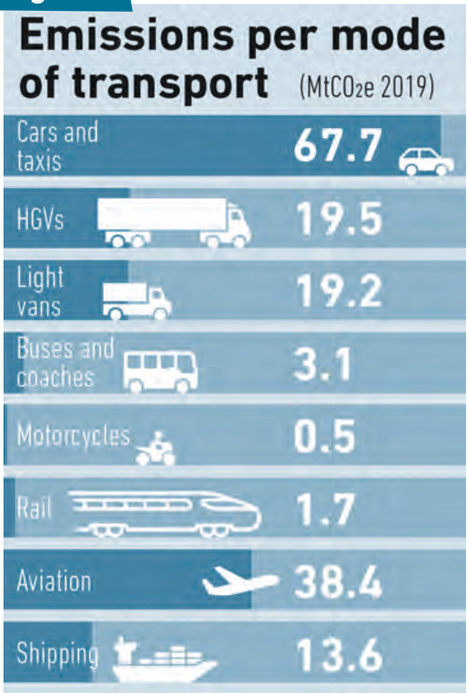
This chapter is about the transformation needed in our transport system if we are to tackle the climate emergency. The changes that we propose aim to massively reduce carbon emissions, improving quality of life and generating the jobs required to make that happen. To achieve this requires a radical transformation in the number and type of different modes of transport, and in the social and political mechanisms to render such actions practical, namely, (i) a shift to public ownership and (ii) a National Climate Service to organise and coordinate such a programme. [1]

In 2016, the transport sector overtook energy production as the largest source of carbon emissions in the UK. While the energy sector reduced its emissions by 63% between 1990 and 2018, transport reduced by only 4.6%. [2] In 2019, the latest year for which complete statistics are available, transport was responsible for 27% of total UK emissions.

Transport emissions are primarily attributed to increased road traffic, which 'has largely offset improvements in vehicle fuel efficiency'. Transport CO_2e emissions by sector are shown in Figure 1 on page 50. [3]

However, it should be noted that *international* aviation and shipping are recorded but currently not counted as part of UK emissions figures since there is

Figure 1



no internationally agreed way of allocating them to individual nation states. Together, these add 44.5Mt CO_2e, more than a third, to the total.

In this chapter we look at each sector of the transport system and how emissions can be massively reduced, and good, well-paid public sector jobs created. This work has never been more urgently needed as we face an escalating climate emergency, a huge jobs crisis and the impact of the COVID-19 health pandemic on our lives.

Characteristics of the future transport system

This chapter is based around the proposition that for too long we have had to organise ourselves around the transport system, rather than transport being a means for members of our society to achieve particular ends. That is, the use of space, be it urban or rural, city or village, is often defined by the transport links that service that place (or not, in many cases). And the methods of providing those links often come at enormous expense to the climate, and to societies and ecologies around the world.

The transport system therefore needs to change to tackle these problems. We argue for a huge increase in public transport to meet people's needs, organised in a way that is far less damaging to the planet than our current methods of transportation and that creates the jobs that we identify here. There are two methods for achieving such sweeping changes in the role of transport in our society: one is the transfer of journeys from more to less polluting modes of transport, and the other is reducing the amount of travelling done.

In terms of transitioning from more to less polluting forms of transport, the basic outlines of the solution are:

- Providing more rail and bus services to facilitate mass movement within and between urban centres and to provide access to transportation for those in rural areas
- Ending the predominance of private motor vehicle use for the majority of journeys
- Transferring as much freight carriage as possible from road to rail, canal and sea
- Significantly reducing air travel and prohibiting airport expansions
- Replacing domestic flights with rail or bus, and international flights with rail, where this is a feasible alternative

> **"We need an integrated transport system that can be afforded by everyone and is owned and operated in the interests of all."**

- Providing the infrastructure to enable greater access to cycling and walking.
- Providing tram services where city centres can accommodate them
- Augmenting other forms of transport with electric vehicles where needed

The aim of these changes is not only to dramatically reduce CO_2 and greenhouse gas emissions. It is also to do so within the context of an integrated transport system structured around an ethos of public service and equality, regardless of age, gender, race, disability or income, that can be afforded by everyone and is owned and operated in the interests of all.

A crucial issue is the energy requirements of a largely electrified transport sector and how to meet them given the competing demands on a finite generating capacity. This needs to be done while also avoiding further damage and exploitation of people and resources in the Global South. Such issues are considered in depth in the chapter on energy. But they have relevance here as, in the system we envisage, transport would be one of the key consumers of that energy.

The creation of an integrated transport system would generate hundreds of thousands of new jobs overall. Where jobs are negatively affected in specific sectors, the principles of Just Transition are essential to guarantee alternative employment and the wellbeing of communities. A National Climate Service and public ownership to protect workers' jobs in transport would ensure that communities that have been heavily dependent on a single employment sector are not left stranded.

What most needs to change

A transformation of the transport system as described above would be a huge challenge in itself. But it becomes even more challenging when we consider that making these propositions realistic requires recognising that the two most polluting forms of transport – cars and aeroplanes – have been built up and normalised over decades as the most desirable ways to travel.

Cars

Private car ownership is so deeply entrenched in our society that it is difficult to believe we could function without it. Around 76% of households in the UK have a car and many have more than one. [4] In recent history, accommodating the private motor vehicle has been the key characteristic of our landscapes, with traffic congestion and struggles over parking spaces in cities, and large, noisy, high polluting motorways cutting swathes through our countryside.

At the same time, privatisation and deregulation has destroyed public transport systems in rural areas and within many towns and cities.

Simply replacing existing combustion engines with electric cars is not the answer. Picture: istock photo.com /oversnap

Changes in employment patterns, gentrification and rising house prices has resulted in people living further from work. The road building policies of consecutive governments has produced and reinforced this problem. But such is the expense and inadequacy of privatised public transport that many people use the car even where the train or bus makes exactly the same journey.

And yet, private car ownership is highly inefficient; most cars spend the overwhelming majority of time idle and unused. Cities are awash with parked cars taking up space, while much of the road systems outside of the congested main thoroughfares are little used, although still used enough to render them dangerous for pedestrians and cyclists. Simply replacing existing combustion engines with electric cars is not the answer as many of these issues would simply be perpetuated. In addition, there would be serious problems with the overuse of scarce resources and the impact their extraction would have on the Global South if electric vehicles were to be produced on such a scale.

Planes

In terms of aviation, the highly commercialised nature of the industry makes flying – despite the advent of low-cost airlines – a relatively elite form of travel. It is estimated that 70% of flights in the UK are taken by just 15% of the population, while around half of citizens do not fly at all. [5] Globally, just 1% of the world's population created half of aviation's carbon emissions during 2018. [6] During the COVID-19 pandemic, the one unaffected area was use of private jets by wealthy individuals escaping lockdowns and avoiding busy passenger planes: in August 2020, private flights were down only 5% on the previous year, compared to 65% for commercial airlines. [7]

The competitive model of aviation among airlines and airports is a barrier to the coordinated public transport network required to encourage travel by other, lower carbon means. That domestic and short haul flights to the same destination are often far cheaper than the train is symptomatic of how the market skews logic and drives passenger choice, with comfortable long-distance train travel tending to be available only to the better-off via first class tickets.

While there is a place for electric cars, as well as developing the use of non-fossil fuel aeroplanes in the future, this needs to be set in the context of a more diverse transport strategy that massively increases public transport and reduces the need to travel.

> "Rail is the key mode of transport around which an integrated and green transport system that provides many jobs would hinge."

What does an integrated green transport system really look like?

The following proposals for an integrated transport system note the ideal form for each mode of transport, how they differ from what we have today, the workforce needed to support this transport system, and the anticipated reduction in emissions against the 2019 baseline shown in the table above.

Rail

Rail is the key mode of transport around which an integrated and green transport system that provides many jobs would hinge. Rail travel has the capability of replacing significant numbers of the two most polluting modes, cars and aeroplanes, of connecting easily with local bus networks and cycleways, and of carrying freight currently transported by Heavy Goods Vehicles (HGVs). Public ownership of trains and rail networks is essential to achieving these objectives.

Applications of rail travel that need to be at the forefront of a green public transport system are:

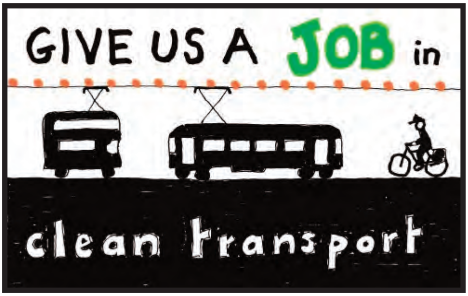
- Cross country travel between large urban centres
- Linkages for small towns and villages and remote rural areas
- Mass transport across large cities
- Cross channel, trans-European travel
- Night/sleeper trains
- Freight carriage

The main priority for reducing private car use is a switch to buses and trains. Trains use less energy per person than buses, and much less than cars. There are two ways in which we can develop a railway system that can fundamentally transform travel practices:

1. *Expand the size of the rail network*: Mile for mile, building railways is cheaper, in some cases much cheaper, than building motorways. Expansion of the system could begin by restoring some of the 6000 miles of track closed by Lord Beeching in the 1960s and the many more miles axed during earlier rail cutbacks.

2. *Increase seat occupancy per train*: The existing train network has little scope for running more trains, but the trains are often not full. Seat occupancy in some other European countries is much higher than in the UK. [8] Bringing car users onto trains would significantly increase occupancy levels, while at the same time providing enough services to avoid the opposite issue – overcrowding – that currently occurs on some trains at certain times.

The existing and expanded network needs to be entirely electric and should rank higher than electric vehicles in priority for deploying the potentially



scarce resources used for generating renewable electricity.

A big gain can be achieved by transferring freight from lorry to rail (and to canal and sea – see below). Rail freight uses about nine times less energy and is around four times more fuel efficient than a lorry carrying the same freight. [9] We propose moving as much road freight as possible onto rail. This requires expanding existing depots and building new ones, with freight broken down and distributed in electric vans that could be recharged at the depot overnight.

The existing train network has little scope for running more trains, but the trains are often not full. Picture: istockphoto.com / Teamjackson

While the scope for a wider network of sleeper trains is less than in Europe, increasing capacity and destinations on existing longer distance routes, in conjunction with affordable, accessible and fast daytime services, offers an alternative to domestic flights. Night trains and better integrated European links, together with additional leave and sustainable holidays for workers, could reduce the number of international and European flights.

