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How a renewable energy COVID-19 recovery creates opportunities for India

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Summary

India has been severely impacted by COVID-19. As the country emerges from this challenging time, it has the potential to accelerate its transition to a zero emissions economy. The Indian government has earmarked at least USD 325bn—corresponding to approximately 11% of the country's gross domestic product (GDP) in 2019—to fund recovery measures. As a part of this package, support is provided for healthcare and welfare, but further measures have included substantial support for businesses, and enhancing credit availability in the agricultural and small and medium enterprises (SME) sectors to stimulate economic growth. These could potentially have negative impacts on the environment by increasing emissions and unsustainable land use. More recent stimulus measures have focussed on further development of battery storage and solar PV, with roughly USD 3 bn announced in support of these industries (Vivid Economics, 2021).

A major opportunity exists for India to take advantage of this situation and accelerate the exit of coal and scaling up of renewable energy, would benefit Indian economy and health and also would assist India moving into a leadership position on climate action globally.

India' climate vulnerability is very high and as a developing country India needs international support to reduce its emissions to the level needed by the Paris Agreement. Within this framework, however, there is a level of action that is consistent with India's own fair share contribution to the Paris Agreement, and that, if taken, would establish a major benchmark for India to demand an appropriate level of international finance and resources to bring its coal power sector to levels consistent with the Paris Agreement

This study shows that India can reduce coal use by scaling up renewable energy by 2030 and that would have the effect of reducing its national emissions to its fair share level in 2030, but getting further to the lower levels implied by the Paris Agreement needs to be fully supported by the international community through climate finance and other means of support.

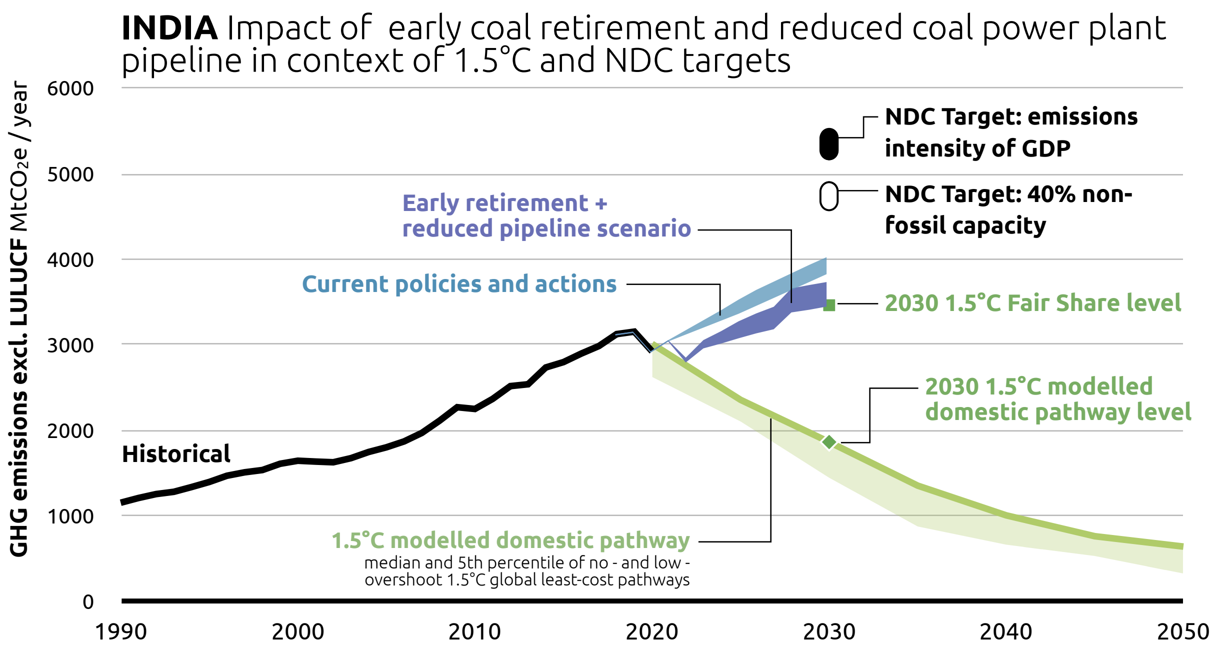

Figure 1 Economy-wide emissions trajectories after the implementation of an early retirement of old power plants and re-evaluation of the existing pipeline. We compare our analysis projections to NDC targets, emissions under current policies and actions and 1.5°C fair share emission levels. The 1.5°C least cost pathways shown here should be achieved with international support.

How is this possible?

A global transition away from coal electricity is not only becoming the economically most feasible option; it is also fundamental to achieving the Paris Agreement's long-term temperature goal. Coal should be phased out globally, and in India by 2040, to limit warming to 1.5°C. A reduction in coal-fired electricity in favour of renewables would also have a positive effect on air pollution, reduce strain on the health system and help save thousands of lives.

Costs of electricity from renewable energy sources have dropped over the last decade. For utility-scale solar photovoltaics, costs have fallen 85% globally since 2010 (IRENA, 2021). According to IRENA, "new solar and wind projects are increasingly undercutting even the cheapest and least sustainable of existing coal-fired power plants". Deploying renewable energy today is not an expensive mitigation action that countries would need to prioritise over development for the sake of meeting climate goals, but has become a means for improving energy access and reducing the costs of energy, and as such, is an enabler of sustainable development.

This shift stresses the relevance of an accelerated uptake of renewable energy, in parallel to a coal phase-out in India, as part of the recovery from the COVID-19 crisis. A green recovery not only supports climate change mitigation, but include co-benefits like creating new jobs opportunities and improving air quality.

Indian policy frameworks currently overemphasise coal

India continues to support coal, with new loans to support a number of drowning thermal power projects, undermining chances of a "green" recovery. Commitment to a green recovery would require India to realign its public spending with the central goal of transitioning to a zero-emissions economy and away from coal. India has yet to submit an updated Nationally Determined Contributions (NDC) target. Accelerating the transition away from coal to renewable energy can also help it to strengthen the mitigation ambition and increase its 2030 NDC target.

How to do this?

