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Why accelerating transformation is just

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Intelligence Briefing

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Abstract

Non-technical Summary. Accelerating transformation to net-zero emissions will limit global warming and the widespread and inequitable harms it causes, alongside bringing other benefits, but new harms may also be created. Recently, it has been argued that accelerating transformation is unjust, particularly because of concerns about critical mineral mining, including for electric vehicles (EVs). However, this ignores the unjust harms from climate change that accelerating transformation alleviates. Here I argue that a faster transition is a more just one, because the harms it avoids – both globally and for the least advantaged people – far outweigh any harms it causes.

Technical Summary. Any transformative change has losers as well as winners, hence the call for a 'just transition' to avoid creating new harms. Recently, accelerating transformation has been challenged on the grounds that it compromises justice. Following a climate justice framework, I argue that the justice of climate impacts avoided cannot be ignored when considering the justice of mitigation actions, as this leads to unjust outcomes – in both utilitarian and prioritarian theories of justice. Taking, as a case study, EV adoption and its association with artisanal mining of cobalt in the Democratic Republic of Congo (DRC), I show that heat-related and air pollution-related deaths avoided globally by replacing internal combustion engine vehicles with EVs are both three orders of magnitude greater than deaths caused in artisanal mining accidents in DRC. Heat-related deaths avoided in DRC exceed artisanal mining deaths. Deaths avoided globally are mostly among the least advantaged people. More generally, accelerating transformation avoids far more harm from climate change and air pollution than any harms it creates, and maximises other benefits, including for the least advantaged people. Thus, while governance should strive to avoid deaths to artisanal miners in DRC, it should also accelerate transformation as the just thing to do.

Social Media Summary. Being anti-net zero is unjust. Slowing transition greatly increases heat-related deaths among the world's poorest people.

1. Introduction

Transforming societies and economies to (net) zero greenhouse gas emissions will avoid escalating harms from climate change and provide multiple benefits, including cleaner air, cheaper electricity, and energy security (Lenton, 2025). The current pace of transition is far too slow to meet the Paris Agreement goal of limiting global warming to well below 2°C; hence, transformation needs to accelerate (Lenton, 2025; Sharpe, 2023). Historical precedents show that rapid transition is possible (Newell & Simms, 2020; Sharpe & Lenton, 2021; Sovacool, 2016). Any transformative change has losers as well as winners, leading to calls for a 'just transition' (Newell & Mulvaney, 2013; Wang & Lo, 2021), defined as 'a fair and equitable process of moving towards a post-carbon society' (McCauley & Heffron, 2018). This recognises that differentiated responsibility should fall disproportionately on those that have historically made greater contributions to causing climate change and those that have greater financial and technological capacity to respond. Recently, tensions between speed and justice have been highlighted (Heffron & McCauley, 2022; Newell et al., 2022; Skjølsvold & Coenen, 2021), and accelerating transformation has been challenged on the grounds that it compromises justice (Pereira et al., 2024, 2025). Justice concerns regarding the mining of critical minerals have also gained widespread popular media attention, notably artisanal cobalt mining in the Democratic Republic of Congo (DRC) (Pereira et al., 2024; Sovacool, 2019).

Governance action is urgently needed to limit the creation of new injustices (Pereira et al., 2024; Sovacool, 2019), including improving working conditions in the DRC's artisanal mines. At the same time, the harms and injustices mitigated, and benefits created, by activities that accelerate transformation need to be considered. Climate change is deeply unjust; it disproportionately harms poorer people worldwide, while being largely caused by rich people (Reich et al., 2025). The purpose of this intelligence briefing is to critically evaluate arguments that speed compromises justice and make the case that a faster transformation is a more just one.

