India's triple challenge:

growth, development and climate change

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Key Acronyms

BAU	business as usual
CANSA	Climate Action Network South Asia
CBDRRC	common but differentiated responsibilities and respective capabilities
CERP	Climate Equity Reference Project
COP21	Conference of Parties 21
ECBC	Energy Conservation Building Code
EE	energy efficient
ERF	equity reference framework
GHG	greenhouse gas
HDI	Human Development Index
INDC	intended nationally determined contribution
IPCC	Intergovernmental Panel on Climate Change
MDG	Millennium Development Goals
RE	renewable energy
UNFCCC	United Nations Framework Convention on Climate Change
SDG	sustainable development goals

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Summary

India’s goals for economic growth are ambitious; the Indian Government is aiming to achieve human development on a par with EU countries. There is also an intention to deliver ‘access to electricity for all’ in India during Prime Minister Narendra Modi’s first term in office. Ministers cannot be seen to be slowing down development to address climate change.

At the same time, India is a country that is already experiencing the destructive impact of climate change: devastating monsoon floods and coastal storm surges. So it is in the interests of India, its people and its economy, for a universal and fair agreement to be negotiated this December at the United Nations Conference on Climate Change (COP21) in Paris, with a target of keeping global warming below 2ºC (and preferably below 1.5ºC).

There is progress from the Modi government on renewable energy (RE), and promises to build smart cities, model villages, to develop solar power and to deliver electricity for all. The increased effort to scale-up RE within the country’s overall energy mix, while continuing to rely on conventional energy sources, can be termed as a slow transition towards cleaner energy in the long term. However, the dominant view of government is that growth is required before resources can be invested in climate action: growth first, climate action later.

In the context of the upcoming Paris climate negotiations at COP21, this report looks at how India’s seemingly conflicting aims can be reconciled, and how a fair global climate deal could be a catalyst for a rapid move towards sustainable development in India. We make the convincing case that moving to sustainable energy now could deliver India’s desired growth and development objectives.

A fair deal in Paris

The current process under the United Nations Framework Convention on Climate Change (UNFCCC) whereby countries propose their intended nationally determined contributions (INDC) is an opportunity to alter the narrative, and to show how an equitable climate deal in Paris could be the key to India becoming an energy-secure and climate-resilient country. This will require the Paris deal to contain an effective ambition review mechanism with a clear equity framework built into it, to ensure each country is contributing its fair share of climate action.

India has submitted its INDC ahead of Paris, pledging to:

- ✓ reduce the emissions intensity of its GDP by 33-35% by 2030, from the 2005 level
- ✓ achieve around 40% cumulative electric power installed capacity from non-fossil-fuel-based energy resources by 2030 with the help of transfer of technology and low-cost international finance, including from the Green Climate Fund
- ✓ create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent, through additional forest and tree cover by 2030.

In Chapter 1, Climate Action Network South Asia (CANSA) argues in support of India’s two-tier INDC, in which India offers, first, to contribute unconditionally to the global effort to tackle climate change; and second, to go beyond its fair share of contribution, on the condition that it is provided with financial and technological support, to help ensure the total global effort is consistent with a global warming pathway of below 2ºC.

Our research[1], however, shows that India's fair share of emissions reduction should be 6% below a business-as-usual pathway (BAU) in 2030, requiring the greenhouse gas (GHG) intensity of its economy to improve by 47% between 2005 and 2030. Additionally, India's conditional contribution could make much larger reductions (40% below BAU), with international support.

The following two chapters demonstrate that India could, in fact, go far beyond its intended contribution, without compromising its development or economic growth.

Delivering a decent standard of living without costing the earth

- Chapter 2 of the report focuses on poverty reduction objectives, and shows that, in many cases, the most cost-effective and sustainable way of delivering poverty reduction is driving it through off-grid RE. If India were to push forward its sustainable energy access policies with vigour, including targeted use of off-grid decentralised energy, it could deliver cost-effective poverty reduction actions in homes, clinics, schools, small enterprises, water access and agriculture.

Achieving low-carbon growth

- Chapter 3 of this report assesses India's potential for developing its residential and industrial sectors in a low-carbon manner. It shows that if India were to implement its own ambitious sustainable energy generation and efficient energy use plan, it could offer a strong domestic INDC pledge at the Paris COP21, far beyond its fair share reduction of 6% from BAU. In addition, India's high mitigation potential provides an opportunity for India to offer to go further along a low-carbon pathway if it receives international support.

We recommend that India increases the ambition of its INDC by making four important contributions:

- an **unconditional** contribution of 47% emission intensity reduction, compared with 2005, by 2030

- an additional 15% reduction in emissions intensity by 2030, ie a 65% emissions intensity. reduction, compared with 2005, **conditional** on receiving financial and technology support

- a **conditional** offer to stop construction of coal-based power plants beyond 2025 if support is made available to increase the share of RE in the system

- meaningful partnership and collaboration with countries to develop and deploy clean energy solutions jointly, and to develop new technologies to accelerate further the transition to a low-carbon future.

Conclusions

As India delivers its growth and development plans, it should view the Paris deal as an opportunity to set itself on a long-term low-carbon path. By building partnerships for technology transfer, capacity building and finance into the Paris outcome, India can set a course towards a modern, self-sufficient and energy-secure future.

We note that India has already entered into a number of partnerships in clean energy development and deployment, with various countries such as the US, Japan, China and Germany. These partnerships include ensuring financial investment flows into India for RE including waste-to-energy systems, energy efficiency, clean and affordable public transportation systems and smart city programmes, among others.

We very much welcome these developments and encourage India to enter into more such partnerships with both developed and developing countries, ensuring North-South cooperation and South-South cooperation. In particular, we support partnerships with African countries that are also seeking technical and financial cooperation and partnership on low-carbon and sustainable development. We re-emphasise that clean energy infrastructure is one of the key focus areas which could lead to meaningful collaboration and partnership between India and many of the African countries. India has announced the International Agency for Solar Technologies and Applications (INSTA) as a solar alliance in partnership with Solar Resource Rich Countries. The new agency aims to ensure universal access to affordable, reliable and modern energy services by increasing the share of RE in global energy mix. Such South-South cooperation can scale up RE in shortest possible time overcoming the existing challenges with respect to costs to consumers, investments in RE and technology transfer. By already committing US$90 million as an initial investment, in spite of resource scarcity, India has conveyed its genuine intentions to find a long-term solution to challenge of climate change. Such intentions from developing countries are commendable and should be encouraged in global policy frameworks.

Chapter 1: Ensuring sustainable growth for India in a fair global climate agreement

Overview[2]

In December 2015, global leaders will gather in Paris for the United Nations Climate Change Conference, representing the twenty-first session of the Conference of Parties (COP21), to negotiate a climate deal that will take us into the 2020s. At this event, India will be one of the key players helping to deliver an historic and ambitious deal. India is still a developing country, but with a population of 1.2 billion it emits large quantities of CO_2. This chapter makes the case that India has a key role to play in laying down the foundations of a Paris climate change agreement in which equity and sustainable development become drivers of climate ambition.

Ahead of COP21, India has submitted its intended nationally determined contribution (INDC), pledging to:

- ✓ reduce the emissions intensity of its GDP by 33-35% by 2030, from the 2005 level
- ✓ achieve around 40% cumulative electric power installed capacity from non-fossil-fuel-based energy resources by 2030 with the help of transfer of technology and low-cost international finance, including from the Green Climate Fund
- ✓ create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent, through additional forest and tree cover by 2030.

'Fair shares' refers to the emissions reductions that each country should be responsible for delivering in a fair and equitable global deal. While Climate Action Network South Asia (CANSA) supports India's INDC and its increased target, our research shows that the reduction target of 33-35% of the emissions intensity of its economy is at the lower end of the fair share scale of reductions.

India and Paris 2015

Six years ago, at COP15 in Copenhagen, countries pledged to take action to limit carbon emissions up to 2020. India pledged to keep its emission levels below BAU and to reduce the carbon intensity of its economy (that is, carbon emissions per US$GDP). Since then, it has embarked on a plan to increase low-carbon energy, including solar power, across the country.

However, the Intergovernmental Panel on Climate Change (IPCC) has predicted that the combined reductions and pledges since COP15 are well below what is needed to stay within 2°C of global warming. There is a significant gap between the global vision of a safe climate and what the nations of the world, especially developed countries, are willing to do about it.

COP21 presents an opportunity to close the pre-2020 gap, especially for developed countries, and put the world on a new, low-carbon track in a post-2020 climate change deal. There has been increasing pressure on emerging economies such as India, China, Brazil and South Africa to contribute more to the global effort. India, in particular, is feeling that pressure. It is a lower-middle income developing country with high emissions (5% of the global total) due to the size of its population.

The current process under the United Nations Framework Convention on Climate Change (UNFCCC) calls for countries to propose their INDC. This presents an opportunity to change the narrative and show how a fair climate deal in Paris could be the key to India achieving a higher score on the Human Development Index (HDI) and becoming an energy-secure, climate-resilient country.

Why equity is critical for an ambitious deal

As the Paris meeting approaches, we face the prospect of an agreement that, while marking a major breakthrough, is likely to be too weak to stabilise the climate system. The mitigation contributions put forward to date by developed countries (the US, EU, and so on) are significantly below their equitable share and are inconsistent with global warming of below 2°C. A new approach to achieving an equitable and ambitious deal is vital. The way to do this is to include a coherent equity framework and assessment process in the agreement.

An equity reference framework (ERF) is proposed that accounts for the UN principle of 'common but differentiated responsibilities and respective capabilities' (CBDRRC), and acknowledges the need for fair access to sustainable development as much as the urgent challenge of stabilising the global climate.

Such an approach to equity could help all countries demonstrate how their INDCs are consistent with a fair share of the global effort. But more importantly, it could empower developing countries, such as India, to support goals of inclusive and sustainable development. Such a framework regards a country's level of development need as integral to its 'national circumstances', and it supports the view that India's equitable share of climate action should not be at the expense of its ambition for inclusivity and sustainability.

Using the ERF, the next section of this briefing makes the case for it being in India's interests to promote a fair and ambitious climate deal in Paris. The final section details the implications for India's approach to COP21.

A modern equity framework

The equity framework used in this report – designed and built by the Climate Equity Reference Project[3] – is based on high-level equity principles, most notably the Framework Convention's key principle of CBDRRC.

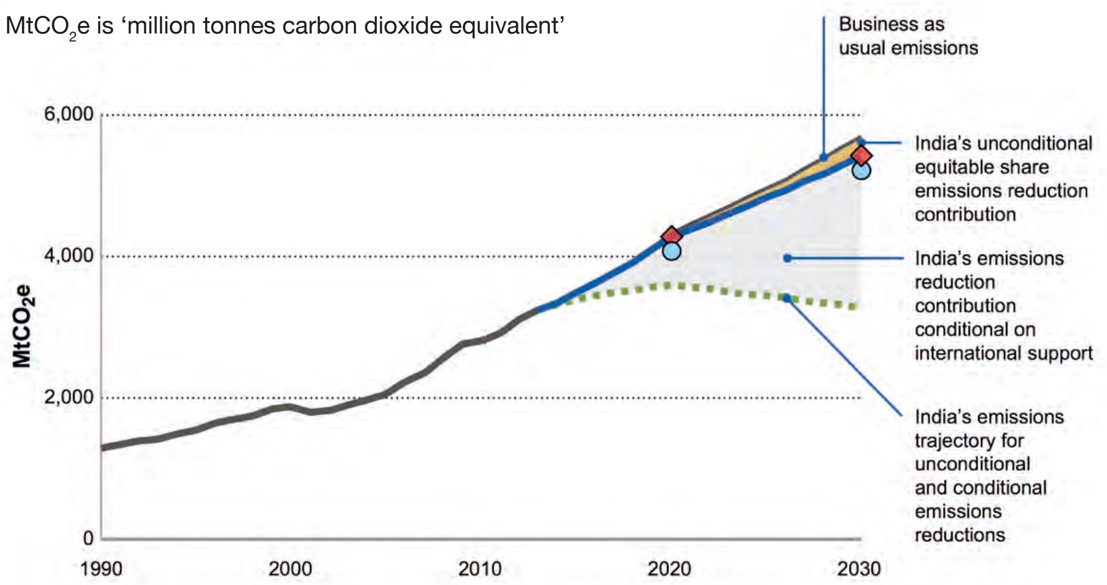
The Climate Equity Reference Project (CERP) framework supports an 'equity band' approach, in which there is considerable flexibility allowed for defining equity. We offer equity settings that are defined by three conceptions of progressivity (how progressively a country's economic capacity to cut emissions is calculated) and three conceptions of the date from which a country takes emissions responsibility (historical responsibility). These settings are:

- no-equity case: no progressivity, and historical responsibility since 1990
- medium-equity case: moderate progressivity,[4] and historical responsibility since 1950
- high-equity case: high progressivity, and historical responsibility since 1850.

Figure 1 shows that India's fair share of emissions reduction is small (only 6% below BAU in 2030 at the medium-equity setting, requiring the carbon intensity of its economy to improve by 47% between 2005 and 2030), though larger than the current INDC of 33-35% greenhouse gases (GHG) intensity improvement. In addition, India's conditional contribution could help close the gap between what is needed to keep global warming below 2°C, and developed countries' efforts towards this, by offering to make greater reductions (40% below BAU) with international support.[1]

India's sustainable development needs are expected to result in a steep increase in emissions. Reducing these in future, from a peak, would require enormous effort. We make the case here that India should therefore be prepared to offer a more ambitious contribution this December, conditional on international support, so that its emissions peak as soon as possible, minimising the cost burden of future reduction efforts.

Figure 1: For comparison, India's 2020 Copenhagen pledges and its INDC are also shown; in both cases, the red diamond is the unconditional pledge, the blue circle the conditional one.



India among developed and emerging economies – 2°C pathway

Despite its low per capita GHG emissions, India is the fourth largest GHG emitter in the world. At the same time, it is a lower-middle income country, and the only emerging economy in that country group. India is compared in figures 2 and 3 (overleaf) with both developed countries and emerging economies.

Figure 2 shows the emissions reductions, in million tonnes, that countries need to achieve below their 2030 BAU emissions. It is clear that India's 2030 equitable share reduction below BAU is small, except in the low-equity case, which we consider inequitable and unfair.

In figure 2, the data presented for all the developed economies show INDC pledges that are far smaller than their fair shares. Developed countries could support mitigation efforts in developing countries to reduce this gap. If such financial pledges were made, the discrepancies between their pledges and their fair shares could be significantly reduced. Figure 2 does not give a complete picture.

