NEW ECONOMICS FOUNDATION

BUILDING A GREEN STIMULUS FOR COVID-19

A RECOVERY PLAN FOR A GREENER, FAIRER FUTURE

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SUMMARY

The coronavirus pandemic has led to a deep economic shock. The number of people claiming out-of-work benefits has soared[1]. Covid-19 has exposed the fragility of humanity's relationship with the natural environment, but many are still calling for a return to an unsustainable economic model that will continue to exacerbate the climate emergency. The response to the last financial crisis failed to tackle either inequality or the climate crisis. To avert the climate crisis and an unemployment crisis, that will each exacerbate economic inequality, this time we need to build back better. By expanding on NEF research published in January 2020, this report sets out a framework for establishing a priority green infrastructure stimulus in response to Covid-19.

KEY FINDINGS

- The immediate Covid-19 crisis and related economic shock is taking place against the backdrop of a long-term climate emergency. Carbon emissions have temporarily fallen due to a massive reduction in travel and economic activity, but a rebound in their levels has already been observed and we are at risk of a further increase as the economy accelerates[2]. Even if emissions do remain suppressed for some time, future higher emissions are likely without structural change.
- The immediate economic crisis resulting from Covid-19 is likely to come in the form of extremely high unemployment. Based on an average of the latest independent economic forecasts, and in the absence of a further response from government, unemployment is likely to sit between 1.5 and 3.1 million by the end of 2021 – up to 1.8 million above 2019 levels.
- A large package of investment in 'green' infrastructure projects, selected on the basis of their potential to create large numbers of jobs across the country rapidly, must sit at the core of government efforts to boost the recovery.
- The failure to respond to the last recession by scaling up investment to meet climate targets was a missed opportunity. If just a third of the funds used for tax cuts between 2010 and 2013 were instead deployed as part of a home insulation programme, residential emissions would have been 30% lower in 2018 than the reality. We cannot repeat this mistake again.

RECOMMENDATIONS

- Our primary recommendation is that the policy response to the current crisis should contain within it the largest feasible stimulus in priority zero-carbon infrastructure.

- We propose a framework for choosing projects based on the speed at which projects can begin, intensity of job creation, the extent to which jobs are spread across the country but can be intensified where they are most needed, and the extent to which projects are resilient to further tightening of social distancing, among other factors.
- Based on the framework presented in this paper, we develop a detailed, illustrative investment package in priority green infrastructure projects between July 2020 and Dec 2021 (see table 1 below). Based on our analysis against this framework, we find that retrofitting homes – installing insulation and heat pumps – should be the dominant component of the green stimulus package.
- We estimated that our illustrative package would see £28.3 billion invested in priority projects over the next 18 months, creating more than 400,000 full time equivalent jobs on average in 2021. However, we also find that it is unlikely that the jobs created from investment in priority green infrastructure alone will be sufficient to ensure that unemployment falls back to 2019 levels by the end of 2021. We therefore propose further job creating interventions and stimulus, particularly through expansions in public services such as child and adult care, and the NHS. Forthcoming papers will set out detailed proposal in these areas.

Table 1. NEF's illustrative green stimulus for investment in priority green infrastructure projects.

	FTE equivalent jobs (thousands) by Q4 2021	Total investment in 2021 (£ billion)	Total investment from July 2020 to December 2021 (£ billion)
Total 'priority infrastructure stimulus' (PIS) by Q4 2021	**406**	**20.2**	**28.3**
Of which			
Total (direct & supply chain jobs)	***352***	***NA***	***NA***
Of which			
Home insulation & heat pumps	*115*	*7.0*	*9.75*
Skills	*37*	*1.9*	*2.6*
Tree planting, peatland reforestation & habitat restoration	*36*	*1.3*	*1.9*
Broadband	*31*	*1.9*	*2.6*
Energy transmission & distribution infrastructure	*31*	*1.9*	*2.6*
Walking & cycling infrastructure	*26*	*1.6*	*2.25*
EVs and charging networks	*18*	*1.1*	*1.5*
Flood and drought defences	*18*	*1.1*	*1.5*
Renewable energy	*18*	*1.1*	*1.5*
District heating networks	*9*	*0.5*	*0.75*
Smart meters	*9*	*0.5*	*0.75*
Recycling initiatives & waste and manure management	*6*	*0.4*	*0.5*
Induced jobs in the wider economy	***55***	***NA***	***NA***

Note: Total investment figures are derived from an analysis of the literature for respective projects and an assessment of feasibility of additional spending in the short term.[3] Annualised investment in 2021 assumes a small backloading of the overall figure, as projects are able to spend more pro rata in the second year compared with the first. Figures for FTE employment show additional annualised jobs (direct and supply chain) created by the end of the stimulus period for each sector. We estimate the potential numbers of jobs created using the ONS FTE multipliers other than in instances where these are sourced from the literature (see respective citations for each project in section 3.2).[4] We also estimate induced (Type II) job creation through increased demand in the wider economy by adjusting Scottish government multipliers to be consistent with ONS data for the UK as a whole. All job numbers are likely to represent an underestimate, first because the multipliers used are likely to be smaller than those expected during a recession, and second because they do not assume any 'crowding in' of private investment.

1. THE CORONAVIRUS RECESSION

1.1 PHASES OF THE RESPONSE

The current coronavirus crisis can be characterised in terms of three phases: the initial emergency phase (where government put large swathes of the economy into hibernation through social distancing and scrambled to provide immediate income support to households and firms); the maintenance phase (where the government support schemes continued but the lockdown measures were gradually lifted and economic activity begins to revive); and the recovery phase (where focus shifts to stimulating the economy and overcoming the economic scarring left in the wake of the crisis).[5] These stages should be thought of more as policy modes, rather than chronological phases. The 'recovery' is unlikely to be fully linear – with the risk of setbacks, stasis and second waves of infection – and so policy will need to move back and forth between different modes of objective and design.

In recent weeks, government measures have moved more towards reopening the economy, with policy, for now, focused firmly on recovery, and the creation of jobs in particular.

A green fiscal stimulus is increasingly seen as common sense, with a recent survey by Oxford Smith School of Enterprise and the Environment of 231 influential economists and government and central bank officials indicating strong support for fiscal policies supporting green investments. This is seen as desirable on environmental grounds and superior in terms of their economic multipliers and impacts on long-term economic performance.[6] In a letter to the Prime Minister, 200 leading businesses also called for a 'clean, inclusive and resilient recovery plan'.[7] The central bankers agree, with Bank of England governor Andrew Bailey among co-authors of an open letter stating that 'the pandemic offers a unique chance to green the global economy.'[8] The question is not whether the government should deliver a green stimulus, but rather how this stimulus can be designed to ensure it delivers on its climate and socio-economic objectives.