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This requires a theory (or theories) of justice and an underlying ethical philosophy. One approach is utilitarianism, in which the consequences of actions are the sole basis for determining right and wrong (a consequentialist, ends-focused approach), and justice is the maximisation of total or average welfare across all relevant individuals treated equally (Mill, 1863). This theory focuses on distributive justice, i.e. who bears costs and who reaps benefits. An alternative is Rawls' (1971) theory of justice as fairness (a deontological, rights-focused approach), which recommends equal basic liberties, equality of opportunity, and facilitating the maximum benefit to the least advantaged members of society in any case where inequalities may occur. This focuses on procedural justice, i.e. fair, transparent, and inclusive decision-making. In the same vein, but within a consequentialist approach to distributive justice, prioritarianism gives moral priority to improving the lives of disadvantaged individuals over those who are already advantaged (Parfit, 1997). Complementing these are theories of planetary or Earth system justice that incorporate intergenerational and interspecies justice (Gupta et al., 2023; Pedersen et al., 2024), and transformative climate justice, which tackles the causes of climate injustice (Newell et al., 2021).

To apply these theories requires a choice of ethical system boundaries (known as the scope of justice (Zimm et al., 2024)) – i.e. who are the relevant individuals when considering the consequences of actions to accelerate transformation? I consider all humanity because climate change has global impacts. This is consistent with a climate justice approach, which seeks to achieve an equitable distribution of both the burdens of climate change and the efforts to mitigate climate change (Schlosberg & Collins, 2014). Rawls' (1971) principle of facilitating the maximum benefit to the least advantaged members of society can still be applied, but to both mitigation actions and their (global) climate consequences.

In the following, I take a consequentialist approach to distributive justice, considering both utilitarian and prioritarian positions within that. For simplicity, I focus on mortality as a metric, which avoids issues of discounting or monetarily valuing lives (Bressler, 2021). Further considering the causes of injustice, the rights of future generations and the rights of more-than-human nature would likely strengthen the case for accelerating transformation. Firstly, I highlight the potential for accelerating transformation to minimise unjust harms from climate change. Next, I weigh up the harms caused and avoided in the example of artisanal cobalt mining in the DRC for electric vehicle (EV) batteries. Then I evaluate other arguments that speed may compromise justice. Finally, I highlight the potential for accelerating transformation to maximise other just benefits.

2. Minimising unjust harm

Unjust harm is already being caused by climate change and is set to escalate. There are hazard, exposure, and vulnerability components to this. The geography of several climate hazards falls disproportionately on the least advantaged (Mendelsohn et al., 2006), including exposure to extreme heat and humidity stress, which is biased to already hot places (Freychet et al., 2022). Furthermore, within a given geography and society, the least advantaged people tend to be more exposed and vulnerable to the impacts of climate change (Hallegatte & Rozenberg, 2017).

This unjust harm is being caused by the activities that cause climate change, notably cumulative emissions of greenhouse gases from the fossil-fuelled energy system and the meat-oriented food system. While global warming increases roughly in proportion to cumulative emissions (expressed in terms of CO_2 equivalents, CO_2e), some key climate harms increase disproportionately with global warming, exacerbating their unjust consequences. Some also unfairly redistribute harm. Notably, global warming reduces cold-related deaths mostly among more advantaged people, while nonlinearly increasing heat-related deaths (Lüthi et al., 2023) mostly among less advantaged people (Bressler, 2025). The activities causing climate change also cause other inequitable harms. Notably, there are ~5 million deaths per year from air pollution related to fossil fuel combustion (Lelieveld et al., 2023), and the poor are disproportionately exposed to air pollution (Rentschler & Leonova, 2023).

A faster transition means a faster decline in relevant activities and less cumulative emissions than a slower transition. Therefore, a faster transition minimises unjust harms. This can be quantified, with the example of heat-related mortality. The mortality cost of carbon synthesises existing studies to quantify the future heat-related deaths caused from a tonne of CO_2e emitted today (Bressler, 2021, 2025), with or without adaptation – meaning the assumption that increasing income will reduce vulnerability over time. Assuming adaptation and considering deaths until 2300, the (marginal) mortality cost of emissions in 2025 is 1.37×10^{-4} deaths/tCO_2e, or without adaptation 3.93×10^{-4} deaths/tCO_2e (Bressler, 2025). Thus, emitting 7300 tCO_2e (assuming adaptation) or 2540 tCO_2e (without adaptation) is expected to cause one premature death during 2025–2300. This is equivalent to the lifetime emissions of 5.7 or 2.0 average US citizens, or of 146 or 51 average internal combustion engine vehicles (ICEVs) (see Appendix). This mortality is weighted to hot countries and less advantaged people, with 75% occurring in South Asia and Sub-Saharan Africa (Bressler, 2025). Applying the principle of intergenerational equity to include premature deaths caused beyond the year 2300 would increase these mortality costs, especially in the case without adaptation, where they could more than double.

