Climate Jobs: Building a workforce for the climate emergency

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

Technical Companion

Contents

CREATING A GREEN, AFFORDABLE AND ACCESSIBLE NETWORK FOR ALL: CLIMATE JOBS IN TRANSPORT

A REFERENCES IN THE CHAPTER

This section presents the details for the numbered references given in the transport chapter of the Climate Jobs booklet.

1. We argue that the majority of climate jobs 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 quickly and successfully, using public funds to create well paid, skilled and unionised public sector jobs.

2. 2019 *UK Provisional Greenhouse Gas Emissions: summary* (publishing.service.gov.uk)

3. *Energy and environment: data tables* (ENV) - GOV.UK (www.gov.uk)

4. *General facts and figures about roads and road use* (racfoundation.org). The 76% figure is for 2019. It is also noted that "the proportion of households without a car has fallen from 48% in 1971 (based on the Census) to 24% in 2019 while the proportion of households with more than one car or van increased over this period, from 8% to 35%."

5. Stephen Devlin and Sandra Bernick, *Managing aviation passenger demand with a frequent flyer levy*, New Economics Foundation, 2015

6. Stefan Gossling and Andreas Humpe, *The global scale, distribution and growth of aviation: Implications for climate change*, Science Direct, November 2020. This assertion can be found more readily and in graphical form on the Stay Grounded website, *A rapid and just transition of aviation*, Stay Grounded discussion paper, February 2021.

7. Niko Kommenda, *Wealthy UK flyers opt for private jets to evade Covid lockdowns*, The Guardian, 21 January 2021

8. European Environment Agency, *Occupancy rates of passenger vehicles*, August 2015. As was noted in the previous edition of the One Million Climate Jobs technical companion, this site appears to no longer be functioning and these are the most recent figures available.

9. Freightera, *Train vs Truck Transportation - Efficiency, Cost, Advantages & Disadvantages*, Freightera blog and infographic, May 2019. In addition to energy consumption and fuel efficiency benefits, other advantages of shipping freight by rail are listed as:

   - Can carry more freight at the same time.
   - Cheaper for long distance.
   - Emit 75% fewer GHG emissions.

   While for trucks the advantages are given as:

   - Predictable scheduling.
   - Cost effective for short distances.

- Better for perishable foods.
- Door to door service.

10. A truly inclusive public transport system should ideally be free to use for all, but we recognise there may be practical reasons why a phased approach to this aspiration might be required. See Reference 14 for further discussion of this issue.

11. *Embodied emissions in rail infrastructure: a critical literature review* (iop.org)

12. Staffing numbers for the rail network are taken from Williams Rail Review, *The Rail Sector in Numbers*, March 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/787082/rail-sector-in-numbers.pdf#page24

    Of the 240,000-strong workforce, roughly two-thirds, 160,000, are employed in 'infrastructure' – maintenance, upgrade, replacement etc. and the remaining third, 80,000 in operational activities – train driving, guards and inspectors, scheduling.

    To build an expanded, fully electrified, network in five years, we have estimated that the size of the infrastructure workforce would need to double for that period, with roughly 10% of the additional workers being retained subsequently for ongoing repair, maintenance and replacement activities. The other 90% will either be redeployed to construction or other activities across the economy, or in some cases through natural wastage.

    The operations staff we estimate would also be doubled, and would be introduced gradually as construction takes place, such that the full complement of additional workers is in post for day one of year six to run the expanded network.

    Applying these assumptions and estimates to the 2019 staffing numbers, gives the following profile for the jobs required in addition to the current 240,000 workforce:

Additional jobs per year (000)	Construction period					Network operational			
Job category	Year 1	2	3	4	5	6	7	8	Etc.
Infrastructure	160	160	160	160	160	16	16	16	16
Operations	0	16	32	48	64	80	80	80	80
Total	160	176	192	208	224	96	96	96	96

13. Ian Taylor and Lynn Sloman, *Building a world class bus system for Britain*, Transport for Quality of Life Community Interest Company, Final Report, May 2016, Figure S1.

14. L Murphy, B Massey-Chase, S Frost, *Fairness and Opportunity: A People-Powered Plan for the Green Transition*, Institute of Public Policy Research, July 2021. fairness-and-opportunity-part1.pdf (ippr.org)

    The report was prepared on behalf of the Environmental Justice Commission and reaches conclusions broadly similar to our own in many respects. It calls for 'all local public transport to be free at the point of use by 2030.' Noting the qualifications 'local' and 'at the point of use' highlights that there are practical considerations to be dealt with in terms of (a) how public transport is funded, (b) the differing costs of short and long journeys, (c) perceptions around subsidisation held by frequent and occasional travellers, and (d) any contrasts between urban and rural transport networks.

Because of issues such as these, our proposal suggests a gradual move towards an ideal of free public transport, starting by ending the market-skewed situation that makes trains more expensive than flying, making public transport affordable for all, and free from the outset for children, the elderly, disabled and those on benefits.

15. European Environment Agency, *Indicator Fact Sheet: TERM 2002 29 EU – Occupancy Rates of Passenger Vehicles*, 2002, p. 4. As with the rail occupancy figures noted above (Ref. 8) this is the one available source as these statistics seem to no longer be collected.

16. Reid Ewing, Keith Bartholomew, Steve Winkelman, Jerry Walters, and Don Chen with Barbara McCann and David Goldberg, *Growing Cooler: Evidence on Urban Development and Climate Change*, 2009.

17. Demand responsive transport - Wikipedia

18. Sustainable Bus editorial, *Trolleybus. A growing demand thanks to zero emission operations* (sustainable-bus.com), 5 December 2020.

19. Statista, *Number of buses used in Great Britain by region*. For 2018/19 the number of buses in use across the U.K. as public service vehicles was 39,400, breaking down roughly as follows:

    English non-metropolitan areas – 15,000
    London – 9,700
    English metropolitan areas – 9,100
    Scotland – 4,100
    Wales – 1,400

20. Mike Berners-Lee and Duncan Clark, *What's the carbon footprint of ... a new car?*, The Guardian, 23 September 2010. This provides the following data for the embodied emissions of manufacturing a new car:

    Citroen C1, 6t CO_2e
    Ford Mondeo, 17t CO_2e
    Land Rover Discovery, 35t CO_2e

    Electric buses are, of course, larger than these but require fewer component parts than fossil fuel equivalents, so we have assumed a broad similarity between a bus and a conventional (petrol-burning) Land Rover, i.e. 35t CO_2e per bus. Given an existing bus population of around 39,000 to be converted and the same number of new buses to be manufactured gives a total of 2.76Mt CO_2e.

21. Staffing numbers for the U.K. bus networks are taken from GOV.UK, *Staff employed by local bus operators* (BUS07).

    Of the 117,000-strong workforce, roughly 23,000, are employed in 'infrastructure' – maintenance, upgrade, replacement etc. and the other 94,000 in operational activities – bus drivers, inspectors, schedulers.

To manufacture an expanded, fully electrified, fleet in five years, we have estimated that the size of the infrastructure workforce would need to double for that period, with roughly 10% of the additional workers being retained subsequently for ongoing repair, maintenance and replacement activities. The other 90% will either be redeployed to construction or other activities across the economy, or in some cases through natural wastage.

The operations staff we estimate would also be doubled, and would be introduced gradually as construction takes place, such that the full complement of additional workers is in post for day one of year six to operate the expanded network.

Applying these assumptions and estimates to the 2019 staffing numbers, gives the following profile for the jobs required in addition to the current 117,000 workforce:

Additional jobs per year (000)	Construction period					Network operational			
Job category	Year 1	2	3	4	5	6	7	8	Etc.
Infrastructure	23	23	23	23	23	3	3	3	3
Operations	0	18	37	56	75	94	94	94	94
Total	23	41	60	79	98	97	97	97	97

22. Transport focus, *Trams become the benchmark for happy passengers, according to the latest tram survey*, 14 June 2017

23. Marcel Robert, *Aubagne aura le premier tramway au monde entièrement gratuit!*, *carfree.fr* (in French). 6 July 2011

24. The Geographist, *100 Largest Cities and Towns in the UK by Population*

Our initial job numbers are based on two assumptions:

(i) The construction of the required infrastructure would be comparable to that needed for rail, i.e. 160,000 for the construction period and 16,000 for maintenance, repair and replacement thereafter,
and

(ii) 20,000 trams would service the target population, each being designated two drivers, giving 40,000 operational staff.