1.2 SHAPE OF RECOVERY

The immediate economic impact of the crisis has already seen the largest monthly year-on-year drop in the UK's GDP on record, with a 20.4% fall in April 2020, following a 5.8% fall in March.[9] The full economic impact will not be known for some time, but the OECD has predicted that the UK's national income will decline by 11.5% in 2020, the worst shock among its OECD peers.[10] Similarly, the OBR illustrative scenario of 14 May

describes a shock to GDP worth 12.8% in 2020,[11] while the Bank of England reference scenario set out a hit of 14% of GDP. If anything close to these scenarios came to pass, it would dwarf the 4% shock to GDP following the great financial crisis[12].

For the purposes of economic stimulus, understanding the range of scenarios for recovery is of particular relevance. The coronavirus crisis, unlike the Great Financial Crisis, was primarily a result of an unexpected exogenous shock (the pandemic) rather than endogenous economic fragilities (these exacerbated the scale of the crisis but in this case were not the direct cause of it). As such, some analyses, including the Bank of England's 'illustrative scenario', mooted the prospect of a V-shaped recovery whereby the economy quickly returns to the level of activity implied by trajectory prior to the crisis. [13] However, such a forecast sits at the extreme, optimistic end of reasonable projections. Notwithstanding continued and sizeable variation in the range of forecasts still being published, the average of the most recent projects from independent organisations and compiled by the Treasury implies a GDP fall of 9.2% in 2020, followed by a partial recovery with 6.5% growth in 2021.[14]

Beyond GDP, which on its own is a very imperfect measure of socio-economic well-being, more tangible impacts on the crisis are forecast to be dire, with the Learning and Work Institute predicting that unemployment could spike to four million, 'an unemployment rate higher than at any point since 1938, in the wake of the Great Depression'.[15] The average of recent forecasts compiled by the HM Treasury suggests unemployment reaching 7.9% in Q4 2020 (approximately 2.7 million workers) and 6.4% at the end of 2021 (approximately 2.2 million workers, and still 2.5% higher than its level before the recession), with a range from less than 4.5% to more than 9%.[16] This uncertainty alongside emerging 'consensus' view that the recovery may not be V-shaped after all suggests that the government must not rely on such hopes and ought instead to aim to design the largest stimulus it can deliver in the next few years.

1.3 UNEVEN IMPACTS

The impacts of the current crisis are unevenly distributed. Some sectors, in particular hospitality, arts and entertainment, air travel and high street retail, have been hit extremely hard by the shutdowns and face long-term challenges to their business models and profitability, as consumer habits change and risks of pandemic recurrence persist. The impacts are also unevenly spread geographically, with regions in the UK with lower average incomes, such as those in the North and in the West of the country, having a larger proportion of jobs at risk.[17] A recent analysis by the Centre for Progressive Policy indicates that with a lack of economic resilience across much of the

UK, three quarters of local authorities 'will not recover their expected level of output based on the pre-crisis trend after five years'.[18]

The impacts also differ between different groups of workers, with those in low-pay, part time workers, the young and those of BAME ethnic backgrounds, being at particularly high risk of permanent job losses or reductions in hours and pay.[19] The results of the economic crisis therefore pose a grave risk of deepening existing socioeconomic inequalities, with risks to young workers particularly acute, due to lifelong 'scarring' impacts of prolonged unemployment when experienced early on in one's professional life.[20]

The specifics of those impacts require policymakers to ensure that recovery measures are targeted appropriately. The income support measures have so far protected many jobs, but government support is set to be gradually reduced from August before fully ceasing in October[21]. Meanwhile as recent research by the New Economics Foundation and the Living Wage Foundation shows, apart from unemployment, the last recession also led to a spike in low-paid insecure work with elevated levels persisting for many years after the onset of the crisis, something we are at risk of repeating without action to ensure good, well-paid jobs for the future.[22]

With the construction sector being among those hardest hit by the current crisis (70% fall in output in Q2 2020 relative to baseline)[23] and with 39% of jobs being at risk according to McKinsey[24], public investment can achieve the dual aim of protecting jobs and implementing shovel-ready infrastructure projects by utilising the skills of many workers hit by the decline in private demand in the sector. Similarly, green infrastructure investments can utilise spare manufacturing capacity, with the OBR projecting a 55% hit to manufacturing in Q2 2020[25]. Furthermore, those local authorities with significantly larger manufacturing sectors than the average are likely to be the most hit by the crisis. Therefore investments in clean manufacturing would also help to tackle regional disparities.[26]

At the same time, with the most jobs at risk in sectors such as hospitality, retail and arts and entertainment[27] where workers may lack technical skills required by many green transition jobs, the government will need to balance continued income support with funded training opportunities and direct job creation. For example, recent joint research by NEF, TUC, aviation unions, and climate action charity Possible found that 'at least 17,000 workers in the sector will need to permanently transition out of employment in aviation' with employment in the sector unlikely to ever recover post coronavirus crisis.[28]

1.4 THE CLIMATE CRISIS HAS NOT GONE AWAY

Carbon emissions have temporarily fallen due to a massive reduction in travel and economic activity, but a rebound in their levels has already been observed and we are at a risk of further increase as the economy accelerates[29]. Even if emissions do remain suppressed for some time, without structural change, the economy retains the potential for much higher emissions in the future. If we do not act now to embed a greener recovery, we risk repeating the pattern of the previous financial crisis. In 2009 global emissions saw an initial 1.4% drop compared with 2008 before quickly rebounding in 2010 to 6% above 2009 levels, and has continued to increase since.[30] The latest Progress Report by the Committee on Climate Change shows that the UK is projected to fail in its annual emission reduction targets, underlining the urgency of zero-carbon transition[31].

