FEATURE

Which Net Zero? Climate Justice and Net Zero Emissions

*Chris Armstrong and Duncan McLaren**

In recent years, and especially following the 2015 Paris Agreement, the target of "net zero" carbon emissions by 2050 has come to the forefront of global climate politics. The U.K., for instance—while hosting the twenty-sixth UN Climate Change Conference of the Parties from October to November of 2021—declared that its principal goal was "to secure global net zero by mid-century and keep 1.5 degrees within reach."[1] At the latest count, 136 countries have made net zero commitments.[2] Meeting a global net zero target would involve any "residual" carbon emissions being counterbalanced by anthropogenic carbon removals achieved through "negative emissions techniques" (NETs).[3] Achieving net zero is essential to stabilizing the increase in temperatures, although the specific temperature at stabilization depends upon the cumulative emissions until that date. If emissions peak in the next few years and net zero is reached by 2050, there will be a reasonable chance of limiting warming to 1.5°C. Though achieving 1.5°C will be formidably difficult,[4] the widespread embrace of national net zero targets would provide an important step toward climate stabilization.

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It is also important to be clear-sighted about the role that net zero can play in governing our climate. Net zero is an important target in the drive toward limiting climate change to manageable levels (as represented by the 1.5°C guardrail). But it will not solve all of our climate problems. The world could meet net zero, for instance, and still see eighty centimeters of sea level rise by 2100 (and significantly more after that).[5] This suggests that net zero is, at most, a necessary but not sufficient response to dangerous climate change. For instance, achieving net zero by 2050 does not guarantee that temperature rise will not exceed 1.5°C: a subsequent period of net-negative emissions will likely be required to reverse any overshoot of temperature goals, and to ensure that temperatures can then be kept well below 2°C above preindustrial levels. Even then, adaptation measures will remain necessary.[6]

Just as importantly, there is not one version but rather many possible versions of net zero. In this article, we draw attention to the crucial questions that are sometimes obscured by superficial agreement on goals such as "net zero by 2050." We argue that crucial decisions remain to be made about the nature of net zero policies, and that these decisions should be made in a way that best advances goals of climate justice. This means prioritizing early climate action in wealthy countries, minimizing reliance on unproven negative emissions techniques, and carefully safeguarding the livelihoods of the global poor.

The Ambiguities of Net Zero

Net zero as a policy goal has been the subject of a remarkable political convergence in recent years. In many ways this appears to be a positive development, but experience suggests that framing matters.[7] Many previous framings of key climate goals have incorporated an overreliance on promises of technological innovation (such as carbon capture and storage, or CCS), which have then underdelivered.[8] Such framings justify procrastination and the deferral of serious mitigation efforts, especially when those efforts would challenge dominant interests and ideologies. In recent decades, the framing of climate goals first shifted away from specified emissions cuts toward reduced atmospheric greenhouse gas concentrations and carbon budgets, and is now shifting once again toward the current net zero frame. To date, each new framing has enabled delays in serious mitigation action, by allowing countries to invest collective political faith in promises of as-yet-unrealized technological capacity.

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The danger, then, is that the net zero target falls into this same trap—in this case relying on the promise of unproven carbon removal technologies at a very large scale—enabling further procrastination over mitigation. How might net zero facilitate such a framing? In this section, we will argue that net zero is a much more open-ended commitment than it may initially appear. In some ways, this feature is an advantage: A degree of ambiguity can mean that an idea has more "convening power" in politics. But it also means that widespread agreement on the importance of net zero nevertheless masks not only important disputes about what it should mean in practice but also the power relations between, and conflicting interests of, the diversity of actors involved.

Climate politics remains a minefield of both deliberate disinformation and unintentional self-delusion.[9] Ambiguous net zero discourses can fuel both problems. When they are co-opted in "discourses of delay,"[10] net zero narratives and policies primarily draw attention to technical responses that promise to minimize disruptions to political and socioeconomic relations. Advocates highlight the apparent impossibility of the rapid elimination of emissions, as well as the setbacks to various economic, political, and social interests that might arise from any attempt at such elimination. Such arguments are then seized on by powerful actors (such as oil and gas companies), and can sustain continued "moral corruption," a phenomenon in which actors grasp at and validate policy responses that reflect their material and socioeconomic privileges—even if this means imposing risks and costs on other, less privileged people.[11]

Although its ambiguities may have helped convene attention, if net zero is to deliver on its promise, disagreements over its concrete meaning cannot be deferred indefinitely but will need to be addressed—and the sooner, the better. Resolving the ambiguities of net zero will be difficult political work. But it will also be necessary for a just transition, in which policymakers take the radical climate action needed to keep global temperature rise well below 2°C without undermining the livelihoods of the world's poor.