Applying these assumptions gives the following profile for the additional jobs required:

Additional jobs per year (000)	Construction period					Network operational			
Job category	Year 1	2	3	4	5	6	7	8	Etc.
Infrastructure	160	160	160	160	160	16	16	16	16
Operations	0	8	16	24	32	40	40	40	40
Total	160	168	176	184	192	56	56	56	56

Given the enormous uncertainty around just which cities and towns might opt to introduce a tram system, and which have a built environment conducive to doing so, we prefer to stipulate a range of plus or minus 25% for these job numbers.

25. Dr Adrian Davis, *Value for Money: An Economic Assessment of Investment in Walking and Cycling*, Bristol City Council/NHS Bristol, March 2010

26. Ian Philips, Jillian Anable, Tim Chatterton, *e-bike carbon savings – how much and where?*, Centre for Research into Energy Demand Solutions (CREDS), 18 May 2020.

    The key findings of the paper are:

    - E-bikes "have the capability to cut car carbon dioxide emissions by up to 50% (about 30 million tonnes per year)",
    - "The greatest opportunities are in rural and sub-urban settings" (because of the availability of other low carbon options in cities),
    - E-bikes can "help people who are most affected by rising transport costs".

27. Department for Transport, *Walking and cycling statistics, England: 2019*, 5 August 2020.

28. Department for Transport, *Road Traffic Forecasts 2018*, July 2018

29. Department for Transport, *Road Investment Strategy 2: 2020-2025*, March 2020

30. Thomas G. Goonan, *Lithium use in batteries*, US Government Science Circular 1371, 2012.

    The report notes that "It would take 1.4 to 3.0 kilograms of lithium equivalent (7.5 to 16.0 kilograms of lithium carbonate) to support a 40-mile trip in an electric vehicle before requiring recharge. This could create a large demand for lithium."

    In terms of global supply, "most of the lithium recovered from [the USGS study] came from Chile, with smaller amounts from China, Argentina, and the United States. Chile also has lithium mineral reserves, as does Australia."

    The report goes on to note that "Another source of lithium is from recycled batteries. When lithium-ion batteries begin to power vehicles, it is expected that battery recycling rates will increase because vehicle battery recycling systems can be used to produce new lithium-ion batteries."

31. The 19Mt Co_2e is arrived at from the following elements:

    Gov.uk, *All vehicles (VEH01)*, May 2021, reports a total of 37.4 million cars and goods vehicles currently registered (not including motorcycles, or buses – the latter having already been dealt with).

    In this chapter we have assumed a 75% reduction in the requirement for these vehicles, giving 9.35 million vehicles.

    Electric vehicles require only one third of the energy required for manufacture compared to petrol vehicles (see Ref 30). Taking the embodies emissions of 6t per car noted in Ref 18 and dividing by three gives 2t per vehicle.

    2t per vehicle x 9.35 million vehicles = 18.7 million tonnes, or around 19Mt Co_2e (the rounding up allows for additional emissions for goods vehicles).

32. Christopher Lampton, *Will Electric Cars Require More Maintenance?*, How Stuff Works.com, 6 December 2011.

33. As ref. 3.

34. Orion Market Research, *UK Aviation Market Growth, Trends - Share and Forecast 2019-2025*, October 2020.

35. Green Sky Thinking

36. D.S. Lee *et al*, *The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018*, Atmospheric Environment vol. 244, Science Direct, 1 January 2021.

    In a complex scientific analysis of the cumulative impacts of aviation, the article estimates that CO_2 accounts for only 34% of the sector's climate impact, the other 66% arising from contrail cirrus and the emission of nitrogen oxides produced at altitude. The article concludes that, "all together aviation represents around 3.5% of present-day radiative forcing. Thus, even though it accounts for around 2% of CO_2 emissions, its impact on the climate is much larger".

37. Almuth Ernsting, *Aviation biofuels: how ICAO and industry plans for 'sustainable alternative aviation fuels' could lead to planes flying on palm oil*, Biofuelwatch, 6 October 2017

    The report notes that "The European Commission has endorsed aviation biofuels for many years…[their] proposal for a new, post-2020 Renewable Energy Directive includes the abolition of a separate renewable energy target for transport, but a new mandatory target for 'advanced biofuels'".

38. As Ref. 6.

39. Department for Transport, *Purpose of travel at selected UK airports - Aviation statistics: data tables (AVI 0108)*, Gov.uk, 2020.

    Over the period 2009 to 2019, the proportion of business passengers recorded is as follows:

% business	2009	2019
Gatwick	15	15
Heathrow	29	25
Luton	18	13
Manchester	17	16
Stansted	16	14

    NB. There are annual fluctuations: Gatwick had reduced to 14% in the two years prior to 2019; Heathrow was at 30% in 2010 before reducing; Luton had been 12% in 2018. The overall trend is for a steady decline, particularly pronounced given that Heathrow is by far the largest airport in terms of passenger numbers, providing around 40% of the survey respondents.

40. As Ref. 5.

41. Aviation Job Search, *How is employment in the aviation industry changing?*, Oct 25 2019.

42. Possible/Autonomy, *Fair Transition for Aviation report* (in preparation), 2021. This report explores the potential for job creation under different emissions reductions scenarios for

aviation in 2030, both from R&D within the sector and from a modal shift to low-emission surface transport.

43. International Transport Workers Federation, *Flags of convenience*, ITF Global, 2021.

    The ITF provide the following explanation:

    "A flag of convenience ship is one that flies the flag of a country other than the country of ownership. For workers onboard, this can mean:

    - Very low wages
    - Poor onboard conditions
    - Inadequate food and drinking water
    - Long periods of work without proper rest, leading to stress and fatigue.

    By 'flagging out', ship owners can take advantage of:

    - Minimal regulation
    - Cheap registration fees
    - Low or no taxes
    - Freedom to employ cheap labour from the global labour market."

44. Christopher Davy, *Global shipping industry at risk of asset stranding as fossil fuels phased out*, China Dialogue Ocean, 17 July 2019.

    The study discussed in the article argues that "shipping will experience an 'aggressive and prolonged transformation' as energy consumption shifts from fossil fuels towards renewables and biofuels [and] warns of 'multi-decade declines in fleet capacity, earnings and asset prices across the affected sectors'".

45. Philippe Crist, *Greenhouse gas emissions reduction potential from international shipping*, OECD/ITF, May 2009.

46. Jon Excell, *The rise of the wind ships*, The Engineer, 19 February 2020.

B Cars, Lorries and Vans

By Michael McGrath

Contents

1. Summary

This section spells out the job consequences, both losses and gains, of the proposed shift away from fossil fuelled cars, vans and lorries. It highlights the resource constraint of electricity capacity and more importantly of battery mineral requirements. It concludes that we must transition away from mass private ownership of cars. This will require a radical transformation of how we get about and will need corresponding radical political change.

2. A note on sources

Figures used in this document are taken from authoritative sources and are referenced for further use by the reader. The conclusions drawn are based on these figures. The Climate Change Committee's Sixth Carbon budget report was published in Dec 2020 in three volumes[1]. There is a wealth of up-to-date information in the three volumes which are well worth reading and can be accessed freely. The report is advisory only, but the government accepted all five previous reports, and their findings then became law. However, and it is a big however, advice and acceptance are one thing, but implementation is another. A massive engagement at grass roots is required if the recommendations are to be

[1] https://www.theccc.org.uk/publication/sixth-carbon-budget/

implemented and our own demands of decent jobs and wages whilst retraining are to be met. Of particular relevance for this document on jobs in transport is the third volume - *The UK's path to Net Zero*, specifically the section on jobs (pp. 282-294). It is called encouragingly "A just transition". References to this major source in the text are indicated by 'CCC'.

3. Introduction

This document supports the transport chapter in the high-level *Climate Jobs* booklet. It will demonstrate that converting the UK's surface vehicle traffic (cars lorries etc) to all electric is not feasible if 'business as usual' continues. There are two key reasons:

i. The demand for electricity will be so high that it will be impossible to build the capacity to achieve the greenhouse gas emission reductions necessary to meet the legal target of a 1.5 ℃ increase by 2030.
ii. The demand for minerals for electric batteries will far outstrip the amount accessible at an economic cost.

Instead, a radical transformation of society is required which will include our transport system. Now guess where this quote comes from:

> "*Climate change is an existential threat to humanity. Without global action to limit greenhouse gas emissions, the climate will change catastrophically with almost unimaginable consequences for societies across the world*." [2]

Another apocalyptic warning from climate activists? No, it is the opening statement of an interim report on achieving net zero by 2050 from the ultra-conservative UK Treasury! The unthinkable is becoming thinkable. Here we tackle another unthinkable – the abolition of the private car as we transition to a net zero world. Can we live without the private car and, if so, what are the implications for jobs?