Thus, a faster transition can avoid massive, inequitable mortality. Accelerated transformation can also create new harms and injustices, but do they outweigh those alleviated?

3. An example of weighing harms and injustices

A well-publicised concern of increased harms is that the extractive industry needs to provide critical minerals for renewable energy and electrification (Pereira et al., 2024). Some of its practices are widely cited in the popular media as a cause of harm. A key example is artisanal cobalt (Co) mining in the Katanga region of the DRC, which provides a critical metal for lithium-ion batteries used in EVs.

In 2019, estimates ranging from 60–80,000 to >200,000 artisanal miners provided ~12% of the cobalt supply from DRC (Gulley, 2023). Together with large-scale industrial mining, DRC provided around 70% of the global cobalt supply (Ritchie, 2023). Artisanal mining brings benefits to miners but also causes harms, notably deaths and injuries from accidents in highly dangerous working conditions (Sovacool, 2019), and it involves child labour (Gulley, 2023). Death rates are uncertain. The World Bank (2020) underestimates 65 per year based on media reports. Siddharth Kara estimates up to 2000 per year based on a questionnaire (~1–2% of the workforce). Some mines have reported annual deaths of 0.4–0.5% of the workforce (Tsurukawa et al., 2011), which equates to 240 to >1000 per year. I take ~500 (65–2000) deaths/year as a central estimate (and range). Governance action is urgently needed to reduce this death toll (Sovacool, 2019).

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About a third (34%) of the world's cobalt supply in 2021 went into EV batteries (the rest went into other batteries and electronics) (Ritchie, 2023), so ~170 (22–680) deaths per year from artisanal mining in DRC are associated with worldwide production of EVs. Not all battery technologies require cobalt (e.g. lithium iron phosphate batteries), but if we assume there is some artisanal mined cobalt from DRC in each of the 17 million EVs sold worldwide in 2024 (IEA, 2024b), the average EV was associated with 1.0×10^{-5} (1.3×10^{-6}–4.0×10^{-5}) deaths from artisanal mining in DRC over its lifetime. Thus, roughly every 100,000 EVs are currently associated with one artisanal mining death in DRC.

While seeking to avoid these mining deaths, the deaths avoided by substituting ICEVs with EVs should also be considered. The global fleet of around 1.5 billion cars and vans in 2023 (dominated by ICEVs) emitted 3.8 $GtCO_2$/year, which has a heat-related mortality cost, just from that year's emissions, of 520,000 to 1.5 million (with or without adaptation). For the average ICEV with total lifetime emissions ~50 tCO_2e (see Appendix), this translates to 6.9×10^{-3}–2.0×10^{-2} deaths/ICEV (with or without adaptation), or one future heat-related death for roughly every 100 (51–146) ICEVs over their lifetimes. Substituting an ICEV with a battery electric vehicle (BEV) reduces total lifetime emissions by 50–80%, depending on the electricity mix (Bieker, 2021). This avoids $(3.5–5.5) \times 10^{-3}$ deaths/BEV (assuming adaptation) or $(1.0–1.6) \times 10^{-2}$ deaths/BEV (without adaptation) (see Appendix), which is about 1000 times (100–10,000 times) more heat-related deaths avoided per EV than currently caused in artisanal mining in DRC.

In addition, the air pollution generated over the lifetime of the average ICEV is responsible for 3.45×10^{-3} deaths/ICEV (see Appendix). BEVs have zero tailpipe emissions and, even in the worst case of running on 100% coal power, can avoid 3.35×10^{-3} deaths/BEV (see Appendix), comparable to the heat-related deaths avoided assuming adaptation.