For example, South Africa's efforts appear small because South Africa's total emissions are smaller than those of other countries. In comparison to its own BAU emissions, however, it actually has to achieve 33% below BAU, while India has to achieve 6% below BAU, in a medium-equity setting. By comparison, figure 3 shows the same data in terms of the tonnes per capita reduction required by countries compared to their 2030 BAU per capita emissions. Here, India's far lower level of development is reflected in its much smaller fair share of the global mitigation obligation.

Thus, South Africa, with much higher per capita emissions, has to reduce its emissions significantly more on a per capita basis than does India. The per capita target for India with the medium- and high-equity settings is almost zero.

Figure 2: India among developed and emerging economies, 2°C pathway. Showing countries' 'fair share pledges' (the emissions reductions, in million tonnes, that countries need to make below their 2030 BAU emissions) for different equity settings.

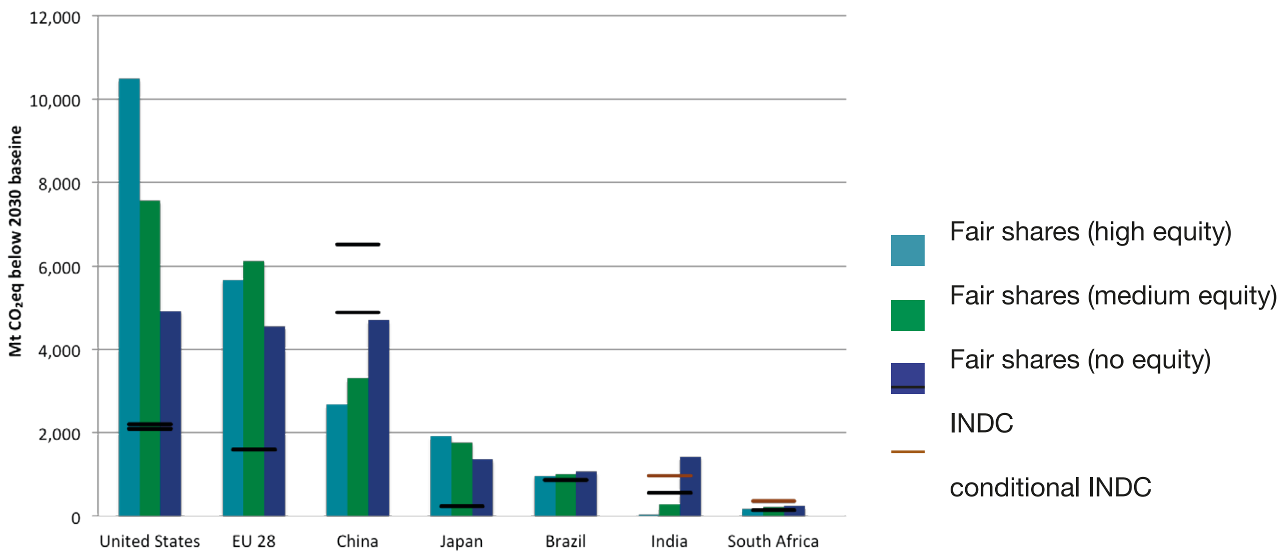
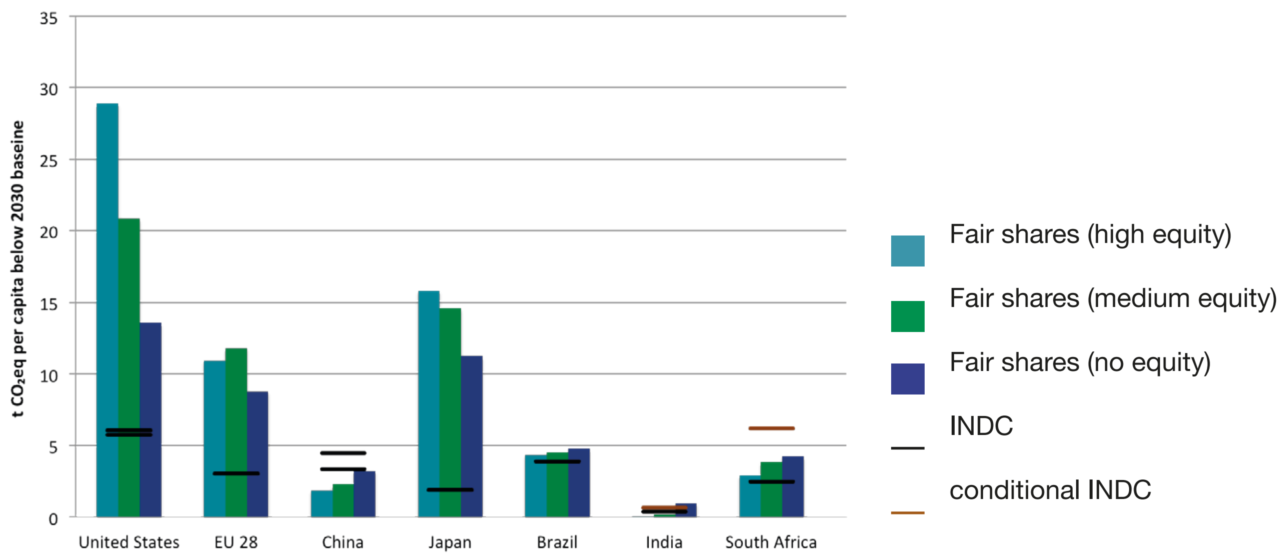


Figure 3: India among developed and emerging economies, 2°C pathway, fair share in tonnes/per capita.



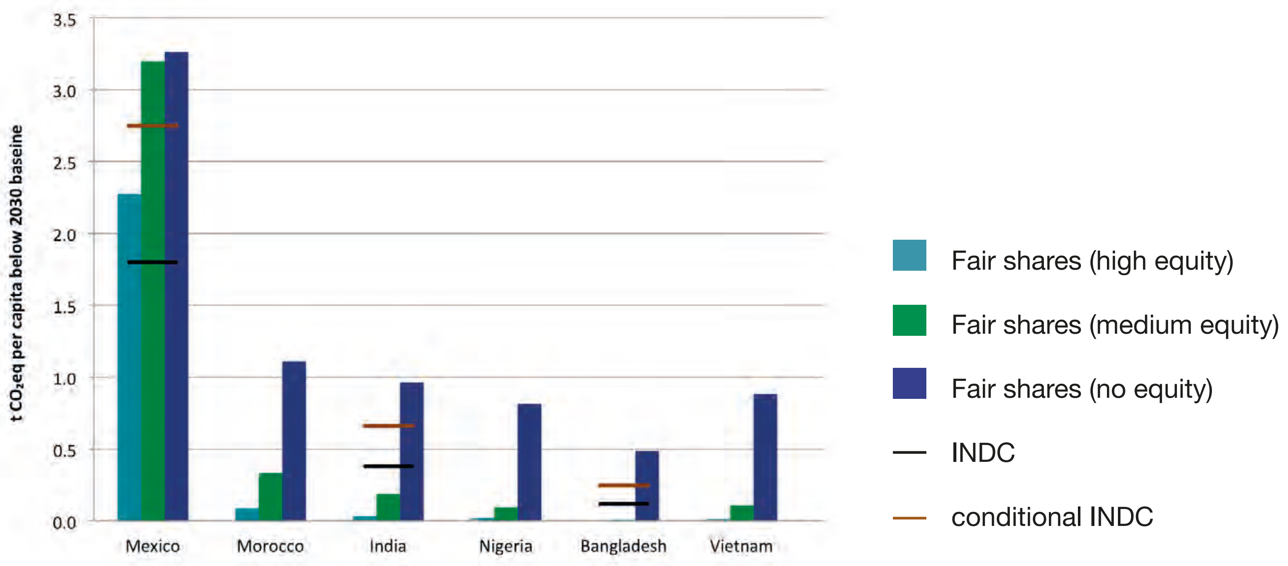
India among lower-middle income countries – 2°C pathway

Figure 4 shows India grouped with lower-middle income countries, in terms of per capita emissions reduction from 2030 BAU per capita emissions. Mexico, an upper-middle income country, is also shown here for comparison.

This puts the efforts of India and other lower-middle income countries into perspective. In terms of required absolute tonnes reduction, India's equitable share will be significantly higher than all the countries shown in the diagram, but the equitable share (expressed in terms of per capita emissions reduction) is comparable to that expected of Morocco. In the low-equity settings, the Indian effort is of the same order as Bangladesh and Vietnam, as all three of these countries have a very low development level, which is not adequately captured by low-equity settings.

Figures 3 and 4, in particular, demonstrate very clearly that it is in India's interest to call for an equitable deal in Paris, which would include an ERF.

Figure 4: India among developing economies, 2°C pathway, fair share in tonnes/per capita.



The implications for India in the Paris agreement

Although the level of carbon reduction required for India to fulfil its fair share is much smaller than the levels for developed countries, the analysis above shows that it is not a trivial amount and would draw on India's political, institutional, financial and technological resources. More importantly, the global decarbonisation challenge will require India to curb its emissions far beyond its own fair share of the effort.

This further reduction should be enabled by international financial and technological support. Inevitably, implementing it will require concerted attention and active cooperation from India.

The next two chapters will demonstrate that India can deliver more than this level of carbon emission reduction, and still meet its development and economic growth goals.

Mitigation cannot be India's primary concern. Rather, it should prioritise resource efficiency, energy access, clean cooking fuel, agro-ecology and all the rest of its inclusive development agenda. And in terms of adaptation, it will have to build its disaster-response capacities, its agricultural resilience, improve the habitability of its cities and the resilience of its transportation systems. All this will require significant resources, a strong policy push, and a great deal of political capital. It will also draw significantly on India's technical and entrepreneurial capabilities.

So what is India's role in a global climate mobilisation?

We recommend that:

- India should continue to focus on poverty eradication and inclusive development[5] that takes proper account of its pressing social environmental constraints (water stress and water security, air pollution and public health, soil depletion and food security, groundwater salinisation, habitat loss, and so on), and achieve the goal of an HDI of 0.9.
- India's inclusive development plan should explicitly account for the challenges that will arise from global climate constraints – both emission constraints and the constraints that will come with sharpened climate impacts.[6,7] These challenges are immense because any ambitious global mitigation pathway will require India's emissions – as for everywhere – to peak very soon.
- Critically, India should clarify and quantify its requirements for international support to ensure that inclusive growth can occur within climate constraints. India should therefore put forward scenario-based INDCs that consider different levels of international support and also explain how such support is consistent with equitable global cooperation in an ambitious climate transition. India should provide clear information and the conditions relating to its 'conditional' offers, so as to ensure that the offers are matched with finance, clean technology and capacity building – and are therefore achievable.

By presenting a more ambitious 'two tier' INDC, with an unconditional and conditional offer based on an ERF approach, India would be affirming its intention to pursue a low-carbon, sustainable development path that seeks to maximise both social and climate-related benefits. India would be helping to lay down the foundations of a post-Paris regime in which equity and sustainable development are drivers of, rather than obstacles to, climate ambition.

Chapter 2: Delivering a decent standard of living without costing the earth

Introduction

A huge challenge for India's policy makers is to formulate an appropriate development strategy that addresses poverty alleviation as well as inclusive growth, while following a low-carbon pathway. Even after 68 years of India's independence, India has close to 23.6% of its population who live below the absolute poverty line and survive on less than $1.25 per day[8], while 59.2% of its population live on less than $2 per day, as of 2011.[9]

Further, even as we approach the end of the Millennium Development Goals (MDG) regime and prepare to transition to a sustainable development goals (SDG) regime, India has not made as much progress towards reaching the MDG as would have been hoped.

There continues to be a fairly large development deficit, across various sectors and issue areas in India, with a large number of people in India still not having access to basic infrastructure such as electricity and clean energy, piped drinking water and sanitation, road infrastructure and proper housing.

The challenges of addressing the development deficit in India are accentuated by climate change. The dominant perception of most policy makers, that development objectives can only be achieved through a fairly high-carbon intensive energy pathway, further adds to the complications.

This chapter addresses some of these misconceptions of policy makers, exploring pathways and options that minimise resource utilisation and promote a sustainable and decent standard of living in a climate-constrained world.

It is pertinent to indicate what a decent standard of living would entail for India. This chapter defines this, using some of the previous research done by Vasudha Foundation[10], and identifies the gap between the current levels of development and thresholds for a decent standard of living. It shows that if India rigorously implements its own targets for RE and energy access it will be able to deliver much of its wider strategy around poverty reduction in an effective and affordable manner.

India's current development deficit: how big is the gap?

Like most developing countries, India aspires to reach an HDI threshold of 0.9. Currently, its level is around 0.6[11], and it ranks about 135 in the world; 0.9 would put India on par with a number of EU countries.

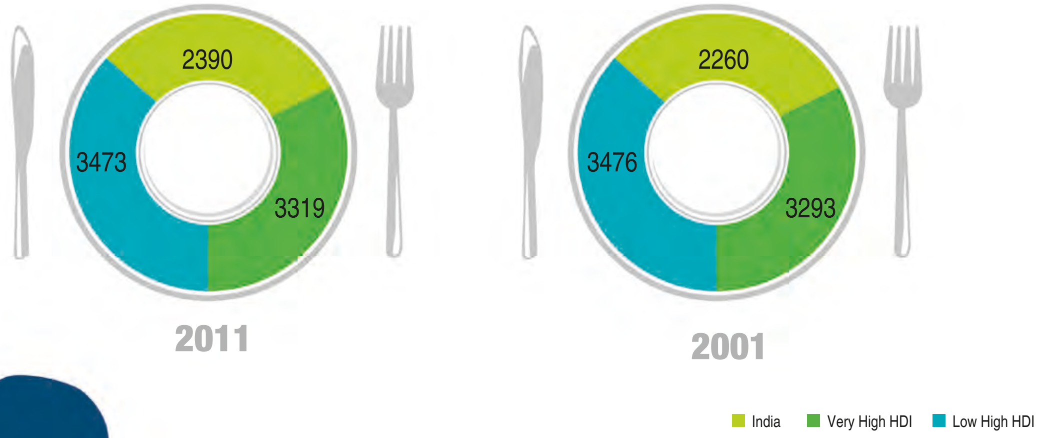
Taking this as the starting point, the research to assess living standards in India, undertaken by Vasudha Foundation,[12] focused in on what achieving this aim would entail, in terms of addressing development across various demand sectors such as food and nutrition; health; education; housing; household assets; infrastructure; water and sanitation; and access to energy. It considered how far India is from attaining a decent standard of living.