In what follows, we will argue that resolving the ambiguities of net zero is important for four reasons, each connected to key concerns of climate justice.[12] First, ambiguous or excessively permissive versions of net zero may provide an excuse for further delay, and even the dilution of climate commitments—which would in turn exacerbate the unfair distribution of harms (both international and intergenerational) imposed by climate change. Second, some pathways to net zero allow for greater cumulative emissions than others. Greater cumulative

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emissions necessarily mean either a higher temperature outcome (which would mean greater harms for the world's poor) or a greater need for future carbon removal (the costs of which would also likely be distributed in regressive ways, if modeling exercises, which predict high reliance on bioenergy with carbon capture and storage, or BECCS, are any guide).[13] Climate policy actors must therefore pay close attention to the variety of pathways to net zero and to the side effects associated with each. Third, pathways to net zero that allow for greater residual emissions would see higher rather than lower levels of continuing fossil fuel use. This would therefore involve more rather than less of the socioeconomic burdens (including pollution and, in some cases, repression and dispossession) typically associated with the extraction, distribution, and combustion of fossil fuels. These burdens are again likely to be unevenly distributed. Finally, ambiguity about the distribution of mitigation efforts across time leads to pressure on countries that have made only modest historical contributions to climate emissions to achieve net zero on similar timescales as those countries that have made significant historical climate emissions. Given that the latter typically have much greater resources and capacities to address the problem, this further compounds climate injustice.

While agreement on the goal of net zero is vital,[14] there is still much work to do in safeguarding climate justice. If the goal is to operate as the lodestar of global climate politics, we need to determine which definition of net zero we are aiming at. Throughout the rest of this article, we will show why a concern for climate justice will often give us reason to prefer some ways of delivering on net zero rather than others. We will examine the timing of climate action, the pathway to net zero, the allocation of residual emissions, the impact on the poor of net zero strategies, and the question of what happens beyond net zero. In doing so, we will emphasize important—but too often neglected—climate justice implications of the commitment to net zero.

The Timing of Climate Action

Even if the world quickly commits to the goal of achieving net zero by 2050, important political choices will still need to be made—and made soon. One of the most crucial decisions relates to timing. In light of the urgency of the climate problem, 2050 is a long way away. Nearly three decades takes us far beyond the regular political cycle of elections and coalition forming. It would be relatively

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easy for leaders today to embrace net zero by 2050, but then to leave the toughest decisions for much later. The mechanism for regular review of nationally determined contributions under the Paris Agreement may create pressure for politicians to continually improve their targets, but it has done little to drive interim action. And given that politicians can rarely bind the actions of their successors very tightly (goals adopted now can be abandoned later, or reconceived with more or less faithfulness to their original aims), there is a strong argument that countries must pursue ambitious mitigation actions early. This is because cumulative emissions matter intensely for temperature outcomes. Unless mitigation is accelerated rapidly to deliver substantial global emissions reductions by 2030, the world will have little chance of avoiding a global temperature rise in excess of 1.5°C.[15]

Here the vagueness of the net zero target becomes apparent.[16] Agreeing on a target of net zero by 2050 does not commit actors to any particular timeline for achieving it, beyond the brute goal of equilibrium between emissions and removals by that particular date. One country (or company) could agree on the necessity of net zero by 2050, and aim to take dramatic decarbonization measures during the 2020s. Another might defer serious action until the 2040s, maintaining or even increasing rates of carbon output in the meantime. Taken by itself, the net zero target is neutral on which pathway is to be preferred. But the choice that is ultimately made between these pathways will make a huge difference in cumulative emissions, which in turn looks likely to have momentous consequences for the climate. And clearly, the longer radical emissions cuts are delayed, the more carbon removal will eventually be required if the world is to have a chance of keeping temperature rise within 1.5°C. This approach places a level of faith in the potential of negative emissions techniques that might turn out to be highly ill advised, as we will discuss below.