2. THE CASE FOR A GREEN FISCAL STIMULUS

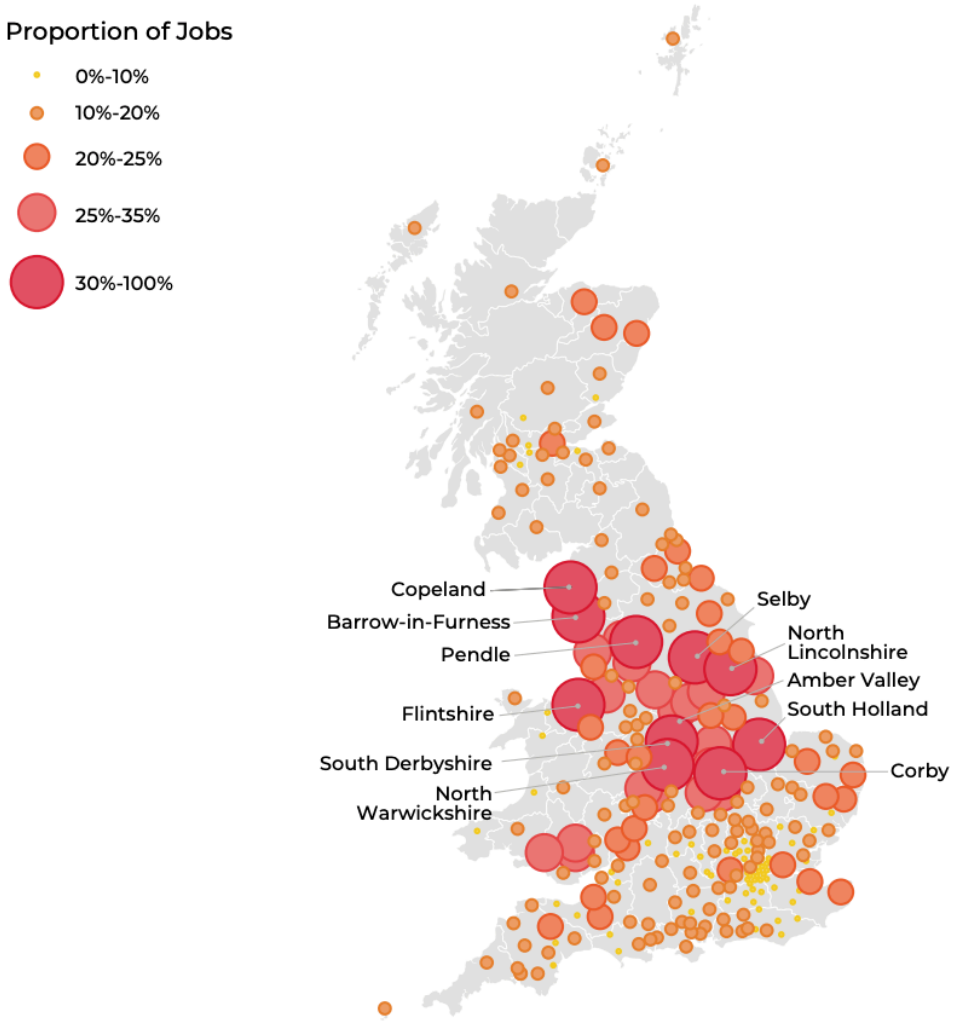
In the simplest terms, the priorities for a fiscal stimulus package today are twofold: first, create jobs where they are needed most, and, second, significantly accelerate the UK's progress against national and international climate targets. This puts the need for a green infrastructure stimulus at the core of the government's response.

In the aftermath of 2008 global financial crisis and the economic devastation left in its wake, the failure to scale up investment in a socially just way to tackle climate breakdown meant a significant opportunity was missed. The government's austerity approach saw vital public services and investment cut back after 2010, increasing inequality and suppressing average living standards by up to £3,600 per year.[32] Following the last recession, there were credible calls on the Treasury to respond to the crash with a green stimulus,[33] but the approach taken was to cut taxes, loosen monetary policy to 'get the banks lending', roll back certain labour and environmental regulations, and embark on a general reduction in government investment (regardless of its implications for climate mitigation).

Green public investment was cut back after 2010, while money was found for tax cuts that benefited the richest households more than anyone else. NEF analysis shows that had just £10.5bn – only a third of the funds used to pay for the coalition government's cuts to income tax and corporation tax between 2010 and 2013 – been used instead to fund a mass home insulation programme, residential emissions would have been reduced by 30% by 2018. Within three years, the energy savings to household bills would also have been equal to the cost of the initial investment.[34]

Significantly, the growing issues of low-paid and insecure work, inequality and climate change are not mutually exclusive but rather deep-seated problems that are joined at the hip. Over four million UK jobs are in 'climate critical sectors' characterised by high greenhouse gas emissions (this figure excludes the aviation sector). These are not evenly dispersed geographically. In more than 40 local authorities, 25% of all employment comes from these sectors. The vast majority of these jobs are highly concentrated in specific areas, primarily in the East Midlands, West Midlands, and Yorkshire and the Humber.[35]

Figure 1. The proportion of jobs in 'climate critical sectors' is highly variable across the UK.
Heat map for proportion of total employment in climate critical sectors by local government area, 2019



Source: NEF analysis based on data from Business Register and Employment Survey, made available by Nomis (2019). For full methodology, see Powell, D., Balata, F., & van Lerven, F. (2020). Trust in transition.[36]

A green stimulus has the potential to generate a huge number of jobs as the UK accelerates on its path towards net zero. A recent report by the Local Government Association estimated 700,000 direct jobs in low carbon and renewable energy could be created in England by 2030.[37] Meanwhile a study from academics at the University of Oxford cataloguing over 700 stimulus policies over 53 countries, found that green projects such as energy efficiency and clean energy infrastructure create more jobs, deliver higher short-term returns per pound spent and lead to increased long-term savings, when compared to traditional fiscal stimulus.[38]