In India, thermal power plants older than 20 years need to install costly pollution control technologies to comply with recent emissions standards and India operates a renovation and modernisation programme for power plants older than 25 years. We find that if India were instead to retire all the coal-fired plants that have been in operation for over 18 years and reassess portions of its coal-fired power plant pipeline, in favour of renewables, it could reduce emissions by 7%–10% below its current policy pathway by 2030.

This corresponds to emissions 30%–35% below the middle of India's current Nationally Determined Contributions (NDC) emissions intensity target range or an emission intensity target of 54-57% below 2005 levels.

This would bring India's emissions levels in 2030 close to levels consistent with its own "fair share" contribution to the Paris Agreement 1.5°C range. These measures would therefore provide an additional and, cost-beneficial opportunity for India to increase its unconditional NDC (Figure 1).

Health benefits of early retirement for old power plants and re-evaluation of coal pipeline

The implementation of an early retirement for old power plants and re-evaluation of the existing pipeline would also have spill-over effects beyond mitigation. We quantify effects on premature deaths resulting from air pollution, and find that India could avoid up to 255,000 premature deaths in the next decade (a reduction of almost a quarter) by reducing its reliance on coal-based electricity generation.

A scenario for India to seize the high ground on Paris Agreement Implementation

The measures investigated in this analysis - early retirement older coal power plants and re-evaluation of the coal pipeline – would align India with the level of policies and action consistent with its own “fair share” contribution to the Paris Agreement. Such measures would very likely result in a 1.5°C compatible rating under the Climate Action Tracker for its policies and actions.

We estimate that this reduction in coal fired capacity, in the absence of additional efficiency measures, would require 160–320 GW of additional renewable capacity to India’s previously communicated 450 GW by 2030 goal. India is likely to achieve, and may even over-achieve, the 450 GW goal, including hydro, under current policies.

With confidence in the ability to reach this goal, India could consider raising its unconditional NDC to achieve the emission levels consistent with the full implementation of the measure studied here, which would require a higher installed renewable capacity target. Such a move would then likely result also a 1.5°C compatible rating under the Climate Action Tracker for its “fair share” target.

India’s conditional NDC target is not rated well by the Climate Action Tracker based on the extent of emission reductions that need to take place within the country’s borders. India will need to go beyond the measures considered in this report and accelerate the uptake of renewables and phase out of coal power even further to put its power sector on a 1.5°C pathway by 2030, and adopt additional measures in other sector to achieve such a Paris compatible level.

The difference between India’s conditional and unconditional NDC under this scenario would then have to be entirely supported internationally. This would provide a very clear and an unassailable demand to the international community that this is the level of support that India needs to make one of the biggest transitions needed, both domestically and globally. The support needed would not just be for technology but also for transitional costs including just transition of the workforce.

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1 Introduction

India has been severely impacted by COVID-19. It is second only to the US and Brazil in terms of loss of life, with over 445,000 people tragically succumbing to the virus by August 2021 (Johns Hopkins Coronavirus Resource Center, 2021). The pandemic response, and subsequent lockdowns, have triggered an unprecedented economic slowdown and social upheaval (Aneja & Ahuja, 2021).

The pandemic-induced decline in economic activities and mobility has led to a significant improvement in air quality. During the nationwide lockdown (March-May 2020), the air quality in India improved significantly (Ravindra, Singh, Biswal, Singh, & Mor, 2021; Sahoo, Mangla, Pathak, Salãmao, & Sarkar, 2021). However, this improvement was temporary and still insufficient for many cities to meet national air quality standards (Selvi et al., 2020). As the lockdowns have eased, emission levels have increased again (Selvi et al., 2020).

Coal-fired power generation is a significant contributor to poor air quality. We estimate that almost 90,000 people die prematurely in India every year, due to air pollution from coal-fired power generation. During the first phase of lockdown electricity demand declined sharply with average coal generation decreasing to 91 TWh in March/April 2020, compared to 80 TWh during the same period in 2019 (Central Electricity Authority, 2021b). The power sector's CO_2 emissions in March/April 2020 were 32% less than the same time period the previous year (Parray, 2020).

Recent developments in India's coal sector indicate that coal-based capacity additions still accounted for about 50% of planned installed capacity (6.8 GW) in 2019–20 (Central Electricity Authority, 2020b). Although no new projects have been approved in the last two years, India's overall power generation from coal and related GHG emissions is likely to increase in the future: the latest report from the Central Electricity Authority projects new coal capacity addition of around 64 GW by 2030 (CEA, 2020b). Hence, to achieve energy decarbonisation, retiring/decommissioning old, high-capacity power plants with lower efficiency and higher emissions must accompany efforts to stop new capacity additions.

As India emerges from the economic downturn, it has the potential to accelerate its transition to a zero emissions economy. New solar and wind are increasingly cheaper than existing coal-fired power plants This development stresses the relevance of an accelerated uptake of renewable energy, in parallel to a coal phase-out in India, as part of the recovery from the COVID-19 crisis. A green recovery leads to benefits related to climate change mitigation, creates new jobs opportunities and improves overall life quality for the population (Climate Action Tracker, 2020a). Such a recovery would require India to realign its public spending with the central goal of transitioning to a zero-emissions economy and away from coal. India has yet to submit an updated NDC target. Accelerating the transition away from coal to renewable energy can also help it increase its NDC target.

In this analysis, we investigate the potential impact of re-evaluating coal capacity for electricity generation in India and analyse the impact of retiring older power plants and reducing the pipeline. We explore the implications of these decarbonisation measures in terms of reducing greenhouse emissions and the co-benefits related to a reduction in air pollution.

A reduction in coal power would also reduce the need for further exploration of the domestic coal reserve in India, which is causing environmental and social issues across the country. However, this is not an issue we have assessed in this analysis.

2 India's coal expansion: slowing, but not yet stopping

Future demand for electricity in India is projected to increase by 4%–6% annually under different assumptions of economic growth (Central Electricity Authority, 2019; NITI Aayog, 2016). Supply side capacity expansion is needed to meet this growing demand for electricity related to the socio-economic macro parameters such as GDP growth rate, population growth rate, resultant activity growth and the structure of the economy. While there was a temporary slowdown in the demand for electricity during the pandemic-induced lockdowns in 2020 (Kanitkar, 2020) and again in 2021, demand is expected to pick up in the post-pandemic recovery period (IEA, 2021). India is heavily relying on coal to meet this increased future electricity demand and Central Electricity Authority (CEA) is projecting a 64 GW coal capacity expansion by 2030 (CEA, 2020b).