The possibility that actors might commit to the target of net zero by 2050 but nevertheless defer radical mitigation efforts opens up other worrying possibilities. For instance, actors might commit to this goal naively or in bad faith. Actors can be said to commit naively if they assume that cheap technical solutions will emerge closer to 2050, without a reasonably well-informed idea of what those solutions might look like, or without a clear recognition of the limitations or costs that might be associated with those solutions.[17] Policymakers might look at the various integrated assessment models on climate change, for instance, and infer that delaying emissions cuts will be the most cost-effective response,

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on the assumption that subsequent technological progress will make mitigation significantly cheaper than it is now. There is evidence, however, that policymakers are too quick to infer that the deployments of future technologies assumed in many of these models are feasible. To the extent that this is a mistaken assumption, policymakers will act naively.[18]

Actors can be said to commit in bad faith, by contrast, if they do so without any clear intention to take decisive action, or to bear their fair share of the costs of global mitigation efforts. History provides ample reason to worry that an overt commitment to net zero might simply operate as a cover for high-emitting industries to continue emitting at current levels. In the past, anticipated advances in nuclear technology or "cleaner" coal combustion have been employed as a reason to defer timely emissions reductions.[19] Today, the technologies that function as the most significant distraction are probably negative emissions technologies such as bioenergy with carbon capture and storage. It is true that if BECCS or similar mechanisms can deliver large net emissions reductions, countries will need to cut emissions less. But BECCS is unproven, and the hopes vested in it could be a dangerous—and, if its proponents understand its likely shortcomings and still place their faith in it, irresponsible—diversion.[20] Its widespread adoption may also, as we argue below, significantly set back the interests of people in the Global South.[21] For these reasons, decisive early action on mitigation is more attractive than reliance on unproven future technologies.

The Pathway to Net Zero

It would be easy to assume that since net zero is an apparently simple goal, the pathway to it must be clear. This assumption is incorrect and glosses over important political decisions that must be made as part of achieving net zero. We have already identified one major issue: the timing of mitigation efforts, and specifically whether to front-load or back-load actions to reduce emissions. But there are at least two further issues regarding net zero that require political decisions, the outcomes of which will impact people's opportunities and livelihoods across the world.

First, it is important to recognize that stabilization at an increase of 1.5°C will require net zero at the global level, but not necessarily at the level of each of the world's countries. Net zero by 2050 is an aggregate goal that is compatible with some countries reaching net zero before 2050, and going on to remove more than they emit, while others reach net zero later. In practice, current net zero

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plans indicate that on a consumption basis, many rich countries may still be net emitters by 2050, with poor countries expected to dedicate more land area to carbon removal activities (as we will see below). But justice would suggest that the richer, historically high-emitting countries should instead be in the group of carbon negative countries in 2050, with poorer countries still being able to make emissions if necessary.[22] Urging India to reach net zero by 2050,[23] for instance, would be unnecessary. It would also be unfair: India, after all, has historically made a comparatively modest contribution to the problem of dangerous climate change, and its ability to absorb the costs of the transition away from carbon is far more limited than many wealthier (and high-emitting) countries. China has committed to reach net zero by 2060, rather than 2050, and its slightly slower path to net zero could enable faster progress in alleviating poverty, which is an important moral goal in its own right. Finland, by contrast, has committed to net zero by 2035, and Germany and Sweden by 2045.[24] In the latter cases, the countries in question have the resources to attempt an accelerated path up to and beyond net zero, rendering the aggregate goal of global net zero possible even if poor countries delay radical climate action. These different pathways are compatible with the idea of "common but differentiated responsibilities and respective capabilities," which has played a central role in international climate negotiations since the 1992 United Nations Framework Convention on Climate Change, and which was given pride of place in the 1997 Kyoto Protocol. Fortunately, though careful management of local transitions will be required, the developed world possesses the capacity—if not always the will—to meet the costs of rapid decarbonization without forcing others into poverty over doing so. But the same cannot be said in many countries of the Global South. A slower transition for such countries is morally acceptable if it is vital to their continued efforts to help people escape from poverty.[25]

The second issue is how to balance the focus on emissions reductions with the focus on developing negative emissions techniques. As we discuss below, any net zero future is likely to see some continuing carbon emissions. Those "residual" emissions would need to be balanced by removals using NETs. But simply saying that emissions and NETs must come into balance to reach net zero is too vague because we can imagine a variety of scenarios that could achieve such balance, each of which would have different social and environmental effects. For example, under what we will call "narrow convergence," emissions are cut to a very low level and are balanced by a modest deployment of NETs. By contrast, under what we will call "broad convergence," emissions remain much higher and are balanced by

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a widespread and large-scale deployment of NETs. Each strategy can hypothetically deliver on the goal of net zero. The two pathways, however, will have very different effects on human well-being and on the global natural environment. There are, we argue, two strong reasons for preferring narrow convergence.