One of the most influential inventions of capitalism – the car - epitomises the possessive individualism that is capitalism's main social characteristic. Individual car ownership did not exist for the large majority of UK citizens until recently: in 1950 there were four million cars on the road, now there are 32 million. Greenhouse gas emissions need to fall to net zero by 2050 but in 2020 have risen by 10% since 2015; cars contribute 14% to this rise. Air pollution caused by the motor car kills, directly or indirectly, many thousands a year in the

[2] https://www.gov.uk/government/publications/net-zero-review-interim-report

UK[3]. The first death officially recognised as being directly caused by air pollution in the UK was Ella, a nine-year old girl who died in South London in 2020. Her death stimulated a campaign for an 'Ella's law' to curb air pollution[4]. About 1700 are also killed in road accidents every year in the UK.

The volume of cars and lorries on the road at present is not sustainable. They and the infrastructure to support them have already destroyed much that was great about our cities, towns and villages as well as concreted over vast swathes of the countryside. The UK government in 2020 committed £27 billion to build even more roads, a figure that dwarfs the amount devoted to environmental enhancement. Prof Greg Marsden, of the Institute for Transport Studies at the University of Leeds has said there should be a moratorium on new road construction pending the take-up of electric vehicles: "*The focus on shovel-ready infrastructure expansion on the roads will, regrettably, simply dig us a bigger climate hole to get out of.*"[5]

However, it is not surprising that with Covid currently making people wary of using public transport that people who do own a car are even more reliant on it. Nonetheless an RAC report showed that about 60% would use public transport more if it was better.[6]

We conclude this introduction with a quote from an angry letter in *The Guardian* newspaper on Dec 12, 2020:

> "*most of the time they [electric cars] will be parked in residential streets outside the homes of eco-minded suburbanites - a testimony to the sheer insanity of the private car, and even more glaring reason why what we need is, in the words of Thea Riofrancos 'rational forms of transport' such as trains, trams, e-buses, cycling and car sharing – and the infrastructure to encourage them.*"

4. Some facts about cars and lorries

Cars are so much part of our world that we assume that everyone has one – or more. Not so, about a quarter of households in the UK do not own a car and ownership has dropped dramatically in inner city sectors[7]. A recent survey found

[3] https://wintoncentre.maths.cam.ac.uk/news/does-air-pollution-kill-40000-people-each-year-uk/

[4] https://www.bbc.co.uk/news/uk-england-london-56801794

[5] https://www.theguardian.com/uk-news/2020/mar/11/chancellor-announces-27bn-for-roadbuilding-in-budget

[6] https://www.rac.co.uk/drive/features/rising-car-dependency-2019/

[7] https://www.thetimes.co.uk/article/affluent-young-leave-cars-behind-zkf58v5pw

that "*39% of those earning up to £20,000 said they didn't own a car*." [8] The cost of running an average car was about £3100 a year in 2020[9] (that buys a lot of taxi journeys – even in London!)

864,000 workers are employed in the automotive industry and its support services of which 180,000 are employed directly making 1.3 million cars a year, 78,000 commercial vehicles and 2.5 million engines.[10] About 250,000 are employed in the bus and coach sector[11]. 80% of cars are exported. Car output declined by 14% in 2019 – the lowest since 2010 - and this decline is likely to continue unless massive new investment is made.

However, road traffic increased by 29% between 1990 and 2018[12] and this is forecast to increase by up to 59% by 2050[13]. There is a contrary view which argues that increasing expense combined with lower wages for more people, online purchasing, online working, environmental concerns and car sharing will reduce the extent of the increase[14].

32 million cars are on the road in 2020 in the UK and are responsible for 61% of road transport emissions. 500,000 HGVs are responsible for 17% of total surface transport emissions, despite being only 5% of road vehicles. The four million vans generate 17% and buses 3% of the remaining emissions [15].

5. Electric vehicles ride to the rescue?

Surely Electric Vehicles (EVs) are the answer to reducing greenhouse gas emissions? They are indeed cleaner - although not as much as you might think - and quieter and easier to maintain. Even the insurance is less at the time of writing. But EVs are not a 'Get out of jail free 'card.

GHG emissions from EVs are less than for an Internal Combustion Engine vehicle (ICEV). However, the comparison is not straightforward. There are

[8] https://www.nerdwallet.com/uk/personal-finance/cost-of-car-ownership/#:~:text=The%20average%20annual%20cost%20of,figure%20rises%20to%20%C2%A35744.40.
[9] https://www.nimblefins.co.uk/average-cost-run-car-uk
[10] https://www.smmt.co.uk/industry-topics/uk-automotive /
[11] https://www.gov.uk/government/collections/bus-statistics
[12] https://www.ons.gov.uk/economy/environmentalaccounts/articles/roadtransportandairemissions/2019-09-16
[13]
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/873929/road-traffic-forecasts-2018-document.pdf
[14] https://www.scrapcarnetwork.org/news/4-key-reasons-why-car-ownership-is-declining-in-the-uk/
[15] https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Surface-transport.pdf

emissions when driving which are effectively zero IF electricity is generated from a renewable resource such as wind or solar. But this is a big IF. Fossil fuel generated electricity will be with us for a long time yet as renewables struggle to catch up with demand. And then there are the life cycle emissions of EVs which most definitely are not zero especially during the long transition to all-electric. We deal with this crucial factor below.

Life cycle emissions of Electric Vehicles (EV) compared to Internal Combustion Engine Vehicles (ICEV)

The life cycle emissions of a vehicle include all the emissions that derive from the raw materials through construction to end of life. Current estimates vary widely but all show that life cycle emissions for an EV are significant and even equal to an ICEV in one study. A sample of quotes from the many recent studies is given in the Note for Sources and the links to the full reports are given below[16] [17] [18].

So whilst EVs are cleaner than ICEVs they are not the game changer for reducing GHG emissions that is often claimed.

Increased energy demand

A crucial factor is the way in which the power is generated to both manufacture and then use electric batteries ('power trains' in the industry jargon). The UK will still rely heavily on fossil fuels even by 2030 when it is intended to stop the sales of ICE cars. About half of all cars will still be fuelled by petrol or diesel. In addition, demand for electricity will be so high that renewable resources (mainly wind and solar) will not be sufficient to meet the demand. According to Jess Ralston, an analyst at the Energy and Climate Intelligence Unit, "*The UK government's target to generate 40 Gigawatts of electricity from offshore wind by 2030, while ambitious, is likely necessary, given that its own advisers say that 75 Gigawatts may be needed from offshore wind to achieve net zero carbon emissions by 2050*"[19]. It is already intended to cover much of the useable North Sea with wind farms to double capacity by 2030; it is difficult to see how doubling the area again can be managed especially as other countries will also want space to build turbines.

[16] https://www.eea.europa.eu/highlights/eea-report-confirms-electric-cars#:~:text=The%20report%20confirms%20that%20the,of%20petrol%20and%20diesel%20cars

[17] https://iopscience.iop.org/article/10.1088/1748-9326/11/4/044007

[18] https://theicct.org/sites/default/files/publications/EV-life-cycle-GHG_ICCT-Briefing_09022018_vF.pdf

[19] https://www.econotimes.com/Offshore-wind-to-power-all-30-UK-million-homes-in-2030-1593638

The whole issue of energy generation is a complex issue and dealt with in more detail in a later section.

Resource constraints

Simpler and starker to understand than energy requirements is the resource constraint on replacing the existing 32 million cars with EVs. The main problem is the half ton battery that drives the car. This is best described in a letter from respected geologists at the Natural History Museum to the CCC. We quote it at length because it is so important. It is one of the very few challenges to the current orthodoxy that we can expand without limit in order to satisfy the requirements of contemporary capitalism. It has not been challenged since its publication in 2019.

> "***The metal resource needed to make all cars and vans electric by 2050 and all sales to be purely battery electric by 2035.***
>
> *To replace all UK-based vehicles today with electric vehicles (not including the LGV and HGV fleets), assuming they use the most resource-frugal next-generation NMC 811 batteries, would take 207,900 tonnes cobalt, 264,600 tonnes of lithium carbonate (LCE), at least 7,200 tonnes of neodymium and dysprosium, in addition to 2,362,500 tonnes copper. This represents, just under two times the total annual world cobalt production, nearly the entire world production of neodymium, three quarters of the world's lithium production and at least half of the world's copper production during 2018. Even ensuring the annual supply of electric vehicles only, from 2035 as pledged, will require the UK to annually import the equivalent of the entire annual cobalt needs of European industry*."[20]

These are not annual amounts so not quite so mind boggling as they might seem at first glance. However, we need to add about 25% for the seven-ton batteries needed by HGVs. and another 25% for the four million vans. Crucially of course we aren't the only country requiring these batteries: we have to scale up globally to the one billion cars on the road in 2020 and all the HGVs and LGVs etc. - that is by a factor of about 30. Roughly speaking 11,500,000 tons of cobalt are needed just to convert the existing fleet. The world reserves of cobalt are about seven million tons – and a lot of exploration had been done so probably not a lot more can be found that is economically extractable. Now add in other battery demand for public transport vehicles and all the other battery requirements. The figures

[20] https://www.nhm.ac.uk/press-office/press-releases/leading-scientists-set-out-resource-challenge-of-meeting-net-zer.html

simply don't add up and one can see that the task is impossible. Of course, alternatives to cobalt exist, although they are not so satisfactory and the same problem persists - the planet's resource are being driven to breaking point. To which we must add the so-called rare earth minerals vital for a range of electrical use – rare not because there isn't much of them but because they are very hard to extract economically. The scale of a one-for-one conversion to EVs has simply not been recognised.