This does not cover all causes of mortality. Accidents in other parts of the EV battery supply chain cause comparable lost life years to the lower estimate of artisanal mining deaths in DRC, and sulphur dioxide, zinc, and arsenic emissions from producing EV batteries cause more lost life years than the higher estimate of artisanal mining deaths in DRC (Arvidsson et al., 2022). Extracting and refining oil also causes mortality (Onyije et al., 2021). Nevertheless, the mortality costs of carbon and air pollution remain orders of magnitude larger.

Thus, from a utilitarian global perspective, accelerating the transition to BEVs is (overwhelmingly) just. From a Rawlsian perspective, deaths caused in artisanal mining are among the least advantaged people worldwide, but so too are a far greater number of heat-related deaths avoided worldwide (including in DRC, Somalia, and Niger) (Bressler, 2025), while air pollution deaths avoided tend to be among poorer people in developing (especially middle-income) countries. Thus, from a prioritarian global perspective, accelerating the transition to BEVs is (overwhelmingly) just.

If one took a narrower view of 'society' as just DRC, each BEV avoids $(1.4–2.2) \times 10^{-4}$ heat-related deaths (with adaptation) to $(5.0–8.0) \times 10^{-4}$ heat-related deaths (without adaptation) in DRC (see Appendix), which is 3.5–615 times the deaths caused per BEV in artisanal cobalt mining in DRC. Clearly, governance should seek to avoid deaths in artisanal cobalt mining in DRC and its other negative impacts (Banza Lubaba Nkulu et al., 2018; Sovacool, 2019), but from a utilitarian perspective, accelerating the transition to EVs is just for the citizens of DRC. From a prioritarian perspective, it is hard to say whether the greater number of people in DRC avoiding heat-related death (in the future) will be less advantaged than those dying in artisanal cobalt mining today, but they could be. Today, over 85% of people in DRC live in extreme poverty (<$3/day) and artisanal cobalt miners are generally better off than this (Sovacool, 2019). The fraction of DRC citizens living in extreme poverty increased from 2012 to 2020, meaning DRC's people are at risk of not being able to reduce their vulnerability to heat-related deaths in future. However, the cobalt mining region of Katanga is notable for its economic development, and the DRC's mineral wealth offers a clear opportunity to lift its people out of poverty and reduce their vulnerability. Thus, accelerating the transition to EVs while seeking to avoid mining deaths could be just for the citizens of DRC from a prioritarian perspective. Such judgements are complicated by the large class, ethnic, and other cleavages at play in determining who benefits from, and who pays the costs of, the transition. Ideally, costs should fall disproportionately on the richest and those who have historically contributed most to causing climate change.

4. Does speed compromise justice in other ways?

Several other justice concerns with accelerated transformation have been raised (Newell et al., 2022; Pereira et al., 2024, 2025).

Accelerated transformation could perpetuate or entrench existing injustices, notably because incumbents are in a better position to mobilise quickly and protect their interests (Newell et al., 2022). A key concern is that unjust extractivism will be perpetuated by a new wave of critical mineral extraction from poorer to richer countries, producing 'green sacrifice zones' (including the example above) (Pereira et al., 2024, 2025). However, globally, the extractive industry for clean energy will be smaller than the fossil fuel one it replaces (Nijnens et al., 2023). Also, the high-value minerals extracted can form the basis of a more circular economy with less extraction (Ma et al., 2025), whereas fossil fuel carbon cannot. This mineral recycling potential increases the incentive to accelerate transformation now (Fabre et al., 2020). Thus, accelerating transformation could hasten the demise of extractivism.

Accelerating transformation may preclude pathways and outcomes that are more just (Pereira et al., 2024), narrowing the range of transition pathways and creating path dependency that locks us into suboptimal solutions. For example, substituting ICEVs with EVs is not the best of all possible solutions. A deeper transformation to a different mobility regime, e.g. reducing mobility and switching to electrified public transport, could (ultimately) achieve a greater reduction in emissions (Pereira et al., 2024) and associated harms (Rose, 2023). However, if (as implied) it takes longer to switch to a different mobility regime, then more cumulative emissions can cause more harm in the intervening time. Conceivably, an accelerated transition to EVs could subsequently undergo a (delayed) switch in mobility regime, starting from a point of lower transient emissions, and with lower ultimate cumulative emissions and associated harms.