The first reason is that emissions cuts provide a more secure contribution to climate stabilization, compared to reliance on NETs. When countries reduce their emissions of carbon or other greenhouse gases, they reduce the driving force of global warming in ways that can be measured and predicted with some certainty. The contribution made by NETs, by contrast, is much less certain.[26] One problem, which we have already noted, is that some NETs remain largely speculative and we do not yet know if—or how well or economically—they will work. Furthermore, even if they are initially successful, many NETs could turn out to be "leaky" in the longer term. That is, even if they initially remove carbon from the atmosphere, their full effect may not endure for the long term. Biological NETs (such as forests and soils) can be quickly turned from carbon stores into sources of carbon emissions, as a result of changes in either climate or land management. Even high-tech engineered NETs such as direct air capture (DAC), in which carbon dioxide is chemically separated or filtered from ambient air, can leak if the captured carbon is diverted for use in enhanced oil recovery or in the production of synthetic fuels or fizzy drinks.[27] This suggests that it may be facile to consider emissions reductions and NETs as simple functional equivalents.[28] Reductions in carbon emissions will have a long-lasting effect, on which we can rely well into the future. In the case of NETs, we have much less ground for confidence. This provides good reason, other things being equal, to favor the former over the latter as means of approaching net zero.

The second reason for favoring narrow convergence is the impact that proposed carbon removal technologies will have on the world's poorer populations. For BECCS to make a major contribution to climate stabilization, for instance, it might require the repurposing of between a quarter and four-fifths of global land currently under cultivation.[29] Where will that land come from? It is clear that high-emitting developed countries simply do not have enough repurposable land within their borders for BECCS or other land-intensive NETs to use to reach net zero under a broad convergence scenario.[30] If they were to lean heavily on BECCS as a means of approaching net zero, they would therefore have to rely on countries in the Global South to make land available for replanting, and compensate them through some kind of carbon-trading mechanism. Such an

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arrangement, however, could have dramatic implications for food security in the Global South. By creating massive new demand for land, BECCS would likely drive up food prices, with especially harmful consequences for the global poor. It could also trigger a parallel to the real-world phenomenon of "fortress conservation"—the creation of protected areas for wildlife (or in this case, carbon sinks) by way of the coerced displacement or exclusion of human users.[31] Reliance on such techniques in the Global South would also put a strain on regional water resources, diverting resources away from poor communities in favor of BECCS. A similar worry applies to domestic energy. Direct air capture technology would, if used at sufficient scale to replace BECCS in the net zero pathways considered above, require up to nine times the energy consumed by the whole of India.[32] Even if the energy used were renewable, there is a high likelihood that the large-scale adoption of this technology would push up energy prices, exacerbating energy poverty. The danger that some emissions reductions technologies would worsen existing global inequalities, and even reinforce severe poverty and dispossession, must be fully considered when selecting the policies or technologies that will bring the world closer to net zero.

For both of these reasons—the challenges of delivering NETs and their potential impacts on the poor—we argue that narrow convergence is more sustainable and just than broad convergence, and that it should be the preferred policy approach. Finally, a further argument in favor of narrow convergence is that of the overall cost to society. Although some NETs may be achieved at low costs, their large-scale deployment is likely to be very expensive.[33] If so, delivering narrow convergence will also be normatively preferable to broad convergence because it will be cheaper, leaving more resources for other morally worthwhile goals such as poverty reduction. Note that in assessment models and politics, the social benefits of accelerated mitigation are frequently undervalued, and the costs of future NETs discounted.[34] As a result, the overall costs of broader convergence are made to appear lower than they really are. This point is even more pressing if the additional costs of broad convergence are likely to be disproportionately shouldered by already disadvantaged groups or by future generations.

Residual Emissions

As we have discussed, net zero does not mean zero emissions. Some emissions may simply be impractical to eliminate, such as methane emissions from rice

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paddies. A good case can be made that some such emissions should be allowed to continue, given that the activities that cause them have clear social value. Activities such as the manufacture of vaccines, or the building of hospitals, might be difficult or impossible without some small carbon footprint. If so, the resulting emissions should be treated as residual: We should assume, at least given the current technology, that they would continue even in a climate-just future. It is such socially essential emissions that would have to be balanced by carbon removal techniques. This is why we have defended an approach of narrow convergence, rather than total convergence: we can assume that some carbon emissions will be with us long into the future.