2.1 CAN WE AFFORD A GREEN FISCAL STIMULUS?

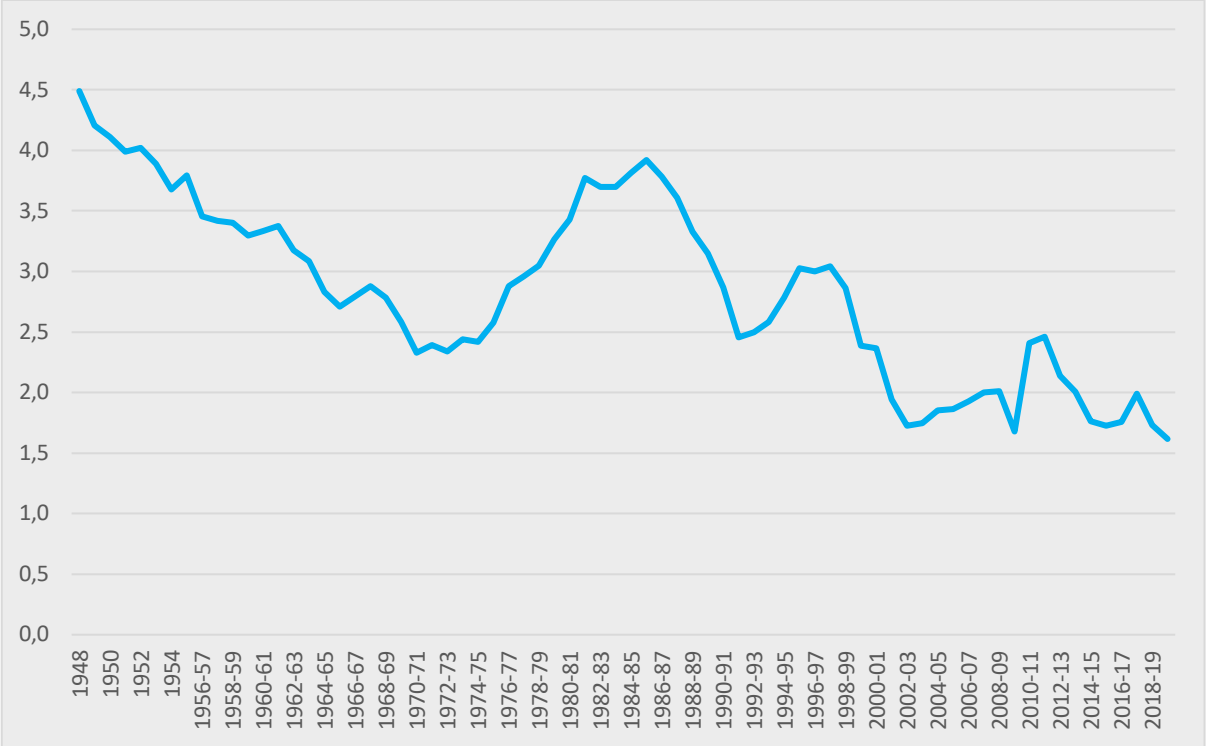
With the government taking unprecedented action to support workers, businesses and the self-employed, the government's budget deficit (the result of the government spending more than it takes in tax revenue) for this year is projected to reach £300bn, more than 15% of GDP.[39]

Look a little closer, however, and this additional borrowing is in fact eminently affordable. The UK government can currently borrow at negative rates for up to three years and can borrow long-term (50 years) for less than half a percent annually. Indeed, when you take into account estimated – low but stable – inflation of 2% per year, the real cost of long-term borrowing is significantly negative – and the principal amount owed in real terms will be lower than nominal borrowed. In other words, government is being paid to borrow, even before considering the socio-economic proceeds of its investments.[40] With a weak global economic outlook, Interest rates are also likely to remain low for a considerable period of time.

As demonstrated in the graph below, when taking into account the debt held by the Bank of England, the cost of servicing government debt is at historic lows (see figure 2 below). As former IMF chief economist at the IMF Olivier Blanchard has argued, if interest rates are kept below the growth rate of the economy, then debt levels as a share of GDP will shrink. Government borrowing for investment that raises output may therefore reduce not raise debt burdens, meaning that in some circumstances, as Blanchard suggests: "Put bluntly, public debt may have no fiscal cost."[41] It is unsurprising therefore that in a survey of 30 of the UK's leading economists, only a single panel member expressed concern about the UK's projected deficit.[42]

Figure 2. The cost of government borrowing is at a record low

UK Debt Interest Payments (net of repayments via the asset purchasing facility, % GDP), 1948 to 2019/20.



Source: Office for Budget Responsibility. Reproduced from Keep, M. (2020). Government borrowing, debt and debt interest: historical statistics. House of Commons Library. Retrieved from https://commonslibrary.parliament.uk/research-briefings/sn05745/

When it comes to borrowing for investment to mitigate environmental breakdown in particular, the case is even more compelling. Pre-existing research has clearly illustrated that the social, environmental and financial cost of inaction will be far greater for future generations than the costs of actions taken today.[43] Moreover, delay or inaction may lead to climate related financial instability, which could cost financial markets and the government trillions.[44] The productive investment under a green fiscal stimulus would result in improved business models, more and better paid jobs, and stronger local economies. All of this will help bring in healthy tax receipts in the long-run.[45]

Finally, despite the specified objectives of the Bank of England's current 'quantitative easing' (QE) programme – reducing long-term interest rates by buying up debt in the market-place – this programme has powerful spillover effects for fiscal policy, through the 'fiscal transmission channel'. The fiscal channel works in two ways. First, by continuing to hold £625 billion of government debt the bank ensures that demand for this debt remains strong, which pushes down the interest rate and lowers the borrowing costs of the government. Second, as the Bank of England buys government bonds,

interest payments on those bonds go from the Treasury to the Bank. However, the Bank of England is owned by the Treasury – so while the Asset Purchase Facility (APF) does not directly remit all its takings back to the Treasury, ultimately the APF and the Bank are public institutions and debts repaid to them remain with those institutions rather than being returned to the private sector. The overall effect is that the majority of the interest payments the government pays out on the £625 billion of debt held by the Bank of England are eventually returned to the Treasury. The Bank's QE programme therefore significantly increases the scope for productive public spending in the form of a green fiscal stimulus.[46]

The conditions for government to borrow to invest have never been more favourable, while the case to act on climate and inequality crises could hardly be stronger. Therefore, the government must reject any 'siren calls' for a return to austerity, and must instead choose to invest in our economic and environmental future.

3. BUILDING A GREEN INFRASTRUCTURE STIMULUS FOR COVID-19

3.1 FORECASTING UNEMPLOYMENT

As discussed in the previous chapter, the effects of pandemic and social distancing measures will transmit primarily through job losses. The final scale of the unemployment crisis is hard to predict with accuracy, and is contingent on two factors in particular: the depth of the initial shock; and the speed of the 'natural' recovery. In order to give parameters to this uncertainty, we set out three scenarios for unemployment in 2021 representing the plausible best case scenario, core scenario and worst case scenario respectively. In formulating these scenarios, we take the average size of contraction in 2020 from the HM Treasury's summary of over 30 independent forecasters since April 2020, and consider three possible paths for recovery based on the range of optimism implied by the same group of forecasters. We take these scenarios to represent the path for unemployment over the next two years, in the absence of any further additional intervention from government as of June 2020. In doing so, these scenarios act as a baseline for the considering the effects of further possible stimulus packages in the UK. In the three scenarios, unemployment in 2021 is set to be just under 1.5 million, 2.2 million and 3.1 million respectively. In order to get unemployment back to the level seen prior to the crisis, this would imply the creation of at least 0.2 million, 0.9 million and 1.8 million net jobs at aggregate, respectively.