A new passenger network designed to wean people off using cars and aeroplanes should have a number of features to improve the network that currently exists:

- More frequent services to attract more passengers and provide a more reliable service

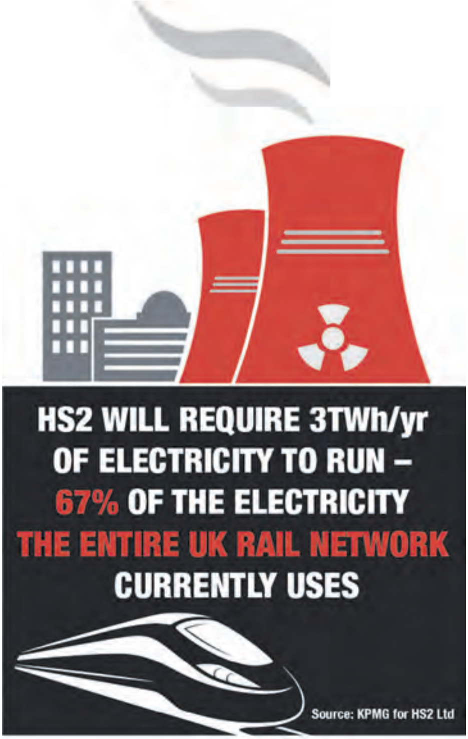
- Affordable or free integrated ticketing, eliminating first class seating, along with ergonomic review of accessibility, luggage and cycle capacity

- Double decker trains, as in France, along with higher bridges and longer platforms, accommodating a larger number of passengers

- Serious attention to ventilation systems and hygiene facilities to prevent virus spread amongst passengers and crew, which could translate into community outbreaks at destinations along routes

- A system of night and sleeper trains, as operated in various parts of continental Europe, replacing domestic and some international flights

- High speed trains to make longer journeys feasible but integrating new projects into the requirements of a genuine public transport system for all rather than, as with HS2, vanity projects of vast expense to the taxpayer affordable only by an elite minority



A shift from road to rail would be the largest single component for reducing carbon emissions from transport (to avoid double counting, this shift is counted in this chapter as a reduction in motor vehicle emissions of around 108Mt CO_2e per year [see below], the largest part of which would result from a transfer to rail and bus).

In the first few years, most of the jobs would be in construction of the expanded network, as well as in electrification of the existing network. These construction activities would incur significant embodied emissions of around 30Mt CO_2e in building the system. 10 Subsequently, however, the network would generate employment in driving, running and planning the service, while reducing emissions from rail to almost zero compared to the current 1.8Mt CO_2e per year.

The work would require jobs during the five-year construction period to upgrade and expand the infrastructure – lay track, build or enhance stations and signalling systems, electrify the network, etc. – with a permanent workforce for maintenance in the years thereafter and eventual replacement. We can expect this task to utilise workers transitioned from the motor vehicle industry following our proposed reduction in car use.

For operations, we assume that the combination of expanding the network and running more frequent services would require roughly double the operations staff, introduced over the course of the five-year construction period as the size of the network increases.

Based on a rail workforce of 240,000 recorded in 2019, [11] including both infrastructure and operations staff, we estimate around 160,000 additional jobs at the outset to build the expanded network, rising to 225,000 at the end of the construction period as additional operations staff are introduced. Subsequently, we estimate this equates to nearly 100,000 extra jobs, in addition to the 2019 workforce, comprising the operations staff running the services and those required to maintain the network once construction is completed and then to replace it as necessary.

Buses

An expanded bus service would be a key component of an integrated and green public transport system. Buses can go to places that trains can't and can efficiently carry large numbers of people.

> **"A significant increase in the bus network and in the number of passengers on each bus is an essential element of reducing the number of cars on the road."**

A significant increase in the size of the bus network and in the number of passengers on each bus is an essential element of reducing the number of cars on the road.

The privatisation and deregulation of UK bus services has led to fare increases, discontinuation of routes, fragmentation and a 'race to the bottom' on staff pay and working conditions. Outside London, bus journeys have halved in number. [12] Returning the bus service to public ownership is essential. Municipal public bus services would allow better service provision, more comprehensive services, simpler fares and coordinated timetables.

Expansion of city bus networks can be implemented alongside measures to reduce car use in city centres, including reserved bus lanes and bus-only streets to reduce journey times. The aim is for a virtuous circle: a more frequent, regular and flexible service would help reduce congestion from cars, in turn encouraging more people onto buses. Another important change is to make buses more affordable. Bringing more people onto cheaper, more reliable services would help to keep income levels up. But travel

should be free for all children, pensioners, people with disabilities, and those on benefits, and National Climate Service investment is vital.

Fuller buses are also much more energy efficient. The average British local bus, on an average day, fills 10 seats. Many European countries, including Italy, Germany, Denmark, Norway, Austria and Spain, manage double that or more. 13 Several studies show that where public transport systems are fast and reliable, people prefer public transport over driving private cars. 14

Picture: Wikipedia Commons.

Buses are not just for cities. Rural bus services, which have been in the front line of cuts under austerity, are vital. Frequent and relevant services need to be restored and developed with much more strategic coordination. We envisage a framework based on inter-urban links and long-distance bus stations at transport hubs on the edge of urban areas. Demand responsive transport (DRT) services operating in a number of British regions to meet specialised needs, 15 such as London's Dial-A-Ride for people who experience accessibility or other barriers to travelling by public transport, can also be linked into these.

These buses could not, of course, run on diesel. Many would run on renewably powered electric batteries, though there are concerns about sourcing the minerals these batteries require. In fact, the most promising technology for electric buses, within city and town centres at least, may be trolley buses with a direct supply of electricity from overhead wires. These disappeared in the UK but not in continental Europe, where in many cities those that did disappear are being revived. 16

Improved and increased bus services require conversion to electric vehicles in order to reduce emissions from 3Mt CO_2e per annum to almost zero. Embodied emissions for replacing existing vehicles and manufacturing a similar number of additional buses [17] would be around 3Mt CO_2e. [18] Transfer of car journeys to buses would provide a significant component of the 108Mt CO_2e per year reduction in emissions resulting from reduced car use.

As with rail, a large increase in staff would be required during the construction period to manufacture new electric buses and convert the existing fleet, with a permanent workforce for maintenance and replacement in the years thereafter. Many would be drawn from those no longer servicing private car use. For operations, we assume that the combination of expanding the network and running more frequent services would require roughly double the operations staff, introduced over the course of the five-year construction period as the size of the network increases.

Based on a bus service workforce of 116,000 recorded in 2019, [19] including both infrastructure and operations staff, we estimate around 23,000 additional jobs at the outset in order to build an expanded bus fleet and electrify the existing buses, rising to 117,000 by the end of the construction period as additional operations staff are introduced. Subsequently, we estimate 100,000 jobs in addition to the 2019 workforce, comprising operations staff to run the services and those required to maintain the network once construction is completed and replace it when necessary.

Trams

Trams sit between trains and buses on the transport ‘spectrum’. They come under the broad heading ‘light rail’. For the most part, trams are electricity-powered and produce little in the way of carbon emissions.

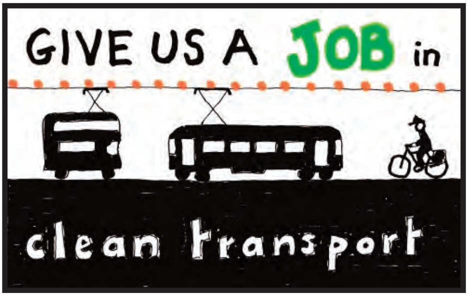
Globally, there are around 800 tram systems in current operation, around half of these being city networks. Trams account for around 3% of all public transport journeys in the UK, where tram

Picture: Wikipedia Commons.

systems operate in Manchester, Sheffield, the West Midlands, South London, Nottingham and Edinburgh. Where trams are in use in the UK, passengers give them a 93% satisfaction rating. [20] As with our bus and train proposals, tram fares should be free-to-cheap to encourage general usage. The Aubagne tramway in Southern France is the world's only tariff free tram service but is nevertheless highly successful. [21]

However, introducing trams should not be the default position. Careful thought should be given to the extent to which they can contribute to an integrated transport system and this would differ from place to place. The cost of implementing a tram system could be high if extensive redevelopment of city streets is needed, both for laying rails and adaptation depending on width, bridges and other obstacles. In a city centre already pedestrianised, or with redevelopment plans, the cost might be more marginal. Cities that had tram services in the early twentieth century may already have wide enough, and obstacle free, streets which could accommodate a revived service.

> 'Where trams are in use in the UK, passengers give them a 93% satisfaction rating."



One tram is estimated to replace around 40 cars on the road, a significant saving of space and a comparable capacity to buses. They also provide convenient, surface level links to rail stations and high streets. Their main disadvantage currently is the hazard that the rails present to cyclists for example. This is a problem that, in a city centre characterised by much reduced car use, would be designed away through the provision of dedicated cycle routes and walkways.

Our assumption is that cities of around 100,000 and more citizens might make use of a tram service in addition to local buses and rail. While that number is arbitrary, there are two countervailing factors: first, towns and cities smaller than 100,000 might wish to introduce a tram service and, secondly, some larger cities may be ill-suited to the adaptations required. With this level of uncertainty, we would caution that the figures presented here could vary by plus or minus 25%.

Based on the number of cities of over 100,000 the urban adaptations required to accommodate a tram service and build the infrastructure would be comparable to the expansion of the rail network with a similar level of embodied emissions to construct, that is 30Mt CO_2e.

The key is building a network of cycle lanes and walkways. Picture: Wikipedia Commons.

The work would require jobs during the five-year construction period to provide the infrastructure – lay track, build stations and signalling systems, adapt buildings and roadways, etc. – with a permanent workforce for maintenance and replacement in the years thereafter. We can expect this task to call significantly upon workers transitioned from the motor vehicle industry by our proposed reduction in car use.

For operations, we estimate that the size of population served by trams in these urban centres would total around 20 million people, and that the requirement could be for 20,000 trams nation-wide, each with two designated drivers, introduced over the course of the five-year construction period.

Given the uncertainty around the extent to which the option for a tram system could be picked up, it is appropriate to consider a range in our job estimates. [22] To build the services we estimate somewhere between 120,000 and 250,000 jobs by the end of the construction period as the operations staff are introduced. Subsequently, we estimate a workforce ranging from 40,000 to 80,000 jobs, comprising the operations staff to run the services and those required to maintain and replace the network once construction is complete.

Cycling and Walking

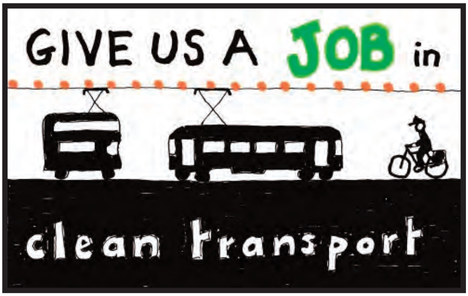
Cycling and walking are a key part of any public transport strategy, especially in towns and cities. Their health and social benefits are such that it has been estimated that every £1 spent on encouraging walking and cycling saves £13 in public health expenditure. [23] The key thing here is building a network of wide, safe, physically segregated cycle lanes and walkways, both alongside roads and on independent routes.

> **"Cycling should be seen as part of ordinary people's everyday mobility, as it is in cities such as Copenhagen and Amsterdam."**

Private car ownership has become a normal and institutionalised element of everyday life. It is culturally embedded and has distorted the physical landscape, with the ‘cyclist’ perceived as a figure of secondary importance with a specialist interest. These perceptions need to be reversed and cycling seen as part of ordinary people’s everyday mobility, as it is in cities such as Copenhagen and Amsterdam. This is not achieved by moral arguments but by providing safe cycle routes and encouraging more people to cycle, leading to a cultural tipping point.

Electric bikes also have an important role to play, [24] particularly outside densely populated urban areas, expanding the range of journeys possible and increasing the number of people who would consider cycling. As well as national measures to promote e-bikes, localised promotion could run alongside the construction of safe cycle lanes linking cities, towns and villages and ultimately a national cycle network.