A counter case can be made that accelerated transformation could create (rather than preclude) opportunities for deeper transformation, because it will cause greater disruption for incumbent actors. Accelerated transformation to EVs is a pertinent example. Already, ever cheaper batteries coming from the electrification of personal mobility are opening up other pathways of accelerating change to lower emissions (Lenton, 2025; Sharpe & Lenton, 2021). Also, cars are the dominant driver of demand for oil. In an accelerated transformation, oil companies and those invested in them

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will experience greater stranded assets sooner (Mercure et al., 2018; Semieniuk et al., 2022), while clean energy assets will grow faster. This should cause oil companies to diversify sooner (or go out of business) and those invested in them (e.g. pension funds) to move their investment elsewhere sooner (or suffer losses). If investors do not respond fast enough, then financial harm will fall upon pension holders in richer countries (Semieniuk et al., 2022). This may open a space for deeper cultural questioning of the incumbent paradigm.

Speed may trade off with procedural justice (Newell et al., 2022), but this is uncertain and should not preclude prioritising justice concerns (Steel et al., 2026). Notably, participatory democratic processes can help forefront justice considerations but tend to be slow to conduct. However, they tend to lead to policy proposals that (if enacted) would greatly accelerate transformation. The deeper problem is that their policy proposals are generally not acted upon (P. J. Newell et al., 2022; Lenton, 2025). Furthermore, incumbent actors in the fossil fuel sector have co-opted some 'just transition' processes to deliberately slow action that is against their vested interests (Newell et al., 2022) – making a mockery of the concept.

More broadly, speed does not conflict with distributive justice. In the law, 'justice delayed is justice denied' – a speedy resolution of cases is widely seen as just for those suffering injustice. Vulnerable communities suffering escalating heat-related mortality may feel the same.

5. Maximising just benefits

Transforming the energy system has justice benefits, in addition to the harms avoided.

Renewable energy is already providing the cheapest source of new electricity almost everywhere (IRENA, 2025b). This can disproportionately benefit the poor, for example, off-grid solar power plus battery storage is starting to bring access to affordable electricity to the ∼700 million people that do not have it (IRENA, 2025a; Lenton, 2025). Several low- to middle-income countries have increased their reliance on low-carbon energy and reduced emissions while increasing per capita GDP and reducing income inequality (Reich et al., 2025). Across 23 higher-income countries, a greater share of renewable energy substantially increases within-country energy justice (Sen et al., 2024).

Renewable energy sources are more equitably distributed than fossil fuels (Overland et al., 2022). Just 12 countries supply 80% of net fossil fuel exports, whereas around 74% of the world's population live in net fossil fuel-importing countries, including many of the poorest people. Switching to in-country generation of renewable energy benefits their balance of trade and economic conditions, and energy security. Meanwhile, the minority of fossil fuel exporters may be harmed if they do not transition their economies in a timely fashion, but they tend to be more advantaged people.

Clean energy gets cheaper the more that is deployed, thanks to several reinforcing feedbacks (Lenton, 2025). Hence, despite upfront costs, transforming the energy system saves a large amount of money, and accelerating transformation saves more money (Way et al., 2022). From a utilitarian perspective, transforming faster maximises benefits to total or average welfare. From a prioritarian perspective, transforming faster can bring greater benefits to the least advantaged people.

6. Conclusion

The allegorical Lady Justice with her scales is often blindfolded, asking that we weigh arguments and evidence in an impartial fashion. Rawls (1971) asks us to put on a metaphorical blindfold in his thought experiment of the 'original position' and select the society we would choose to live in if we did not know which social position we would occupy in it. I apply this globally and conclude that I would much rather live in a world undertaking accelerated transformation to (net) zero emissions than one undergoing a slower transition. This is because if I end up at the bottom of the pile, my chance of dying prematurely from heat or air pollution is reduced, and my chance of gaining access to affordable electricity and wider economic opportunity is increased. From a utilitarian or a prioritarian ethical perspective, the case is clear: Accelerated transformation maximises total or average welfare across all humanity, whether treated equally or giving greater moral weight to the well-being of those who are worse off. Further considering the rights of future generations and of more-than-human nature would only strengthen the case for accelerating transformation.

