

A framework for evaluating India's net zero commitments

The Glasgow Climate Pact arising out of the 26th Conference of Parties (COP26) of the UNFCCC reaffirmed the Paris Agreement temperature goal of 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C' (Glasgow Climate Pact, UNFCCC, 2021). Although countries agreed on phasing down coal and lowering fossil fuel subsidies, the pledges are viewed as inadequate and keep the world on track towards warming well above 2°C. In COP26, India has pledged to become a net-zero country by 2070, meaning that its fossil-fuel emissions will be offset by sinks. Net zero is an important concept, because the long lifetime of carbon dioxide in the atmosphere ensures that global warming is roughly proportional to cumulative emissions and, since CO₂ is well mixed in the atmosphere, the contributions of different countries to global warming depend on their respective cumulative emissions. Therefore, as long as there are net emissions, there will be more warming in the pipeline and it is only once the world reaches net-zero emissions that further global warming will cease.

The linear relationship between cumulative emission and temperature rise is measured by a proportionality constant, the 'TCRE' (transient climate response to cumulative emissions), which is estimated to be between 0.27°C and 0.62°C per trillion tonnes of CO₂, with a large range of uncertainty owing to differences between models. The contributions of different nations to global warming can be reckoned in terms of their cumulative emissions. Since India's past contribution to cumulative emissions is 3.4% of the world total, its contribution to global warming (taking the mean TCRE of 0.45°C per trillion tonnes) is 0.037°C, as opposed to the world total of 1.1°C from about 2.5 trillion tonnes of CO₂. Much of that contribution comes from large industrialized nations, with the US, EU, Russia and China contributing two-thirds of the global cumulative emissions.

Even countries that are not major beneficiaries of past fossil-fuelled development do not have the option of business-as-usual, when one considers that the carbon budget for 1.5°C or 2°C warming is limited not only by past emissions, but also by the presence of other climate forcings besides CO₂, in addition to aerosol-induced cooling which is expected to diminish this century. India is not only among the 10 largest cumulative emitting nations, but also the world's third largest emitter with a rising share of world

emissions, following the US and China, as rising incomes and concomitant energy use bridge the disparity between population and per capita emission. Therefore, India's net zero announcement at COP26 is relevant for global mitigation efforts as well as in the spirit of enhanced ambition in its nationally determined contributions (such as, by 2030, expanding the renewable fraction of electricity generation capacity to 50% and reducing emissions intensity further compared to the 2005 baseline). A majority of countries (responsible for about 90% of the global emissions) have declared policies or pledges for net zero by the mid-century (<https://zerotracker.net/>). For countries whose emissions will probably increase in the next few decades, like India's, a net-zero date does not limit cumulative emissions within this period. The shape of the country's emissions curve in the meantime will drive total emissions, including how rapidly it grows in the next two decades, when emissions peak; how long it stays that way and how quickly the emissions decline. There is no way to predict what will happen in the coming decades, but simple calculations are nonetheless instructive. India currently emits about 2.6 billion tonnes of CO₂ each year. If, hypothetically, the country would lower emissions to zero by 2070 in a linear fashion, the future cumulative emissions would be 62 billion tonnes for an average value of CO₂-induced warming (given mean TCRE) of just under 0.03°C, which is lower than its past contribution. Not increasing emissions is unrealistic, and projections have India increasing energy use several fold prior to deeply decarbonizing its economy. More relevant for the country's development goals is how much energy use and concomitant emissions should and would increase before decarbonization sets in. This is also an important factor for global cumulative emissions: specifically, how high will India's annual emissions become before they decline? The country's per-capita energy use and emissions are less than one-half the world average, which is itself pressed by limited access to energy services in much of the developing world and thus liable to grow. Therefore, considering a peak and net zero by 2070 scenario for India, assuming that the maximum emissions are about four times the country's present value will lead to cumulative emissions that are 3–4 times the above figure (or about 190–250 billion tonnes), depending on how soon the emissions peak occurs. This is comparable to, yet smaller than, historical emissions from the largest emitting countries.