The research analysed data from a wide range of indicators, for each of the previously identified sectors for India, and compared it with data from similar indicators from a range of countries, which have an HDI index score of 0.8 and above.

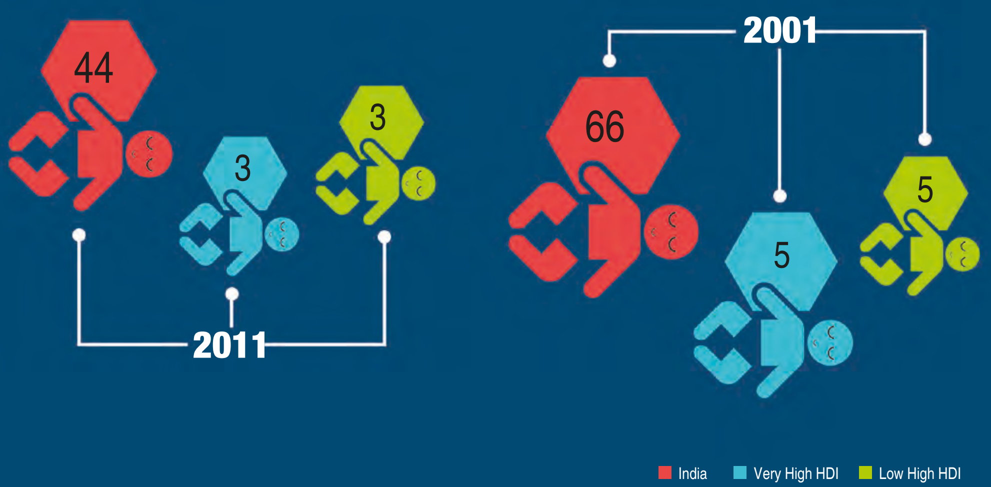
A snapshot of India's current levels of development for various key indicators (which are closely aligned to new SDGs compared with those of developed countries, is presented in the following diagrams.

Health Indicators:

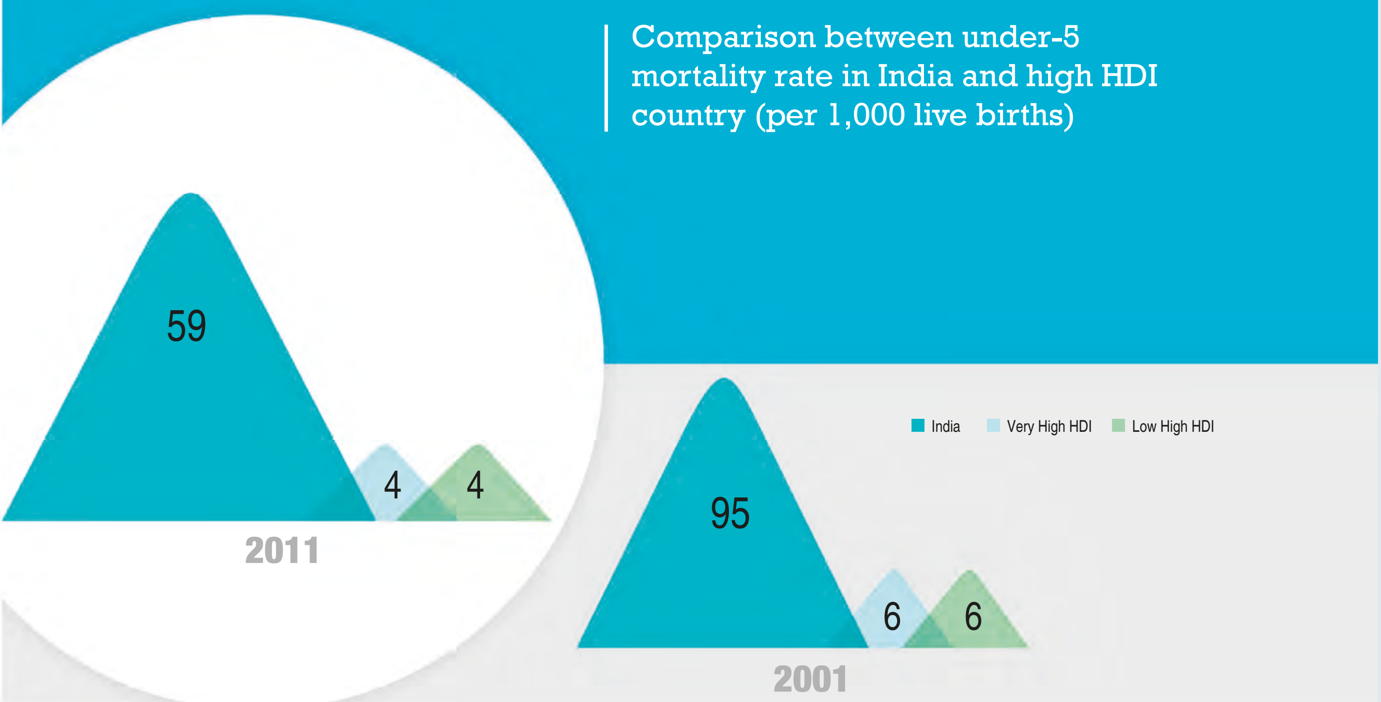
Comparison between dietary energy supply in India and high HDI country (kcal/day)



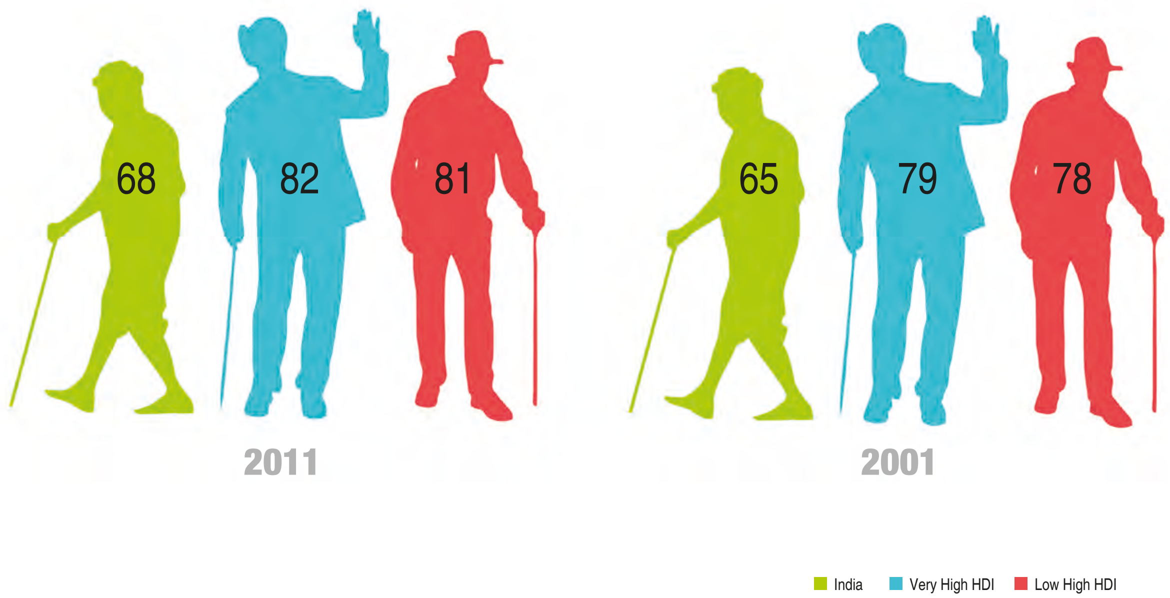
Comparison between infant mortality rate in India and high HDI country (per 1,000 live births)



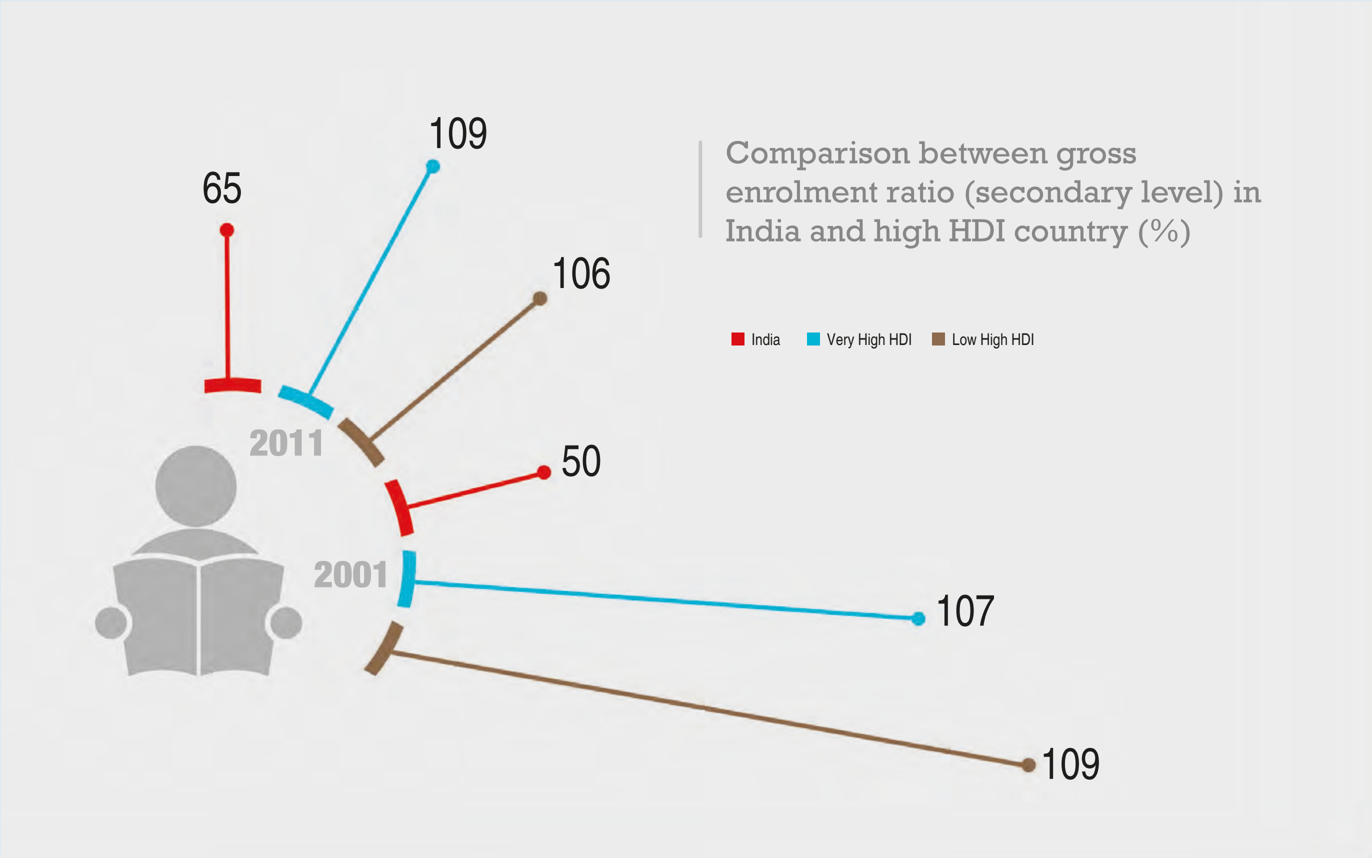
Comparison between under-5 mortality rate in India and high HDI country (per 1,000 live births)

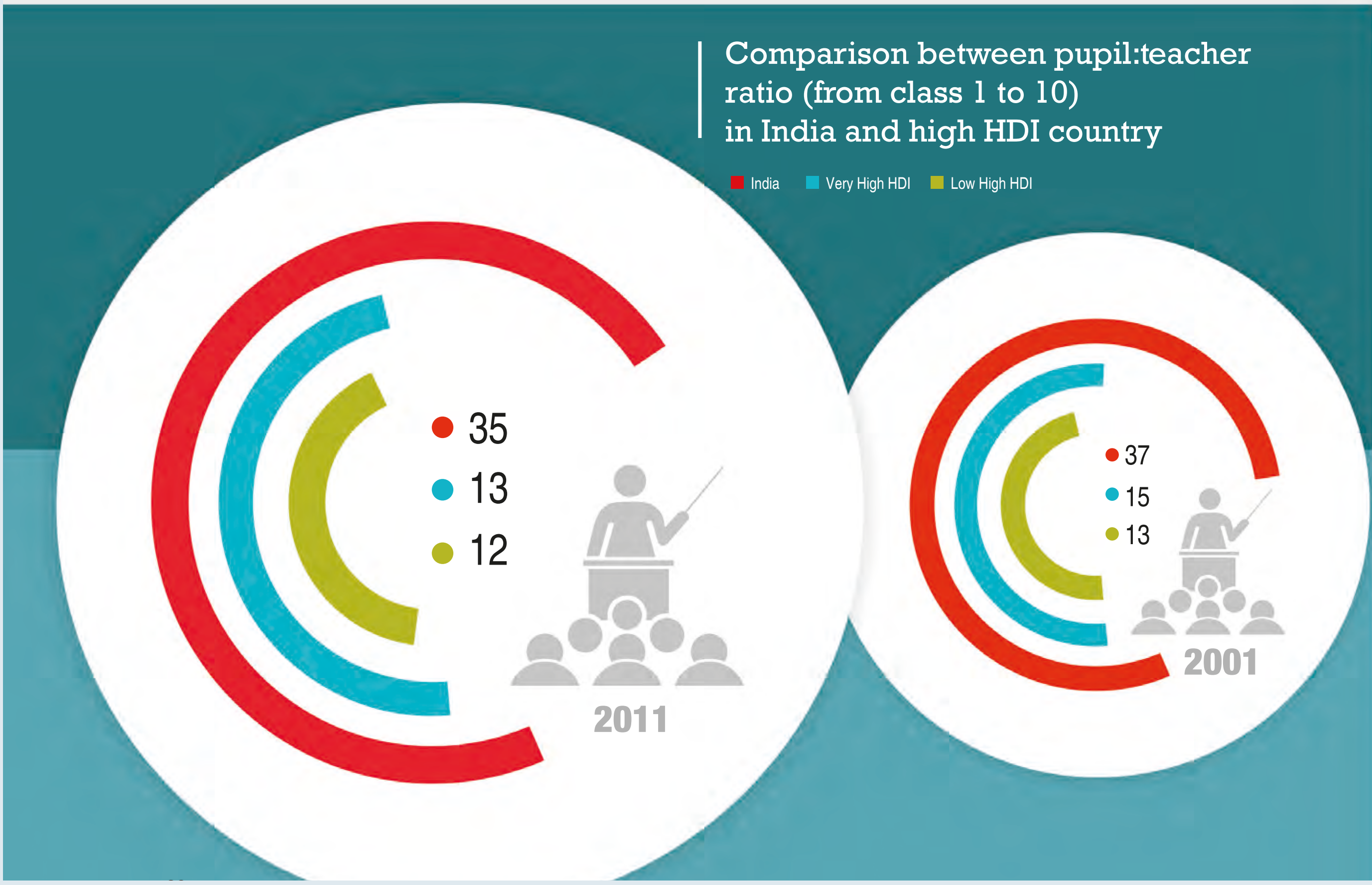


Comparison between life expectancy in India and high HDI country (years)