Similar requirements for safe, separated spaces apply to walking. Consistent with a reduction in car ownership and the use of roads in city centres for buses and occasional electric vehicles, more space can be set aside and adapted for pedestrians. Where such pedestrianised zones exist in city centres, they are highly popular and far more sociable and



Picture: istockphoto.com / ArtMassa

amenable to activity than a high street rammed with congested traffic. Consequently, the impact on emissions from a switch to cycling and walking is counted here as a component of the 108Mt CO_2e reduction in car use noted below.

We propose a doubling of the current 64,000 workforce that support cycling and walking [25] for the first five years. This is needed to create the urban and rural infrastructure to enable safe accessibility for bicycles and pedestrians, adjusting road layouts and so on, in coordination with changes to enable bus and tram services.

Subsequently, we estimate around 6,000 jobs to maintain bikes and infrastructure, and another 6,000 for manufacturing and selling the increased number of bikes. Our estimate is therefore 64,000 additional jobs for the first five years and 12,000 jobs thereafter.

Electric vehicles

The volume of cars and lorries on the road at present is not sustainable. Road traffic increased by 29% between 1990 and 2018 and is forecast to increase again by

> “We need a transition away from mass private car ownership and a conversion of the cars that we have to EVs.”

up to 59% by 2050. [26] Cars and the infrastructure to support them have already seen the destruction of large sections of our cities, towns and villages as well as the concreting of vast swathes of the countryside. And yet in 2020, the UK government committed £27 billion to build even more roads. [27]

Are Electric Vehicles (E.V.s) the answer to reducing greenhouse gas emissions? They are cleaner, although not as much as you might think, quieter and easier to maintain – even insurance is cheaper at the time of writing. But E.V.s are not a ‘Get out of jail free’ card. Converting the UK’s surface vehicle traffic to all electric is not feasible on a one-to-one replacement basis. There are two key reasons:

i. The demand for electricity would be high and in competition with demand from other sectors including other modes of transport, and

ii. The demand for resources for electric batteries would far outstrip the amount accessible and involves considerable exploitation in the Global South.

The lithium required for a large-scale transition to EVs would bring inordinate pressure and exploitation to communities in Argentina, Bolivia and Chile. Alternative mineral sources exist, such as calcium, magnesium, mercury or zinc, but would involve similar exploitation and are both less efficient technically and more expensive. [28]

In practice, we need two key developments: a transition away from mass private car ownership to socially or communally owned vehicles for use by all, AND the conversion of the cars that we need to EVs. Within the context of a diverse transport strategy, the number of EVs needed could be accommodated in a way that a one-for-one replacement of current petrol cars could not.

Our suggestion is that in addition to a huge expansion of the public transport system as outlined above, the following developments would help make a transition away from private car ownership feasible:

- Community sharing of electric cars both formally and informally, for example through car clubs
- Linking smart phones to fleets of public electric cars so that a vehicle can be accessed for use
- Shared taxis – as is common in many other countries
- ‘15-minute neighbourhoods’ in which residents are within walking distance of all essential services

Even with all the above, some exemptions will be necessary, for example for the elderly, disabled people, doctors and others who deliver front line services. EVs can be utilised where needs demand it, adding another option to transport possibilities, alleviating the current congestion of roadways, and remaining within resource constraints while other forms of public transport are massively expanded.

The manufacture of the required number of EVs would incur around 19Mt CO_2e in embodied emissions. [29] However, our proposed massive transfer from cars to public transport – and the electrification of those cars and lorries that would be in use – would reduce emissions by around 108Mt CO_2e each year based on 2019 figures.

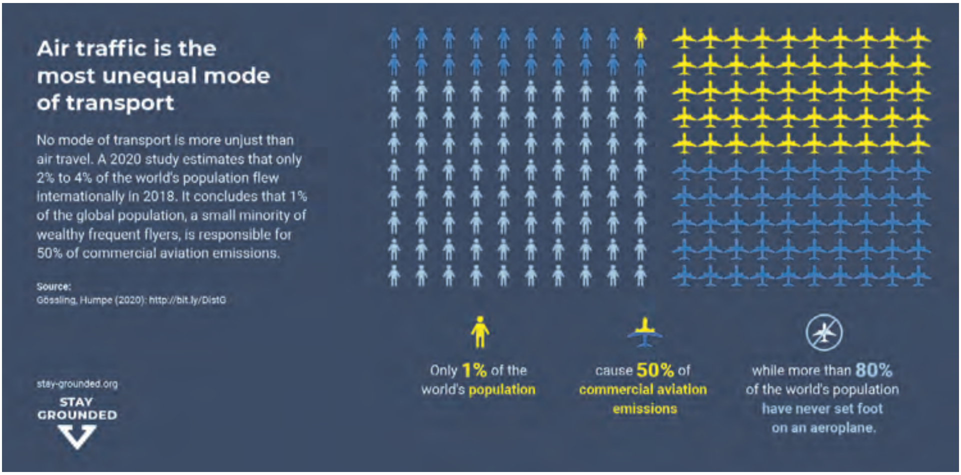
EVs are easier to manufacture than petrol cars, requiring fewer parts and less maintenance, which has implications for the workforce: around one third of labour time is required per electric car when compared with a petrol car. [30] In addition, our public transport system calls for a huge reduction in the number of cars, of around 75% compared to today's car numbers, and that they be designated for specialist needs, accompanied by huge extensions to rail, bus and other modes providing the primary sources of mobility.

As such, private car production will be a minus on the transport jobs balance sheet. With the current 180,000 jobs in manufacture and a further 18,000 in maintenance, the impact of a two-thirds reduction in switching to EVs and a 75% reduction in the number of vehicles required would produce a net job reduction of 165,000 in the first five years. However, this would be compensated by a transfer of many of these jobs to manufacturing of trains, buses and trams, and in supporting bicycle and pedestrian access, as counted in the respective sections above.

Aviation

Aviation is one of the most significant contributors to climate change. In the UK in 2019, total emissions from aviation (shown in the table at the beginning of this chapter) amounted to 38Mt CO_2e, more than 20% of all transport emissions. Aviation is the industrial sector seeing the fastest growth in emissions. While the UK's total emissions decreased by 39% since 1990 and domestic transport by 3%, emissions from international aviation to and from the UK *increased* by 138% over the same period. [31]

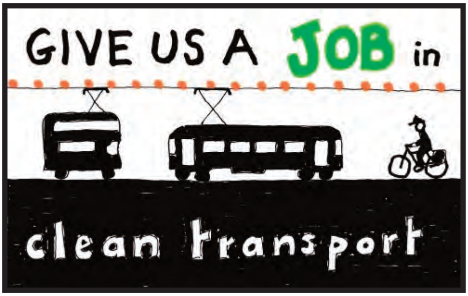
Equally importantly, the industry aspires to continue and accelerate this growth in the coming decades. [32] Flight numbers tend to double every 15 years [33] and if unchecked, that trend will be matched or



The threat posed by continued and increasing air travel could not be clearer. Picture: Guy Smallman.

exceeded between now and 2050. And while the proposed displacement of domestic flights by expansion of long-distance, high speed, electrified rail travel will help, domestic aviation only accounts for 1.5Mt of CO_2e compared to 36.3Mt CO_2e from international flights.

Further, it is not only the *amount* of CO2 emissions that is so threatening in the case of flying, it is also the *effect*. Greenhouse gases emitted in the thinner air of high altitudes is disproportionately damaging, having roughly double the



polluting effect of the same amount of carbon emitted on the ground. [34] Since it is long haul, international flights that fly the highest and spend longest in the upper atmosphere, the threat posed by continued and increasing air travel could not be clearer.

There are two ways of reducing aviation's impact on the environment:

A. Reducing the number of flights through a combination of tax schemes and economic and societal changes

B. Technological solutions that reduce the carbon footprint of each flight

While technical innovations are to be welcomed, such developments on any meaningful scale are predicted to be decades away, contrary to the aviation industry's powerful 'greenwash' that presents these innovations as justification for continuing with business as usual. The battery power required for electric planes would limit the range of flights that could

> **“Only by reducing the amount of flying can urgent climate goals be achieved.”**

use this technology, while alternative fuels are either unproven or – as with biofuels – have such significant detrimental effects in terms of land use and exploitation, especially in the Global South, that they are effectively unusable. [35]

Given these issues, like-for-like replacement of current aeroplanes with non-fossil fuel equivalents will not impact the 2030 climate time horizon. Only by reducing the number of flights can urgent climate goals be achieved. In the short to medium term, therefore, there is a need to transition workers in the domestic and European travel industry to other areas of the transport system.

Regular flyers in the Global North do not take into account the uneven nature of access to flying – globally only about 5%-10% of the population will ever set foot on a plane. [36] Fuel tax exemption and ludicrously low fares on budget airlines have encouraged frequent flying, second-home hopping, and even airline commuting, which is clearly not sustainable.

However, the number of business flights has reduced in recent years, [37] a trend that is likely to accelerate given that the pandemic has seen us take to online platforms, bringing people in remote locations together effectively and at low cost. Many companies are taking the opportunity to reduce costs by altering their travel policies as regards meetings and, in some cases, re-thinking the very concept of retaining dedicated offices. If such developments were combined with a renewed emphasis on the localisation of trade, food growth and manufacture, the economic benefits of aviation expansion would become considerably more tenuous.

There are important social justice issues around access to reduced and more realistically priced aviation, for example for separated families and those with relatives living far away, often impacting migrant communities more directly. While a steeply progressive tax regime applied to frequent flyers might help to blunt the amount of excessive flying, [38] the wealthy will always find a way around increased prices or scarcity. A limit on the number of flights a person can take, in combination with an expanded public transport system including European rail travel, and longer holidays, would be more effective in producing the reduction required as well as more accurately reflecting the social justice aspects.

Given the urgency of the need to reduce the amount of flying and to implement the proposed expansion in public transport, many current aviation workers need to be transitioned to rail and other transport modes. An end to domestic flights and a reduction in flights to and from Europe of, say, 50% in the short to medium term would reduce UK emissions by around 20Mt CO_2e per year, and as a proportion of the current workforce in the sector, [39] would involve the loss of around 110,000 jobs. A Just Transition under the auspices of a National Climate Service is therefore essential to reallocate workers to other sectors of the transport system.

Shipping

We cover shipping because of its significance for global emissions but of all the modes of transport modes, shipping is one of the most difficult to map onto a national climate jobs plan. About 90% of global trade is carried by sea, and around three-quarters of merchant ships are registered under 'flags of convenience', mostly in tax havens, a system that can also undermine workers' rights. [40]

There are three ways in which the industry's emissions can shrink towards zero carbon. The first is for the shipping industry itself to shrink. Fossil fuels make up 40% of maritime trade [41] and a reconfiguration towards a more circular economy would also tend to reduce global transport.

The second way is to reduce the energy needed. This could be done immediately by cutting ship speed. Cut speed by 20% and even accounting for the necessary extra ship capacity, emissions are reduced by 24%. [42] Cut speed by 30% and emissions drop reduced by 33%. Retrofitting technologies currently exist to give a wind power boost to ships, reducing fuel use by 8% or even 20%. [43] There is much greater potential if ships are designed for this from the ground up, but this is only at an early stage.