The increase in coal-fired power capacity addition is one of the main drivers of emissions growth in India (Das & Roy, 2020). India's coal-fired power plant pipeline is the second largest in the world (Montrone, Ohlendorf, & Chandra, 2021) and is one of the few to have increased since 2015 (Malik et al., 2020). At the end of 2020, India had over 200 GW of coal-fired power plants in operation (Figure 2).

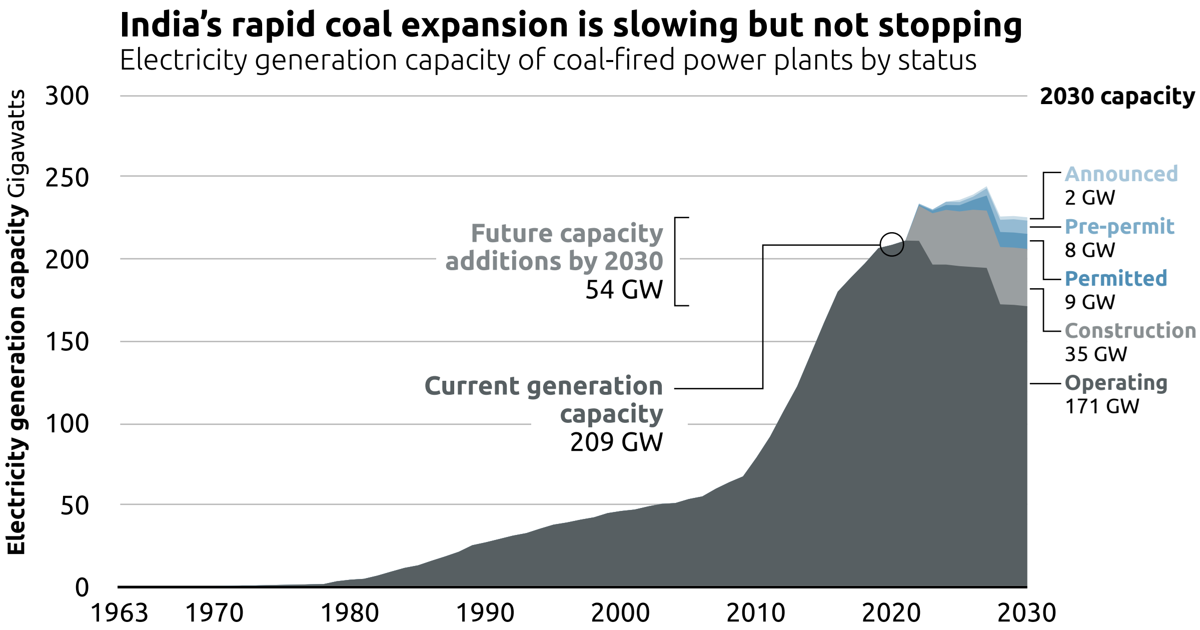

Figure 2 India's current coal installed capacity and pipeline as of January 2021 (Global Energy Monitor, 2021). Note that the fast deployment of 35 GW under construction may be delayed in practice (Shah, 2021).

For a 1.5°C Paris compatible pathway, coal need to be fully phased out by 2040 at the latest (Climate Analytics, 2021). Data from the Global Coal Plant Tracker (GCPT) shows that 577 GW of coal-fired power projects in India had been cancelled or shelved between 2010 and June 2018. National Thermal Power Corporation Ltd (NTPC) has reportedly shelved 10.5 GW of its planned coal-fired power projects in India (Buckley & Shah, 2018). Further, around 29 GW of pre-construction capacity is showing no development (Shah, 2021). However, this rollback of announced projects owes more to economics than environmental considerations. The coal-fired power sector in India accounts for a significant share of non-performing assets (NPA) that continue to trouble the Indian banking sector, accelerating project cancellations through lack of financial viability, and there has been an increase in low-cost renewable capacity installations (Buckley & Shah, 2018; Shah, 2021).

According to the current policy of CEA, coal fired power plants which are older than 25 years will undergo repairs in order to extend the life expectancy of these plants by an another 15-20 years (CEA, 2020a). According to new emissions standard which came into force in 2017, thermal power plants are subject to maintain certain emissions level of CO_2 and other pollutants and power plants older than 20 years are required to install various pollution control technologies (CEA, 2016; India Environment Portal, 2015). All of these measures require additional investment. If these ageing power plants were retired early, this would create an opportunity to shift this investment to towards the expansion of renewable capacity.

The COVID-19 pandemic is set to further weaken the already strained health of India's power sector due to the high accumulation of debt of the power producers following low electricity demand during economic slowdown (Kanitkar, 2020). Yet, approximately 35 GW of coal-fired power plants which are currently under construction are still expected to come online in the next five years alone (Global Energy Monitor, 2020), representing an increase of 16% coal capacity.

Although renewable energy is central to India's National Electricity Plan 2018 (NEP 2018), with a target of 275 GW capacity from renewable sources by 2027 and an ambition of 450 GW by 2030 (IEA, 2020a), coal capacity is projected to increase simultaneously from 192 GW in 2017 to 238 GW by 2027. Installed capacity of renewables more than doubled in the last six years, from 39 GW in 2015 to 94 GW in March 2021 (Central Electricity Authority, 2021a), an average annual increase of around 15%. Over the same period, coal-based power generation also increased, at an average rate of 6% annually (Central Electricity Authority, 2020a). However, NEP 2018 includes a timeline of retiring coal power plants older than 25 years in two phases leading to a reduction of currently installed coal capacity by around 48 GW between 2017 and 2027.

3 Coal expansion risks stranded assets as renewables keep getting cheaper

Two thirds of India's coal-fired power plants were built in the last 10 years, and India also has the world's second largest coal projects in the pipeline. For India's emissions to get onto a 1.5°C compatible pathway, it should abandon the proposed coal projects in favour of renewable energy, which would generate a significant number of stranded assets in the power sector over the next decade (Malik et al., 2020; Montrone et al., 2021; Shah, 2021).