Table 2. Forecast scenarios of the coronavirus crisis recovery.

	Optimistic scenario (fast 'V-shaped' recovery)	Core scenario (medium recovery)	Pessimistic scenario (slow recovery)
Forecast unemp. rate Q4 2021 (%)	4.2	6.4	9.1
Forecast unemp. level Q4 2021 (m)	1.5	2.2	3.1
Unemployed above the 2019 level in Q4 2021 (m)	0.2	0.9	1.8

Source: NEF analysis of HM Treasury compilation of independent forecasts for the UK economy[47]. Our core scenario represents the simple average for the entire sample of recent independent forecasts. Our optimistic and pessimistic scenarios represent the average for the three most extreme data points at each end of the sample range, respectively.

3.2 ESTABLISHING A FRAMEWORK

A successful green stimulus programme must satisfy a number of criteria. As the chancellor and relevant government departments prepare their plan for a green recovery, they must ensure that it delivers on what should be its dual primary objectives: setting the UK on a path of deep and sustained reductions in carbon emissions alongside providing timely investment to generate good jobs and aid the economic recovery. With this in mind, and building on recent New Economics Foundation analysis published in January, we propose a number of key tests for identifying the priority investments within green infrastructure projects, in the following order of priority:[48]

- **Timeliness:** This criterion is based on the length of lead-in time between a decision to invest being taken, and the first spending taking place. Shorter lead-in times, even if only to embark on the planning phase (for large-scale projects, spending during the planning phase can reach up to 25% of capital investment) will be a critical factor for an effective stimulus between now and the end of 2021.[49]
- **Labour intensity:** The number of new, full-time equivalent jobs that are created for a given unit of investment. Given the impact of the current recession on jobs, the labour intensity of new projects will be a critical factor for an effective stimulus.
- **Broadly based:** The extent to which the stimulus effects of a project can be spread widely (such as a programme installing home insulation). Given that the economic effects of social distancing measures are spread across the country, it is important that stimulus measures are as broadly based as possible. However, higher concentrations of hospitality and tourism in some local economies will also require larger intensities of job creation.[50] Measures that are broadly based, but nonetheless allow for *discretionary* targeting, are likely to be the most effective at the present moment.
- **Enabling potential:** Certain projects will hold particular value because they support or facilitate other projects further down the line, or because they are a necessary or sufficient condition for future projects. For example, transmission and distribution infrastructure of electricity enables the flow of renewable energy to charging points, which further enables investment in the production of electric vehicles.
- **Total carbon abatement:** This effectively measures the total expected reduction in the amount of carbon emissions from a given project.
- **Social distancing compatible:** With the risk of a second wave of the pandemic and uncertainty about when an effective pharmaceutical intervention can be delivered, some level of social distancing is likely to continue for the foreseeable future. While most projects can be safely progressed already, particularly during

the planning phase, some will be at greater risk of disruption should social distancing measures be re-tightened.

Stimulus projects should also aim to ensure that the jobs created are high quality in terms of security, training and pay. Job quality is a primary factor for consideration for the government's stimulus package overall. However, it is best addressed through labour market policies such as union reform, job protection and minimum wage policies, rather than through individual investment decisions, so we do not treat it as a primary test for the purposes of this paper. NEF will be publishing further proposals pertaining to job quality over the coming months.

Multipliers

The argument that investment in green infrastructure is an efficient way to create new jobs in the economy rests partly on the idea that beyond the direct jobs created, investment in infrastructure also has a strong multiplier effect on economic output. That is, increased infrastructure spending by government is generally expected to result in high economic output in the short term by stimulating aggregate demand and crowding in private investment, and higher output in the long term by increasing overall productivity[51]. The resulting boost to economic activity will result in further indirect job creation beyond the direct jobs created.

Multipliers will be higher or lower under different circumstances, and depend critically on several factors in particular. First, the state of the economy: whether the business cycle is in a period of contraction, slow growth or fast expansion. In a recession, with very high levels of economic slack (for example high unemployment or under-used capital), multipliers are particularly high[52]. Second, monetary accommodation: multipliers will be tend to be higher when monetary policy is constrained as the interest rate is at the effective lower bound[53]. Finally, the size of multipliers also depends significantly on the efficiency of the investment – in the short run, multipliers on government infrastructure spending may be small if activity needs to be delayed whilst planning permission is obtained for example. Nevertheless, as the examples in the next section show, there are many projects that are 'shovel ready' and will provide timely and efficient returns.[54]

There will always be significant debate over the exact size of a given multiplier at a particular point in time, precisely because it depends on such a range of factors.

Nevertheless, the empirical evidence suggests that when in a recession and when monetary policy is constrained, public capital spending and infrastructure in particular have significant positive effects on long-run output, productivity, and jobs. For example, using both cross country panel estimates and model simulations, the IMF concluded that increased public infrastructure investment would have raised output significantly in the short and long term following the 2008 recession[55]. And recent analyses of sizeable German infrastructure investment programme during the peak of that recession[56], and of the American Recovery and Reinvestment Act of 2009[57], find large and significant multipliers.

3.3 NEF'S ILLUSTRATIVE STIMULUS PACKAGE

Based on the above criteria, we have reviewed a long list of carbon abatement measures compiled mainly from the work done by the Committee on Climate Change. Any final ranking and shortlisting for a public stimulus package will depend on the preference and weighting afforded to each criterion respectively, which ultimately will need to be a judgement call by policy makers based on the best evidence available at the time. For illustrative purposes, however, we rank our long list on the criteria described above (section 3.1), ordering by each variable in turn (left to right in table 3 below) and based on reviews of secondary literature and interviews conducted over the past 12 months. The selected projects for our illustrative stimulus are highlighted in green, and we briefly discuss each of our selected projects below.

Table 3. Framework, analysis and selected projects for our illustrative green infrastructure project.