Our estimate is that, while the steps described would reduce carbon emissions from shipping by around 5Mt CO_2e per year, there is minimal impact in terms of job loss or gain.

The workforce needed to provide a green, cheap and accessible public transport system

The proposals for a massive overhaul of transport described in this chapter can be a great positive in the urgently needed massive decarbonisation of the transport sector and in developing services to meet the needs of the whole population and create many jobs. Building the transport system of the future will involve significant embodied emissions, of around 66Mt CO_2e, to manufacture new vehicles and provide the necessary infrastructure; once operational, however, such a large-scale shift to electrified transport would result in an emissions reduction of around 140Mt CO_2e every year against the 2019 baseline.

Building the public, green and integrated transport system described above would provide around 400,000 jobs, introduced over a five-year construction and transition period. The permanent workforce required to run that public transport system would include workers transferred from the car and aviation industries and would add at least another 200,000 jobs to those already employed in the transport sector. In this way, we can create a green and affordable transport system that doesn't wreck the planet, that is accessible to all, generates many jobs in our communities, and that is a vital part of the solution for our climate emergency.

chapter 5

Decarbonising processes and materials: climate jobs in industry

What we need from industry

This chapter explores, in brief, parts of industry and the carbon emissions that are 'locked-in' when we make and use products. We focus on ways of decarbonising industry and the changes needed more broadly in this area in order to transition from an economy that makes climate change worse to one that gives us a more sustainable future.

The infrastructure needed to transition our energy system, insulate homes and build an expanded public transport system will require many important sectors in industry to play a major role. This will require a serious effort to decarbonise these sectors and a rethink about what we want industry to do.

Most industrial processes and materials are energy intensive and require high temperatures for combustion. This makes industry carbon heavy and therefore challenging to decarbonise. There are two key elements that need to happen together to achieve this. First, we need to decarbonise the process by which we make the materials used in industrial production, which means transforming the industrial practices, including relocalising production and making the process more circular. The second key element is prioritising policies that reduce demand for these carbon heavy materials in the first place. These two factors, both explored below, need to be put in place as a matter of urgency in order to change the nature of industry locally and globally.

"It is debatable whether capturing and storing carbon emissions is preferable to not generating those emissions in the first place."

What makes industry high carbon?

Primary or foundational materials for manufacturing on a large scale include concrete, steel, aluminium, copper, plastics, chemicals and oil refining. The processes for producing all of these emit significant amounts of carbon. A large part of the emissions is associated with the fossil fuels burned to generate the heat required to combust and combine the constituent elements, and with the chemical processes involved in burning iron ore, limestone and clay to make iron, cement and bricks respectively.

In the UK in 2019, carbon emissions associated with industry amounted to around 102 Mt CO2-e. [1] Yet this is only around a quarter of the industrial emissions that the UK should take responsibility for as the embodied carbon of our imports (overseas industrial production plus international transport to get the products here) account for a further 300 Mt CO2-e. [2]

The steel industry alone is responsible for 11% of the annual CO2-e emitted globally [3] and 1.85 tonnes of CO2-e are emitted for every tonne of steel produced, [4] while plastic generates 2.5 tonnes of CO2-e per tonne, plus a further 2.7 tonnes of CO2-e if that single tonne is incinerated at the end of its life. [5]

Carbon capture and storage: a flawed strategy

Existing proposals to decarbonise industry largely hinge on a huge expansion of carbon capture and storage (CCS) technologies. This is an overall approach to decarbonisation we reject as counter-productive and obstructive to the investment required in more viable long-term solutions.

CCS is being heavily promoted as 'the answer' by industry and governments alike. [6] Like sustainable aviation fuels, it has become mythologised as the panacea for the sector, primarily because it is felt to enable the continuation of 'business as usual'. Most industrial processes would continue in the same way, but the carbon emissions produced from the processes would be captured and stored underground.

While CCS is a component of many decarbonisation plans society-wide, it has a particularly high profile in industry, not least because many industrial processes are characterised by the removal of carbon from the raw material, making the question of what happens to the removed carbon paramount. As such, a persuasive argument can be advanced that CCS is a 'natural' solution to the problem of industry emissions; the existing decarbonisation roadmaps for these industries are highly dependent on CCS because process emissions, particularly from limestone, iron ore and ethylene used to produce cement, steel and plastic respectively are felt to be unavoidable.

The steel industry alone is responsible for 11% of the annual CO2-e emitted globally and 1.85 tonnes of CO2-e are emitted for every tonne of steel produced.

Picture: Guy Smallman

However, it is debatable whether capturing and storing a continuous, and increasing, stream of carbon emissions, even if technologically feasible, is preferable to not generating those emissions in the first place. (See more on the Technology of CCS in chapter 2, Energy). We can also note that CCS is unproven and unreliable. After 30 years of development, it has barely progressed past the basic research or demonstration stages, and therefore "cannot deliver rapidly enough or at sufficient scale to provide the levels of mitigation agreed by national laws and international declarations". [7] To date, operational CCS facilities are scarce in the UK, [8] while the government's commitment extends only to "continue to extensively engage with prospective developers and wider stakeholders in 2021 to test and further develop business model designs". [9]

As a response to pressure to meet climate targets, CCS is now seen by industrial companies as preferable to investment in developing alternatives that would also require the replacement of their entire infrastructure. But from the perspective of the long-term future health of people and planet, it would be far better to invest in alternatives that really do decarbonise the industry rather than merely store the carbon. At best CCS should be a marginal technology used in the most limited of circumstances not the major solution currently proposed. It is the alternatives, the transformation of production processes, the reuse of materials and development of substitute materials rather than carbon capture and storage which should be the focus for investment.

How can we decarbonise industry?

In this chapter, we identify 'industrial processes' as a separate activity from the energy used to power the production facilities (See chapter 2, Energy) and from the uses to which the materials are subsequently put (building, transport, agriculture).

The technology largely exists to change some of these industrial processes but needs to be developed at scale and deployed in place of existing facilities. A common theme across these changes is the need to electrify processes, as well as reduce energy and resource consumption across the economy. [10] There is also a need to eliminate industrial processes that produce carbon emissions directly, for example brick kilns, cement kilns and blast furnaces, and ensure the alternatives use less energy and that they are fully renewably powered.

Currently, however, there is little incentive to change and to render existing operations obsolete – "established firms have a natural incentive to keep the market as it is". [11]

> "We need to decarbonise industrial production by transforming the practices of industry, relocalising it and making it more circular."

High temperatures, created by combusting fossil fuels, are needed to smelt the iron ore.

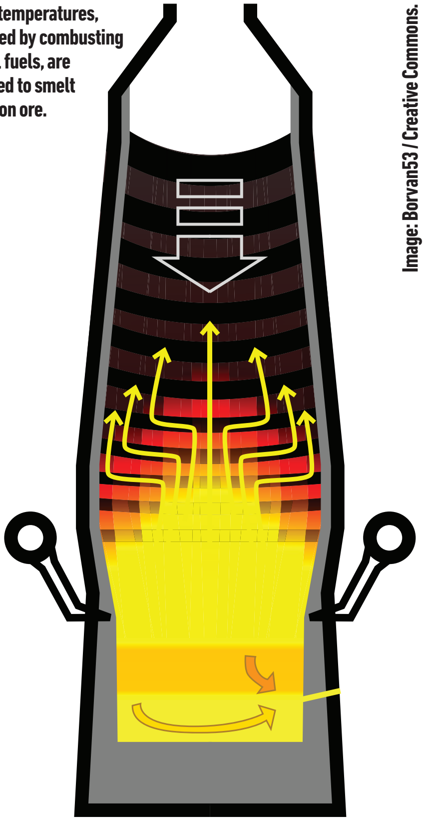


Image: Borvan53 / Creative Commons.

Carbon Heavy Industrial Processes and Materials

The production of industrial materials is very carbon intensive. As the two materials most widely used in construction, and therefore making a significant contribution to the emissions associated with industry, we look here at concrete and steel.

Crucially, as part of a shift in the 'foundational elements' of the construction industry, there should be a planned reduction in the generation of concrete. [12] Cement-making kilns are huge heating machines that grind raw

> "Replacing blast furnaces with electric arc furnaces is crucial."

input materials such as limestone, heat them to produce Portland clinker and grind the clinker to produce cement. This involves burning coal, oil or gas (or in some cases waste plastic, tyres or other polluting materials) in the kilns at extremely high temperatures. Cement is the major ingredient in concrete and is a high carbon material. There should be a plan to rapidly end the use of these kilns.

The development of new forms of cement, using other materials to replace clinker, could, in theory, result in a significant reduction in carbon emissions. [13] However, like CCS, this technology is largely unproven at scale. It is more important that we reduce our use of concrete by changing the nature of construction and the built environment, including how we treat existing buildings. In some cases, alternative products might include low-temperature clay fired blocks to replace the much more dominant concrete blocks and bricks (which have a carbon footprint of at least 1 Mt CO2-e in the UK).

Currently, investment in reusing and repurposing, or in developing substitute materials, is discouraged as commercially unviable, creating a barrier to the necessary developments. [14]

Incentives, instead, encourage demolition, thereby wasting the embodied carbon in already existing products. Few products or buildings are intentionally designed for disassembly or deconstruction. A shift to designing, building and constructing products and buildings that are designed in this way is an urgent part of the transition we need to make. The immediate starting point should be the promotion of a circular approach to cutting the emissions in carbon heavy materials through re-use, re-purpose, re-imagine and re-engineering what already exists.

Just as for concrete, we need to reduce the amount of steel we use in production. This is one significant reason why there needs to be a shift to public transport rather than replacing existing petrol-driven private cars with an equivalent number of private electric cars (see chapter 4, Transport). In construction the emphasis should be on retrofit rather than building more taller and often unwanted office buildings. [15] This would shift the pallet of materials used in the construction sector.

A UK steel industry could then focus on producing the steel needed for a rapid roll-out of renewables whilst reducing the demand for steel elsewhere in the economy. A far more concerted and widespread effort to salvage scrap metal would be required in the UK. This 'scrappage' could be used to replace iron ore imports from other parts of the world and to replace blast furnaces with electric arc furnaces.

> "It is clear that to overcome the inertia and opposition to tackling emissions in industry key sectors must be taken into public ownership."

Replacing blast furnaces with electric arc furnaces is crucial. Traditionally, steel is produced by smelting and reducing iron ore in coal- or coke-fired blast furnaces to remove the oxygen. Electric arc furnaces, on the other hand, operate on electricity – which would, of course, have to be produced by renewable sources rather than fossil fuels. These furnaces also use scrap metal, which reduces the processing to one stage, from scrap metal to steel, rather than two stages, producing iron ore and using that to make steel. [16] While electric arc furnaces can also use direct reduction iron, an iron that melts at a significantly lower heat and therefore reduces energy consumption, [17] it could be possible through assiduous re-use of scrap metal and re-thinking of how much steel production is actually needed (see next section) to meet the UK's steel needs wholly from scrappage.

Not only should all existing blast furnaces be replaced but the plans to open a new coking mine in West Cumbria must be scrapped, as this transition could take place now. A plan for the closure of blast furnaces and replacing them with electric arc furnaces as part of a just transition shifting existing steelworkers to these new industries could see completion by 2025.