India must take action now to halt construction of its pipeline projects to minimise stranding coal power assets, which could save INR 1.55 trillion (USD 21bn) (Montrone et al., 2021). Retiring old coal power plants can yield savings of INR 530bn (USD 7.15bn) over five years by avoiding installation of the expensive pollution control technology that units older than 20 years are legally required to have, following the revised emissions standard of thermal power plants (Fernandes & Sharma, 2020).

India subsidises both fossil fuels and renewable energy through direct subsidies, fiscal incentives, price regulation and other government support. Direct coal subsidies have remained largely unchanged since 2017 and are still approximately 35% higher than subsidies for renewables (Garg et al., 2020). Coal-fired power generation also receives indirect financial support from the government through exemption from income tax and land acquisition at a preferential rate (Garg et al., 2017). A National Clean Energy Fund (NCEF) was set up in 2010/11 to channel financial support to clean energy efforts, funded through a cess (tax on coal) on coal, but its focus on environmental project support ceased after the introduction of the Goods and Services Tax in 2017.

Thermal coal imports in India increased by 12.6% (197.84 million tonne) in 2019-20, at a cost of approximately INR 1.25tn (USD 17bn) (Varadhan, 2020; Verma, 2020). While India does have significant coal reserves, due to its high ash content, a large number of operating and pipeline projects (25 GW) do not use more than 30% of domestic coal, sourcing the rest from other countries, mainly Indonesia and Australia (Global Energy Monitor, 2020) which will continue to add to the trade bill.

Solar tariffs in India have declined by 17% annually between 2016 to 2019 (from USD 0.0786/kWh to USD 0.0447/kWh) mainly because of the falling capital costs of solar power generation (IRENA, 2020). This means solar tariffs are now 20% cheaper than the NTPC generated coal-fired power tariff (Bhushan, 2017). They reached a new all-time low level of INR 1.99/kWh (USD 0.027/kWh) in November 2020 (Bhaskar, 2020). With this falling price of renewables INR 70bn (USD 940m) could be earned per annum by the generation companies if 36.5 GW capacity of ageing coal-fired power plants were replaced with renewables under the current tariff of electricity and long-term power purchase agreements between electricity generation and distribution companies (Fernandes & Sharma, 2020).

To minimise the effect of COVID-19 on the economy, the Indian government has earmarked at least USD 325bn to fund the recovery measures (Garg, Schmidt, & Beaton, 2021). This corresponds to approximately 11% of GDP in 2019. India's fiscal stimulus supports clean energy activities such as battery production, renewable energy and energy efficiency schemes (NITI Aayog, 2020). Data from Vivid Economics reveals that India's Green Stimulus Index (GSI) score has improved significantly but still remains negative, mainly because of its continued support for coal and gas initiatives (Vivid Economics, 2021).

4 India's greenhouse gas emissions in the context of the Paris Agreement

COVID-19 has a marked impact on India's emissions by saving 1.7 Gt cumulative CO_2 emissions from the transport sector (NITI Aayog, 2020) and reducing total electricity generation by 2.5% in 2020–21 compared to 2019–20 (Ministry of Power Government of India, 2021). The Climate Action Tracker estimates that India's emissions decreased around 7% in 2020 compared to 2019 due to the pandemic (Climate Action Tracker, 2020b). But India looks set to miss an opportunity to lock in deep emissions reductions as it recovers from the pandemic. Without additional measures, emissions are projected to return to their upward trend between 2020 and 2030 (Climate Action Tracker, 2021).

The full effect of the pandemic or recovery measures remains unclear. Despite this uncertainty, emissions are projected to rebound after the short-term dip and increase by 30%–40% between 2020 and 2030. Emissions, excluding land use, land use change and forestry (LULUCF) are projected to reach approximately 3,840–4,025 $MtCO_2e$/year in 2030 (Figure 3).

To be in line with the Paris Agreement's 1.5˚C long-term temperature goal, India's domestic emissions (excluding LULUCF) would need to decrease by 17% below 2010 levels by 2030 (median estimates: Figure 3). The reduction range is derived from global model runs of the IPCC special report on 1.5°C that distribute emission reductions across countries and sectors in a cost optimal way to limit global temperature rise to below 1.5°C by the end of the century (Huppmann et al., 2019).

The result of this analysis indicates plausible emission reductions within India's borders; however, this does not mean India must achieve this emissions reduction on its own. India will require support from the international community to achieve this 1.5°C compatible pathway. For a Paris-compatible target, India, in updating its NDC, would need to establish a reduction target, conditional on international support, compatible with this pathway.[1]

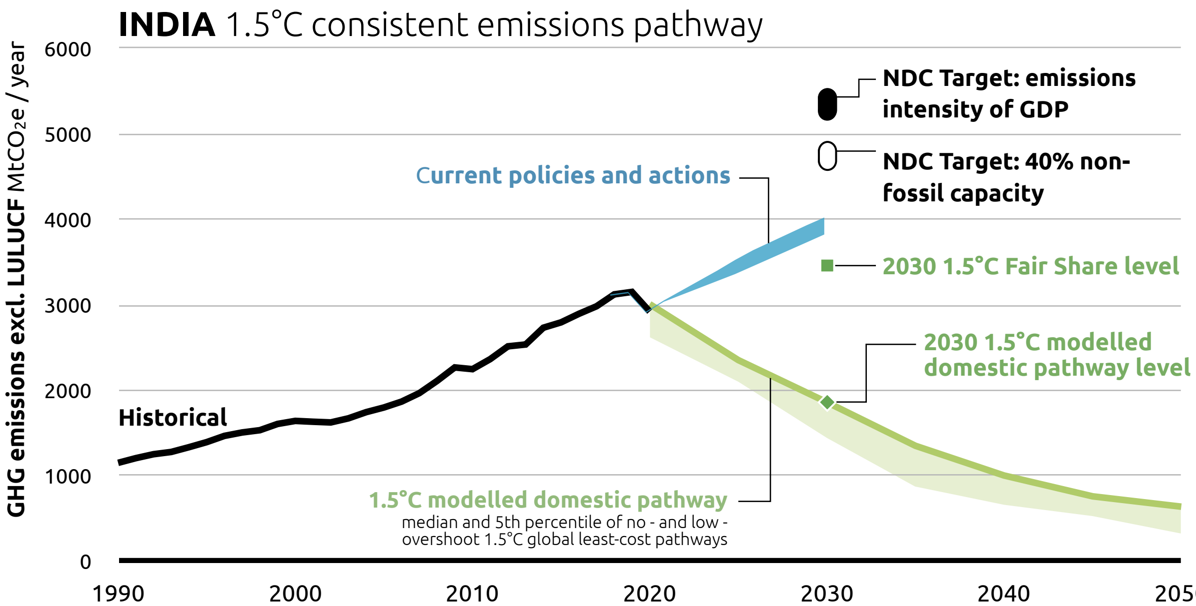

Figure 3 India's emissions projections under current policies and actions (Climate Action Tracker, 2021). We compare these to NDC targets and 1.5°C fair share emission levels. The 1.5°C least cost pathways shown here should be achieved with international support.