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Appendix: Calculations

Vehicle total lifetime emissions: ICEV: 2023 global fleet of cars and vans: 1.5 billion. 2023 total emission from cars and vans: 3.8 $GtCO_2$/year (IEA, 2026). Assume fleet is dominated by ICEVs. Average emission per ICEV: ~2.5 tCO_2/year. Average lifetime of ICEV: ~18 years (Oguchi & Fuse, 2015). Embedded emissions of medium-sized ICEV: 3.7 tCO_2e (IEA, 2024a). Result: ~49 tCO_2e/ICEV. Independent estimate: Life-cycle GHG emissions of average ICEV: ~250 $gCO_2e\ km^{-1}$ (Bieker, 2021). Average lifetime distance: ~200,000 km. Result: ~50 tCO_2e/ICEV. **BEV**: Life-cycle emissions of BEV with grid electricity mix: ~125 $gCO_2e\ km^{-1}$ (Bieker, 2021). Average lifetime distance (conservative): ~200,000 km. Result: ~25 tCO_2e/BEV. Life-cycle emissions of BEV with renewable electricity: <50 $gCO_2e\ km^{-1}$ (Bieker, 2021). Average lifetime distance (conservative): ~200,000 km. Result: <10 tCO_2e/BEV. Proportional reduction in emissions ICEV to BEV: 50–80%.

Heat-related mortality: ICEV: Global: Mortality cost of emissions in 2025 (until 2300): 1.37×10^{-4} deaths/tCO_2e (with adaptation), 3.93×10^{-4} deaths/tCO_2e (without adaptation) (Bressler, 2025). Lifetime emissions: ~50 tCO_2e/ICEV. Heat-related deaths worldwide: 6.9×10^{-3}–2.0×10^{-2} deaths/ICEV (with or without adaptation). **DRC**: Mortality cost of emissions in 2025 (until 2300): 5.57×10^{-6} deaths/tCO_2e (with adaptation), 2.06×10^{-5} deaths/tCO_2e (without adaptation) (Bressler, 2025). Heat-related deaths in DRC: 2.8×10^{-4}–1.0×10^{-3} deaths/ICEV (with or without adaptation). **BEV (avoided mortality)**: 50–80% of the deaths/ICEV. **Global**: (3.5–5.5) $\times 10^{-3}$ (with adaptation) to (1.0–1.6) $\times 10^{-2}$ avoided deaths/BEV (without adaptation). **DRC**: (1.4–2.2) $\times 10^{-4}$ (with adaptation) to (5.0–8.0) $\times 10^{-4}$ avoided deaths/BEV (without adaptation).

Air pollution-related mortality: ICEV: 2015 deaths from road traffic air pollution worldwide: 246,000 (Anenberg et al., 2019; Miner et al., 2024). 2015 global fleet of motor vehicles: 1.28 billion. Assume fleet dominated by ICEVs. Average lifetime of ICEV ~18 years (Oguchi & Fuse, 2015). Air pollution deaths: 3.45×10^{-3} deaths/ICEV. **BEV**: Zero tailpipe emissions. Efficiency ~0.2 kWh/km. Average lifetime distance (conservative): ~200,000 km. Lifetime electricity consumption: 40 MWh. Air pollution deaths per TWh of electricity production: coal 24.5 deaths/TWh, oil 18.4 deaths/TWh, biomass 4.63 deaths/TWh, gas 2.8 deaths/TWh, and nuclear 0.052 deaths/TWh (Markandya & Wilkinson, 2007). Assume worst case 100% coal electricity: 1×10^{-4} deaths/BEV. Deaths avoided by substituting ICEV: 3.35×10^{-3} avoided deaths/BEV.

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