Project	Timeliness	Labour intensity	Narrowly or broadly targeted	Enabling potential	Total abatement ($MtCO_2e$)	Social distancing compatible
District heating networks	Fast	Strong	Broad	High Enabler	High	High
Reskilling & training	Fast	Strong	Broad	High Enabler	n/a	High
Evs and EV charging networks	Fast	Strong	Broad	Moderate Enabler	High	High
Tree planting & nature restoration	Fast	Strong	Broad	Moderate Enabler	Moderate	High
Broadband	Fast	Strong	Broad	Moderate Enabler	Low	Moderate
Home insulation	Fast	Strong	Broad	Low Enabler	High	High
Heat pumps	Fast	Strong	Broad	Low Enabler	High	Moderate
Cycling and walking infrastructure	Fast	Strong	Broad	Low Enabler	Low	High
Recycling initiatives	Fast	Strong	Broad	Low Enabler	Low	High
Smart meters	Fast	Strong	Broad	Low Enabler	Low	Moderate
Onshore wind	Fast	Strong	Moderate	Moderate Enabler	High	High
Solar projects	Fast	Strong	Moderate	Moderate Enabler	High	High
Flood and drought resilience	Fast	Strong	Moderate	Low Enabler	Low	High
Waste and manure management	Fast	Strong	Moderate	Low Enabler	Low	High
Habitat conservation	Fast	Strong	Moderate	Low Enabler	Low	High
Peatland reforestation	Fast	Strong	Narrow	Low Enabler	Low	High
Bus infrastructure	Fast	Medium	Broad	Low Enabler	Low	High
Energy transmission & distribution infrastructure	Moderate	Strong	Broad	High Enabler	High	High
Electric buses	Moderate	Medium	Broad	Low Enabler	Low	High
Railway electrification	Moderate	Medium	Broad	Low Enabler	Low	High
Hydrogen refuelling	Moderate	Strong	Narrow	Low Enabler	High	High
Enteric fermentation	Moderate	Strong	Narrow	Low Enabler	Low	High
Hydrogen-fuelled boiler	Moderate	Strong	Narrow	Low Enabler	High	High
Soil and water conservation	Moderate	Strong	Narrow	Moderate Enabler	Low	High
Offshore wind	Slow	Strong	Narrow	Moderate Enabler	High	High
Scale-up production/ manufacturing wind turbine facilities	Slow	Strong	Narrow	High Enabler	High	High
Scale-up production/ manufacturing solar facilities	Slow	Strong	Narrow	High Enabler	High	High

Source: Author's judgment based in a range of secondary literature and interviews, as well as data from the ONS and Committee on Climate Change (CCC). The long list of projects submitted for this analysis was compiled mainly from work done by the CCC. More precise numerical weightings for each project against respective criteria are available on request.

Home insulation and heat pumps: Retrofitting homes with new insulation in particular is an extremely strong candidate for a green stimulus package. It is labour intensive, shovel-ready, has a short lead-in time, and can be rolled out either right across urban and rural areas or else targeted where it is most needed. Retrofitting homes and buildings with heat pumps to replace gas boilers is also one of the most important means of reducing household and business sector emissions. However, supply chain and market development needs to be encouraged now for this to be a feasible option in the future. In 2019, the government's Renewable Heat Incentive (RHI) supported the construction of only 11,000 heat pumps (out of some 20,000 installed in total)[58]. with the proposed government policy post-2022 (Clean Heat Grant) not expected to deliver much more than 12,000 pumps a year[59]. This is massively short of required rates of construction to install 2.3 million pumps by 2030 (the CCC's central scenario for the fifth carbon budget[60]), and 19 million by 2050. In addition, there is currently a significant gap in the availability of qualified heat pump installers. The Heat Pump Association estimate that, assuming a rapid upscaling to one million annual installations by 2030, some 38,000 installers will be required in total, compared with barely 916 needed in 2019[61]. Therefore major investment now is required to build up the sector's skills and capacity in order to reach these targets, which would provide both brand new jobs and new opportunities for current boiler installers that retrain.

Retrofitting homes has by far the largest potential (in terms of scale) for short and medium-term investment, and can therefore be expected to dominate a priority green stimulus package. The Energy Efficiency Infrastructure Group highlight that many energy efficiency improvements, including insulation, can be implemented right away whilst meeting the Covid-19 health and safety guidelines.[62] As every region in the UK needs significant investment in upgrading its housing stock, the investment could be spread uniformly across the UK, but there would also be flexibility to prioritise the poorest and most deprived regions first. Separate analysis by NEF has produced a detailed policy package for a significant injection of public investment in a major retrofit program over four years from a combination of loans, grants and tax reliefs.[63] Based on this detailed analysis, we estimate that an investment of £9.75 billion would be feasible over the next 18 months, with 115,000 full-time equivalent annualised jobs created by the end of 2021.

Reskilling and training: The UK is currently suffering from a low-carbon skills gap, with the CCC outlining that virtually every sector of the economy is going to require a degree of reskilling and training, with gaps particularly acute for heat pump installations and tree planting supply chain.[64] Meanwhile, analysis at the Resolution Foundation

shows a high proportion of the new unemployed either have either had fewer opportunities to gain qualifications or are less able to commute long distances to work compared with the average worker.[65] Therefore it is key that a substantial amount of green fiscal stimulus is directed towards upskilling and retraining existing workers in their immediate localities[66]. The New Economics Foundation and partners have previously proposed that the current job retention scheme should be repurposed as a new job reskilling programme which protects employment while workers are supported to transition into alternative roles.[67] Crucially, this will need to involve local authorities, businesses and trade unions to ensure that training provided matches local labour market needs and leads to good, secure jobs. This investment in qualifications would also be particularly beneficial from the perspective of rebalancing regional inequalities, with the highest uptake likely to be in the regions hit by the highest proportions of furloughed and unemployed workers. With an investment of £2.6 billion over the next year and a half, we estimate around 37,000 full-time equivalent annualised jobs could be created by the end of 2021.[68]

Tree planting and nature restoration: New scientific evidence suggests planting trees and restoring habitats is perhaps one of the most effective means of tackling climate change because of the capacity to remove carbon from the atmosphere.[69] The Woodland Trust suggest that an additional 1.5 million hectares of woodland need to be created in the UK by 2050 to support the net zero target.[70] Increasing tree cover, peatland restoration and other habitat restoration measures also has major benefits for environmental resilience and supporting human wellbeing. However, it is seasonal work, therefore it would need coupling with other types of work or paid retraining schemes.[71] Tree planting can also be rolled out nationwide – while some areas are naturally more suitable for woodland creation than others, a potential to plant individual trees, or small but biodiverse and carbon capture-efficient Miyawaki mini-forests can be planted across much of the country, including in many city areas.[72] In order to enable a mass tree-planting programme, capacity of the supply chain (such as tree nurseries) needs to be expanded: therefore additional investment is needed now to enable the UK to reach necessary levels of tree planting in the coming years. IPPR estimate that reforestation combined with peatland restoration could create up to 46,000 jobs by 2030[73]. In the short term, we estimate around 36,000 jobs could be created by the end of 2021 through £1.9bn of additional funding.[74]