But how do we define which emissions are to be treated as residual, and which should be earmarked for eradication? If the "residual pie" is of limited size, who should get to consume it? This is a hugely significant normative question, and the answer will have important socioeconomic ramifications within the global transition away from carbon. In contemporary climate politics, many actors—both countries and companies—have already laid out future plans and strategies for decarbonization that assume they have a good claim to a slice of the residual pie. But whether those claims are well founded is sometimes far from obvious. In the rich world, for instance, aviation is often treated as a likely source of residual emissions, even when alternatives (such as video conferencing or rail travel) exist, and despite the highly socially unequal distribution of air travel. Likewise, significant industrial sectors such as steel or concrete also currently lack a clear pathway to absolute zero. On the assumption that countries' reliance on removals using NETs will, and should, be limited, those activities and sectors that are angling for residual emission status are staking competing claims to what is a limited resource. What is at stake is the right to be among *the* activities chosen to be offset by those limited removals. Oil and gas companies that suggest continued emissions arising from their sale of fossil fuels will be offset by large afforestation or forest protection projects—as Shell has, for instance[35]—are not only gambling on the uncertain permanence of such removal techniques but are also effectively claiming some of the residual emissions pie. But since the size of that pie is limited, arguments that offsetting emissions from driving or flying (much of which may be considered a luxury activity) is permissible may not be compatible with also accepting emissions from subsistence food production, or from meeting other basic needs. On paper, many corporations have committed to the net zero target. But on closer inspection, their plans frequently turn out to assume

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that substantial portions of their carbon emissions are going to be offset by carbon removals, rather than avoided in the first place. They are claiming, that is, a large slice of the residual emissions pie—a slice that will, as a result, not be available to less privileged actors.

The role of residual emissions is key in order to fully understand the justice implications of the transition to net zero. We urgently need clarity about which emissions should be considered residual and why—and we must insist that those that claim a slice of the pie present an argument for why they should receive it instead of others. Providing a full answer to those questions would require us to turn to a wider account of climate justice. But one key distinction is that between subsistence emissions and luxury emissions.

"Subsistence emissions" are those that are necessary to meet people's most basic rights. They would include the emissions created by small-scale subsistence farming, or to provide essential domestic heating. "Luxury emissions," by contrast, are not necessary to meet anyone's basic rights. In an influential early contribution to debates on climate justice arising from the Global South, Agarwal and Narain introduced this contrast between luxury and subsistence emissions by asking, "Can we really equate the CO_2 contributions of gas-guzzling automobiles in Europe and North America or, for that matter, anywhere in the Third World with the methane emissions of draught cattle and rice fields of subsistence farmers in West Bengal or Thailand? Do these people not have a right to live?"[36]

A core principle of climate justice should be that no one is required to eradicate their subsistence emissions in order to meet a particular carbon budget if the better off could reduce their luxury emissions instead.[37] To require the global poor to reduce their emissions while treating luxury emissions as residual would fail to accord equal respect for the well-being of the poor. Similarly, what Darrel Moellendorf has called the "anti-poverty principle" declares that mitigation efforts should not make it more difficult for people to escape from absolute poverty. Since we live in a world where we could meet the challenge of dangerous climate change without keeping people in serious poverty, it would be unjust to load the costs of transition onto the shoulders of those who can least afford to bear them.[38] That principle, too, would suggest actors should foreground the interests of the global poor when determining which emissions should be considered residual. Unfortunately, the de facto claims to residual emissions made by most wealthy actors, and their implications, remain unclear and undebated. Since residual emissions caused by the wealthy must come at the expense of subsistence emissions by

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the world's poor, exposing the scale and pattern of this problem is an important first step toward climate justice.

We have argued for the desirability of minimizing residuals (and the removals needed to offset them) in the delivery of net zero by pursuing a path of narrow rather than broad convergence. Here we will offer a final word of caution regarding residual emissions and net zero. Net zero rhetoric is being used to validate the continued use of "avoidance offsets"—controversial emissions-trading mechanisms whereby one actor is permitted to continue emitting by paying another to reduce their emissions by an equivalent amount. In a net zero scenario where all remaining emissions are counterbalanced by removals, no actor able to make further emissions reductions would have any incentive to sell an avoidance offset, rather than reducing their need to fund or generate equivalent removals. But during the transition to net zero there is a danger that such offsets will continue to be a distraction from reduction efforts, and that the resort to them could perpetuate injustice. To date, the establishment of markets in avoidance offsets has generated—and been plagued by—a series of problems that have tended to prolong emissions rather than stimulate their reduction.[39] Many offsets have merely repackaged or double counted existing or already planned emissions reductions rather than generating additional action. There is also a worry that because carbon offsetting and trading in markets raises the prices of emissions-intensive products, it provides—in effect—a license to pollute for the wealthy and more pain for the poor.[40] The notional arguments presented in favor of such avoidance offsetting focus on economic efficiency, rather than justice, and more narrowly lean on an entirely instrumental case that such mechanisms direct funding toward desirable measures.