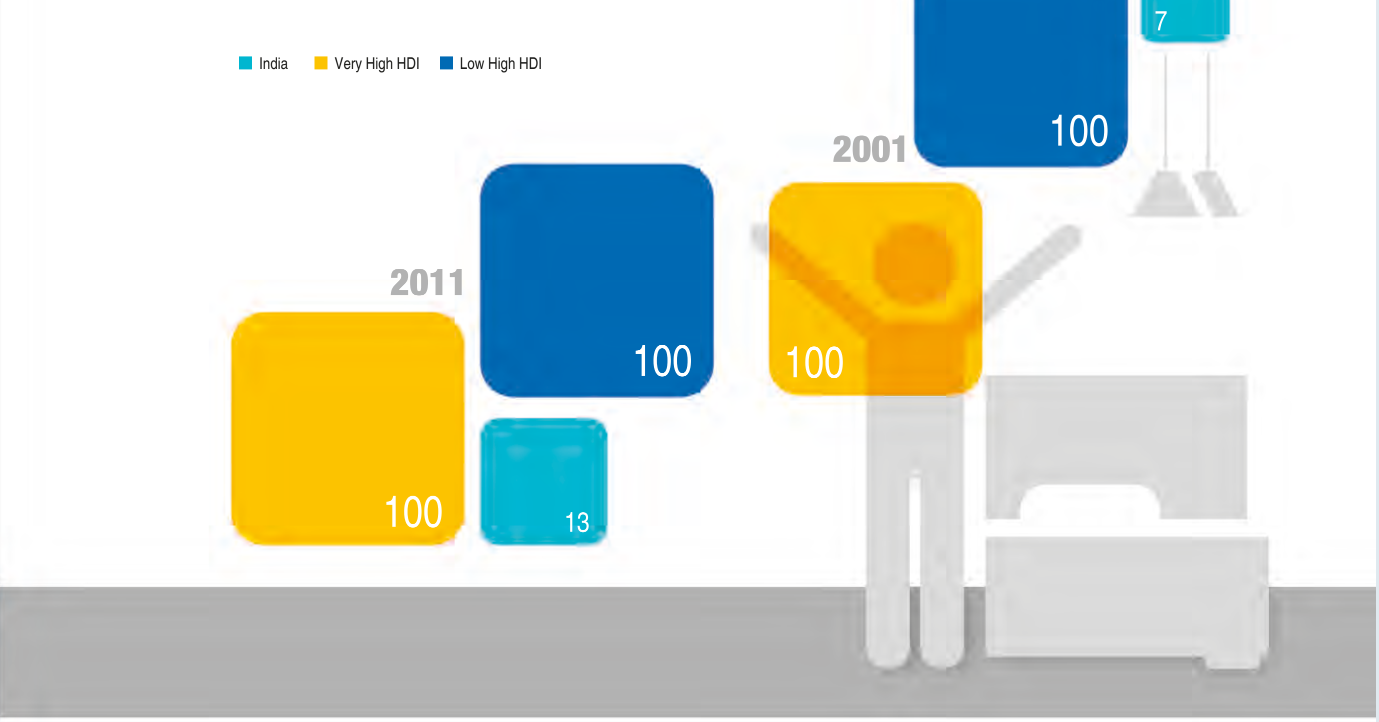


Indicators related to access to education:

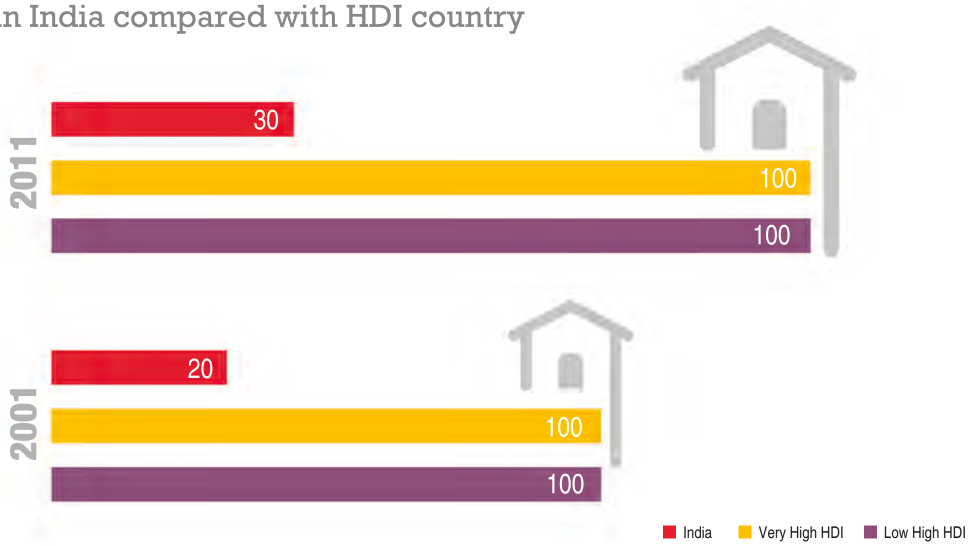




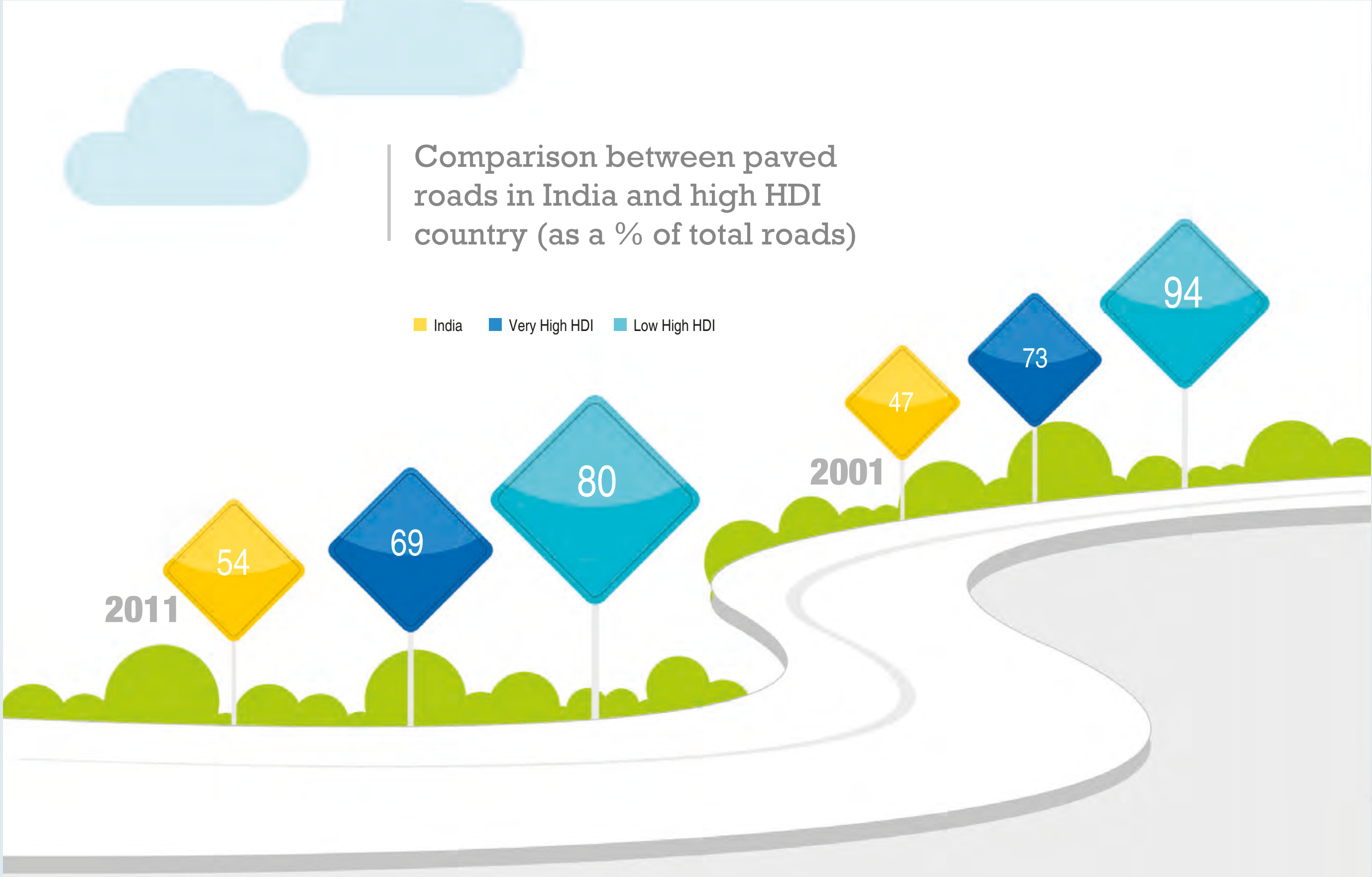
Comparison between room space (living space of 10 sq metres/person) in India and high HDI country (%)

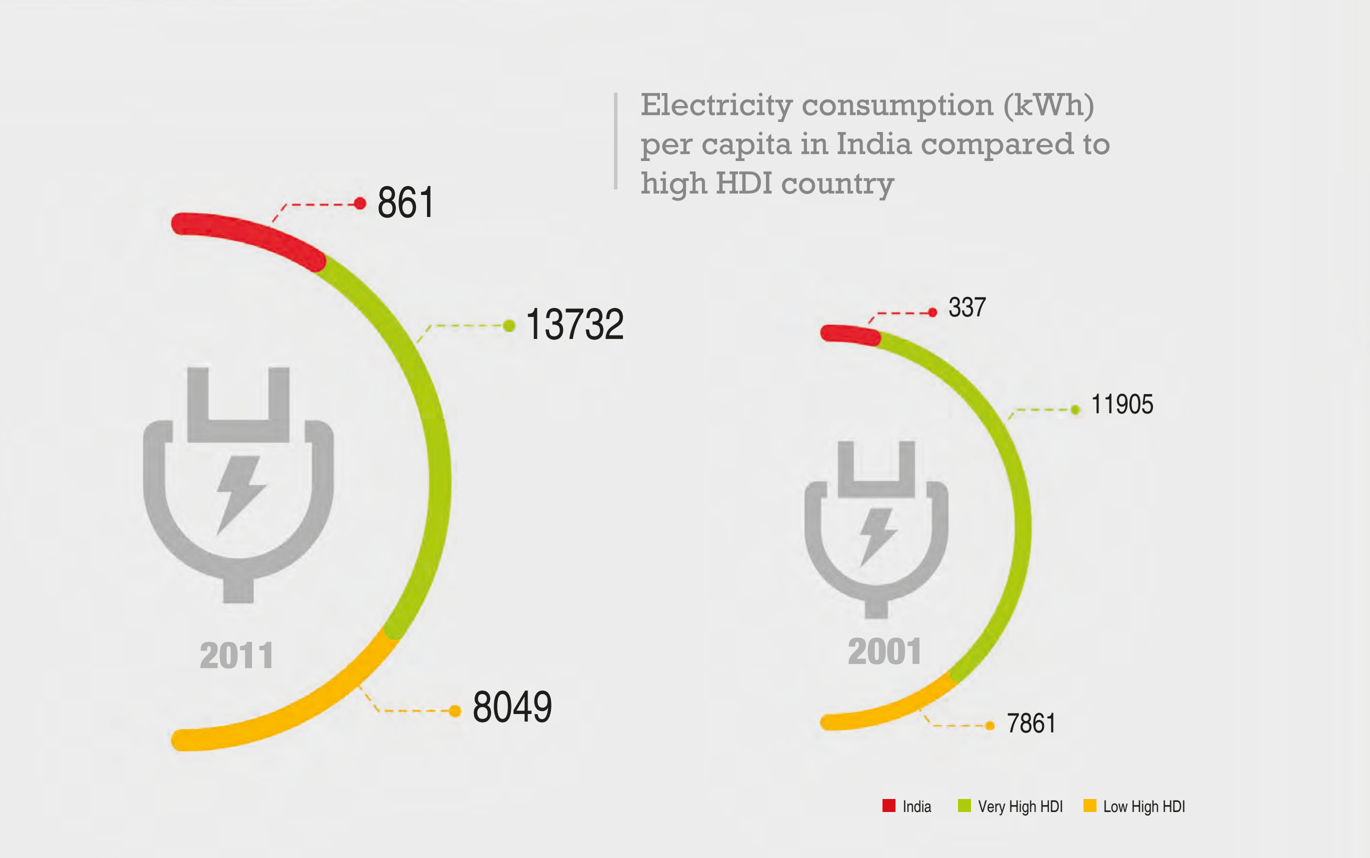


Percentage of roofs made from pucca/concrete in India compared with HDI country

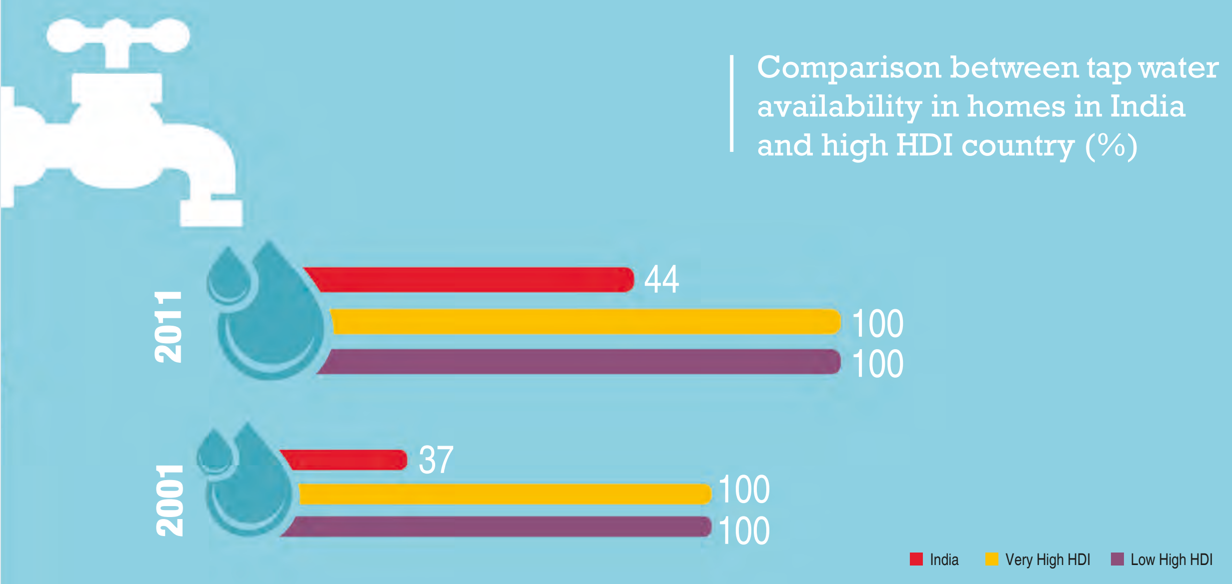


Indicators related to access to basic infrastructure:

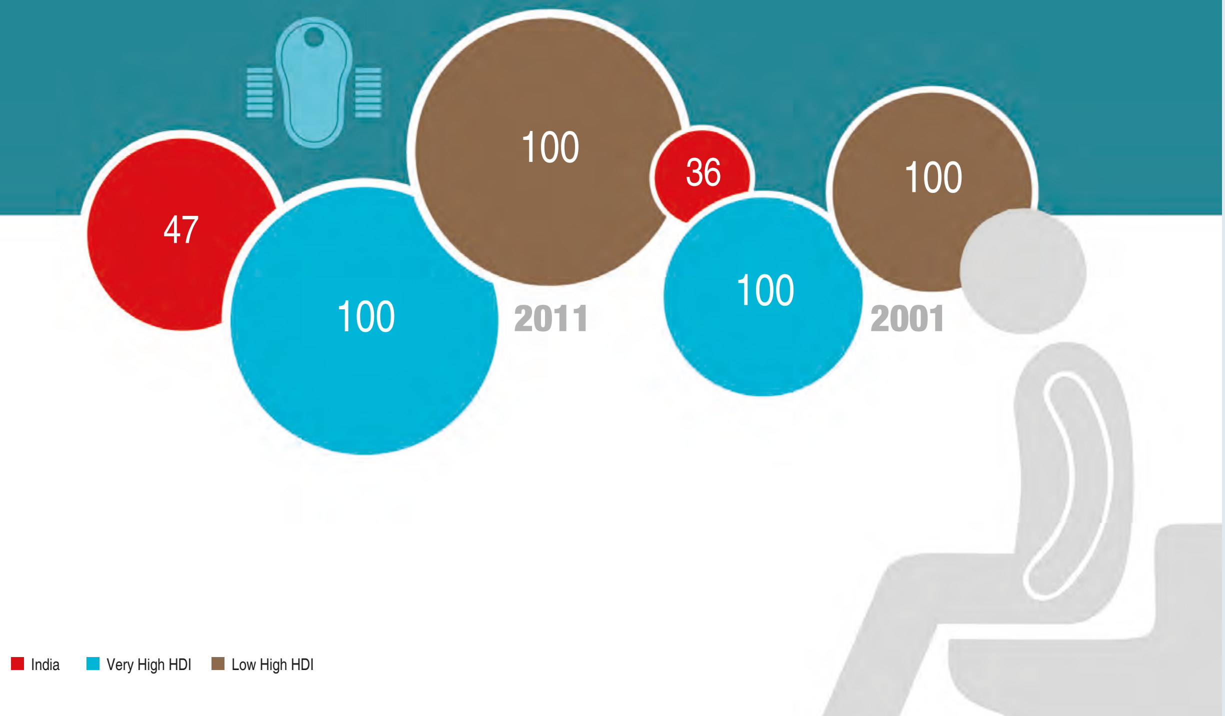




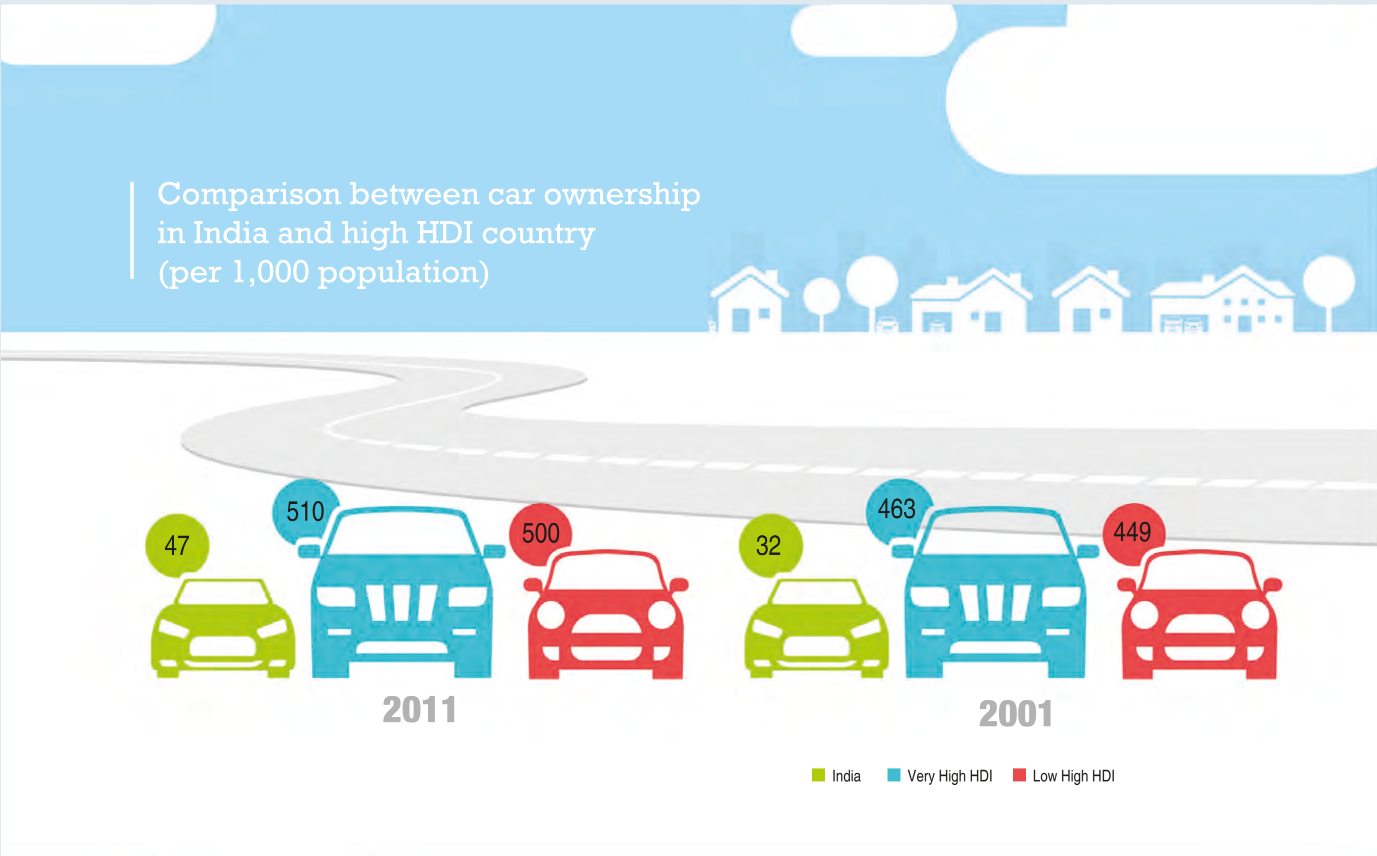
Comparison between tap water availability in homes in India and high HDI country (%)

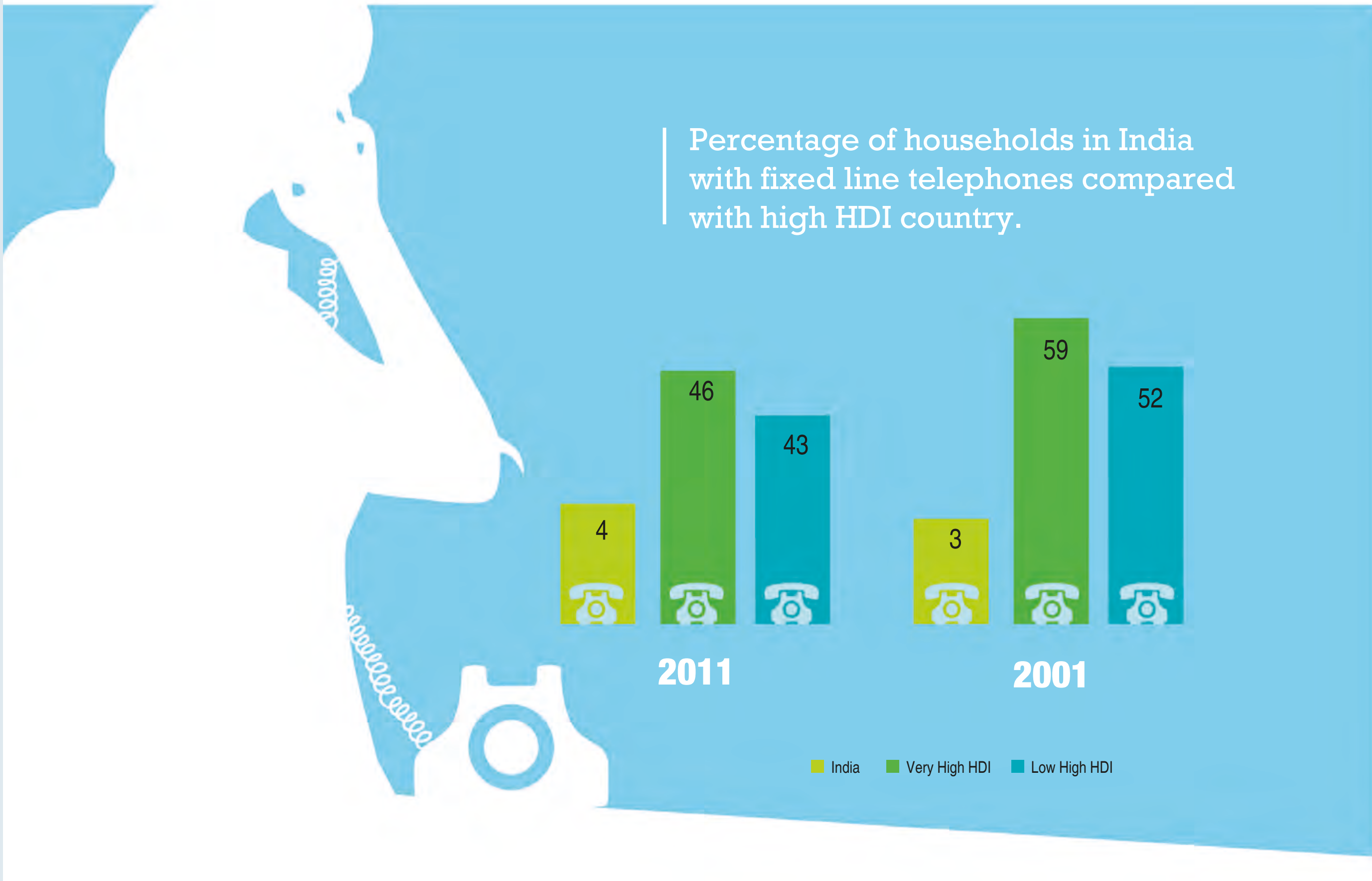


Comparison between percentage of homes with WC facilities in India and high HDI country

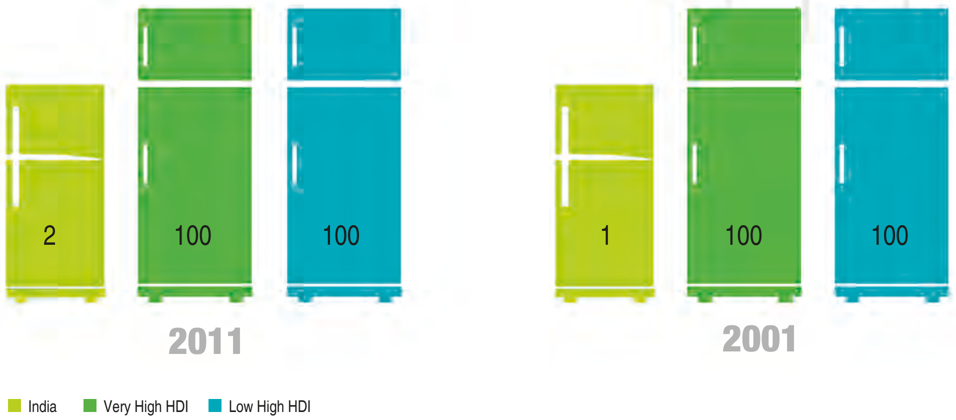


Prosperity indicators

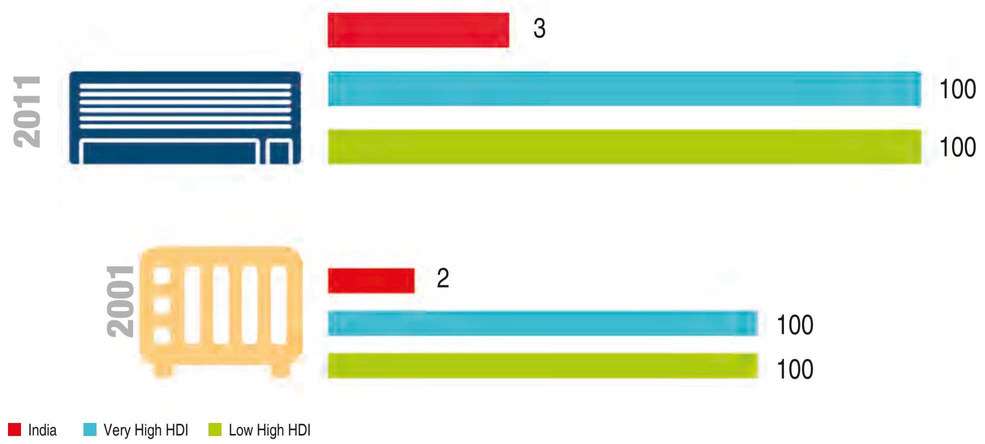




Percentage of Indian households with a refrigerator compared with in a high HDI country



Percentage of Indian households with air conditioning compared with in a high HDI country



Even a cursory glance at the charts presented shows how wide a gap there is between India and countries that have a high HDI rank or score. Despite India being one of the fastest-growing economies in the world, many aspects of a 'decent standard of living', taken for granted by people living in high HDI-ranked countries, are far beyond the reach of most people in India, including basic amenities such as tap water supplies and WCs at home.