We must also take into account the social and environmental impacts of extraction. Mining is a dirty business. 50 tons of ore or up to 1900 tons of brine are needed to produce one ton of lithium. Both processes require very large amounts of water that destroy the livelihood of farmers in the region of extraction

Cobalt is widely used in battery production and mainly found in the Congo. Even allowing for the disgraceful exploitation of child labour used in its processing it is still very expensive. At the time of writing Apple and Google were being sued in a test case over the deaths of at least 14 children in the Congo. Cobalt is also found on the sea floor but collecting it in the vast quantities needed would cause wholescale destruction of the marine ecology. Nickel is touted as a replacement for cobalt, but this is in the very early stages of development and again would be required in vast quantities.

The brute fact is that the UK cannot sustain 32 million all-electric cars and even less can the world sustain the current one billion that are currently on the roads.[21]

Of course, some of the dramatic impact described here will be moderated by end-of-life recycling but this will need to be managed with great care given the dangerous nature of the materials involved.

6. Electric vehicles – Lorries (HGV) and vans (LGV)

There are 500,000 HGVs registered in the UK and four million LGVs[22]. The CCC is recommending that the Government ends diesel sales of HGVs by 2040[23] and there are powerful reasons for doing so.

"*Despite comprising only 5% of UK road vehicles, heavy goods vehicles (HGVs) produce 17% of GHG emissions from the surface transport sector. Therefore, it*

[21] https://www.acea.be/statistics/tag/category/world-production

[22] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/898747/domestic-road-freight-statistics-2019.pdf

[23] https://www.theccc.org.uk/wp-content/uploads/2020/12/Policies-for-the-Sixth-Carbon-Budget-and-Net-Zero.pdf

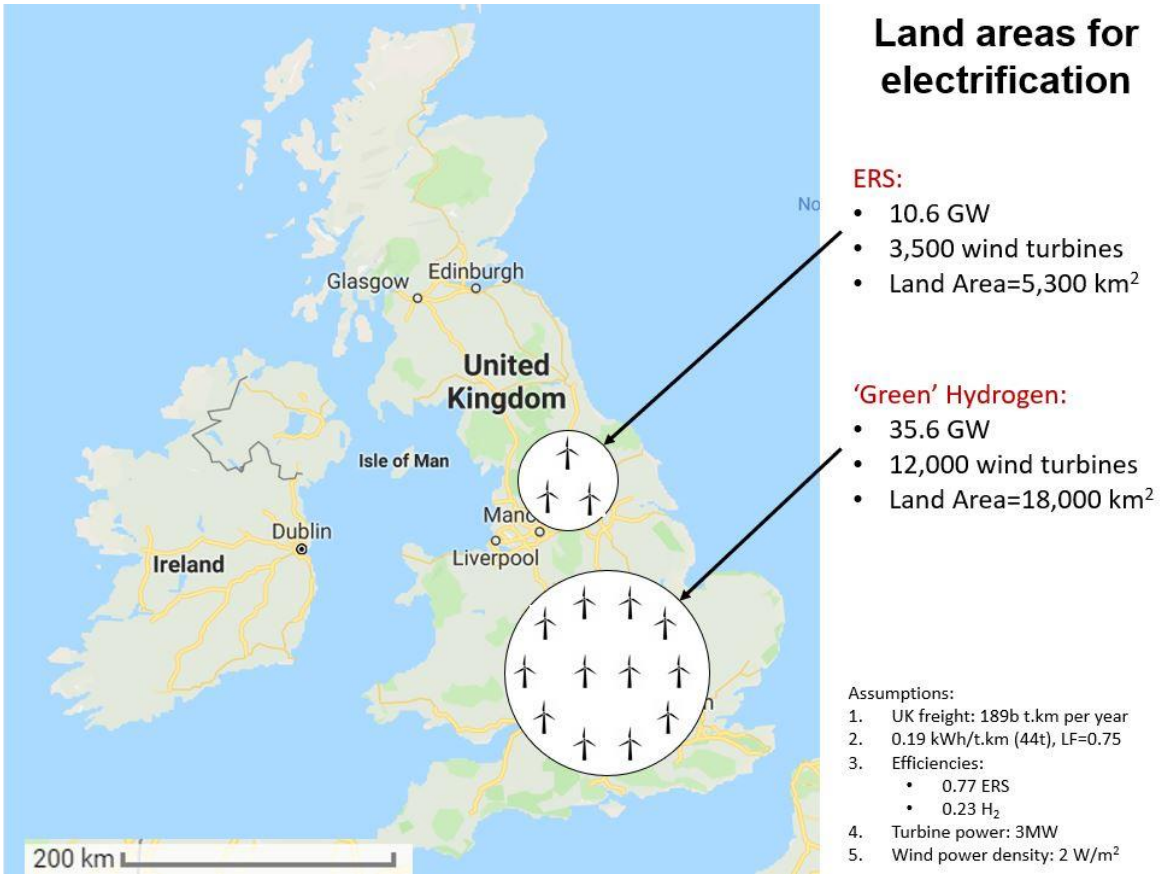
is important to enable the sector to transition to zero-carbon alternatives in a timely manner."[24] Diesel powered HGVs are also a cause of both bladder and lung cancer as well as more commonly dizziness, nausea and headaches. Unless radical change takes place in the HGV sector it will be responsible for 20% of all emissions by 2050. Pilot schemes for both electric battery and overhead transmission and hydrogen powered HGVs are active in 2020 both in the UK and elsewhere, but the vital infrastructure at present exists only on paper when we need to reduce emissions by 50% by 2030 in order to keep global warming to 1.5^{o}C.

The 500,000 HGVs would each require a battery weighing up to seven tons (Tesla Semi) - that's 3,500,000 tons, much of which is lithium, cobalt and other rare metals. The total power requirement is about 8.3 gigawatts which is about a fifth of what is planned from offshore wind – and that's just for HGVs. The map below gives a neat illustration of the amount of land that would be needed for the wind turbines to generate this amount of electricity. A report suggests that "*A better solution for long-haul HGVs is direct electrification, particularly using an electric road system – ERS. This could be implemented in the UK within 10-15 years, for a cost significantly less than the UK Government's planned expenditure on roads for 2020-2025. The combination of a national ERS and battery electric urban delivery vehicles would decarbonise almost all of the UK's road freight operations... at only a fifth of the cost of HS2*".[25]

It sounds good but this solution still requires a fifth of the planned electricity generation and still requires a car sized battery on board the HGV. In addition, the authors acknowledge that their proposals would only deal with 65% of HGV mileage and local delivery would need to be by battery operated vans – (see the section on cars for the resource implications of battery production.) There is no indication that the government is likely to adopt this as a solution and the CCC is particularly weak in this area simply recommending that the government should produce a plan for freight in the early 2020s.

[24] https://www.theccc.org.uk/wp-content/uploads/2020/12/Policies-for-the-Sixth-Carbon-Budget-and-Net-Zero.pdf

[25] http://www.csrf.ac.uk/2020/02/blog-long-haul-lorries-powered-by-hydrogen-or-electricity/#:~:text=The%20UK's%20HGV%20fleet%20transports,requirement%20is%20approximately%208.2%20GW



Estimated land areas of wind turbines needed for powering the UK's heavy goods vehicles by electric road system or via 'Green' Hydrogen (electrolysis)

7. How many jobs will there be in EV production?

The numbers currently employed range from 450,000 estimated by the CCC to 864,000 by the Society of Motor Manufacturers and Traders – the difference being what is included. However we cut the cloth, we must start with the demand that existing jobs are defended until retraining on full wages are guaranteed and a decent job is available at the end of the training. Why should workers' pay the price of the transformation when they have no control over the changes taking place?