Materials

Alternative materials for use in construction and other industries have been developed but have not been enthusiastically adopted by industry because they are often rejected by construction firms and other vested interests who are content to make huge profits from unsustainable practices. [18] Investment and research into alternative materials is needed in construction and industry. But the biggest shift required is one where the 'alternative materials' for new buildings and infrastructure is simply the bricks, concrete and steel of what is already there through reusing and repurposing rather than demolishing.

For plastics production, and the wider refinery industry that sits behind it, the emphasis is on solutions recognisable to most households – reduction in use, avoidance of single use plastics, reuse and recycling of as much material as possible – facilitating 'a shift to a circular plastics economy' but again a far more systematic and comprehensive approach to reuse than the current one is needed. [19]

Re-thinking social purpose

Linked to the issues discussed above is a more socialised view of industry: rethinking, scaling-down, localising and increasing circularity of supply chains and transforming, production. Rather than continuing to build and buy more, with ever more disposability, due in part to marketing and in part to built-in obsolescence, the social purpose should shift to scaling down production and eradicating over production whilst increasing the functionality and longevity of what is made. Ultimately, some products may not be replaced with alternative products but with local services that enable sharing.

Green bans, a form of strike action conducted for environmental or conservation purposes, originated in Australia in the 1970s, led by the Builders Labourers Federation (BLF) and used to protect parkland, low-income housing and buildings with historical significance.

The philosophy of Green Bans was summarised by BLF union leader Jack Mundey:

"Yes, we want to build. However, we prefer to build urgently required hospitals, schools, other public utilities, high-quality flats, units and houses, provided they are designed with adequate concern for the environment, than to build ugly unimaginative architecturally-bankrupt blocks of concrete and glass offices...

"Though we want all our members employed, we will not just become robots directed by developer-builders who value the dollar at the expense of the environment. More and more, we are going to determine which buildings we will build...

"The environmental interests of three million people are at stake and cannot be left to developers and building employers whose main concern is making profit. Progressive unions, like ours, therefore have a very useful social role to play in the citizens' interest, and we intend to play it."

Female members of the New South Wales Branch of the Builders Labourers Federation on the International Women's Day march in Sydney, March 1975.

We need to look beyond the sector and consider the wider built environment and associated products and services, including assumptions about how we will live in the coming decades. This means re-examining the amount of construction we do, with a view to reducing the 14 Mt CO2-e in emissions the construction sector produced in 2019 [20] through a strategy of reduced consumption of materials.

Future consumption can be reduced by taking a new approach to design, using higher quality, low carbon materials in construction, for example by reducing the amount of waste of materials on-site and increasing reclamation, reuse and recycling. We can also place a higher value on maintenance, lack of which was responsible for the downfall of many post-war council housing projects. We should value the embodied carbon and embodied skills in what we have already.

A combination of far lower carbon materials, collaborative working and investment in staff required for upkeep (more caretakers) could help restore optimism and consensus around the social value of housing, transport and energy systems designed to improve the climate. This requires creativity, collaboration and a bottom-up plan to deliver a better future.

Another area to look at is the design and durability of manufactured parts, such as the concrete and steel beams used in construction. Much of the material used is not doing any work in terms of reinforcing and supporting the overall structure. By using Computer Aided Design, collecting digital data and sharing knowledge among those involved, buildings can be designed to have much longer life spans or plans could be put in place to re-use their component parts, while also sustaining many skilled jobs. [21]

> **"Construction and maintenance of public buildings and programmes to tackle homelessness and housing shortages must be key priorities."**

Applying these ideas to current materials would provide significant benefits. But if applied in addition to replacement or substitute materials and transformed production processes, then the benefits are multiplied.

Currently, the UK government is responsible for commissioning 40% of construction. It could therefore stipulate the use of low carbon materials in those projects and set targets for embodied emissions. What is clear, however, is that to overcome the inertia and opposition to tackling emissions in industry, some key sectors need to be taken into public ownership. Construction and maintenance of public buildings and programmes to tackle homelessness and housing shortages must be key priorities. Similarly, public ownership of key parts of industry, such as steel, would accelerate the development and implementation of these alternative solutions with a focus on rapid decarbonisation through investment in the methods outlined above rather than developing a huge infrastructure to capture carbon. The goal must be to reduce the 2019 emissions figure of 102 Mt CO2-e to 5 Mt CO2-e by 2030.

Jobs

Our arguments here propose a transformation of industry and the jobs within it, generating a need for a just transition of industry in the UK. Some of these proposals would involve changing the type of work within the sector.

We have also argued for a huge improvement in the recycling and re-use of materials, as well as a re-focusing of priorities on making fewer things and ensuring they last longer in order to reduce overall consumption. Such developments might reduce the need for some types of jobs. This loss would be offset by an increase in repairing products, recycling materials and maintaining new facilities, including rigorous maintenance of industrial products to avert obsolescence and over production, especially in regard to extending the life of buildings.

In the longer term, meeting the needs of local communities while ensuring a decarbonised approach to production might involve the development of locally based plans as an alternative to industry's current model of carbon intensive clusters, and this could generate many jobs on a localised basis.

chapter 6

Working the land: climate jobs in food, agriculture and nature

The environmental crisis would be challenging enough if climate chaos were the only issue facing us. Unfortunately, that crisis is unfolding at the same time as nature itself is being rapidly degraded. Today's loss of species and habitats, and associated ecosystem collapse, are contributing to some of the highest rates of biodiversity loss that the planet has ever seen.

The crises of climate and biodiversity are not separate. Biodiversity loss threatens to undermine nature's crucial capacity to help us slow climate change, and climate change itself causes biodiversity loss. It also threatens to undermine the very ecological functions that support society – including soils, fisheries, food and drinking water.

In this context, feeding our growing population poses a double challenge. We need to urgently tackle the impact that the current food system has on the climate, environment and humanity. Also, as the climate in which our food is grown becomes far less predictable, we have to ensure fair access to healthy food for all.

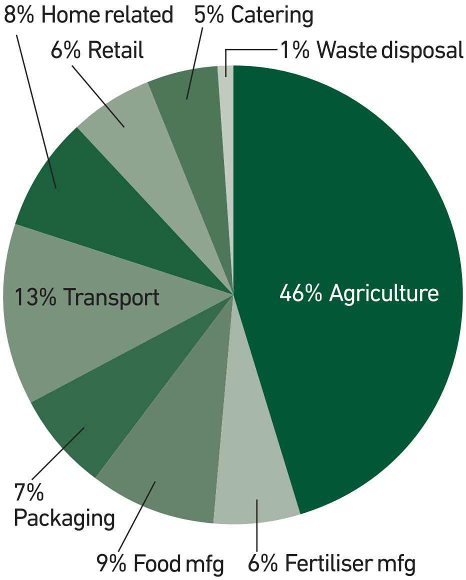
The way we use land in the UK impacts on these closely interlinked problems. This report is written at a time of upheaval for UK agriculture, which has been shaped by dependence on EU subsidies. Post-Brexit trade deals have prioritised the maximisation of profits rather than developing sustainable agriculture and well-paid agricultural jobs. There are also worrying moves towards marketisation in both nature recovery ('biodiversity offsetting') and the use of carbon credits for soil carbon and planting trees. As previous carbon markets have proved, this would be both an inadequate response to the climate crisis and would risk creating other problems.

Instead, we need to use this moment to move to a more sustainable system, in which emissions are cut, nature is restored and those labouring in the food and agricultural sector have good pay and working conditions. There is scope for job creation in nature recovery: a 'National Nature Service' as part of the National Climate Service. The changes to the food system we propose in this report would also create jobs, especially in rural areas. Modern poverty is often seen as an urban phenomenon, but rural poverty is also a serious issue in the UK and has been greatly exacerbated by austerity. [1] Tackling the connected crises of climate and biodiversity loss can also create the good skilled and well-paid jobs needed to tackle these social inequalities.

Food and climate

Agriculture and the wider UK food system are significant contributors to greenhouse gas emissions. Around 10% of UK emissions come from our own agricultural sector, with around the same amount again from food manufacturing,

Food-related emissions



transport, packaging, retail and catering, which brings the total up to around a fifth of our emissions. But we cannot only consider those emissions generated in the UK since we import around 45% of our food. [2] It has been estimated that this increases the food system's contribution to UK emissions to 30%. [3] Some of the food grown here is consumed elsewhere. However, the UK is a net importer of food – our exports of food and drink are worth less than half the value of our imports. [4]

The chart (below left) shows the division of food-related emissions (data from the National Food Strategy Independent Review [5]).

CO_2 makes up a relatively small proportion of agricultural emissions, with bigger contributions from two other powerful greenhouse gases.

Methane (CH_4) is produced by bacteria in the stomachs of ruminants (cows and sheep) and can also be released from manure. Methane has a relatively short lifetime in the atmosphere, breaking down after about 12 years into CO_2 and water. Yet compared to CO_2, as a greenhouse gas it is over 80 times as powerful measured over the first 20 years. Even compared over 100 years from when it is released, it is still around 30 times as powerful. [6] Over half of UK agricultural emissions are attributed to methane generated by cows and sheep. [7]

Nitrous oxide, N_2O, is released mainly from the use of synthetic fertilisers and from livestock manure. It is around 270-300 times more potent than CO_2 and stays in the atmosphere for over 100 years. [8] Vast quantities of artificial nitrogen fertiliser, a significant contributor to greenhouse gas emissions both during manufacture and after application, is used on arable land.


Picture: istockphoto.com /dageldog

Ecological destruction

Agriculture based on high-input and intensive monoculture does not just have a climate impact: it damages soils, pollutes rivers and strips out habitats for wildlife. The UK is one of the most nature-depleted countries in Europe, with one in seven species now at risk of extinction. [9] Soil compaction and erosion occur on both arable and grazed land. Run off from farmland may contain eroded soil, nitrate and phosphate fertilisers and animal waste, all of which contribute to river pollution. The environmental impact of intensive agriculture is felt not just here in the UK but overseas, where much of our food is directly produced and where animal feed is grown for export to the UK.

> "The global food system is based on the free flow of capital."

Corporate monoliths squeezing farmers

The global food system is based on the free flow of capital and the expansion of transnational corporations. Just four companies now control two thirds of corporate seed sales worldwide, while four companies control about 70 percent of global agrochemical sales. Three companies are in the top four of both lists, Bayer (including Monsanto), Corteva Agriscience and Syngenta. [10] Financial institutions are major players as agricultural products have become tradable assets for speculation on the global markets.

In the UK, supermarket chains dominate over 95% of food retail, with three-quarters of our food bought from the biggest five: Tesco alone accounts for over a quarter of the market. [11]

> "Today, supermarket chains sell 95% of the food we eat."

The imbalance of power between these corporations and farmers pushes farm gate prices down. Half of farms make a significant loss on their agricultural activities – the price they sell their produce for often doesn't cover the costs of growing or raising it. [12] On average, farms' income from subsidies is greater than from agriculture, though it varies by farm type. [13]

Food poverty and health

Food banks and unhealthy levels of obesity are to a large extent a symptom of high levels of poverty and inequality in our society. In general, those on poorer incomes have poorer diets – and the poorest 10% are almost twice as likely to die of preventable diseases as the richest 10%. [14] Unhealthy foods tend to be cheaper per calorie, are often more convenient, and they dominate advertising. [15]

Cutting greenhouse gases from agriculture and land use: what works and what doesn't

A wide range of solutions have been proposed to cut greenhouse gas emissions from agriculture and land use. Some of the current proposals are examined below. However, not all of the proposals provide solutions and, indeed, some reinforce the problem.