This latter argument has been widely adopted by advocates of NETs as a means to direct funding to assist the development and deployment of such technologies. But tethering the development of NETs to carbon prices in emissions-trading markets would be far from socially optimal and would not guarantee either net zero in general or narrow convergence in particular. Using carbon prices alone to drive the development of NETs could be expected to channel investment to more limited but less costly forms of removal, and would guide their deployment according to the ability to pay, rather than the underlying environmental or social need. The result of such an approach would most likely be too little investment in NETs to actually achieve net zero while also slowing emissions reductions and thereby increasing the need for more NETs use. More generally, policymakers

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should beware that while any realistic version of net zero must incorporate a notional offset or counterbalance between residual emissions and removals, this need not rely on a market mechanism of offsetting at all. Further, any offsetting mechanism that permits trading of *avoidance* offsets is likely to prove counterproductive to the goal of narrow convergence net zero. This is a fundamental shortcoming of most current efforts to promote carbon trading, including that by the high-profile international Taskforce on Scaling Voluntary Carbon Markets, established by economist and banker Mark Carney.[41]

The Distribution of Side Effects

We have seen that net zero could in principle involve a large quantity of residual emissions, matched by a heavy reliance on NETs. While both narrow and broad convergence deliver on net zero, we have already suggested several reasons for favoring the narrow strategy, maintaining a modest set of residual emissions, and granting priority in their use to the global poor. Residual emissions would then be linked to subsistence-related (rather than luxury) projects. Here we propose another significant reason for favoring narrow convergence: the social costs of both continuing emissions and NETs will be far higher if we pursue a pathway of broad convergence, and far lower if we pursue narrow convergence instead.

Let us concentrate first on emissions. Although the extraction and consumption of fossil fuels has powered development and "modernization" over the past two centuries, we have become increasingly aware of the multiple problems exacerbated by the extraction and burning of fossil fuels. As fossil fuels continue to be burned, people will experience not only the resulting political and security problems but also the massive health effects associated with their use (separate from issues related to climate change). Particulate pollution from the use of coal and oil poses an enormous threat to physical health in many countries. Moreover, low-income and disadvantaged populations are disproportionately affected, both within and between countries.[42] We can say the same of coal and oil extraction as we can for their use, since the negative impacts of coal mining,[43] oil and gas pipelines,[44] and refineries,[45] as well as traffic pollution[46] and aircraft noise,[47] have all been demonstrated to fall more heavily on disadvantaged communities, including the domestic poor and/or disadvantaged ethnic groups. Meanwhile, in many countries, dependence on fossil fuel extraction and export has been associated with a lack of political inclusion and even repression.[48] In

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other words, not only the climate impacts but also the wider socioeconomic burdens of fossil fuel extraction, distribution, processing, and use all contribute to environmental and political injustice. The tighter the convergence involved in net-zero policies, the more these injustices can be reduced.

A parallel point can be made on the NET side of the equation. The technologies in question have yet to be widely deployed, and so the relevant notes of caution are necessarily more speculative in this case. Nonetheless, we can identify and anticipate many concerns associated with the resource flows involved. To be sure, some carbon removal interventions appear likely to have limited undesirable side effects. Such options are typically either modest in scale (as in the case of peat bog or salt marsh restoration) or raise concerns about verification and the permanence of removals (as in the case of soil carbon sequestration). But the problems associated with more scalable and verifiable techniques are manifold. Carbon forestry (the planting or managing of forests primarily for the purpose of sequestering carbon), for instance, has long raised justice concerns regarding the impacts of such forest management on indigenous and subsistence users of forests,[49] while the production of biomass for energy use and biofuels has been associated with problems of land use change, land grabbing, and food insecurity,[50] with particularly severe impacts on women. The land requirements associated with broad convergence net zero strategies—especially those heavily reliant on BECCS—are orders of magnitude larger than those that generated concerns over the impacts of biofuels on food security during the early 2000s. Alternative technologies also raise concerns. Direct air capture would require significant energy inputs and, in some configurations, could also generate significant water demands in water-scarce environments.[51] Enhanced weathering—through the spreading of basic or ultrabasic rock dust—could be done at a small scale using existing waste materials, but at a larger scale it would impose demands for additional mining, as well as energy requirements for grinding.[52] BECCS and DAC both require pipelines for transmitting CO_2 to storage,[53] which might be expected to generate similar patterns of impact and public concern as oil and gas pipelines. No individual NET could meet likely demands alone and each has problems/impacts that would grow with scale.[54] A portfolio of different technologies is likely to be preferable, as well as more feasible, but in light of these socioeconomic impacts, the smaller the overall requirement for NETs, the better.