As the old saying goes making predictions is very difficult especially about the future. Studies vary considerably on the job implications of moving to EVs. However, in the current 'business as usual' model there will likely be a reduction in the jobs in EV production and maintenance for a number of reasons. EV powertrains have far fewer components than internal combustion engine vehicles and even less moving parts; hence they are quicker to build and requires much

less maintenance. A battery factory requires a far smaller work force than an engine plant.[26] [27]

A very detailed report from the London School of Economics suggests that 158,000 jobs can be generated in EV battery and car manufacture if investment is made in the so called gigafactories – a play on words meaning simply 'gigantic'.[28]

The trade union UNITE is of course concerned at the loss of jobs through electrification and firms such as Tesla are viciously anti-union. General Secretary Len McCluskey writes in the introduction to UNITE's pamphlet on the subject, "*a decline in demand for petrol and diesel poses questions for our members on North Sea platforms, oil refineries and behind the wheels of fuel tankers. UNITE is keen to support this transition from ICE vehicles to EVs, provided it is managed justly to defend employment*."[29] The 32-page document is as much concerned with autonomous driving vehicles - which affects their lorry drivers - as it is with EVs but fails to go beyond generalities on the need for retraining and identifying potential new jobs.

AND there is a useful summary of what was the Labour Party position prior to the shift to the right under Starmer[30]. The form of words may remain but the chance of a vigorous defence of this position is unlikely.

"*The transport sector provides a compelling example of the extent and complexity of the impact on jobs and work that will come from decarbonising our economy. Changes to employment in this sector alone could include: new employment in the supply of electricity and hydrogen to vehicles; the elimination of roles in the production and supply of petroleum and diesel; the transformation of manufacturing jobs to reflect new types of vehicles and transport infrastructure; and a modal shift to public transport from private vehicles resulting in significantly greater employment in the bus and train sectors. In view of the scale of transformation required, the Green New Deal must guarantee the defence and expansion of support, protections, and rights for workers, with sensitivity to the*

[26] https://europe.autonews.com/article/20180605/ANE/180609877/ev-push-threatens-75-000-german-auto-industry-jobs-study-says
[27] https://fas.org/sgp/crs/misc/IF11101.pdf
[28] https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2020/10/Jobs_for_a_strong_and_sustainable_recovery_from_Covid19.pdf
[29] https://unitetheunion.org/media/1225/a-manufacturing-strategy-from-the-unite-automotive-sector.pdf
[30] https://static1.squarespace.com/static/5c742a3c77b9036ccae1eddf/t/5d721c74d8766100019c81e8/1567759478751/4+A+just+transition+to+well-paid%2C+unionised%2C+green+jobs.pdf

scope and impact of the project of decarbonisation." Labour Party Green New Deal.[29]

8. Jobs outside of vehicle manufacture and support

It is clear that short of massive inward investment jobs in the car industry employment will decline over the next ten years. However, this decline is unlikely to kick in before about 2025 by when EVs will be making a significant impact. Some job opportunities are noted below, taken from the 6th CCC report. There are many others including those employed in the massive retraining infrastructure that will be needed.

i. As of 2020, in the medical sector there were 106,000 full time equivalent (fte) vacancies in the NHS ranging from porters to admin to paramedics to consultants.

ii. Linked to this is the care sector where there were 112,000 fte vacancies. It is clear that both these sectors are likely to grow, and both are labour intensive. Many of the jobs are low paid but one would hope that the bright light that has been shone on their importance during the Covid pandemic will offer better prospects. A key factor here will be the ability of trade unions to organise more successfully in both these sectors.

iii. A major area is in retrofitting homes and buildings to higher energy saving standards – estimated by the CCC at 200,000 ftes. A more ambitious target is two million jobs described in the Buildings chapter of the *Climate Jobs* booklet.

iv. Public transport is dealt with in the Transport section of the booklet but just to note here that large increases in employment are possible in manufacture, infrastructure, driving and maintenance.

v. Investments in offshore wind manufacturing in Hull have been attributed to reducing unemployment benefit claims by close to 60%.

vi. The Office for National Statistics (ONS) estimates that 225,000 people are currently employed in the UK's low-carbon technology and renewable energy economy, representing around 0.7% of the total UK workforce, with an additional 5,000-10,000 jobs being added each year.

vii. The CCC recommends an additional annual investment in UK buildings of over £10 billion per year. The Construction Industry Training Board (CITB) analysis suggests that the energy efficiency programme in the

2020s and following low-carbon heat programme would require an additional workforce of over 200,000 new full-time equivalent roles from the late 2020s through to 2050. More roles may be required in the heat pump and other supply chains if those are UK based.

viii. The CCC also recommends additional annual investment in the electricity sector and energy networks growing to around £20 billion by 2030. Work done for National Grid on the energy system employment opportunities in a transition to Net Zero suggest up to 400,000 low-carbon jobs could be needed over the next 30 years, including jobs in buildings retrofit. This is comparable to direct employment in the UK's energy sector of 144,000 today. 260,000 will be in new roles, while the remainder will be replacing those who have left the workforce. Importantly, they note the opportunity for these jobs to be spread across all regions of the UK.

ix. There may also be employment opportunities for the UK from exports if it becomes a market-leader in the production of low-carbon technologies. The Energy Innovation Needs Assessment (EINAs) recently conducted by BEIS assessed these opportunities and found innovations in low-carbon manufacturing technologies could support up to 80,000 jobs in the UK by 2050. These jobs would also be high quality, with wages above the UK average."[31]

In contrast to these opportunities, employment in the UK's oil and gas sector "has seen employment drop by 35% between 2013 and 2019"[32]

9. What is the alternative to 'business as usual?

If we are to leave a world fit for our children and grandchildren to live in then we need to change our lives dramatically. We can transition away from private car ownership if the following programme is implemented fully by 2030:

- Community sharing of cars both formally and informally.
- Car clubs owned and managed locally.
- Car rental - as today but again managed locally.
- Shared taxis - requires a culture shift but is common in many other countries.

[31] https://www.gov.uk/government/publications/energy-innovation-needs-assessments
[32] https://oilandgasuk.co.uk/wp-content/uploads/2019/08/Workforce-Report-2019.pdf

- Well run integrated public transport is vital and dealt with in the booklet.
- Bikes (e and non-e) - dealt with in the booklet.
- Walking - dealt with in the booklet.
- Working from home - voluntary but likely to increase over time and hence reduce journeys.
- Online shopping - will likely continue to increase, meaning less car journeys but more van and cargo bike deliveries.
- 15 minute neighbourhoods in which residents are within walking distant of all essential services. Local planning, consultation and implementation needed.
- Even with all the above some exemptions will likely be necessary - for example – the elderly and infirm, doctors etc.

There are some useful pointers for the collective use of cars in a Wikipedia article[33]

The number of business cars will continue their pre Covid decline partly as a result of more home working which will likely continue. Similarly, the growth in online shopping means that the number of car journeys will decline in the longer term. 15 minute neighbourhoods are growing in popularity especially in cities. Living within 15 minutes' walk of everyday shopping, schools, medical centres, green space and other service facilities should lead to a further decline in the need for personal car travel. A national transport system under public ownership is a vital element - cheap or free, integrated and high quality. Cycling can be encouraged by a massive increase in well-designed cycle lanes separate from cars, vans and lorries as is common in many European counties. Well-designed walking routes in cities are becoming increasingly popular. These all need planning and resources. The planning exists in places like Leeds which has just published a plan for a car free city[34]. Hamburg is well on the way as is Oslo. These initiatives important though they are will not in themselves solve the problem, but they are part of the solution.

We have argued above that private car ownership will need to go. But jobs will still exist in making and maintaining:

i. community cars

[33] https://en.wikipedia.org/wiki/Carsharing

[34] https://s3-eu-west-2.amazonaws.com/commonplace-customer-assets/leedstransportstrategy/Leeds%20Transport%20Strategy_p11.pdf

ii. buses and coaches

iv HGVs and vans

v. Not forgetting that the complete transition to all-electric cars will take 20 years and 30 years for HGVs and vans; so petrol and even diesel will be around for a long time yet.