1 For more information on the emissions levels India would need to achieve under fair share considerations, see our full CAT India country analysis.

5 The importance of rethinking the role of coal in India

A global transition away from coal-fired thermal electricity is fundamental to achieving the Paris Agreement's long-term temperature goal of limiting warming to 1.5°C. Coal should be phased out globally, and in India, by 2040 to limit warming to 1.5°C (Climate Action Tracker, 2020c; Cui et al., 2019). To that end, countries, including India, must halt new coal-fired power plant construction and reduce the utilisation of existing plants as they transition to zero emissions economies (Climate Action Tracker, 2016; Kuramochi et al., 2018).

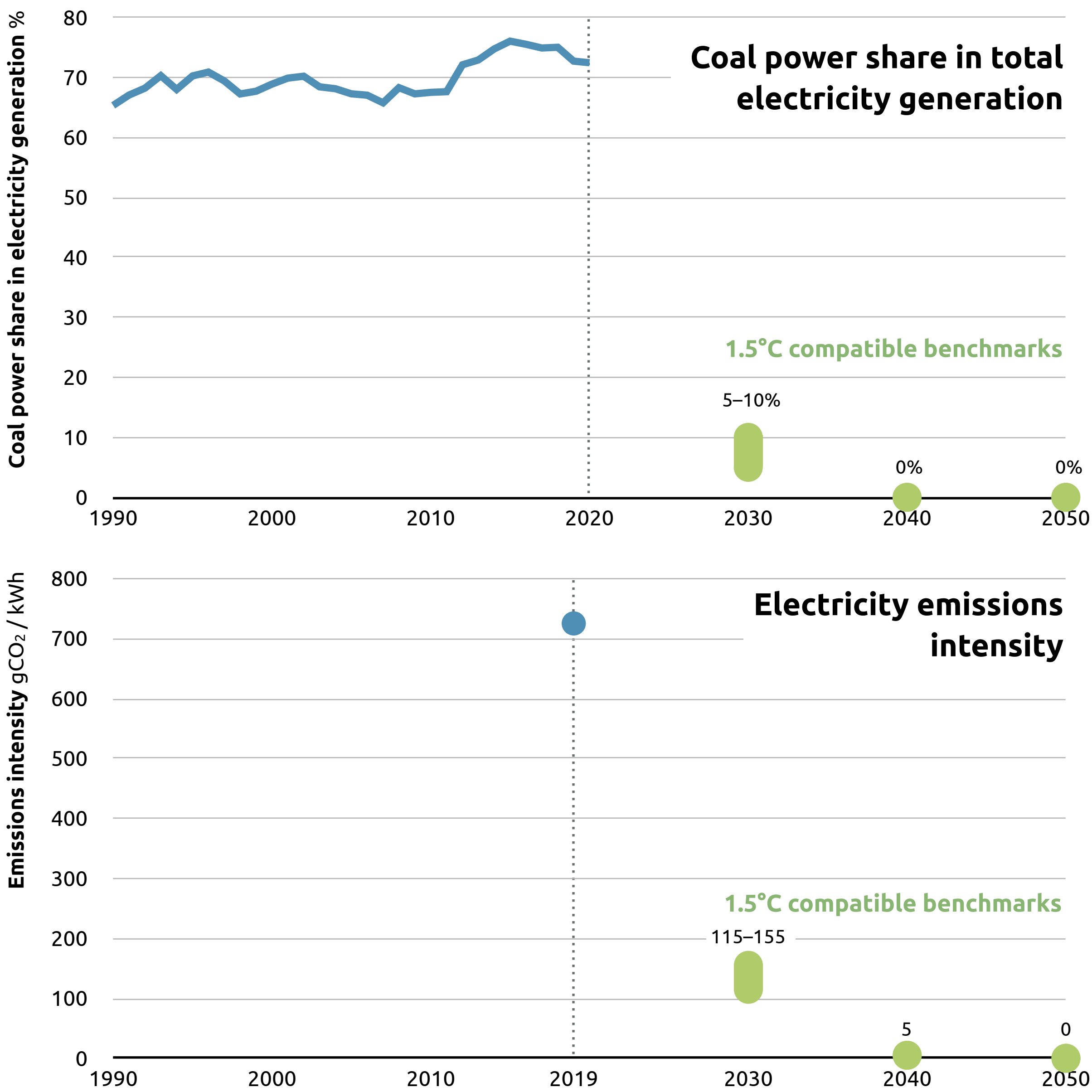

Figure 4 Benchmarks for grid emissions intensity and coal share in electricity generation in India necessary to meet the goals of the Paris Agreement (Climate Action Tracker, 2020c; IEA, 2020b).

Some countries in the region are taking action against coal:

- The Philippines is the first country in the Asia-Pacific region to plan a moratorium on new coal. In October 2020, Energy Secretary Alfonso Cusi announced that new coal-fired power plants will no longer receive permits from the Department of Energy (DOE) (Ahmed & Brown, 2020; Climate Home News, 2020; Department of Energy, 2020).
- Bangladesh's earlier plans to build new coal power plants (17 GW) has been rolled back as these projects are no longer cost efficient because of the high price of imported coal (Gerretsen, 2021).

India's continued plans to expand coal capacity are off track compared to action by other countries in the region. For a Paris-compatible development path, India will be required to reduce its grid emissions intensity and coal share to zero before mid-century (Figure 4). To scale climate change mitigation ambition in its power sector, India needs to revisit its plans to build new coal power plants and accelerate the retirement of existing plants.