Broadband: As the CCC have suggested, investment in broadband should form a major element of a green recovery. While improved broadband infrastructure does not reduce carbon emissions directly, by enabling more people to work from home more often and

long-term, it supports a positive shift towards more environmentally-friendly behaviours, such as more remote working leading to reduction in travel emissions.[75] Investment in full-fibre broadband also has a huge potential to support other jobs across the country. Recent research by CEBR (done for the Openreach) suggested that 'making it easy for people to work from home would be likely to bring 450,000 people whose primary task is caring, 150,000 people over 65 and 125,000 people with dependent children into the labour force' while 'the increase in working from home could save 300 million commuting trips, representing a carbon reduction of 360,000 tonnes per annum'.[76] This would have major positive impacts especially for non-city regions, enabling many more jobs to be performed from anywhere in the country, and so to become less concentrated in the most dynamic agglomerations. With an investment of £2.6 billion over the next 18 months, bringing forward some of the £5 billion the government already committed to connecting hardest to reach households, or by providing additional funding, we estimate around 31,000 jobs could be created by the end of 2021.[77]

Energy transmission and distribution infrastructure: The UK's distribution and transmission networks are in urgent need of upgrade, if we are to meet the goals of a net-zero transition. Electricity transmission networks are high-voltage cables that run across the UK to bring power from generators to the electricity distribution network – which dispenses electricity to industrial, commercial, and domestic users. Investment in the transmission and distribution network infrastructure is a high priority, primarily because it enables greater electrification of homes and transport, but also because without it, sufficient renewable energy projects cannot be brought onto the system. Research for the National Grid suggests that to get the UK to net zero by 2050 target, 117,00 jobs will be required this decade across the energy sector as a whole, with 65,000 brand new roles and 52,000 jobs to replace leaving and retiring workers in the sector.[78] In the medium term, the CCC estimated that £9 billion of investment in the electricity network will be required by 2025[79]. This is the only project we include our illustrative stimulus package that does not have a particularly short lead-in time. It is nonetheless included on its strength against all of our other criteria, as well as the potential to increase near-term spending by bringing forward planning. We estimate that an £2.6 billion investment over the next 18 months could lead to the creation of some 31,000 by the end of 2021.[80]

Walking, cycling and bus infrastructure: Important investment could be made in walking, cycling, and bus infrastructure, while encouraging a permanent shift to much greater levels of walking and cycling as experienced during the pandemic. Earlier this

year, the government committed to a £5 billion investment over five years, with £2 billion of it targeted improved walking and cycling infrastructure[81]. With fast-tracked planning processes, these projects should be brought forward as much as possible in the recovery phase as part of the new planned Cycling and Walking Investment Strategy.[82] But to reach the target of doubling cycling and increasing walking by 2025, the government should increase the level of investment further, with Greenpeace suggesting the level of funding will need to be tripled to £6 billion over the next five years to reach those goals[83]. This project is of particular regional relevance, with many mayors and local leaders having already declared plans for major transformation works in their cities and regions. In the short term, we estimate around 26,000 jobs could be created in these sectors by the end of 2021 through an investment of £2.25 billion over the next 18 months.[84]

Electric vehicles (EV) and charging networks: Transport is the UK's highest emitting sector, with emissions increasing rather than declining in recent years. This decade alone (assuming a net zero target only in 2050), some 60,000 charging points will need to be installed to power some 11 million electric vehicles.[85] In a report for the TUC, Transition Economics calculate some 24,000 jobs will need to be created within the next two years, while LGA estimate as many as 95,000 jobs in EV charging and manufacturing by 2030 in England alone.[86] Improving the EV charging network also has the benefit of a wide geographical spread, with additional chargers needed throughout the UK. We estimate around 18,000 jobs could be created in these sectors by the end of 2021 through £1.5bn of additional funding.[87]

Flood defence and drought resilience systems: Over £30 billion in investment will be needed between now and 2050 to tackle flooding and coastal changes, while £21 billion of investment is needed to make sure households and businesses are resilient to droughts and water shortages.[88] The government has earlier this year committed £5.2bn funding for flood defences between 2021-25: this investment should be brought forward as a part of a priority green infrastructure stimulus.[89] Both the CCC and the National Infrastructure Commission have stressed the need to improve the resilience of the UK's infrastructure and the nation's adaptation to the destructive risks of climate change, such as that highlighted by recent devastating floods[90]. The National Audit Office also estimates that for every £1 spent on protecting communities from flooding, around £9 in property damages and wider impacts is avoided[91]. Therefore, while not an enabler or contributor to emissions cuts, investment in resilience and adaptation measures should be seen as an important element for additional green investment, with a potential to generate jobs primarily in the regions most prone to flooding and coastal erosion[92].

Much of this work could take the form of maintenance or upgrades to existing infrastructure which means it is likely to have particularly short lead-in times and would be relatively easy to deploy. We estimate that an £1.5 billion investment over the next 18 months could lead to the creation of some 18,000 by the end of 2021. [93]

Renewable energy projects: Renewables (mainly solar and wind energy sources) are less expensive than carbon-intensive forms of power generation in the UK and are a critical pillar to reaching net zero by 2050. The sector is already largely market driven and less in a need of direct government investment but a proportion of stimulus could be diverted to additional projects such as solar PV installations on the roofs of all public buildings and increasing the contracted capacity (including onshore wind and solar) for the Contracts for Difference (CfD) auctions, as suggested by Greenpeace.[94] Additional government investment could accelerate the capacity expansion during the recession, and we estimate that a £1.5 billion investment over the next 18 months could lead to the creation of some 18,000 by the end of 2021.