10. Conclusion

There is a problem underlying all the predictions of a green all-electric future contained in the research literature. It is that for many writers "It's easier to imagine the end of the world than the end of capitalism."[35] They do not even acknowledge that capitalism itself will ensure the end of the world by destroying the world's resources in pursuit of private profit. The crisis in the system is coming to a head in this generation. Its resolution requires a fundamental transformation of society and economy. This document has looked at the rapidly developing electrification of the transport sector. The alarming consequences for increased electricity generation and resource extraction and refining is but one illustration of the problems facing us in moving away from fossil fuelled vehicles. We have argued that we need to transition away from private car ownership and suggest how this can be done. The killer argument that is ignored in much of the literature, which itself reflects attitudes generally held, is that we cannot continue to destroy the world's resources at the scale needed to drive over a billion cars and millions of lorries. Electricity will be required at such a vast scale that much of the UK and coastal waters will be covered by solar panels and wind turbines, which will be particularly devastating for the species that also inhabit our world. We need above all to address the politics of how we have got into this mess and how we get out of it. The solution to the problems raised here must include the ownership, control, production and distribution of the wealth of the planet by those who create it - we, the workers and peasants of the world.

[35] Mark Fisher. Capitalist realism: is there no alternative?"

C Cycling and Walking
By Simon Shaw

Introduction and context

We need to think of cycling and walking as part of a public transport strategy – they are good for your health, and the only CO_2 they produce is in the air you breathe out.

A key argument is that where cycling is the norm, no one identifies as a cyclist '*any more than they would be identified as someone who wears a coat*'[1] In several European cities (e.g. Amsterdam, Copenhagen) cycling is an accepted and widespread means of transport. To encourage and expand cycling as a healthy and non-polluting form of mobility requires a similar cultural shift in the UK in contrast to the current view of the 'cyclist' as a profession or hobby. While the onus is on the rider dressing as if to go and work in a nuclear processing plant with layers of protective gear and specialist dayglo clothes and a helmet, cycling in the UK will not break through to the twenty to thirty percent of journeys taken by bicycle in Denmark and the Netherlands.

The history of safe cycling in the Netherlands is interesting. Simone Langehoff's death in 1971 was just one of 450 fatalities that year. Her father Vic started a campaign, arguing that the Netherlands was the most dangerous place in the world for child traffic casualties. On September 20th 1972 he used a full page advertisement in the newspaper he worked for *De Tijd* to announce a new pressure group called 'Stop de Kindermoord' – Stop the Child Murders. It rapidly became a major protest organisation using direct action such as staging mass 'die-ins' and occupying busy roads and turning them into impromptu play streets. The politicians gradually started to listen when the movement was given an unexpected boost as a result of the 1973 oil crisis which saw the price of petrol quadruple, leading many to question the future of the car. The Netherlands gradually re-engineered their roads with the result that in the Netherlands around thirty percent of journeys are by bike, despite owning slightly more cars than the British[2].

Shoppers on bikes in the Netherlands buy smaller portions of unhealthy food as they have less carriage capacity but therefore make more frequent journeys and buy fresher food. City of Copenhagen Statistics department confirms that although people shopping on bikes tend to buy less, they do make more frequent journeys and spend more overall[3].

Public health issues

Peter Walker writes about cities currently '*being built for rapid, anonymous, one-tonne metal boxes, often carrying a single person for a laughably short distance*': '*Even if you decide to shun every cycle lane built, you will still benefit from the cleaner air, safer, quieter streets and more people-orientated urban environment*'[4]. The standard calculation is that one lane of a typical UK road can carry about two thousand vehicles an hour – with bike lanes that shoots up to fourteen thousand an hour. In nations that have broken the car

culture cycle routes are protected /separated and bikes are given traffic light priority. '*If a cycle route is not safe for an eight-year-old, it is not a cycle route*'[5].

The number of deaths attributable to cars (3500 daily globally) contrasts with about 100 cyclists dying on the road annually in the UK. About a quarter of car-related deaths are pedestrians and cyclists - as cars have become safer for the driver, they have become more dangerous for non-car drivers[6].

According to the UK Department of Transport, 1 to 2% of journeys are made by bike[7]. The number one oft stated reason for not cycling is fear of an accident due to motor traffic. Statistics show that the average person would have to cycle two million miles before having a serious accident[8].

However, every year about 85 000 Britons die as a result of conditions linked to lack of physical activity. According to the World Health Organisation lack of physical activity globally is the fourth major cause of premature death globally[9]. The National Travel Survey says that a fifth of people have not walked for more than twenty minutes once in the last year[10].

Studies published in the Lancet show that physical activity is likely to be undertaken if it is integrated into everyday life rather than being an artificial extra[11]. Figures from the 2011 census show that while average commute times are increasing still more than half were under three miles[12]. More than two-thirds of commuters travel less than six miles to their workplace. The increasingly popularity of e-bikes make these distances more manageable to the less experienced cyclist.

Current urban environment

Cars receive huge hidden subsidies such as cheap on road parking, despite being owned by a minority of the population. As argued elsewhere in the transport chapter of the *Climate Jobs* booklet, there should be an end to private car ownership, with an emphasis on other modes of transport, publicly owned, and on communal use of Electric Vehicles only where other modes do not meet the specific need. At present even regular car users do not use their cars for the vast majority of the time. Innovative plans to link smart phones to fleets of cars that can be summoned for use could free streets from the majority of parked vehicles and leave more room for cyclists and pedestrians.

The deeply unjust truth is that in thousands of cities from London to New York to Shanghai to New Delhi, transport is built mainly around cars and thus explicitly for the benefit of the richer than average who disproportionately own them. More than this, the external social costs of driving tend to fall predominately on the less prosperous who are more likely to live near a main road, enduring noise and smog with their community bisected by heavy traffic[13].

Bikes are powerful sign of democracy – someone on a $30 bike is as important as someone in a $30,000 car. A 2015 study in NYC found that the number of female cyclists doubled from ten to twenty percent if the cycle lane was protected and not just paint on the

road. Because of the development of cycle lanes the levels of cycling increased by 250% from 2006 to 2014. The secret to this success is segregated cycle lanes which must be continuous. Between 2000 and 2014 there was a rise in cycling NYC of around 450% but the number of serious cycle related injuries fell from 440 to 341[14].

A 2011 TFL survey found that the London cyclist was typically; white, male, under forty and in the middle to high income bracket[15]. A similar 2016 survey found an increase in BAME cyclists following the introduction of more and safer cycle network[16]. People who could cycle to their work on lower incomes rarely appear in the statistics. An OECD report in May 2014 argued that the health impacts of driving necessitate that it needs to be disincentivised by making it more expensive[17].

Proposed solutions

The key thing here is building a network of wide, safe, segregated cycle lanes that are not simply blue paint on a road. This can be done quickly where they run alongside roads. The comparative success of the cycling superhighways in London depends on continuous kerbs, protected junctions and bike-only traffic light sequences.

With a more developed policy for cycle use it should also be possible to build well-lit lanes that follow independent routes, for example on the verge of railway embankments where there is space and no potential hazards. With this kind of investment, cycles could probably replace a tenth of car passenger miles.

£27.4 billion is being invested over the next 5 years through Highways England's roads plan to ensure the road network is fit for the future and safe, reliable and efficient for drivers and businesses[18]. £175 million has been announced for high-quality cycling and walking infrastructure across England to make local journeys safer for all. The funding came as a survey undertaken by Kantar Media revealed that 65% of people across England support reallocating road space to cycling and walking in their local area. Nearly 8 out of 10 people (78%) support measures to reduce road traffic in their neighbourhood[19].

However, the Transport Secretary has set tough new conditions on councils receiving funding, requiring them to ensure schemes are properly consulted on. This will help avoid the problems seen in a minority of the schemes developed in the first round of funding. If these conditions are not met by a council, the Transport Secretary has been clear that future funding allocations will be reduced, and clawbacks could also be imposed.

'Mini-Hollands' aim to make cycling pleasanter, safer and more convenient. The infrastructure changes include segregated cycle lanes; measures to calm motor traffic; redesigned town centres; cycle hubs and a range of behaviour change measures including community bike rides. The schemes also include measures to improve the walking environment such as new pedestrian crossings at key locations, and the creation of new public spaces with seating, trees and flowerbeds.

As of June 2021, almost all of the 59 proposed infrastructure schemes were complete or under construction. What impact did they have? Although many of the schemes are still in delivery or very recently completed, there is evidence of a positive impact on active travel behaviour. A study investigating the early impact of the programme discovered that people in the areas subject to these modifications were 24% more likely to have done any cycling in the previous week and walked or cycled for 41 minutes per week more than those where such improvements have not yet been made[20].

Mini-Holland status was also associated with a more positive perception of the local cycling environment and the community.

Key figures

- £15 million contributed to the programme from the borough's own sources,
- 24% more likely to have done any cycling in the previous week,
- 59 proposed infrastructure schemes.

The multi-million-pound investment marks a step towards the ambition to deliver more active travel options in communities across the country and build back greener – benefitting the nation's health and the environment.

Jobs

There are three main sources of jobs that would add to employment in the transport sector: changes to, and maintenance of, infrastructure; manufacture of cycles (including electric bicycles) and associated equipment; changes in social behaviour and their benefits.