6 The effect of a reduction of coal-fired power on India's emissions

In the February 2020 budget speech, Finance Minister Nirmala Sitharaman announced the shut-down of old and polluting power plants to meet emission norms introduced in 2017. To comply with this emission standard, thermal power plants which are older than 20 years would require installation of pollution control technologies (CEA, 2016; India Environment Portal, 2015). This would result in considerable additional investment into these aging plants (Fernandes & Sharma, 2020).

An alternative would be to retire plants once they reach 20 years of age and replace the capacity with renewable energy, an approach taken by Indonesia (Reuters, 2021). We estimate that this could avoid 160 $MtCO_2e$ from the power sector by 2030. However, this reduction remains insufficient to align India's current policies with a 1.5°C Paris compatible domestic pathway or its fair share obligations (Climate Action Tracker, 2021).

To assess how the Indian power sector can become Paris Agreement compatible, we assess the effect of two measures on the way to a complete coal phase-out in 2040. The first is the 'Early retirement' scenario based on the concept of retiring old coal power capacity and replacing it with renewable energy. In this scenario we retire coal-fired power plants once they have been operating for over 18 years, an increase from the 20-year cut-off which we have found not sufficient to reach the 1.5°C temperature goal. The second is to follow good practice examples of other coal-dependent Southeast Asian countries, e.g. the Philippines and Bangladesh, to reduce coal expansion plans—the 'Reduced pipeline' scenario.

Both scenarios are quantified based on a reduction below the CAT's current policy emissions projections:

- **Early retirement:** excludes emissions from power plants in operation for over 18 years. This results in a reduction of almost 52 GW in total installed capacity by 2030 compared with current plans.
- **Reduced pipeline:** excludes emissions from subsets of the new coal plant pipeline, ranging from exclusion of the whole pipeline to the exclusion of announced power plants only. This results in a range of 2–20 GW reductions in total installed capacity by 2030.

While implementing these two scenarios would not be enough to curb emissions (Figure 5), they would see a start to decarbonising the power sector.

Each scenario individually could reduce CO_2 emissions in 2030 below current policies, leading to emissions in 2030 between 3,560-4,015 $MtCO_2e$:

- The '**Early retirement**' scenario alone would result in reductions of around 7% below the current policies.
- The '**Reduced pipeline**' scenario is more uncertain due to the distinct stages of the power plants in the pipeline. This scenario alone could reduce emissions by up to 2.5% below current policies.

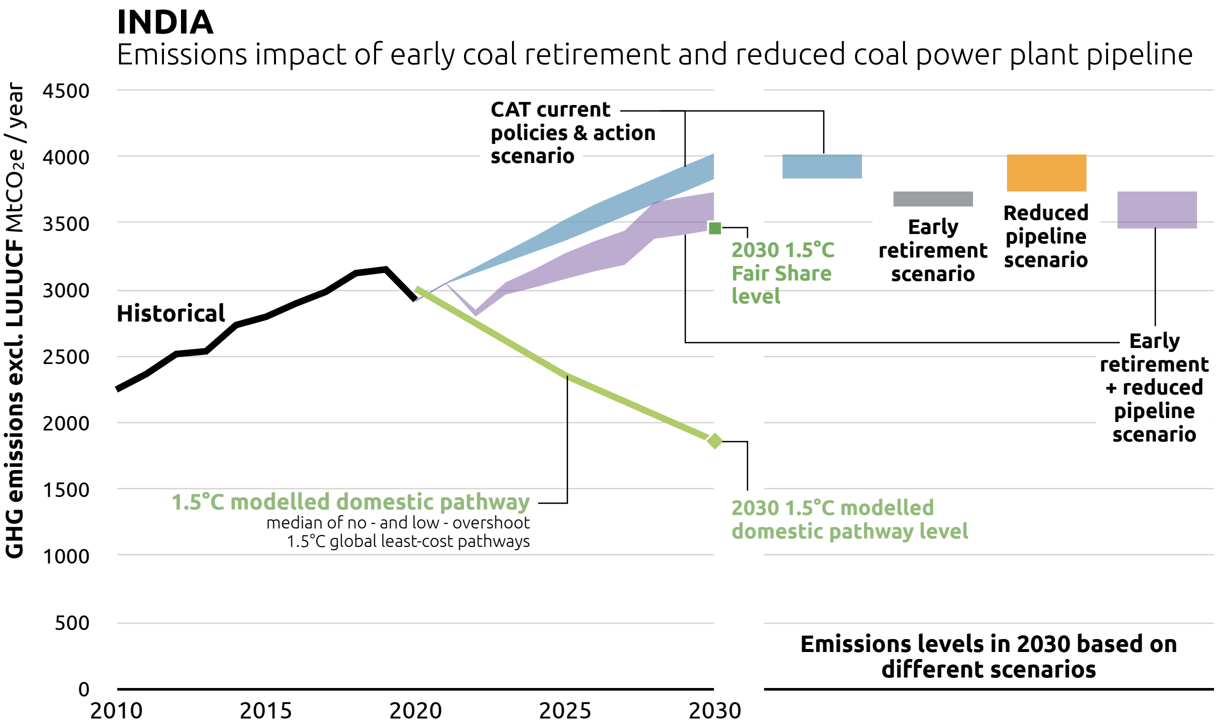

Figure 5 Economy-wide emissions trajectories, excluding LULUCF under distinct scenarios of coal-fired electricity generation capacity.

Early retirement *combined* with a reduction in the existing pipeline could reduce emissions to 3,460–3,730 $MtCO_2e$, which is 7%–10% below current policies.[2] The most ambitious reduction estimate would already bring India in line with the minimum reductions required to contribute its fair share to a 1.5°C compatible global pathway (Figure 5).

We estimate that this reduction in coal fired capacity, in the absence of additional efficiency measures, would require 160–320 GW[3] of additional renewable capacity to India's previously communicated 450 GW by 2030 goal. India is likely to achieve, and may even over-achieve, the 450 GW goal, including hydro, under current policies.

In addition, this change of direction in the power sector represents a small but necessary step towards aligning India's current policies with a 1.5°C Paris compatible modelled domestic emissions pathway. Compatibility requires economy-wide emissions to fall below 1,860 $MtCO_2e$ in 2030 (excluding LULUCF) within India's borders, a reduction of around 50% below current policies, to be achieved with international support.