Thus, given the importance of India's future maximum emissions, its net-zero pledge together with early steps to decarbonize its economy will play an important part in circumscribing the country's future emissions, consistent with its role in international climate action. It will also contribute to mitigating regional warming from CO₂, which has also been found to scale proportionally with global cumulative emissions. Domestic mitigation will play a rather small role in mitigating warming over India as the country's contribution to global cumulative emissions will remain small. India gains more from emissions reductions of the dominant global emitters (the US, EU and China), which are subject to the challenges of non-binding commitments, and global coordination and collective action among these large emitters will be especially important. However, India's position is further complicated by the likelihood of large damage costs of global warming. There is growing evidence of higher impacts of climate change in countries with warm climates, making the social cost of carbon high in countries such as India. Taken together with growing evidence of limits of adaptation to the effects of warmer temperature and hydroclimatic changes, the case for early and rapid decarbonization by India to limit the emissions intensity of its growing energy use may yet be strong.

India's first predicament, shared by other developing countries, is that the impact of national mitigation actions and the net-zero pledge is small compared to the much larger benefits that would ensue from rapid global collective action towards decarbonization and net zero. India's climate mitigation actions will likely have short-term economic costs and long-term economic and climate change benefits within the country. For example, a transition away from coal in electricity generation, despite its long-term benefits, will involve difficult social and economic costs and dislocations in the next few decades. However, such mitigation actions and net-zero pledge would have a larger impact when they are used as moral persuasion to motivate stronger global action as well as for give and take in climate negotiations. Therefore, an analysis of the effectiveness of any mitigation is incomplete without taking into account how India can use it in international climate diplomacy.

There is the need for urgency of rapid global climate change mitigation given that India is likely to face among the highest climate-related damages, and among the highest social costs from every additional tonne of carbon emitted. Studies point to an already adverse impact of warming on economic growth in India. With global warming of 2°C, the country will face substantial impacts from increased magnitude of heat stress, glacial retreat in the Himalaya, substantial sea-level rise over much of its long coastline, and increase in extreme flooding. India and other developing countries are also victims of an iniquitous global regime where a few countries have emitted, and will continue to emit, a disproportionately high share of greenhouse gases into the atmosphere. A second predicament that India faces is thus the force of urgency of action against climate change colliding

with this inequity, with the recalcitrance of the developed world to agree to a fair deal or climate reparations.

Finally, as a developing country, India's most important imperative will be to provide its citizens sustainable development, inclusive growth and a decent standard of living. The challenge will be to meet this development imperative in a carbon-constrained world along a pathway that is yet to be invented. Unlike many regions in North America and Europe, India has a combination of abundant solar energy but seasonal wind energy. Hydroelectric resources are limited and gas as a bridging fuel is not an economic option. A future fossil-free electricity system will require very high levels of storage, especially as transportation and building energy use will also become electric. Decarbonization of industry will likely require the development of a hydrogen economy using technologies that are yet to be developed.

These three predicaments underlie any analytical framework in which one might analyse India's options and mitigation actions. In other words, these help us ask and answer the question: What should be India's choices given the difficult hand that it has been dealt? The multiple criteria for evaluation of the effectiveness of different choices as well as the multiple objectives that have to be met make these exceptionally complex. These are not problems easily amenable to the calculus of constrained optimization that is used to address economic aspects of climate change mitigation in integrated assessment models, especially when we might have to settle for less-than-optimal solutions. For example, the imperative of rapid growth in an uncertain world might require early retirement of new and existing infrastructure such as coal power plants. India might also develop and deploy expensive technologies to improve competence and signal intent as well as incentivize collective action, as in the case of its early push for electric vehicles. Furthermore, these decisions should also take into account other benefits like water and energy security, reduction in air pollution and associated health and mortality improvements.

India's net-zero pledge is a goal for our low carbon growth and emissions trajectory, and provides a scaffold for the climate mitigation and adaptation choices in the coming decades. The larger role of the country's mitigation should be in incentivizing global action. The pragmatism of urgent action would have to balance the idealism of climate justice. India has to provide for inclusive growth and a better life in this constrained world. A multidisciplinary approach is needed to address the different facets of the country's decarbonization.

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