New social developments have advanced the cause of cycling. Ebikes have given new groups access to cycling, they also open up possibilities in a post Covid world of online shopping – many fast-food deliveries are made now on electric bikes. This could easily be extended to cargo bikes, as currently many large vans are used to deliver very small packets, this would be a win for the companies in terms of costs and speed of delivery, and for the customer and the riders in terms of new areas of employment.

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D Climate jobs – aviation
By Tahir Latif

Introduction

In considering aviation, we are looking at a different societal function from that served by road vehicles and, to some extent, rail. The scope is largely international, even global. There is overlap in that, in the UK, as elsewhere, internal (domestic) flying currently takes place that could theoretically be accommodated by train or bus, but the defining feature of the aviation industry is its global reach, which forces a slightly different focus.

In terms of jobs, the fundamental issue is that aviation, like car travel, is a polluter that needs to be curbed in its current form, while rail travel is a relative non polluter. The basic assumption is that to benefit the climate, a shift from polluters to non-polluters is needed, and that this must be accompanied by a corresponding shift in the labour force.

In the case of aviation, however, there are a number of conflicting factors to be considered:

1. Aviation is an aggressively profiteering industry that is vehemently opposed to any suggestion of limitations on flights (and therefore on profits).

2. As a powerful lobbying industry, aviation is able to use its resources to promote 'greenwash' about so-called solutions to its own environmental impact, and to have these myths become widely regarded as truth.[1]

3. For workers, a simple logic of more flights = more jobs, and less flights = fewer jobs, exerts a strong intuitive hold that compels many trade unions to support unsustainable expansion plans,[2] even while their employers attack job numbers, and terms and conditions.[3]

4. These points lead to a conclusion that only by integrating aviation into a publicly owned transport system, supported by a National Climate Service, can climate issues be addressed and workers employment protected.

Current situation

The aviation industry points to the relatively low level of contribution that flying makes to global carbon emissions. However, that figure needs to be set in context:

1. Aviation is the industrial sector whose carbon emissions are growing faster than any other, with UK emissions from international aviation growing by 136% since 1990.[4] It is also important to note that the percentage of carbon emissions are not a true reflection of the impact of aviation emissions; due to their being released at altitude, the relative effect is around three times greater than the equivalent amount of carbon emitted on the ground, primarily as a result of non-Co2 emissions such as NOx, soot and water vapour.[5]

2. Plans for growth of the sector far outstrip those of any other industry, with the UK industry committed to a programme of continuous growth to 2050. Even with the advent of the

COVID-19 pandemic reducing flying in 2020 by 65%,[6] growth projections remain intact: to return to pre-pandemic (2019) levels by 2025 and to grow by 150% by 2050.[7] These levels of growth would require the associated airport expansions to accommodate the increase in arrivals and departures (albeit in a longer time frame than was estimated pre-Covid).

In short, aviation is a key contributor to climate change, and its expansion plans would see that contribution grow massively in the coming decades. Clearly that situation is untenable in climate terms, and all actors agree that action has to be taken. However, what the industry, whose economic viability is founded on generating the demand to justify a perpetual increase in flights, considers adequate action is very different from a more objective critique of the requirements.

Reducing aviation's climate impact

There are three categories of action that could be taken to mitigate aviation's impact on the environment:

(i) *Implementation of technical solutions* such as alternative fuels, new engine and aircraft types and designs - that reduce the carbon footprint of each flight taken.

(ii) *Offsetting the emissions* produced by a flight through other activities that provide an equivalent reduction in emissions.

(iii) *Reducing the amount of flying* carried out, I.e. demand management, achievable through a combination of government edict, tax schemes and lifestyle change.

The position of the aviation industry with regard to these three categories can be summarised:

- technological solutions are offered as the ultimate answer in the long term once the necessary research and development has perfected them

- offsetting schemes to reduce aviation's carbon footprint will bridge the gap, thereby enabling growth to continue until those solutions are available

- demand reduction is rejected out of hand as a feasible option, with dismissal generally couched in terms of a constraint on individual freedoms.

Busting the myths behind aviation industry solutions

Technical and scientific solutions to the climate impact of aviation are to be welcomed. No climate activist would disagree with that – a successful call for a reduction in the amount of flying would not exclude us from wanting to see whatever flying remains from being carried out in a more climate friendly way. Whether alternative fuels, aircraft technology, or a combination of both, in principle we would welcome investment aimed at the development of such solutions.

What we do object to is that these solutions are used as industry greenwash that ignores reality in order to justify the continuation (or restoration, post-pandemic) of business as usual. All actors agree, including government and industry, that viable solutions will not be available till the late 2030s at best, maybe the 2040s, or even 2050.[8] Many of the solutions currently proposed are 'false'

(i.e. create as many problems as they solve) or 'need work' (i.e. require more R&D to get it right). In particular, synthetic or so-called sustainable fuels have either not been fully developed, are expensive and energy intensive to use, or produce more emissions than conventional kerosene.[9]

We are therefore looking to some future time for the potential advent of alternative ways of flying, hence the DfT commits to 'net zero domestic aviation by 2040' and net zero for all aviation by 2050.[10] Even leaving aside the problematic nature of the term 'net zero'[11] that is a long way off. That means plans for immediate traffic growth, and associated airport expansions, are being made even though solutions will not be available and are therefore represent purely an increase in fossil fuelled flying. This includes recovery to 2019 levels by 2025 and then continuing to grow thereafter – more flights in 2026, more in 2027, 2028 and so on.

We can usefully ask:

i. How does such growth square with a climate emergency for which radical action is needed by 2030 to keep within 1.5°C,[12] and
ii. How will the availability of solutions, even if accelerated to the 2030s, help to solve a climate crisis that is happening very visibly right now.[13]

Given that growth is planned that is contrary to climate targets, and that solutions will not be available for many years, the entire weight of resolving this contradiction is thrown onto the concept of 'offsetting'. Simply put, the aviation industry asks us to accept the story that the amount of carbon emitted by aeroplanes over a period of, say, 15-20 years (from a 2025 recovery to pre-pandemic levels, through a period of continuous annual growth, to an assumed availability of solutions in 2040 or 2045) will be entirely offset by other activities across the economy.

There are two main problems with accepting this proposition:

1. The *flaws* in offsetting – offsetting does not even attempt to deal with two thirds of aviation's climate impact including water vapour and soot at altitude.[14] CO_2 emitted immediately starts warming the atmosphere and continues doing so during the decades which it takes trees in offsetting projects to grow. And trees are not as safe a carbon store as leaving fossil fuels in the ground (see for example recent wildfires burning offset projects.)[15] Schemes claiming to reduce deforestation have also been thrown into doubt as to whether they actually reduce emissions.[16] The maths doesn't add up: with all countries and all sectors needing to achieve net zero, there won't be spare emissions reductions available to buy as offsets.

2. The *injustices* of offsetting – these are both sectoral (other industries have to reduce beyond their immediate capabilities, with potential consequences for their own transformations, so that aviation can grow) and geographical (development in the Global South has to be sacrificed for the excesses of an already privileged North).[17] Set that against an aviation sector that predominantly services a tiny elite who take multiple flights with impunity (15% of UK citizens take 70% of flights[18] and 1% of the world's population is responsible for half of all aviation emissions[19] – such statistics also demonstrate that calls for reductions in flying are, contrary to the propaganda, not targeted at the average family).

In simple terms, if we have to accept a continuation of some emissions while en route to a decarbonised society, what logic says that aviation should be at the front of the queue for those emissions? If there are to be 'embodied emissions' these need to be reserved for essential

construction, for example of wind turbines, electric trains, buses and vehicles, and insulation of homes.

To combat the climate catastrophe that is happening and on which we need to have made significant strides by 2030, there is no alternative to reducing the amount of flying that we do (or more accurately, not restoring it to pre-pandemic levels). Such a conclusion is ideological anathema to industry and government (and, until the alternatives proposed here become policy, many trade unions). Consequently, the subject of demand reduction cannot be broached and is absent from the UK's plans for the decarbonisation of transport.

An alternative view of jobs

As described above, a reduction in flying is an inescapable conclusion by any objective and sane measure of what is best for our society, its people, their jobs, and quality of life. But we also need to consider the consequences of a reduction in flying on the workforce. The sector does employ many workers, directly or indirectly,[20] and expansion would produce a need for more jobs of that type (security, air traffic control, flight and cabin crew etc). Consequently, workers are understandably worried about their continued livelihoods if the growing call for flying to be constrained were to be carried out in practice.