District Heating Networks: District heating networks are a strong candidate for a green stimulus investment. As identified by the Committee on Climate Change, there exists an early pipeline of projects that could be rolled out quickly, and with current build rates significantly below what is required, this project needs rapid scaling-up.[95] With an investment of £0.75 billion over the next year and a half, we estimate around 9,000 full-time equivalent annualised jobs could be created by the end of 2021.[96]

Smart meters: Smart meters are already demonstrably improving the energy efficiency of both residential and commercial properties, while reducing energy bills for households and firms. Without a more flexible energy system, in part delivered by smart meters, the Committee on Climate Change estimates, the costs of reaching net zero emissions in 2050 could be up to £16 billion higher per year higher.[97] With an investment of £0.75 billion in the installation of smart meters over the next year and a half, we estimate around 9,000 full-time equivalent annualised jobs could be created by the end of 2021.[98]

Recycling and waste management infrastructure: Emissions from waste contributed 4% of total UK greenhouse gases emissions in 2017, primarily from decomposition of biodegradable waste in landfill sites, from treatment of waste water and from composting and incineration of waste.[99] A lot of these are tackled primarily through regulations, but there is also a need to improve and expand recycling infrastructure to replace incineration. Additional government investment of £1 billion over three years as identified by Greenpeace could leverage faster private investment to support these

initiatives[100]. In the short term, we estimate around 6,000 jobs could be created by the end of 2021 through £0.5bn of additional funding.[101]

3.4 SUMMARISING OUR ILLUSTRATIVE STIMULUS PACKAGE

Based on the analysis above, we set out an illustrative green stimulus package to meet different scenarios for economics recovery from Covid-19 (see Table 4 below). Our assessment of possible infrastructure projects against the criteria set out above, and in view of prevailing constraints in the labour market, suggests that a green stimulus in priority infrastructure projects over the next 15-18 months would be in the order of £28 billion, or 1.3% of 2019 (pre-recession) GDP, creating 406,000 annualised, full-time equivalent jobs by end of 20221. Within this figure, 352,000 jobs would be created directly through investment in industries and their supply chains, with at least a further 55,000 jobs created in the wider economy through increased spending power.[102]

Table 4. NEF's illustrative green stimulus for investment in priority green infrastructure projects.

Number of direct, indirect and induced jobs from the stimulus packages. Monetary amounts represent figures of annual investment in the final year and cumulative investment assuming 18-month stimulus period.

	FTE equivalent jobs (thousands) by Q4 2021	Total investment in 2021 (£ billion)	Total investment from July 2020 to December 2021 (£ billion)
Total 'priority infrastructure stimulus' (PIS) by Q4 2021	**406**	**20.2**	**28.3**
Of which			
Total (direct & supply chain jobs)	***352***	***NA***	***NA***
Of which			
Home insulation & heat pumps	*115*	*7.0*	*9.75*
Skills	*37*	*1.9*	*2.6*
Tree planting, peatland reforestation & habitat restoration	*36*	*1.3*	*1.9*
Broadband	*31*	*1.9*	*2.6*
Energy transmission & distribution infrastructure	*31*	*1.9*	*2.6*
Walking & cycling infrastructure	*26*	*1.6*	*2.25*

EVs and charging networks	*18*	*1.1*	*1.5*
Flood and drought defences	*18*	*1.1*	*1.5*
Renewable Energy	*18*	*1.1*	*1.5*
District heating networks	*9*	*0.5*	*0.75*
Smart meters	*9*	*0.5*	*0.75*
Recycling initiatives & waste and manure management	*6*	*0.4*	*0.5*
Induced jobs in the wider economy	***55***	***NA***	***NA***

Note: Total investment figures are derived from an analysis of the literature for respective projects and an assessment of feasibility of additional spending in the short term.[103] Annualised investment in 2021 assumes a small backloading of the overall figure, as projects are able to spend more pro rata in the second year compared with the first. Figures for FTE employment show additional annualised jobs (direct and supply chain) created by the end of the stimulus period for each sector. We estimate the potential numbers of jobs created using the ONS FTE multipliers other than in instances where these are sourced from the literature (see respective citations for each project in section 3.2).[104] We also estimate induced (Type II) job creation through increased demand in the wider economy by adjusting Scottish government multipliers to be consistent with ONS data for the UK as a whole. All job numbers are likely to represent an underestimate, first because the multipliers used are likely to be smaller than those expected during a recession, and second because they do not assume any 'crowding in' of private investment.

However, unless there is something close to a v-shaped recovery (scenario 1 from the beginning of chapter 3 above), it is unlikely that the jobs created from investment in priority green infrastructure alone will be sufficient to ensure unemployment falls back to 2019 levels. Even assuming that all jobs created through investment are additional at aggregate, with no substitution from existing employment, our core scenario of a 'medium recovery' would imply a level of unemployment that is around 500,000 higher compared with 2019 levels. However, in practice, not all jobs created will result in a net 1:1 reduction in unemployment. It is therefore likely that Government will need to take additional measures to reduce unemployment further. Monetary policy will have a key role to play in keeping government borrowing costs low, but any further additional stimulus and job creation from monetary policy on top of this is likely to be small if not negligible, given quantitative easing and interest rate cuts have been all but exhausted. Forthcoming papers from NEF will set out our proposals to achieve additional job creation, through a combination of tax and welfare reform, and investment in expanded public services such as the NHS, social care and childcare.

4. CONCLUSIONS

Investing in priority green infrastructure has the potential to generate at least 400,000 jobs in the near term, just as the UK comes to terms with a likely post-coronavirus unemployment shock. The government should aim to invest at least £28 billion into priority green projects over the next 15-18 months, and as the economy recovers, continue to invest significantly in order to ensure that the UK permanently shifts onto a trajectory for new zero-carbon infrastructure consistent with meeting its climate targets.

However, unless there is something close to a v-shaped recovery, it is unlikely that the jobs created from investment in priority green infrastructure alone will be sufficient to ensure unemployment falls back to 2019 levels. It is therefore likely that Government will need to take additional measures to reduce unemployment further. Monetary policy will have a key role to play in keeping government borrowing costs low, but any further additional stimulus and job creation from monetary policy on top of this is likely to be small if not negligible, given quantitative easing and interest rate cuts have been all but exhausted. Forthcoming papers from NEF will therefore set out our proposals to achieve the additional job creation, through a combination of tax and welfare reform and investment in expanded public services.

The recovery from the previous recession felt illusory for many, with average real terms earnings remaining below their pre-2008 level all the way to 2019.[105] And the climate emergency globally saw no recovery at all, but in fact a significant worsening, putting us at a precipice of catastrophic and potentially irreversible climate breakdown.[106] This time we need to build back better.

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