Especially alarming is the gap for indicators such as infant mortality and mortality for under-fives, which shows just how much more needs to be done to ensure that as many children in India, as elsewhere, are able not only to survive, but to live productive and healthy lives.

More than 95% of Indian households still do not have access to appliances such as refrigerators or air conditioning units (so cannot regulate extreme temperatures in their homes).

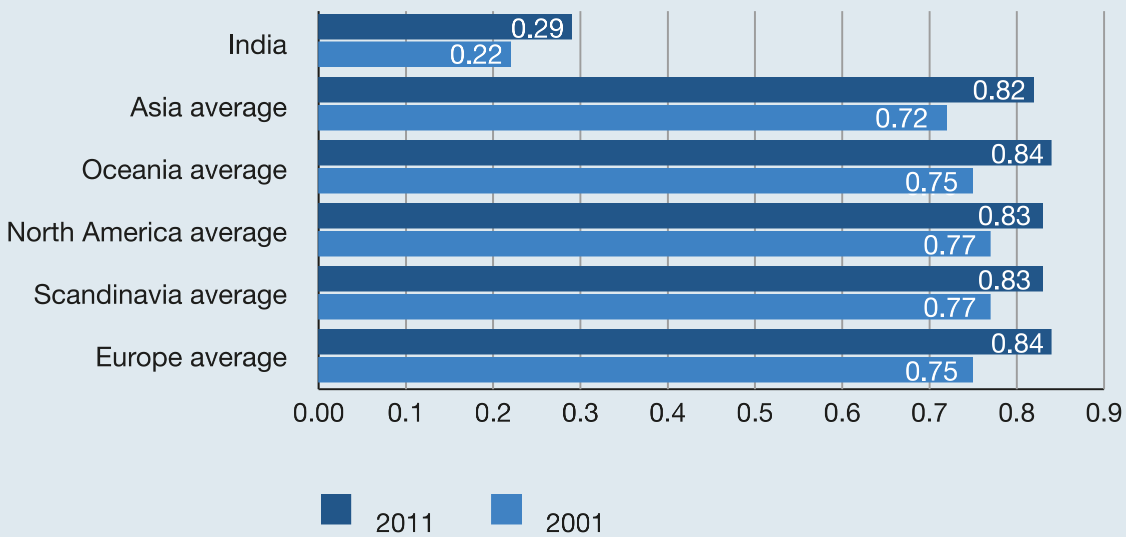
In summary, a composite 'decent standard of living index' measuring India's current development levels was created, and compared with a similar composite index created for countries with a development index of between 0.8 and 0.85, based on data collected for the sectors mentioned above, for comparable indicators. Countries with an HDI index of between 0.8 and 0.85 are categorized as 'low-high HDI countries' and countries with an HDI index of between 0.85 and 0.90 are categorized as 'very high HDI countries'.

To conclude, the results clearly show that India is a country with large development deficits, when compared with both very high HDI countries and countries with relatively low-high HDI levels.

No matter which indictor you choose to look at, the development deficit is highly significant.

The study also measured the levels of development across the years in India and charted the growth rates in development for the various indicators. This revealed that, if past trends and pace of growth were to continue, it could potentially take India as long as 30 years to reach the thresholds of even the low-high HDI countries for all the indicators. Analysis found that a comprehensive approach must be adopted to ensure India is able to reach the comparable levels of development in high HDI countries for all the indicators.

Figure 5: Comparison between composite decent standard of living index for India and other regions of the world.



The driver for achieving decent standards of living

India needs to make swift decisions about how best to alleviate poverty and ensure all people in India have access to basic services. An effective way forward may be to identify a set of drivers via which to do this.

Clearly, one of the key drivers is access to energy. There is sufficient evidence to prove that, without energy services of adequate quality and quantity, countries have struggled to meet their MDGs. This includes India, which, though it has met some of its MDGs to a certain extent, has some way to go to address large gaps in a few of them.

A new set of SDGs will replace the MDGs in 2016, and this includes goal seven: ensuring access to affordable, reliable, sustainable and modern energy for all. However, it is clear that access to energy will be integral to delivering almost all of the other 15 goals. It is important to unpack how energy access solutions can support other development objectives including modern cooking fuels, improved cook stoves, increased sustainable biomass production, and expanded access to electricity and mechanical power. These are necessary for meeting all the goals.

Lack of access to energy has a direct impact on HDI scores. A quick look at the HDI of various states in India, and their household access to electricity, clearly shows that states that have very poor household electricity access also have a very low HDI score. The following graphs illustrate this.

Figure 6: A comparison of HDI and household electrification rates in Indian states.

Source: compiled on the basis of HDI data from the Human Development Report of 2012 and Census data of 2011.

As stated previously, most of the SDGs have a direct link to the standard of living indicators and energy access, while some of them have an indirect link to energy access. The following provide examples of the direct link between some of the SDGs and access to energy.

End poverty in all its forms, end hunger, achieve food security and improved nutrition and promote sustainable agriculture.

- Approximately 47% of India's total workforce earns a living from agriculture, according to figures from 2012[13], but only 35%[14] of agricultural land is irrigated. This means the vast majority of farmers are dependent on rain for irrigation, which often restricts them to one cultivation cycle per year, rather than cultivation throughout the year. Access to electricity or other energy could potentially convert the non-irrigated land to irrigated land, leading to more cultivation per year that could translate to increased income and employment throughout the year.

- In addition, access to energy could 'add value' to agricultural produce, via the establishment of agriculture-based cottage industries, and increase the shelf life of products.

Further examples of how access to energy could end poverty and hunger are outlined below:

- Access to energy could enhance market access and avoid food wastage thanks to cold storage facilities for perishable commodities. In the absence of such facilities, most agricultural produce is currently self-consumed and much of it is wasted.

- Access to energy would reduce time spent collecting fuel for cooking, heating, and boiling water, leaving more time for working.

- Access to energy for cooking would boost the availability of nutritious, cooked food. Very often, particularly in rainy seasons, many rural families do not have access to fire wood, for heating or cooking.

- Access to clean energy would improve working conditions for many of the industries that continue to depend on charcoal and coal; for example, the brass handicraft cottage industry, or small-scale iron foundries.

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

- Access to inclusive and equitable quality education entails a good standard of school buildings and infrastructure, availability of good teachers and increasing the teacher: pupil ratio, plus adequate energy for laboratories and teaching aids.

- Access to energy would enable all of the above by:

  - helping rural schools to attract teachers

  - enabling deployment of IT-enabled teaching aids and modern laboratories, including use of the internet

  - ensuring adequate lighting, even in the evenings, to enable children to study in the post-sunset hours

  - freeing children from the time-consuming domestic chores of collecting firewood for cooking and boiling water, enabling them to attend school

  - boosting income streams for families, enabling them to send their children to school, rather than sending them out to work

  - supporting the establishment of vocational training centres and evening schools for adult education.

Achieve gender equality and empower all women and girls.

- In most parts of rural India, even today, it is the girls and women who are responsible for fetching water, sometimes from a long distance away, and also for collecting firewood for cooking. Access to energy could bring a piped drinking water supply to these areas and availability of modern cooking fuels could free the women and girls to attend schools or engage in other employment activities.

Other examples of the direct link between energy access and women's empowerment include:

- Opportunities to tap into entrepreneurial talents in women, which are often neglected when their time is taken up with other chores.

- Rural areas in India are home to a number of rich handicrafts and some of the art and crafts produced by women have earned huge recognition worldwide. However, many of these handicrafts are dying, and one reason for this (among others), is that the women do not have the time to invest in these talents. Access to energy could ensure these talents are supported, as well as creating a market for such products, worldwide.

Ensure healthy lives and promote wellbeing for all, at all ages.

- Most primary healthcare services in India do not have access to electricity and therefore are only first aid clinics, at best. Access to electricity would allow health centres to store vaccines and life-saving medicines, and to develop facilities for emergency care and differential diagnosis.

- Access to clean energy solutions would reduce the risk of smoke-induced diseases and, potentially, the incidence of fire-related injury.

- Access to energy would enable use of air conditioning, which would help keep away mosquitoes and other insects.

- One of the pre-requisites for increased life expectancy is a clean environment. Access to clean energy solutions is integral to developing a clean environment.

Ensure availability and sustainable management of water and sanitation for all.

- A clear link has been identified between access to energy and piped drinking water, and between energy access and water for irrigation.

- A regulated water supply can ensure optimal use of scarce resources, particularly in a country such as India, where there are water shortages in many areas.

Protect, restore and promote sustainable use of terrestrial ecosystems and sustainably manage forests, combat desertification, and halt reverse land degradation and halt biodiversity loss.

- Access to clean fuels reduces deforestation.

- Improved cook stoves reduce GHGs.

Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.

- This, again, is directly related to access to energy. Energy access would enable cottage industries to be set up in rural areas, potentially generating employment and promoting inclusive growth. It could potentially stem the rapid urbanisation in countries like India, caused by a migration of people from rural areas to urban areas in search of work. Energy access would allow the development of decentralised and resilient infrastructure and reduce the reliance on large companies for employment generation.

Poverty alleviation and a decent standard of living – the limitations of a BAU (high-carbon intensive) approach for energy access solutions

Having clearly established that access to energy is one of the most important drivers of poverty alleviation and would ensure access to basic infrastructure for all people in India, while putting India on a pathway to meeting sustainable development goals, let's consider current access to energy. Table 1 demonstrates the stark reality of energy access in India.

As can be seen from the table, close to 25% of India's households do not have access to electricity, and only around 18% of households have access to modern energy fuels for cooking and heating.

While the overall rate of household electrification has improved substantially in the past decade, the actual availability of power is often limited to as little as a few hours during the day. Load dispatch reports from various electricity distribution utilities, and data available with the Central Electricity Authority and the Indian Government's Planning Commission, indicate extremely low per capita electricity consumption (of just 8 kWh per month) in up to 67% of the rural households that have electricity connections.[15]

The government has tried to address the issue by substantially increasing the capacity of electricity generation plants. Capacity has increased from 74,420 MW in 2002 to 269,450 MW in 2015. However, despite this 300% rise in electricity generation capacity, the electricity supply has reached only 10.1% more rural households.

Notably, the current government has made energy security one of the highest priorities for the country and has pledged to provide all people in India with 24-hour electricity by 2022, with solar power playing a major role in this. In order to widen the options for energy supply, the government is working towards introducing long-term policies and schemes for an unprecedented expansion of RE projects. It recently announced a revised target for RE of 175 GW by 2022, which comprises an extra 100 GW solar power, 60 GW windpower, 10GW biomass and 5GW small hydro.

Table 1: Energy access statistics for India

Population without access to electricity (in millions)	Rate of electrification (%)	Urban electrification rate (%)	Rural electrification rate (%)	Household dependence on traditional bio-mass such as firewood, dung cakes and crop residue (%)
306	75%	94%	67%	82%

Source: Census of India, 2011.

While these actions are positive and encouraging steps, there is a continuing preference for a conventional, and centralised, grid-based, approach to energy access.

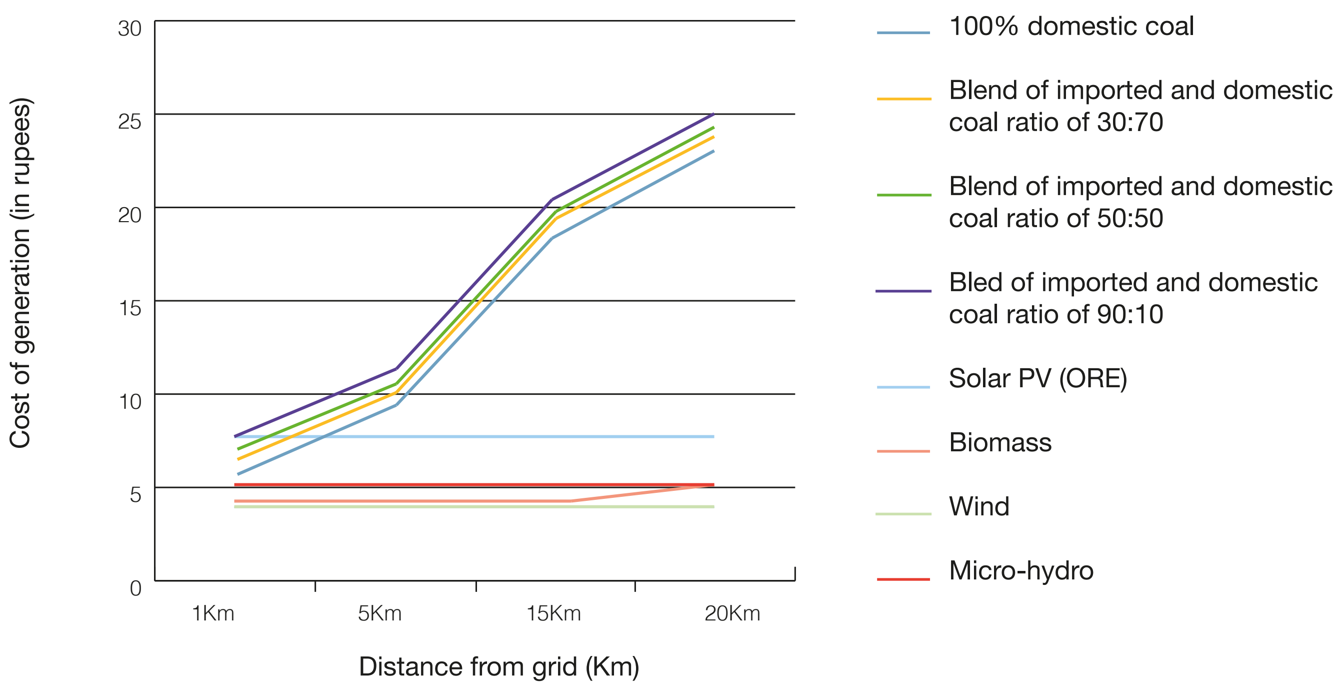
The centralised power supply model, where the cost of supplying power to rural areas is high and rises with distance from the grid, is increasingly making rural electrification difficult and uneconomical. Most coal-fired power plants are facing a huge shortage of domestic coal, which, in any case, has a poor efficiency rate, and are resorting to imports. However, the cost of generating electricity from imported coal is also proving to be very high. This boosts the costs for the loss-making electricity distribution utilities still further, with the result that most of them avoid supplying electricity to rural areas.