Increasing farming efficiency

There are a range of techniques which aim to reduce the use of chemical inputs and greenhouse gas emissions, not through fundamental change but through farming 'smarter'. These are suggested as a key part of the solution by the National Farmers' Union (NFU). [16] Examples include precision farming to deliver fertilisers and pesticides when and where they are needed, controlled release fertilisers, feed additives to reduce methane emissions from ruminant livestock and energy efficiency to cut fuel usage. Changes to increase productivity of food growing without increasing the associated emissions are also included, as this would reduce the food's carbon footprint.

Research into methods of farming smarter that cut waste, pollution and emissions, and save producers money, can help reduce agriculture's climate impact. But some can reproduce intrinsic problems, such as dependance on large areas of monoculture. They therefore prevent the development of methods such as regenerative farming, outlined below, which can play a much more important role in reducing emissions.

Reducing livestock

One of the most contentious issues is how livestock can fit into an agricultural system that is compatible with a safe climate. Ruminants (cows and sheep) are the most obvious target for reduction, as

> "Cows and sheep account for over half of the UK's emissions from agriculture."

their production of methane means they account for over half of the UK's agricultural emissions. 17

Production of meat and dairy uses a large amount of land as well: 85% of the farmland that feeds the UK, here and overseas, is used to rear animals. This includes land used for grassland and feed crops. By comparison, the 15% of farmland (roughly half in the UK, half overseas) that is used to grow plant crops for human consumption provides 68% of our calories. 18

One of the big shifts in our diets in recent years has been an increase in the popularity of chicken. Cheaply produced in large industrial units, chicken now accounts for over half total meat consumption. 19 The main climate impact of chicken and pigs is the feed they consume, with soy in particular linked to deforestation. The UK imports around three million tonnes of soy and soy products for animal feed, mostly from South America, and another one million tonnes for other uses. There are some attempts to certify that soy production is not linked to deforestation, but around 1.5 million tonnes of UK imports are not covered by these. 20

Reducing meat and dairy consumption has to be part of the solution to climate change. Protein consumption in the UK is around 70% higher than that recommended by WHO guidelines for a healthy diet. 21 Processed meat is particularly damaging for health, with high fat and salt content.

Trade deals which allow cheaper meat imports with lower standards also need to be challenged. Reducing UK cattle and sheep farming will not be a gain for the climate if consumption stays the same and farmers in the UK are undercut by imports with higher production and transport emissions.

Agroecology/regenerative farming

The terms regenerative agriculture and agroecology are both used to describe farming which considers the ecology of the entire system: people, plants, animals (both domesticated, pollinators and pests) and the soil. This approach to farming seeks to minimise external inputs, such as artificial fertilisers and pesticides.

Picture: istockphoto.com/JMichl

Teaching sustainable horticulture. Picture: Laura Whitehead / flickr.com.

> **"Agroecology and regenerative farming must play a central part in tackling the climate and ecological crisis."**

To achieve this, the farms are more diverse, for example combining different crops for their benefits to the soil and to minimise pests and diseases. Where livestock are included, their manure is used to fertilise the soil, and rather than imported feed, pasture grazing and home-grown feed are used where possible. [22] This approach challenges the current trend of extreme specialisation over wide geographical areas, with arable monocultures dominating in one region and livestock in another.

There are significant climate benefits from this type of farming, which are described below, as well as evidence that this model of farming may be more resilient to weather extremes and variations in climate. [23] Some practices may also be adopted in more 'conventional' farming.

Climate benefits of agroecology

Reducing dependence on artificial fertilisers cuts both emissions and the risk of polluting the local environment. Nitrous oxide, which, as explained above, is a powerful greenhouse gas, is released when nitrogen fertilisers are applied to the land. The production of fertilisers is also energy-intensive, requiring the burning of fossil fuels. Where excess fertiliser is washed off the land, it damages river ecosystems.

A focus on the soil ecosystem, protecting and increasing carbon stored in the soil. UK soils contains about 10 billion tonnes of carbon. [24] Intensive agriculture has caused arable soils to lose 40 to 60% of their organic carbon, [25] while overgrazing also causes carbon loss. Declining soil quality affects fertility. Methods that help restore soil carbon include shallow and more targeted soil tillage (avoiding deep ploughing that breaks up the soil and releases carbon), planting cover crops which avoid leaving soil bare, including those in the legume family which increase soil nitrogen, and avoiding overgrazing. [26]

Integration of trees, shrubs and hedgerows. Agroecological farming creates space for agroforestry: where trees or shrubs are grown around or among crops or pastureland. Crucially, this is done not just for the benefits for carbon capture and wildlife (although these are important) but because they increase the productivity of the overall system, providing fruit, nuts, coppiced wood or shelter.

Agroecology and regenerative farming must play a central part in the shift we need to make to tackle the climate and ecological crisis.

Bioenergy

The Climate Change Committee's strategy for UK land use proposes a significant role for 'sustainable bioenergy crops', such as growing wood for fuel on short rotation coppicing. However, the use of land for growing biomass on a large scale is not a sustainable solution, potentially taking up substantial areas of land for a relatively small energy contribution. There is also a high risk that biomass power stations are set up to burn wood sourced domestically but then may be unable to meet the demand and revert to the damaging practice of importing wood from clear-cut forests. These issues are addressed further in the chapter on energy. [27]

Similarly, the National Farmers' Union's Net Zero strategy includes growing large areas of maize to generate energy from anaerobic digestion. [28] As normally grown (without being undersown with a cover crop) and in a UK rainy climate, maize is associated with soil erosion and consequent damage to river ecosystems. [29] The use of large areas of farmland for this purpose is also a significant concern since it directly competes with food production.

Marketisation of soil carbon

Soil plays an important role in retaining carbon. However, this important role of taking up atmospheric carbon is already being exploited by those wishing to expand carbon markets. Carbon markets can make money for those investing in them but are not effective in reducing emissions. Companies have already been established in the US which pay farmers for adopting soil-friendly methods, creating 'carbon credits' which can then be sold. These credits are being sold to companies which use them to offset emissions, allowing them to continue to pollute.

The problems with this approach have already been shown by carbon offset projects planting trees. Some of these projects have failed from the start, with young trees failing to establish, [30] others have been linked to biodiversity damage or loss of the land rights of local communities. [31] Similarly, concerns have also been raised that the carbon storage in soil may not be permanent. [32] So there are immediate uncertainties about whether emissions are offset at all. There is also a more fundamental objection to a system which justifies continued emissions. In reality, we need both rapid cuts and also action to promote uptake of CO_2 by restoring ecosystems – one cannot offset the other. There is now interest in developing a 'soil carbon market' in the UK. [33]

Picture: istockphoto.com / espy3008

Farming to regenerate communities and protect the climate

Better regulation and a shift away from supermarkets

The UK grocery market is worth around £200 billion. [34] Currently, food industry companies' standards in areas that impact emissions vary. These areas include food sourcing, energy efficiency, wastage and the treatment of food producers and workers. Initiatives in these crucial areas are left to individual companies, which are reluctant to take action that may be perceived as undermining market share. There needs to be clear government regulation to tackle the huge emissions produced by current practices across the industry.

Food waste is a big contributor to greenhouse gas emissions. Supermarket trading practices cause this in the way they market to consumers (multi-buy offers, unclear best-before dates) and the way they treat suppliers. To meet supermarket demands for supply and cosmetic standards, farmers over-produce, increasing food wastage. Producers also have to absorb the costs of unfair supermarket trading practices including the last-minute cancellation of orders, unexplained fees and rejection of goods for cosmetic reasons. [35]

Picture: istockphoto.com /Paolo Paradiso

The centralised supermarket supply system is inefficient in terms of transport emissions. Vegetables may be transported to a warehouse at the other end of the country for distribution, some eventually being driven back to be sold at a supermarket close to the field in which they were grown.

Research by organisations such as Landworkers' Alliance and Sustain also argue for shorter supply chains, not only in terms of distance but, just as importantly, in terms of ensuring more money goes directly to producers. Closer links between farms and independent retailers reduce transport emissions, channel a greater proportion of the money consumers pay to farmers, and also allow greater investment in the agro-ecosystem, as well as improving the pay and conditions of agricultural workers. A shift to independent retailers also has the potential to create more jobs and encourage money to circulate within the local economy. [36]

Invest in horticulture

For a healthy diet, fruit and vegetables should make up two-fifths of what we eat, but most of us in the UK eat much less than that. Horticulture, in other words growing fruit, vegetables and ornamental crops, uses around 1% of our agricultural land. [37] Over the last 30 years the area planted to vegetables in the UK has fallen by a quarter, [38] and over half of what we eat is imported. [39]

The Landworkers' Alliance, a union of farmers, growers, foresters and land-based workers, has proposed measures to dramatically increase the number of small-scale, agroecological producers growing fruit and vegetables close to the point of sale, with a particular focus on perishable, high-value crops. With closer links between producer and sales, these locally grown foods would be affordable to consumers. [40]

Such producers tend to grow a more diverse range of products, creating work throughout the year, in contrast to the highly seasonal nature of more specialised horticultural businesses, whose supply of workers willing to work seasonal jobs for long hours for low pay is in jeopardy. Another possibility is to combine seasonal work in horticulture with nature conservation, where the greatest demand for labour is in the winter.

A cultural shift is needed, not to entirely eliminate food imports but to understand the seasonal nature of foods and move away from air freight and energy-intensive out-of-season production.

Jobs in agroecological farming

The potential benefits for the climate, soil health and biodiversity have been set out above. This more labour-intensive model of farming also has significant social and economic benefits. However, in order for it to be taken up more widely, agricultural research and training need both significant investment and a change of focus, with much more emphasis on farmer-led research.

> **"The potential for meaningful, rewarding, well-paid, skilled work in nature recovery is huge."**

In the short term, it's important to protect council-owned county farms from sell-off and expand these into more areas. These were set up at the end of the 19th century to provide a way into farming for young people and have the potential to generate income and promote innovative and climate-friendly farming methods. [41]

A National Climate Service could play a role in ensuring that each area has access to appropriate training and jobs in locally grown food, working with local FE colleges, schools and local authorities.

Workers and agricultural wages

The changes described above all need a shift of culture and expectations, but also funding. As well as directing more of the money paid for food to producers, agriculture is a source of public good: access to healthy affordable food for all; decent jobs; clean water and air; flood reduction and prevention; carbon sequestration; wildlife habitat to reverse the loss of biodiversity; and public access to nature. These all need investment, public funds, which should be channeled not to the largest farms but to supporting the wellbeing of the land and those who work on it.

Picture: www.flickr.com/photos/wirewiping/

Farm labour is hugely undervalued and underpaid. The abolition of the Agricultural Wages Board in England in 2013 removed guarantees on pay, overtime, sick pay and other benefits. [42] The horticulture sector has also been heavily reliant on seasonal labour from the EU, with risks of exploitation and abuse. [43] Improved pay and conditions have to be a priority, including for migrant workers here in the UK, and safeguarding workers' rights and fair pay for imported food. It is also clear that anti-immigration policies are not the solution to low pay in agriculture or any other sector. There are many more workers in retail, food processing and catering. These also need decent, well-paid, unionised jobs.