To put things more positively, by contrast, even though low-carbon energy technologies are not immune from distributed environmental and social impacts,

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reducing emissions would generate multiple net co-benefits, including health and other benefits that have historically been poorly considered in climate policy and modeling.[55] More active transport options (such as walking and cycling, where feasible) can be a stimulant to greater health and well-being, in which the benefits of increased physical activity can be expected to far outweigh the harms from additional road accidents.[56] Better home insulation can reduce energy poverty, excess winter deaths, and respiratory problems.[57] Globally, the fine particulates generated by fossil fuel combustion result in over ten million deaths per year, mainly in China and India,[58] and are a major—though often unaccounted for—social cost associated with fossil fuel use. The transition away from fossil fuels, if managed properly, offers the potential to create more skilled jobs: wind, wave, and solar power industries could sustain many more jobs, for instance, than are currently sustained by the fossil fuel industry.[59] As mentioned earlier, this transition could also reduce some of the political maladies associated with fossil fuel extraction in many parts of the Global South. Renewable energy sources are less associated with conflict within and between states, not least insofar as they are less geographically concentrated than oil and gas reserves.[60] Subject to adequate just transition policies, new green jobs could offer citizens greater opportunities for economic autonomy and political voice. None of this is to suggest that poorly designed emissions reduction programs could not also have negative social or distributional consequences. But these could be managed with good policy design and would likely pale in comparison to the impacts of the large-scale continued fossil fuel use that is licensed by the broad convergence strategy.

After Net Zero

Let us imagine that the world does get to global net zero, eventually. We will all breathe an enormous sigh of relief: Global temperatures will then be expected to remain relatively stable or may even decline slowly for centuries to come.[61] Would the project of achieving climate justice be complete, or would major issues remain to be resolved? As a final note of caution, we argue that major decisions about climate justice would remain even in a net zero world. In this sense, net zero is a major intermediate goal on the road toward achieving climate justice, but it is by no means the only (or final) goal. The world would still face major questions, for instance, about temperature targets. Having achieved net zero and probably stabilized temperatures, what should our long-term goal be? Returning to and keeping within +1.5°C in

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perpetuity? Or should we try to get back to the preindustrial baseline? A rise of 1.5°C, after all, represents a ceiling if we want to avoid major negative environmental impacts from climate change, but it should be possible in principle to reduce global temperatures even further, once net zero has been achieved.

Whether policymakers and leaders choose to do so in such a case would presumably depend on complex calculations about the costs (and benefits) of remaining at +1.5°C, compared to the costs (and benefits) of reducing warming still further. Plausibly, ethical analysis here would involve a reckoning of the relevant interests not only of human beings, including future generations of people, but also of members of other species (and perhaps of the existence value of vibrant and resilient ecosystems as well). Regardless of the choices made, there would remain significant issues of adaptation justice, which would demand reflection on the distribution of moral and legal liabilities for the costs of adapting to an already changed climate. There would also be questions of compensation to resolve, since climate impacts on human well-being are already with us; moreover, even the threat of climate change can be seen as a form of harm, undermining people's commitment to and faith in the projects that matter to them.

If the world has followed a pathway of rapid emissions reductions and narrow convergence, temperatures may remain within +1.5°C. But it is likely that some degree of climate repair or restoration will nevertheless be seen as desirable, even if this means lowering global temperatures further. In this case, we stress that the better the efforts to achieve a narrow convergence, the greater will be the remaining capacity for negative emissions techniques to be directed toward such a goal without unacceptable environmental or justice implications.

In considering such futures, as well as conventional issues of harm and reparation (who is responsible? who should pay?), we might also be driven to consider wider questions of repair and restoration of the earth's ecosystems—and deeper questions of what exactly repair might mean in this context. Repair can be understood narrowly and instrumentally as an intervention to restore the functioning of an object or system. From the perspective of climate science broadly construed, such restoration might be achieved by returning atmospheric greenhouse gases to preindustrial levels. But experiences in other arenas of repair indicate that practitioners also frequently understand repair in relational and noninstrumental ways, as an activity that centrally involves care for and attachment to the subject of repair. That understanding would preclude treating the object(s) of repair purely in such an objective and instrumental manner. In the context of the

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climate, reflection on the meaning of repair might even entail a deeper questioning of whether the entity in need of repair is indeed the "climate system," or is instead the relationship between humans and the Earth, understood in the context of the interwoven histories of colonialism, industrialization, and climate change.[62] If so, an especially valuable side effect of the achievement of net zero might be the beginning of a wider conversation about humanity's place within earth's ecosystems.