If India could achieve power sector benchmarks for a 1.5°C pathway by 2030, e.g. an electricity emissions intensity of 115–155 gCO_2/kWh by 2030, this could contribute around 900–1,000 $MtCO_2e$, i.e. around half the required reduction for a Paris Agreement compatibility domestic emissions pathway. Achieving these power sector benchmarks would need a much stronger uptake of renewable energy technologies and will require international support.

India has not submitted an update of its NDC targets (as of 29 October 2021). It is very likely to overachieve its current NDC target (Climate Action Tracker, 2021). Re-evaluating coal dependency presents a huge potential to scale up climate ambition as part of the update. India could become a global climate leader if it abandons plans to build new coal-fired power plants, and instead develops a strategy to phase out coal for power generation before 2040 as part of its enhanced NDC target.

2 The percentage reductions are a lower bound estimate, given uncertainty on whether the sources used in the CAT current policy pathway include the NEP 2018 retirement plans. See Assumption section for more details.

3 The uncertainties in these estimates stem from the uncertainty on the whether the sources used in the CAT current policy pathway include the NEP2018 retirement plans. See Assumption section for more details

7 Wider co-benefits of less coal for electricity generation in India

Atmospheric emissions from coal-fired power plants are a heavy burden on human health. We estimate that almost 90,000 people die prematurely each year in India due to air pollution from coal-fired power plants. A reduction in coal-fired electricity would have a positive effect on air pollution, reduce strain on the health system and help save thousands of lives (Conservation Action Trust, Urban Emissions.info, & Greenpeace India, 2012; Guttikunda & Jawahar, 2014).

The CAT assessed the combined effect of the 'Early retirement' and 'Reduced pipeline' scenarios on air pollution and their impact on premature deaths. We quantify premature deaths avoided between 2020 and 2030. We focus on the effects of three major air pollutants (i.e. NO_x, SO_2 and $PM_{2.5}$), associated with negative impacts on human health, and the four leading causes of death: heart disease, stroke, lung cancer, and chronic obstructive pulmonary disease—for more on methods, see (Schiefer & Fearnehough, 2020).

Our results show that if current coal capacity expansion plans were fully implemented, over a million people could die prematurely over the next decade in India due to air pollution from coal-fired power generation (Figure 6).

Around 45,000 of these deaths would be caused by coal-fired power plants not yet at construction stage which could be replaced by renewable energy sources. Another 210,000 premature deaths will be due to power plants that have been operating for more than 18 years and which could be retired before end-of-life. The implementation of an early retirement, combined with a reduction of the coal plant construction pipeline could avoid around 255,000 premature deaths in the next decade.

These results are subject to uncertainty: we have only quantified premature deaths caused by the four most significant diseases caused by air pollution for adults over the age of 25. The inclusion of other diseases and/or population groups would likely increase the effect. We have also only quantified premature deaths, excluding morbidity-related health impacts from hospitalisations, work-days lost, etc.

However, India also announced much more stringent emissions standards for thermal power plants in 2018. We estimated that if these were to be implemented, premature death rates could fall by up to two-thirds from these values. However, so far these limits have not been enforced, although the new National Clean Air Program may improve enforcement (Cropper et al., 2021).

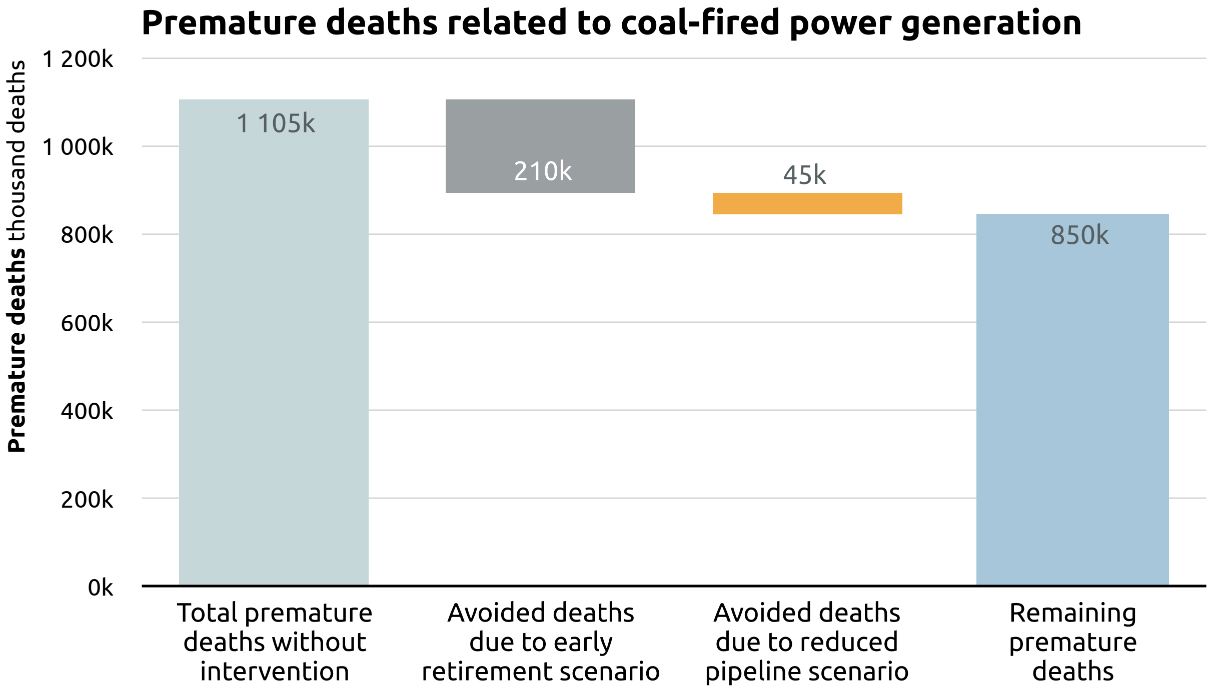

Figure 6 Total premature deaths related to coal-fired power generation in India between 2020 and 2030 and avoided deaths under certain scenarios.

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Assumptions

Current policy projections

The current policy emissions projections are drawn from the CAT's September 2021 country assessment for India and include an estimate of the impacts of the pandemic on emissions. Please refer to the Assumptions page of that assessment for further details (Climate Action Tracker, 2021).