This undermines the conventional belief of most energy policy makers that electricity generated from coal is the cheapest and most reliable method of addressing energy access solutions. They remain under the impression that decentralised RE is costlier and less reliable than conventional grid supply.

Figure 6 shows a cost comparison of decentralised distributed RE and conventional coal-fired power plants, according to distance from the grid and present a different picture.

At least 50,000 of the 55,0000 villages in India will always be too remote to be connected to the grid at a reasonable cost. What is required, then, is demand-driven electrification that can be tailored to local needs and scaled according to local requirements.

Figure 7: Cost comparison of decentralised distributed RE with conventional coal-fired power plants.



The strategy of increasing the capacity of electricity generation from coal to address the issue of energy access, which has been followed by successive governments in India, has not worked. The pattern of household electrification rates across the country reveals that the coal-rich states, considered to be India’s electricity ‘hub’, are still in the dark and in abject poverty. The states in which there is the greatest concentration of coal power plants have the lowest rates of household electrification in the country, and lower standards of living. The installation and operation of coal power plants evidently does not go hand in hand with wealth creation and wealth does not ‘trickle down’ to local people.

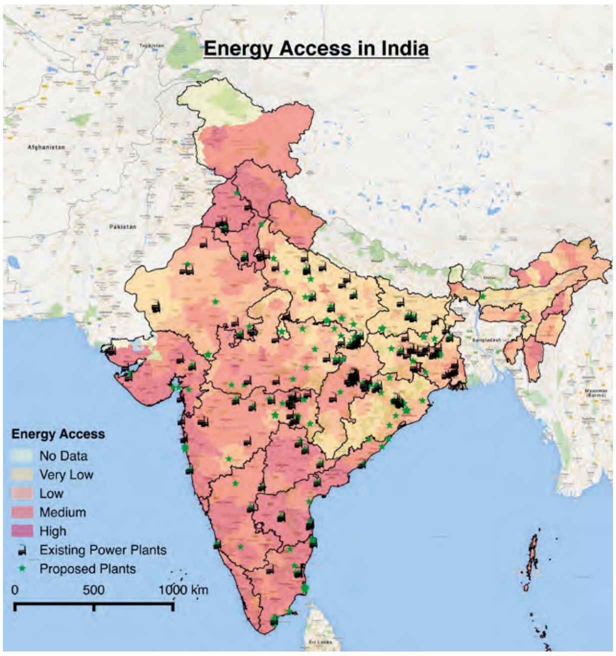
The comparative images in figure 7 demonstrate the link between energy access and HDI in India, and a possible link between conventional energy pathways and energy access.

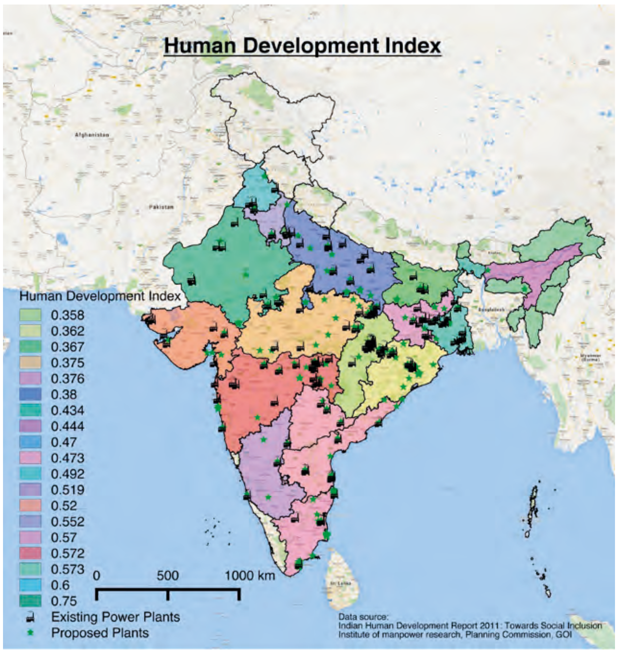
The Geographic Information Services (GIS) presentation of maps of India, showing the relationship between coal-fired power plants and energy access and between HDI and energy access, presents an accurate picture of what is happening on the ground.

There are various side effects of a coal-centric energy pathway, including pressure on water supplies. Coal-fired power plants are huge consumers of water, and given that large parts of India are in severe water-shortage zones, there is often a conflict of interests between local communities and the power plants. This is an important issue, from the perspective of poverty elimination in India. As stated earlier, close to 47% of India’s workforce are dependent on agriculture for their livelihoods, meaning they are dependent on water availability for their irrigation needs.

Coal-fired power also comes at a significant cost to the environment and to human health as a result of increased air pollution, and this has a bearing on the goal of ensuring people in India have a decent standard of living.

Figure 8: Link between energy access and HDI in India.





Source: Compiled using GIS from data sourced from the Central Electricity Authority, Ministry of Power, and the UNDP’s India, Human Development Report 2012.

Conclusion

To conclude:

a) Access to energy is an ongoing problem in India, and government polices followed to date have not solved it.

b) In line with predictions from the International Energy Agency, continuing to follow BAU will leave 20% of India's population without access to electricity and modern energy services in 2030.

c) There are clear indications that the current dependence on centralised, conventional grid power systems has failed to address the lack of access to energy, and new and alternative pathways needs to be put in place.

d) Access to energy in India is closely linked with alleviation of poverty and better standards of living. The current coal-focused energy policy could also have adverse implications for health, water and sanitation, employment, and income.

e) Until recently, the general perception has been that all RE options (whether on- or off-grid) are expensive, inefficient, and dependent on nature. However, a detailed analysis of the actual costs of energy generation indicates the reverse.

f) If India pushes ahead with its combined plans for full electricity access and RE development, these could ensure delivery of its ambitious development and poverty reduction objectives, without increasing its carbon footprint.

Merely setting targets for clean energy solutions does not, in itself, deliver clean, reliable and affordable electricity and energy for all.

One clear action that would help achieve this would be to increase focus on decentralised RE solutions, particularly in remote rural areas. The fact that most of the electricity distribution companies are experiencing financial pressures is a well-established fact. It is clear that alternative solutions, such as decentralised RE, are not only cost-effective, but could also provide reliable and sustainable access to energy for all.

As well as giving prominence to decentralised RE solutions, the new energy strategy must look at diversification of energy sources. It needs to mainstream robust cost-benefit analysis from a poverty alleviation perspective, before zeroing in on the most appropriate energy solution.

The new energy pathway needs to reap the significant benefits of energy efficiency and address the technical barriers to scaling up RE, through smart grids. From an institutional and governance perspective, a transparent and consultative institutional and governance framework needs to be put in place.

India has a number of new programmes and targets, which include a very ambitious RE target of 175 GW by 2022; electricity for all by 2022 (24 hours-a-day, seven days-a-week); elimination of poverty (US$1.25) by 2022; and 100 sustainable and smart cities by 2022.

Decentralised RE solutions should be at the centre of relevant programmes, to ensure that the envisaged targets are met. It should be noted that a solution such as decentralised RE not only helps eliminate energy poverty, but could boost standards of living. It is perhaps the best short-to-medium term measure of this. It also plays a huge role in reducing India's carbon emissions.

This report does not suggest that India should stop pursuing electricity grid expansion in the medium-to-long term, but that decentralized renewable energy can co-exist with the grid, and in fact, be an additional source of revenue for individuals and utilities, by supplying extra electricity to the grid. Every kWh of electricity generated will contribute to, and go a long way to securing, India's energy future.

Chapter 3: Achieving low-carbon growth

Introduction

India aspires to achieve an HDI of 0.9[16] and inclusive growth. These goals are expected to increase the GHG emissions if India follows the BAU path of development. An increase in GHG emissions would arise from increased energy consumption per capita, due to growing incomes, a shift away from traditional biomass energy to commercial energy in the household sector, and increased demand for consumer goods. GHG emissions will also grow if a dependence on fossil fuels continues.

This chapter explains that there is a new low-carbon way forward for India.

India – business as usual

Table 2 breaks down the growth in CO_2 per capita in India into three factors: emissions intensity of energy; energy intensity of growth; and per capita growth. The data clearly shows that growth in GDP per capita is a key driving factor for increasing per capita GHG emissions, and has negated any gains in energy efficiency (primary commercial energy use per capita of GDP). The increase in emissions intensity is also indicative of the income growth effect, as traditional biomass use is increasingly substituted for commercial energy. This trend is expected to continue over the next decade or two in India if it takes a BAU approach.

India's Ministry of Environment, Forest and Climate Change released a report[17] in 2009 providing an analysis, comparing five different studies on projected GHG emissions. The analysis indicated that GHG emissions would range from four to seven $GtCO_2e$ in 2030, compared with the ministry's estimated GHG emissions of 1.73 $GtCO_2e$ in 2007.[18] The Expert Group on Low Carbon Growth (EGLCG) established by the Planning Commission of India had, in its final report,[19] projected India's CO_2 emissions to be approximately 5.7 $GtCO_2$ in 2031. At this level of emissions, it is estimated that India would be contributing upwards of 10% of global emissions by 2030. The TERI-WWF[20] study estimated BAU emissions for India in 2050 at 11.2 $GtCO_2e$, whereas a report prepared by Imperial College London[21] put the estimates at almost 8$GtCO_2$. This increase in emissions primarily comes from fivefold increase in energy demand in the baseline driven by growth.

Table 2: Growth rate (%) of key energy and GHG emissions parameters for India.

	2000 - 2005	2005 - 2010	2010 - 2011	2011-2012
CO_2 per capita	1.13	1.37	1.03	1.06
Emissions intensity of energy ($tC0_2$/unit primary energy)	1.03	1.10	1.01	1.02
Energy intensity (primary energy/unit GDP (PPP))	0.85	0.90	0.98	1.00
Income growth (GDP (ppp) per capita)	1.28	1.39	1.05	1.03

Author's own calculation based on IEA data.

India – on a lower carbon pathway

In the opening chapter of this report, CANSA estimated India's equitable share of emissions reduction for 2030 as a 6% reduction on BAU, or a 45% emission intensity reduction by 2030, compared to 2005.

This chapter assesses the opportunity and potential to achieve these reductions. The report uses a simple model developed by the Indian Planning Commission, India Energy Security Scenario 2047 (IESS, 2047), to assess the potential opportunities for reduction in the Indian economy, and then assess the potential for India to go further in emissions reduction with international financial and technical support.

The IESS, 2047[22] model was developed to review different scenarios and develop alternative strategies for achieving goals in the energy sector. The IESS, 2047 is an energy scenario-building tool which generates the energy demand and supply scenarios for India leading up to the year 2047. The final demand and supply numbers will be generated according to the adoption of different combinations of energy-efficiency measures and technology interventions on the demand side, and an increase in indigenous resource production of the country on the supply side.

The Planning Commission drew on expertise from academics, experts and researchers to create the energy scenarios. The model uses data pertaining to 2011-12, based on published sources; the future scenarios are based on projections, developed in consultation with different stakeholders. Therefore, the tool does not highlight a preferred projection, and users are free to build their own interpretations from the scenarios presented. The strength of the IESS, 2047 is that the tool allows users to replace the numbers to create scenarios for the year 2047. All the estimates reported, unless otherwise stated, are based on scenarios developed using the IESS, 2047.

The assessment uses the basic scenarios created and picks the combinations to develop a BAU scenario, against which the emission reductions are estimated. The BAU scenario corresponds to a determined effort scenario, wherein the model chooses energy efficiency measures reflecting current efforts. In the case of RE, it picks scenarios that best reflect the solar and wind missions put in place by the government. As the model base year is 2012, and built to coincide with plan periods, the analysis of mitigation potential is represented for the year 2032, the end of the fifteenth plan period. Estimated GHG emissions in the BAU scenario are 5.92 $GtCO_2e$.

The next section outlines energy efficiency measures in power generation, household and commercial sectors, industry and transport, and provides estimates of GHG emission reductions from these measures. In the case of the transport sector, the measures for increased use of public transport, to meet passenger demand, and the use of rail to move freight, are also covered. These are measures that have significant sustainable development benefits and are also financially viable, and thus could be implemented as India's own emissions reduction contribution.

The section after this outlines measures of transformation that India should undertake in order to reduce its long-term costs of moving to a zero emissions economy. These measures cover building energy efficiency; increasing the use of electricity in the transport sector; and increasing the proportion of RE. These measures would require international support and could be defined as conditional contributions from India. A key challenge is substituting the use of fossil fuel in industry for alternatives, as of all the measures considered, GHG emissions from industry will contribute approximately 67% of GHG emissions. This is primarily from direct use of fossil fuels in industry.

Quick gains - contributing to the fair share and more

As stated in chapter 1, India's equitable share of global mitigation contribution is 6%, or 380 $MtCO_2e$, reductions below baseline. This section outlines measures that could enable this goal to be reached and surpassed, enhancing India's energy security and reducing the overall cost of creating energy infrastructure. Energy efficiency and development patterns that reduce energy demand are critical to the above two objectives.

The TERI-WWF study identified that, through aggressive energy demand management, ultimate energy demand could be reduced by 43% by 2050. The efforts towards energy efficiency have also been prioritised by the Indian Government through multiple programmes and projects.

Energy generation efficiency – technical and distribution, ultra-critical technology for coal

India's technical and distribution (T&D) losses are very high at 23%,[23] which means that for every four units of electricity produced at a power plant, only three are received by the consumer. This increases the cost of power; the investment cost of creating new power plants; and the investment required to produce more fuel for the power plants; not to mention the environmental impacts and energy spent on transporting the fuel to power plants. The world standard for T&D losses is 7%. This would require significant investment in strengthening the grid and reducing losses, but is the most cost-effective option as it would reduce the need to increase power generation capacity. A target of achieving world standard by 2042 (as in the IESS, 2047 model) would result in significant emissions reductions of 215 $MtCO_2e$ by 2032. The ESMAP (2011) study[24] estimated that achieving these standards by 2030 could save as much 568 $MtCO_2e$.