Conclusion

In this article, we have given a cautious welcome to the growing consensus on the importance of committing to net zero. Net zero, as we have shown, is a precise goal in some ways (insofar as it calls for emissions and removals to be clearly matched, for example), but vague or ambiguous in others. Since net zero is a *balance* between emissions and removals, the target of net zero emissions by 2050 does not place any strict limit on cumulative emissions prior to that date, and it does not place any strict limit on residual emissions or the extent of removal offsets. It also does not involve commitment to any specific temporal distribution of mitigation efforts, or indeed to any specific distribution of mitigation efforts between different actors.[63] Those will be hugely important political questions in the years to come, with powerful interests served better by some answers than others. All of this amounts to saying that there are many different conceivable net zeros, and that apparent convergence around the net zero goal should not distract us from the fact that many of the most important political decisions still remain to be made, and that many of the most important distributive and social impacts remain to be determined.

Indeed, we have argued that there are strong reasons of climate justice for favoring some versions of net zero over others. We have abundant reason to favor a net zero strategy in which those who can reasonably bear the burden of doing so act to pursue early and aggressive mitigation policies, rather than leaving the most important contributions to be made much later, or by others who can scarcely afford to bear the burdens of doing so. We also have reason to favor a net zero strategy in which we place the lion's share of our faith in known emissions reduction techniques, rather than being heavily reliant on as-yet-unproven negative emissions techniques. A commitment to net zero is a commitment to balancing a seesaw in which residual emissions are balanced by carbon removals, achieved

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via various negative emissions techniques. In principle, net zero might mean two elephants on a seesaw, or it might mean two mice. We have argued that while some emissions should certainly be treated as residual, it is best to pursue a strategy in which residual emissions are modest and largely earmarked for the poor and vulnerable, and in which reliance on carbon removals via negative emissions techniques is also correspondingly modest—thus putting the seesaw (of our societies and polities) under minimal stress. By resolving the ambiguities of net zero, and pursuing a pathway of what we have called narrow convergence, we will have the greatest chance of achieving climate stability without exacerbating existing socioeconomic problems and North-South inequalities.

NOTES

[1] "COP26 Goals," UN Climate Change Conference UK 2021, ukcop26.org/cop26-goals/.

[2] Net Zero Tracker, zerotracker.net/.

[3] For a definition of "net zero," see also Intergovernmental Panel on Climate Change, *Global Warming of 1.5 ° C: An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* (Cambridge, U.K.: Cambridge University Press, 2018), p. 24. While we use "negative emissions techniques" here, the terms "greenhouse gas removal" and "carbon dioxide removal" are sometimes used to refer to the same basic basket of techniques for capturing greenhouse gases (particularly CO_2) from the atmosphere and sequestering them for prolonged periods of time.

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[10] Lamb et al, "Discourses of Climate Delay."

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[15] IPCC, *Global Warming of 1.5°C*; Kevin Anderson, John F. Broderick, and Isak Stoddard, "A Factor of Two: How the Mitigation Plans of 'Climate Progressive' Nations Fall Far Short of Paris-Compliant Pathways," *Climate Policy* 20, no. 10 (2020), pp. 1290–1304; and Stephen M. Smith, "A Case for Transparent Net-Zero Carbon Targets," *Communications Earth & Environment* 2, art. 24 (2021).

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[34] McLaren, "Quantifying the Potential Scale of Mitigation Deterrence from Greenhouse Gas Removal Techniques."
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Abstract: In recent years, the target of reaching "net zero" emissions by 2050 has come to the forefront of global climate politics. Net zero would see carbon emissions matched by carbon removals and should allow the planet to avoid dangerous climate change. But the recent prominence of this goal should not distract from the fact that there are many possible versions of net zero. Each of them will have different climate justice implications, and some of them could have very negative consequences for the world's poor. This article demonstrates the many ambiguities of net zero, and argues in favor of a net zero strategy in which those who can reasonably bear the burden adopt early and aggressive mitigation policies. We also argue for a net zero strategy in which countries place the lion's share of their faith in known emissions reduction approaches, rather than being heavily reliant on as-yet-unproven "negative emissions techniques." Our overarching goal is to put net zero in its place, by providing a clear-sighted view of what net zero will achieve, and where the "net" in net zero needs to be tightened further if the world is to achieve climate justice.

Keywords: net zero, climate justice, negative emissions, carbon dioxide removal, residual emissions