For the power sector, the CAT current policy emissions projections draw from the IEA's stated policies scenario for India for the upper bound, and from the 2029 Power Report by the Indian Central Energy Authority for the lower bound (CEA, 2020b; IEA, 2020b).

Coal plant data

The coal plant data was taken from the Global Coal Plant Tracker (Status: January 2021) (Global Energy Monitor, 2021) excluding any cancelled or shelved plants as well as captive plants (plants used for on-site electricity generation in industrial sites). The database contains information about capacity, efficiency, location and plant age per plant.

In the baseline scenarios, we have assumed a lifetime of 45 years for coal plants built in or after 1977. This was based on the average fatigue life of coal plants in India of around 25–30 years and a typical extension of the plant's life by a further 15–20 years through appropriate repairs/replacements (CEA, 2020a). For plants built before 1977, we made plant-specific assumptions on lifetime where possible, e.g. based on other units in the same plant or additional public information. If no information was available, we used a lifetime of 55 years for plants built in or after 1966, and 60 years for older plants. The resulting lifetimes ranged from 45 years to 64 years.

For the baseline we also retired 38 GW of capacity (175 units), 83 units totalling 14 GW by 2022 and 92 units totally 24 GW by 2027. These plants were listed for retirement in the NEP 2018 as per new environmental norms. Note that the NEP 2018 contains a total of 263 units totalling 48 GW, but 88 of these (10 GW) had already been removed from the coal plant database.

For the Early retirement scenario, we shortened the lifetime of all operating plants to 18 years maximum, roughly in line with the Paris Agreement compatible benchmark for a complete coal phase-out by 2040 in India.

For the Reduced pipeline scenario, we excluded all plants not yet under construction.

We used an average capacity factor of 61% for all plants based on the average actually achieved capacity factor of coal power in two sample years, 2016 and 2019, as reported in the guidelines of Central Electricity Authority (CEA) (CEA, 2020a).

Note on alignment between bottom-up analysis here and CAT current policy pathway:

It is not clear whether the planned retirements in the NEP 2018 have been accounted for in the two sources upon which the CAT current policy pathway is based.

The CEA report, e.g., which forms the basis for the lower bound of the CAT current policy pathway, contains a 2019 installed capacity figure for coal in line with the coal plant database we use (just over 200 GW), but projects capacity to increase to over 260 GW by 2030, in contrast to the 225 GW we project. This could be either due to the report assuming that the 48 GW of planned retirement will not proceed or because the report is more bullish on the deployment of additional, and likely more efficient, plants.

If it is the case that these planned retirements are not reflected in the underlying current policies and action scenarios, then there will be additional emission reductions, of a similar order of magnitude to the reductions in our ER+RP scenario expected until 2030. The percentage reductions from our scenario are conservative in this sense.

Air pollution quantification

The air pollution impacts were calculated using the AIRPOLIM-ES tool. The AIRPOLIM-ES, developed by NewClimate Institute under the Ambition to Action project, is a spreadsheet-based model that uses an accessible methodology for quantifying the health impacts of air pollution from different sources of electricity generation and other fuel combustion. It calculates the impacts on mortality from four adulthood diseases: lung cancer, chronic obstructive pulmonary disease (COPD), ischemic heart disease, and strokes, the prevalence of which is increased through exposure to air pollution.

The health impact assessment is based on emissions of particulate matter ($PM_{2.5}$), NO_x, and SO_2. The model estimates the annual electricity generation (GWh) for each plant, as well as the corresponding emissions of air pollutants using plant-specific data and country-specific emissions factors from the GAINS model developed by the International Institute for Applied Systems Analysis (IIASA). Note that because we did not have plant level information regarding emissions control systems in place, we used the average emissions factors from the GAINS model for all plants.

The exposed population living within four distance bands (0–100 km, 100–500 km, 500–1,000 km, and 1,000–3,300 km) from each power plant is estimated using open-source Geographic Information System (GIS) software, also considering population growth using estimates from the UN World Population Prospects (UN DESA, 2019). The model uses the intake fraction concept to estimate the change in $PM_{2.5}$ concentration in the ambient air based on the calculated pollutant emissions. Intake fractions indicate the grams of $PM_{2.5}$ inhaled per tonne of $PM_{2.5}$, NO_x, and SO_2 emissions. These fractions—drawn from literature based on air dispersion modelling—enable estimation of the change in $PM_{2.5}$ concentration.

To calculate the increased mortality risk per additional tonne of pollutant emissions, the estimated change in $PM_{2.5}$ concentration (from primary $PM_{2.5}$ emissions as well as secondary $PM_{2.5}$ from NO_x and SO_x emissions) is multiplied with the respective concentration-response function. Concentration-response functions are estimated based on long-term medical cohort studies and indicate the increase in cause-specific mortalities per 10 micrograms per cubic metre increase in $PM_{2.5}$.

The Global Burden of Disease project provides mortality rates by disease for different age groups at the country level. The model obtains age-weighted mortality rates by disease using the share of the country's population in each age class. The risk estimates, age-weighted mortality rates, and exposed population are combined to calculate the number of premature deaths per tonne of pollutant for each cause of death. Finally, these numbers are multiplied with the estimated pollutant emissions to obtain the total premature deaths per pollutant and cause for each power plant. Premature death refers to deaths that are attributed to exposure to a risk factor, e.g. air pollution, and could be delayed if the risk factor was eliminated.

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The Climate Action Tracker (CAT) is an independent scientific analysis produced by two research organisations tracking climate action since 2009. We track progress towards the globally agreed aim of holding warming well below 2°C, and pursuing efforts to limit warming to 1.5°C.

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Climate Analytics is a non-profit climate science and policy institute based in Berlin, Germany with offices in New York, USA, Lomé, Togo and Perth, Australia, which brings together interdisciplinary expertise in the scientific and policy aspects of climate change. Climate Analytics aims to synthesise and advance scientific knowledge in the area of climate, and by linking scientific and policy analysis provide state-of-the-art solutions to global and national climate change policy challenges.

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NewClimate Institute is a non-profit institute established in 2014. NewClimate Institute supports research and implementation of action against climate change around the globe, covering the topics international climate negotiations, tracking climate action, climate and development, climate finance and carbon market mechanisms. NewClimate Institute aims at connecting up-to-date research with the real world decision making processes.

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