A National Nature Service

Farmland covers 70% of our land in the UK so using agroecological and regenerative approaches as described above is vital for restoring lost habitats. But much more is needed if we are to reverse the trends that have made the UK one of the most nature depleted countries in Europe. [44]

Organisations and employment opportunities working towards nature recovery have been around for decades. The work usually falls under the title of 'conservation' – although this is an inadequate category for approaches that in many cases are more dynamic and positive than the term suggests. Today, practical jobs in this area, and those created in support of their objectives, number in the thousands across the UK.

But this area of work is underfunded and insecure, relying often on short-term contracts and short-term funding. This needs to be repositioned, with job creation and livelihoods regarded as a central justification of conservation's rationale and remit, alongside the need to tackle biodiversity loss and the climate crisis. The potential for meaningful, rewarding, well-paid, skilled work in nature recovery is huge if conservation and nature restoration were viewed as proactive with an explicit social desire to replenish nature and create jobs. Many UK conservation organisations have called for a 'National Nature Service', [45] creating around 70,000 ongoing jobs in restoring landscapes, protecting species and planting trees. One of the main aims of the proposal is youth job creation.

The labour-intensive rural skills that once dominated and dictated our landscape characteristics and associated biodiversity are still required to manage such valuable habitats. (See the Technical Companion). These can be stimulating jobs because they are not simply a matter of using skilled manual labour. They combine that with ecological knowledge and awareness. Restoring the kind of habitats that have been degraded in the UK is a labour-intensive process, as is the case where land remains in agricultural production but is redirected towards

> **“Conservation organisations have called for youth job creation through a ‘National Nature Service’.”**

desired agroecological methods. Much of this work is also key to maintaining or restoring carbon sinks, which, by drawing carbon down from the atmosphere, are the best way of helping to tackle the climate crisis. There is enormous potential to create a significant workforce dedicated to nature recovery throughout the UK.

What is required above all for such a vision to be realised is direct public investment in training and jobs, in the creation of thousands of public sector climate jobs in this area. A National Climate Service could co-ordinate research, collaborate with organisations working in this area, identify the work that is required and marshal and train workers needed to carry out this urgent, rewarding and inspiring work.

Planting trees

Tree planting can help biodiversity and encourage decarbonisation through carbon sequestration. Appropriate reforestation can have other benefits – downstream flood management and access to nature near cities and towns. However, tree planting cannot be a one-size fits all approach but needs careful consideration. If trees are planted on agricultural land or other sensitive habitats – particularly through mechanised monoculture approaches – then they could have negative impacts on biodiversity. Planting trees on peat is particularly damaging to the climate. Tree planting needs to be carefully assessed against global impacts too. If tree planting causes loss of productive land, there is a danger of it resulting in higher food imports, leading to industrial agriculture intensification taking place elsewhere in the world.

Forests can be both productive, enabling wider use of climate-friendly construction materials and reducing unsustainable timber imports, and beneficial to wildlife, climate and local communities. Financial support for sustainable forestry and training for jobs in this area, which has been relatively neglected, [46] is needed as part of a wider strategy to create structurally and biologically diverse woodlands and to incorporate more trees into our cities, towns and farmland, restoring nature and helping to tackling the climate crisis.

Peatland restoration

Around a tenth of the UK is peatland – one of our most valuable carbon stores, and which is in serious decline. [47] The restoration of these ecosystems is important because peat erosion – historically a product of overgrazing, peat extraction and land drainage – releases greenhouse gases such as methane and carbon dioxide. A nationwide programme of work to rewet and restore degraded peatlands will generate many jobs, carbon sequestration and biodiversity benefits.

Rewilding – or wilding

‘Rewilding’ is an approach which focuses on reintroducing processes that create a diverse habitat. At a basic level this may be simply allowing scrub and native trees to regenerate by removing sheep or deer from heavily grazed areas (cheaper and more effective than tree planting). For more examples, see the Technical Companion.

Despite fears that this means a conflict between farming and releasing land for wildlife, a relatively small amount of land 'rewilded' within existing national parks can create eco-tourism and conservation jobs. However, full recovery of biodiversity also requires more wildlife-friendly farm management and agroecological approaches to agriculture as the dominant form of agricultural production across the UK.

Many of those involved with developing this approach use the term wilding rather than rewilding to avoid the idea of recreating a long-vanished ecosystem or any suggestion of excluding people from the landscape.

Urban wilding

The importance of access to nature for mental health is sufficient justification for investing in and protecting our trees and green spaces in towns and cities, boosting biodiversity. There are other practical benefits: reducing urban heat-island effects with much needed shade, and softening urban drainage schemes to reduce the risk of flash flooding, considering reestablishment of waterside habitats such as reed beds and scrub. [48]

Avoiding market approaches

In seeking to reverse biodiversity losses, conservationists have tried to convince politicians, businesses and economists that nature carries economic value, increasingly described as 'natural capital'. The danger of treating nature as a tradeable commodity can be clearly seen in the practice of 'biodiversity offsetting', where licences are given to destroy existing wildlife habitat, even with rare species, in return for creating habitat elsewhere. [49] While the destruction is guaranteed, the quality of the replacement is not at all.

The central role of nature in supporting our economy is critical to understand. But, instead of marketising nature, we should instead change the economic system to recognise the values of nature that are cultural, qualitative and intrinsic. Instead of putting a price on nature, our goal should be to recognise our place within nature and work to restore it, learning from our collective environmental history and the practices of other cultures and societies.

To make our food system truly sustainable a global perspective is essential. By developing our own food growing capacity and taking responsibility for the environmental and human impacts of our imported food in our trade deals, we can ensure healthy food for all and cut greenhouse gas emissions rather than simply outsourcing them. Just as importantly, we need to focus on local needs, supporting the regeneration of both communities and ecosystems through skilled jobs in agroecology and nature recovery. A National Climate Service would support training and necessary skills development, and as part of this, the National Nature Service would focus on creating additional youth employment in rural areas.

chapter 7

Towards Zero Waste: climate jobs in the circular economy

Our current economic model encourages resource use which results in huge amounts of waste. It has been described as a "throwaway economy" based on a linear "extract, make, transport, use and dispose" approach to many of the products we use and need. This has huge consequences for our climate and has created waste pollution reaching even the most remote parts of our land and oceans. [1]

It is also a global justice issue, with the waste produced in the UK exported in huge quantities overseas. Greenpeace has calculated that the UK exports more than two and a half Olympic swimming pools of plastic waste every day. [2] Meanwhile, further pollution is created by manufacturing and importing new goods that use up limited and finite resources such as water and minerals.

We need to move towards a zero-waste economy, one in which the creation of waste is minimised and in which what we currently call waste is regarded as a resource. This means we need to scrutinise what is best to do with the things and materials that people and industries no longer want or need and to extend their life. This type of approach, which must start with reducing the scale of resource and energy use within environmental limits, is often called a circular economy.

The linear model is deeply embedded in the current economic system and is reinforced culturally through marketing and advertising. Moving away from it will be challenging but will both reduce emissions and pollution and create many jobs in repair, reuse, recycling and remanufacturing in communities around the country. The story of the generation of waste and its disposal intersects with issues covered in all the other chapters of this report.

There is an urgent need for a national plan to create a circular economy. A National Climate Service could help coordinate a move away from a capital heavy and jobs light model of dealing with waste to a more collective, community based approach with a large number of public sector climate jobs in this area.

Why waste is a problem for the climate

In 2019, 26.4 million tonnes of waste was produced in the UK, over half of which was sent to landfill. [3]

Methane gas is produced when organic matter such as food waste and vegetation break down in landfill. Methane is a much more potent greenhouse gas than CO2, over 80 times as powerful measured over the first 20 years. [4] Other greenhouse gases produced from landfill sites include CO2 and nitrous oxide.

The Climate Change Committee reports that emissions from treatment and disposal of waste in the UK fell in the late 1990s, when there was some progress in diverting waste from landfill, but this progress has stalled. [5]

However, the emissions from our waste exports are not included in our national carbon budget. Much of our household waste is off shored abroad, mostly for incineration in Europe. The emissions transporting waste around the world are significant. In 2020 the UK exported 537,000 tonnes of plastic waste, mostly to Turkey (39%) followed by Malaysia (12%) and Poland (7%). All three countries have very low recycling rates and have a serious problem with plastic waste being dumped or burned illegally. [6]

How waste is currently dealt with

Household waste is controlled by local authorities: with responsibilities often split between District and Borough Councils (waste collection) and County Councils (waste disposal). These functions are combined in some councils, especially those structured as unitary authorities. At present only about 45% of materials are recycled or composted [7] and only 2% of products are close to fulfilling their service life potential through repair, reuse, and remanufacturing. [8]

Picture: istockphoto.com / Lya_Cattel

As well as the climate impact, gases from waste disposal pose wider health, safety and environmental risks for communities living close to landfill, treatment plants and incinerators. This includes air pollution and chemical leakage. There is a big safety issue for workers in the inherently risky waste industry. [9]

In addition to landfill and recycling, incineration is widely used for residual waste with plans to rebuild bigger plants in a number of areas. The argument for expansion of incineration is the claim that it is "better than landfill" but 2021 research shows that this is only marginally better.

Although often promised at the planning stage, very few incinerators in the UK use the waste heat, so their carbon emissions are higher than coal fired power stations per unit of electricity generated. [10] Plastic is made from fossil fuels and therefore burning it in incinerators is still fossil fuel generation; using the product for something else is just an intermediate step.

Large scale capital investment in existing and new incineration plants is a block to meeting recycling targets as the plant needs feeding with waste. Incineration expansion is a climate and racial justice issue with incinerators usually sited in low income, often diverse neighbourhoods, exposing the community to high levels of particulate pollutants. Subsidies to support incineration would have a greater impact if they were invested instead in environmentally friendly, resource and energy saving practices that follow the waste hierarchy: waste reduction and reuse, and then recycling and composting. [11]

"We need to move towards a zero-waste economy, one in which the creation of waste is minimised and in which what we currently call waste is regarded as a resource."

Food waste from households and businesses is a significant problem in the UK. As explained above, it creates methane and other emissions. It is estimated that the waste of edible food equates to 15 billion meals a year – enough to feed the entire UK population three meals a day for 11 weeks. [12]

Food waste is often dealt with through anaerobic digestion, breaking down the waste in a sealed, oxygen-free tank called an anaerobic digester to produce biogas, biofertiliser and heat. This cuts emissions considerably compared to sending biodegradable waste to landfill. However, anaerobic digestion still produces nine times the emissions of preventing waste. Where possible, for plant waste, home or community composting is preferable, returning nutrients to the soil. [13] Crucially the primary goal must be to systematically reduce food waste in the first place, from farm to fork.

Protesting against an incinerator in Edmonton, north London. Picture: Shaun Dey.

More jobs in a circular economy: what the solution looks like

Goods designed to last

We need to prevent built in obsolescence, where items are manufactured with an intended short lifespan and little capacity to repair faults. We need changes in the law to stop manufacturers of electrical items and other goods from producing these with built in obsolescence. There have been small steps in this direction, with the UK now requiring white goods such as dishwashers and washing machines to be made in a way that would allow repair, including making spare parts available within the first two years of a new product and up to 10 years after discontinuation. But there is a long way to go, as computers and smartphones, for example, are excluded. The law needs to cover all products with a requirement that they be made to last, are repairable and can be disassembled at end of life.