It can be assumed that a reduction in the amount of flying that takes place, if all else remained the same as today, would require less of the jobs that workers currently do. But if that reduction were carried out in a planned way that puts people and planet first, loss of current jobs would be counterbalanced. We can identify several stages to these developments:

1. The previous section argues that there is no alternative to an immediate reduction in flying if we are to meet crucial 2030 climate targets. This means a loss of existing aviation jobs and a need for redeployment to other parts of an integrated transport system, and to other areas of the economy that are expanding and require workers.[21] It is this immediate scenario that is articulated in the transport chapter of the Climate Jobs booklet.

2. We have also argued that technological developments to reduce the climate impact of flying are to be welcomed, even if implementation is beyond the urgent 2030 target. But to achieve workable solutions at all requires significant investment now in research and development, utilising the skills and expertise of workers in the aviation industry. For the Climate Jobs booklet, we have made a modest estimate that 10% of the jobs lost due to a reduction in flying could be 'added back' to the aviation sector to support the R&D required for long term solutions.

3. If and when solutions are developed that are not greenwash but actually enable climate friendly flying, staffing in the aviation sector could regrow. In fact, for reasons outlined briefly below, these technical solutions are likely to be more labour intensive than current operations and therefore provide significant employment. However, much of this is currently speculative, as well as outside the time frame for the Climate Jobs booklet, so does not form part of our general argument at this stage.

Jobs of the future

As noted, technical solutions aimed at 'green flying' are several decades away. But the research is happening now, and the following offers initial speculations based on a number of sources as to what that might look like for the aviation workers of the future.[22]

The battery power of electric planes will limit the range of flights using this technology for the foreseeable future. And while, as with motor vehicles, electric planes use less parts, are easier to build and require less maintenance than their existing fossil fuel counterparts, this is balanced by the likely provision of short hop journeys only, requiring staff of all types at more frequent points.

Other options for alternatives to fossil fuel are being developed and will have scope for application over the coming years. A future structure for the aviation industry comprising the following elements has been proposed as:

- Road, rail, ferry or small electric aircraft for journeys under 500 miles
- Medium range hydrogen aircraft for journeys of 500-1500 miles
- Synthetic fuel aircraft for journeys over 1500 miles

In each case, pricing can be used to discourage flying, with the most likely impact being a decision to choose an alternative, cheaper mode for shorter journeys, and a reduction in the amount of long-range journeys. The mix of potentially very different aircraft types requires a bigger and more diverse staff to build, maintain and operate. Flying planes more slowly to make the most efficient use of fuel also has impacts in terms of crew and ground staff, and lengths of shifts and therefore could increase job numbers.

Airports would also need to be designed very differently from now, which casts current airport expansion plans as redundant or a colossal waste of money given the extensive overhaul they would need. Such expansions would quickly become stranded assets and undesirable by any longer-term economic standards. Applying the likely technical solutions would require:

- Smaller regional airports rather than large 'hubs'
- Shorter runways and gates to accommodate smaller aircraft
- Facilities for providing fuel to the three likely aircraft types (electric, liquid hydrogen, synthetic)
- These facilities would be needed even though the sector would be experiencing a reduction in passenger miles flown.

Clearly this kind of transformation of the sector runs counter to the economic orthodoxy that drives the sector we currently have - more labour per passenger mile equals economic inefficiency. But it is only airline profits that would lose out, not labour. All of the above generates a significant need for jobs, including increases in:

- Pilot, cabin crew, ground, crew, airport staff
- Aircraft design and development (including engines and associated technology)
- Airport architecting and design
- Training jobs for the new technology (including pilot retraining).

It should be reiterated that the above scenarios are purely speculative, though based on a rational assessment of likely developments, and assuming people and planet are prioritised above profit.

Socioeconomic dimensions

Clearly the arguments made in the Climate Jobs booklet for a more comprehensive network of public transport to supplant private vehicle use can also be applied to travel by aeroplane. The quickest win as regards aviation is the replacement of domestic flights, primarily by a planned expansion of long-distance rail travel, high speed, electrified and including night and sleeper trains. Some medium to long journeys might also be conducive to bus service provision. Either case requires a net transfer of jobs from aviation to alternative services.

But, as described above, the eventual development of technology and genuinely sustainable fuels will most likely require more workers per passenger mile to operate. This means that, after a 'sag' in aviation employment numbers, during which redeployment to other modes and sectors will be the priority mechanism for protecting jobs, there could be an increase in aviation sector jobs in the longer term. We can consider this increase as being outside the time frame of the Climate Jobs booklet, but nevertheless provides an additional source of optimism.

More radically, in terms of travel, we can consider the changes in lifestyle proposed to better support the health and restoration of our ecosystems as being particularly apposite in the case of aviation. While private car use might be the biggest transport problem the environment faces in terms of common everyday usage, aviation's global reach has the greatest implications in terms of lifestyle (and begs more strongly the question of whose lifestyle are we talking about).

In the first instance, it should be noted that the amount of business flying is small and reducing.[23] That trend is likely to be exacerbated given that the pandemic has compelled the use of zoom and other online platforms to bring people in remote locations together effectively and at low cost. Indeed, many companies are, in light of these developments, altering not only their travel policies as regards meetings but also the very concept of retaining dedicated offices.[24] Combined with a renewed emphasis on the localisation of trade, food growth and manufacture proposed in the Climate Jobs booklet the much-touted economic benefits of a huge expansion in aviation become considerably more tenuous.

That still leaves open the question of what constitutes 'good' or 'bad' aviation.[25] Undoubtedly visiting friends and relations, experiencing other cultures, building global relationships would broadly be categorised as 'good', while the ability to export exploitative practices and implement economic colonisation of less developed countries would be 'bad'. Of course, much flying is not that cut and dried, and such definitions are laden with value judgements that would be difficult to resolve. But it could be useful to test these broad categorisations against the flying that occurs today to see how far they are currently met, and therefore what the scope is for reducing flying from a purely socioeconomic perspective.

Ownership issues

Aviation is one of the most privatised and commercialised of all industrial sectors, with a near rabid obsession with squeezing every last penny of profit from every aspect of its operations. The industry as currently constituted is spectacularly unsuited to the task of transition in the name of the climate, and hostile to its own workforce, who are all too commonly seen not as skilled workers to be valued but as an inconvenient overhead to be replaced wherever possible.

Clearly the types of change to the aviation sector described in this section have implications for how the industry is owned and operated. Reduced flying and encouraging potential passengers to take another mode of transport to reach their destination wherever possible, is in direct conflict with the competitive model that motivates industry players. Any capitalist enterprise seeking to realise profits, in any undertaking, seeks to attract customers not to direct them elsewhere.

Similarly, the transformation of aircraft fleets from fossil fuels to alternative, non-polluting, forms aspired to in the future, involves labour 'inefficiencies' in strict market terms. This is completely the opposite of recent trends in aviation, where automation, dispensing with all but core services, and other changes, have been made with the explicit intention of reducing the size of the workforce to increase profit margins. This is made clear when we consider that national security is equally subject to these economic vagaries, in the form of electronic passport gates replacing checking by security staff in order to reduce staff costs.[26]

What these trends tell us is that workers future employment prospects lie more securely with the transformations described here than with a return, after the pandemic, to business as usual, where that business includes employers trying to minimise workforce costs by any means possible.

It is therefore important to look again at ownership structures, what could benefit from being brought into the public sector, and whether that means nationalisation, regional or local ownership, workers control, democratic accountability etc, or some mix of these.[27] Whether regional and local airports operating short-range flights in the future is conducive to local ownership structures is worth considering. At the very minimum, an integrated transport system needs governmental coordination and planning but given aviation's global scope more might be required to manage the transformation needed.

From the perspective of Climate Jobs, it suffices to say that private owners would consider both the need for an immediate reduction in flying and a more labour-intensive long-term future for the sector as counter to their economic interests, so the issue of public ownership in this context is very much a live one. Our position in the Climate Jobs booklet is for public transport, and integrating aviation into that public network, under the auspices of the National Climate Service, is essential.

Other issues

Two other important factors need to be taken into account when considering the future of aviation. Each is worthy of a study in itself but in the context of this report they are significant for how they could impact on the arguments presented here as regards jobs:

1. *International coordination* - aviation is inherently international/global, we cannot hive off UK aviation workers from those in other countries, it needs a coordinated international effort among workers worldwide to bring about such transformational changes.

2. *Impact of the pandemic* - since Covid-19 brought aviation to a virtual halt in 2020, with a projected time frame of years to return to previous levels, the opportunity to rebuild the sector in a more benign form cannot be wasted. If the changes discussed here seem radical, they are less so given that there is at the time of writing, very little flying going on.

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