We also need to cut back on the number of disposable items produced and used, particularly plastic goods and packaging. The legislation to ban single use plastic products in the UK falls well behind that

> "As well as the climate impact, gases from waste disposal pose wider health, safety and environmental risks for communities."

around the world, with a target to achieve this of 2042. This is far too late and to create a circular economy for plastic, we need to eliminate all single use, problematic and unnecessary plastic items. In addition we need to ensure any plastics that are needed are reusable, recyclable or compostable, and that we circulate all the plastic items we use to keep them in the economy and out of the environment. [14]

Reuse and rent

There is already a considerable second-hand economy, from charity shops to specialist websites. This could and should be expanded. But for some things it makes sense not to just use and eventually pass on but to share them, hiring when needed. In UK cities and in particular in London there are now a range of car clubs that provide access to shared vehicles to members on a pay-as-you-drive basis without the expense of ownership or cost of repairs. Sharing or renting also makes sense for things like specialist domestic or gardening tools. There are already some small-scale initiatives aiming to do this. We need to not just protect our libraries of books but supplement them with libraries for other things.

Creating a culture of reuse should include collection, cleaning and distribution of glass and plastic bottle collection for reuse and distribution along with reverse vending machines, currently being trialled. In Scotland a drinks container deposit scheme is being introduced from July 2022, when PET plastic, metal and glass will carry a 20p surcharge as a returnable deposit when the vessel is brought back to a voluntary collection point at shops and transport hubs. 15

Repair

There is huge potential for jobs and specialist training to be created for repairing complex goods and extending the life of items, from electronics and digital goods and machinery to fabrics and furniture refurbishment.

Currently manufacturers have very little incentive to make things easily repairable. As well as regulation, shifting to an affordable rental model for some goods, where manufacturers, not consumers, bear the cost of built-in obsolescence, could help to change this. In the twentieth century, newer and more expensive items – from bus tyres in the 1920s to

televisions in the 1960s – were for hire rather than purchase. A similar approach can be used in business and industry. In some technical industrial chains, manufacturers rent key components to service providers while remaining responsible for maintaining and overhauling them.

Remanufacturing

Remanufacturing is the process of recovering, disassembling, repairing and sanitising components for resale at "new product" standard. Remanufacturing, in common with original manufacturing, tends to require more skilled workers. Investment in training to develop the right skills for the workforce is vital. Remanufacturing has potential in construction and industry, rebuilding industrial machinery and using remanufactured parts, for example for construction machinery such as diggers and excavators and other industrial hardware. One of the greatest potentials for remanufacturing is in the automotive sector. Rather than scrapping cars and creating electric vehicles from scratch, car manufacturing plants could retrofit existing cars.

Recycling

Reducing waste is much more effective than recycling the materials from which it is made, but recycling is still an important part of the system. When we think of

> **"The waste of edible food equates to 15 billion meals a year – enough to feed the entire UK population three meals a day for 11 weeks."**

recycling, we tend to think of our household waste materials like aluminium, which can be recycled again and again, indefinitely, and plastic, which has only limited potential for recycling, tending to be downgraded into materials of a lower value each time.

However, recycling also needs to take place on a larger scale. In construction, which has a huge carbon footprint, building design needs to build in end-of-life deconstruction combined with a shift to building renovation rather than demolition and rebuilding. Steel reuse is very important and easily re-usable components include steel piles, hollow tubing used in buildings, and light gauge products such as rail sleepers. (See Chapter 5, Decarbonising Processes and Materials).

In the next 30 years, about 5,500 wind turbines will be decommissioned in Scotland with 1.25-1.4m tonnes of material, ferrous metals (steel, iron), which are currently exported for recycling. Decommissioning these in Scotland could save 35% of embedded carbon, 60,000 tonnes of fibreglass and 90,000 tonnes of resin and balsa, materials that are all currently landfilled. [16]

Refurbishment and reuse will develop skills, jobs and safeguard against future shortages. Community jobs in recycling in a circular economy would include return schemes, waste disposal in kerbside recycling and sorting to separate waste.

Food Waste

Supermarket pressures on farmers can increase food waste through demand for "perfect" fruit and vegetables and last-minute changes in orders. (See Chapter 6: Working the Land). Marketing to encourage over-buying and unclear Best Before information increases the problem and needs to be addressed. Food surpluses should be used for people where possible, and regulations should be changed to allow safe use for animal feed. In France, there is already a ban on supermarkets throwing away or destroying unsold food. [17]

How many jobs could be created?

A study by the Green House think tank suggest that work in recycling and reuse could create a net gain of 83,000 jobs. Training programmes could equip workers with the necessary skills in repair, refurbishment and remanufacture. [18]

Waste management has been largely privatised and tendered out, even when under local authority control. A National Climate Service could coordinate a more collective, community-based approach, creating thousands more safe, skilled, trade-unionised, public sector jobs.

Jobs which help create a circular economy would drastically cut emissions and keep finite resources in circulation for as long as possible to benefit people and planet.

chapter 8

Building a movement in trade unions and beyond: What you can do

We need emergency, transformative action. Addressing the climate crisis can seem daunting. But new environmental movements, involving hundreds of thousands of people, are growing in confidence and radicalism. Thousands have joined Climate Strikes and Extinction Rebellion protests. Many workers, organised and unorganised have been both inspired and educated about the urgent need for action to tackle the climate emergency.

This pamphlet shows how we can transform our economy and the large number of many different jobs that will be needed to do that. Workers have a key role in winning change because of their central role in the economy. Protecting jobs by transforming those that are unsustainable into sustainable jobs and creating more work to reduce emissions is key. Building a workforce for the climate emergency is both necessary and possible.

Understanding climate jobs and the social and economic changes needed to deliver them has become a broad discussion within sections of the movement. Previous editions of this report have encouraged activist groups and trade union bodies to embrace the idea that we can create good, well paid, trade union jobs as part of the transformative economic shift towards a sustainable world.

However, to force government action, we need to do two things. We must further popularise the idea of climate jobs, and we need to build campaigns to win them from the government and employers.

Popularising Climate Jobs

The first step is to get as many people as possible to read this pamphlet. If you are a member of a trade union, why not see if you can get your branch to agree to buy copies for the wider membership? If you are an activist with an environmental

Can you use this pamphlet, and its arguments, as a way of making the declarations made by many institutions real?

group or campaign, why not order copies to circulate among other activists.

Organise a meeting to discuss the ideas. If you, your trade union or your group has a particular area of interest, energy, education or housing for instance, then how about organising a meeting around the relevant chapter. Contact the Campaign Against Climate Change and we will help find a speaker - perhaps one of the authors of the relevant section.

In 2019, as a result of the climate strikes and Extinction Rebellion protests, many institutions in Britain declared "climate emergencies". These included local councils, trade unions, companies and many civic bodies. Few have yet to take real action. Can you use this pamphlet, and its arguments, as a way of making the declarations real? This might mean sending copies to relevant politicians and activists and lobbying councillors and other figures.

The wider trade union movement should also adopt climate jobs as a demand. Many branches, regions, trades councils and national unions already support the campaign for climate jobs. In many areas, trades councils or other bodies have launched campaigns for mass retrofitting of houses, or for investment in public transport such as the expansion of bus routes and services. These are really important campaigns that stand a chance of winning the changes we need. Can you pass a motion to support the demand for climate jobs, or initiate a specific campaign?

Changing our workplaces

One part of environmental campaigning at work is to reduce the environmental impact of workplaces and industries. There have been numerous campaigns over such issues, from installing facilities to encouraging staff to use bicycles and reducing the use of plastic. We need many more of these sorts of campaigns. But they cannot just be about changing staff behaviour. Trade unionists are in a unique position to understand how workplaces and industries operate. We should demand changes to reduce emissions and destructive environmental impacts. Crucially these changes must be done in the interest of workers and our environment, not at the expense of working people and their working conditions. Environmental arguments, including air pollution and workplace temperatures, are another part of the trade unionist's argument when it comes to broader questions of employment, health and safety and other workplace issues.

As well as placing climate jobs within general campaigns against job losses, austerity and the protection of services, as a national movement trade unions must get behind key local campaigns and industrial actions. For example, car factories slated for closure can be used for manufacturing electric vehicles. There is huge unrealised potential in worker-led transition plans, epitomised by the 1976 Lucas Plan for alternative manufacturing produced by Lucas Aerospace workers.

Build a Climate Jobs Movement

In September 2019, the biggest climate strike yet took place. There was unprecedented involvement of trade unionists and workers in the protests. For the first time, many workers took part collectively with the support of their union - an important step forward. The fight for climate jobs requires the participation of working people. Winning a "Just Transition" will mean ensuring that as we transform workplaces, industries and the economy, that no one is left unemployed. This means workers and their trade unions must actively fight for new jobs, redeployment and training.

The first step to workers' participation is being involved in discussions around environmental issues. The idea that working people are not interested in the environment is a myth; there is a long tradition of workers being involved in such campaigns. General concern across the population is high. In August 2021, a survey showed the public ranked the environment as the second most important issue facing us (behind the coronavirus pandemic). IPCC reports from 2018 onwards and unprecedented extreme weather events across the globe have led to historically high levels of concern among the public. Inviting a speaker to a workplace or trade union meeting is an excellent way to begin discussions about environmental issues. In 2019 during the Climate Strikes, activists in many places were able to show films or host discussions.

The next step is to get trade unions and workers involved in local campaigns and protests. Collective participation of workers in the Climate Strikes helped build confidence around environmental

Picture: Sean Vernell

issues. Workers' involvement strengthens the movement, but also makes it easier to raise demands about climate jobs inside the movement itself.

As well as being out on the streets, trade unionists and climate jobs campaigners should be represented around the table whenever decisions are being made, for example about local climate plans. Trade union representation can ensure both the urgent changes we need and prioritise wider benefits, such as the creation of jobs and improvements to livelihoods and environments. Without this representation, decision making in this area can too easily simply provide another opportunity for corporate interests to dominate.

The fight for a sustainable future is the struggle of our time. Working people must, through the demand for climate jobs that transform the economy, place themselves at the heart of this movement. In doing so, we can create an economy that is run in the interests of people and the planet. We hope that this pamphlet helps encourage workers and trade unionists around the world to join that struggle.

Affiliate to Campaign against Climate Change, visit our website for model motions and information on how to affiliate your union branch.

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CLIMATE JOBS

Building a workforce for the climate emergency

Time is running out. We can no longer allow year after year to be wasted as an even more frightening climate crisis develops. There is an alternative to this failure which could deliver rapid emissions reductions and create jobs.

This report outlines the type of workforce needed for the Climate Emergency and argues that to deliver this we need to break from the failed reliance on the market, investing instead in a huge expansion of public sector jobs across all sectors, from transport and energy to food, homes, education and more.

The changes needed are ones which will improve our lives, ensuring warm homes, a fully integrated public transport system and a restoration of nature. Most importantly, investing in these jobs would give us a fighting chance for a safe climate and ecology now and in the future.

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2021 Edition
Published by the Campaign against Climate Change
Bulk purchases: £3.50 for orders over 10 copies