Coal-based power plants are inevitable, at least in the near future (phasing out of coal power plants is touched upon in the next section). As a short-term measure, improving the efficiency of coal power plants could result in significant cost- and emissions- savings, as well as energy security benefits. The IESS, 2047 model, in its 'heroic effort' scenario, assumes that only super-critical (SC) technology will be used for the majority of new power plants between 2020 and 2030, and less than 25% of new capacity additions will be of the more efficient ultra-super critical coal (USC) or integrated gasification combined cycle (IGCC) technology. Even this would result in a reduction of approximately 95 $MtCO_2e$ by 2032. USC use has significantly increased recently, and the L&T MHPS joint venture[25] in India even has the capacity to produce USC boilers. In the short term, the emissions reductions from unavoidable coal power plants could be reduced even further, by making USC the mandatory minimum standard for new coal-based power plants. This could easily reduce emissions by approximately 200 $MtCO_2e$.[26]

Energy efficiency measures in power generation alone could result in 310 $MtCO_2e$ (fair share requirements) to 768 $MtCO_2e$.

Housing and commercial sector - energy lighting, appliances efficiency

The residential sector accounted for 25% of total electricity consumption in 2011. Lighting and major appliances such as fans, televisions, refrigerators and air-conditioning units account for about 80% of residential electricity consumption. With increasing incomes, appliance ownership is going to increase, both in rural and urban areas. One area in which electricity use will increase is lighting, as kerosene is replaced by an aggressive electrification campaign to provide electricity to every household by 2022. IESS, 2047's heroic scenario assumes that, by 2047, 90% of appliances will be high-efficiency appliances. This would lead to a reduction in electricity consumption of about 300 TWh per year, and approximately 340 $MtCO_2e$ emissions by 2032. Improving efficiency in commercial lighting and appliances would reduce this by another 60TWh and around 66 $MtCO_2e$ GHG per year.

One of the major drivers of inclusive growth is increased availability of clean commercial fuels for cooking for all households, especially in rural areas. This implies shifting from biomass energy to liquefied petroleum gas (LPG) or even piped natural gas. In rural areas, an alternative fuel is biogas. This is likely to increase emissions, but it might help reduce pressure on forests as well as significant indoor air pollution. Addressing efficiency of cooking appliances is, thus, very important. Improvements in efficiency could result in emissions from cooking decreasing by about 20 $MtCO_2e$ by 2032.

India has undertaken a number of steps to replace incandescent lamps with compact fluorescent lights (CFLs). These programmes should be speeded up to switch to light-emitting diodes (LED). GoI Offshore has already launched a scheme to replace all street lights with LED lamps and a scheme of lamp replacement with LEDs in Delhi. The Bureau of Energy Efficiency (BEE) currently has a scheme for energy efficiency labelling. This covers only four appliances and should be extended to all appliances. Lighting and appliance efficiency could contribute 426 $MtCO_2e$.

Transport - efficiency norms, public and private passenger transport and freight transport; increased public transport in urban areas

Energy demand in the transport sector is expected to grow due to increasing urbanisation and the impact of higher incomes on travel behaviours. Increasing income is expected to boost private vehicle ownership, inter-city and intra-city passenger transport, and holiday travel. The UN DESA report[27] predicts that roughly 850 million people in India will live in urban areas by 2050. At the same time, the increasing size of the economy is expected to result in growth in freight transport. The IESS, 2047 model predicts that transport's share of the total energy expenditure is expected to grow from 17.5% in 2012 to 23% in 2032.

Increasing urbanisation would increase the strain on environments and would require active management of passenger demand. Planned urbanisation policies and transit-orientated development would help minimize the commuter trips and manage demand. Similarly-focused rural development, which addresses inclusive growth, would also help reduce rural-urban trips. Furthermore, IT and IT-enabled services would help decrease the travel demand. The IESS, 2047 model estimates that such measures could result, approximately, in a 16% reduction in passenger travel demand by 2032. This could result in 49 $MtCO_2e$ emissions by 2032.

Intensifying efforts to increase the share of public transport to meet the passenger demand would help improve the environment in urban areas as well as reducing GHG emissions. Enhancing systems like BRT and rail-based urban passenger modes of transport would help increase use of public transport. Increasing the share of public transport as a proportion of total transport from 49% to 66% by 2047 would result in an emissions reduction of around 70 $MtCO_2e$.

Fuel-efficiency standards for modes of transport is an important area to tap into. Though the CAFE fuel economy standards were proposed for passenger transport some time ago, these need to be put in place and aggressive targets adopted, to reduce the energy consumption. The report of the EGLCG estimated that improving efficiency by 1% every year could result in as much as a 132 $MtCO_2e$ emissions reduction by 2030.

The increase in freight transport is another area through which national needs could be addressed at the same time as reducing GHG reductions. Increasing the share of rail-based freight transportation, along with improving the efficiency of the freight trucks, is key to these objectives. Efforts are already being made to increase the share of rail freight via creation of dedicated freight corridors. This will require substantial investment, but it is required to achieve the potential for growth. Current efforts will result in a decrease in share of rail freight to 29%. Efforts to increase this to 45% by 2047 could result in 20 $MtCO_2e$ emissions reductions.

According to the study by EGLCG on low carbon options, all the measures discussed above could result in emissions reductions of around 179 $MtCO_2e$.

Industry - covering energy efficiency in steel, and cement

Industry accounts for around 50% of total energy demand. A significant part of this comes via the use of fossil fuels. Electricity only constitutes about 17% of total demand. Seven sub-sectors – aluminium, cement, chlor-alkali, fertilizer, iron and steel, pulp and paper, and textiles – combine to represent the largest energy consumers and, together, consume around 63%[28] of total energy. Even among these seven industries, cement, iron and steel and chemicals consume around 53% of the total. Other industries include small- and medium-sized enterprises, which are important, and which also consume a significant proportion of total energy.

With the growth of India's economy, the demand for materials and goods is expected to grow strongly. IESS, 2047 projects the energy demand for industry to more than double between 2012 and 2032. The largest share of the increase comes from direct use of fossil fuels and electricity continues to be less than 15% of the total energy demand.

India has initiated a 'perform, appraise and trade' (PAT) scheme and covers all the energy-intensive industries mentioned above. Under this scheme, each designated consumer (or facility covered by the scheme) is assigned a specific energy consumption (SEC) reduction target, compared to the baseline, to be achieved by a defined date. IESS, 2047's scenario is of intensifying the PAT scheme to cover about 80% of the units under the industries covered. It also assumed that units not covered by the PAT scheme would achieve half as many efficiency gains as those under PAT. Schemes are also designed to improve energy efficiency in small-and medium-sized enterprises, which have high employment and inclusive growth potential. These measures are expected to reduce GHG emissions by 267 $MtCO_2e$ by 2032.

The Indian Government's new National Steel Policy, its roadmap for the steel sector, envisages reducing specific energy consumption to 4.5 Gcal/tonnes steel in 2025-26 from the current 6.3, roughly a 30% reduction. It also includes a target for CO_2 emissions per tonnes of steel by 2025-26. This is motivated by a desire to make the industry more competitive, as well as energy security concerns. The EGLCG report considered a number of options for energy efficiency including the recovery of lost heat, for example, in waste gases. The EGLCG estimated that these measures could reduce GHG emissions by 65 $MtCO_2e$ by 2032.

Similarly, it estimated that measures undertaken in the cement industry to improve energy efficiency could, alone, achieve 25 $MtCO_2e$ by 2032. In the cement sector, emissions from processes could be reduced significantly through the substitution of lime with other materials such as refuse-derived fuel, fly ash, and so on. Thus, these estimates could be on the conservative side. Based on data from the CDM project on the blending of cement, and projected cement capacity of 756 MT in 2030 (IEA 2011)[29], the estimated GHG savings from 10% blending would result in about 38 $MtCO_2e$. However, the availability of materials for blending might limit blending levels.

Therefore, significant potential exists for reducing energy use, and hence GHG emissions, through energy efficiency measures. A number of programmes and measures are already being implemented in these sectors. Strengthening these measures further, and upscaling them, could contribute an (approximate) 19% emissions reduction below BAU. This is much higher than India's 6% equitable share of the global emissions reduction, and significantly higher than India's current INDC. Table 3 summarizes the reduction potential of each measure.

Table 3: Summary of quick gains emissions reduction.

GHG emissions baseline 2032 ($MtCO_2e$)	5,923
Reductions from power sector efficiency measures	-310
Housing and commercial lighting and appliances	-426
Transport sector demand management, and efficiency measures	-179
Industry sector energy efficiency	-268
Total GHG emissions post-energy efficiency measures	4,740

Early stabilisation and peaking - conditional contribution to faster switch to low-carbon development pathway

Energy efficiency could help to shrink energy demand significantly, but by 2032, India would still need much more energy than it needed in 2012. Thus, even with energy efficiency measures outlined earlier, GHG emissions in 2032, in line with the IESS, 2047 model, would be approximately 5.9 $GtCO_2e$, equating to upwards of 10% of global GHG emissions. India is expected to graduate to being a high-middle income country by 2030. Its global responsibility would therefore be much higher than currently, requiring a much sharper cut in emissions than is required today. The challenge of reducing emissions post-2030 would come from locking into fossil fuel-led energy growth up to 2030. India has a window of opportunity today to seek international support to employ the measures mentioned above to reduce its GHG emissions significantly. This would reduce its need to cut emissions dramatically in future, and would cut the cost of future GHG reductions.

Energy-efficient buildings construction

IESS, 2047 claims that 70% of the building stock that exists in India in 2030 will be built between 2010 and 2030. Growing incomes are also expected to boost demand for heating and air conditioning, leading to an increased demand for energy. Energy-efficient building envelopes (the parts of a building that form the primary thermal barrier between interior and exterior) can help manage total energy needs. Realizing this potential for energy saving, BEE has developed an Energy Conservation Building Code (ECBC), but this is presently only mandatory for commercial buildings with a connect load of 100 kW or more, and only enforced in seven of India's states (though 16 more states are in the process of making these norms mandatory). BEE has also launched a green labelling scheme to promote the code in other commercial buildings. EGLCG estimated there would be 100 $MtCO_2e$ reductions per year by 2030 as a result of increasing the share of ECBC compliant commercial buildings to 80%. Extending the code to residential buildings, as well as to retrofits, would increase the potential savings by much more.

Though the ECBC regulation is important, ensuring faster implementation of standards would require an enabling environment for the construction industry to create capacities among architects, designers and engineers, as well as creating the manufacturing base for materials. Adhering to the code may not initially be as cheap as standard construction. This would require creating funding models to help bring down costs for buyers, particularly residential buyers.

Transport sector - electrical vehicles and better freight management through growth model

Gasoline and diesel are the two main fuels used in the transport sector and only a small proportion of energy is provided by electricity (for long-distance rail systems and urban railways). Of the total energy consumed by the transport sector, only 2% currently comes from electricity. According to the IESS, 2047 model, in 2032, the transport sector, despite all the energy efficiency measures and other transport changes, would contribute around 10% of total emissions in India.

A deep cut in emissions from the transport sector requires a shift to alternative fuels. Biofuels and ethanol have been tried in the past, but given the demand for food and the significant need to replace fossil fuels, these options may have limited potential. Shifting the energy source to electricity is the option for the future, especially with the development of electric cars, as well as the solar potential in India. Charging cars may not need a grid-connected system and could actually work with standalone, RE-charging stations.

Car ownership, and thus car manufacturing capacities for fossil fuel-based cars, is increasing and could be a major impediment to a future move to electric cars. It is therefore important to ensure an early peak in fossil fuel-based cars by creating the necessary conditions between 2020 and 2030 for a significant shift to electric vehicles. This, again, requires incentives for car manufacturers and buyers as well as an infrastructure to support the use of electric vehicles. A move to electric vehicles would also help address the growing problem of air pollution in urban centres. The government could start with schemes to increase the share of electric vehicles in urban areas. Such a signal would also align long-term investments in the vehicle industries towards use of electric vehicles. The previously mentioned ESMAP (2011) study shows that, even with all the efforts to reduce emissions from the transport sector, emissions from two-wheelers and private cars will account for approximately 30% of total GHG emissions from the transport sector. Targeting this sector for transformation would enable the creation of similar paths for other sectors.

The International Energy Agency (IEA) 2013[30] study into the outlook for electric vehicles highlights that, with increased spending in developed countries on research and development and the creation of infrastructure to support electric vehicles, the costs of owning and operating them are likely to fall significantly by 2020. This, alongside tightened emissions targets for fossil-fuel based cars, is likely to result in price parity in developed countries.

The IESS,2047 model projects that the fossil fuel requirements of the transport sector in 2032 will be 10440PJ. Even if just 5% of this came from renewable electricity (522PJ), it could result in an emissions reduction of approximately 73[31] $MtCO_2e$. This would support further expansion of electric vehicles.

Management of freight demand should be pursued aggressively, given its potential for growth. Freight demand is linked to economic activity and growth in different sectors, and given the growth potential in India it is likely to increase rapidly. The demand in 2011 was 1,604 billion tonne-kilometres (a BTKM or 'one tonne-kilometre', is moving one tonne of goods a distance of one kilometre). The IESS, 2047 model projects that freight demand will grow to 15,190 BTKM by 2046-47. This scenario assumes that demand slows due to better organisation of economic activities, creation of industrial clusters and better logistics. The experts behind IESS, 2047 found that this demand could be further reduced by 18% through: increased decentralised production and consumption; concentrated economic activity in logistics parks; industrial clusters and industrial centres; and highly professional logistical organisation of goods transportation. This could reduce demand to 13,728 BTKM by 2046-47. These efforts could reduce emissions by 25 MtCO2e by 2032.

Energy generation – a shift to RE at a rapid pace with a clear cut-off date for phasing out the building of coal-based power plants)

Energy demand management could effectively reduce the dependence on fossil fuels, but given the need for energy, emissions in 2047 will still be very high and could represent a significant proportion of global emissions. A shift to RE is needed to achieve a zero GHG economy. A number of initiatives are already in place to increase the share of RE, having started with the National Solar Mission. Indian central government has provided a range of incentives for harnessing rooftop solar power and a number of state governments have followed suit. Some states have realised that RE solutions are faster to implement and, with prices falling, are becoming competitive. Thus RE meets the need for a speedy solution to the population's electricity deficit.

RE prices, especially for solar and wind, have been decreasing rapidly and many reports suggest solar is expected to achieve grid parity prices with fossil fuels in the near future. This means that creating a significant fossil fuel-based capacity over the next decade would be detrimental to keeping energy costs low, which is important for growth, as well as enhancing energy security.

The key challenges to expanding RE, and a sustained transformation, are the significant investment needed to strengthen the grid and interconnectivity within India and the wider South Asia region; using smart grid technologies to manage the higher share of RE in the grid; and investment in storage technologies. India should use the window of opportunity to seek partnerships that will enable it create the necessary grid infrastructure to upscale the RE deployment, and be in position, by 2030, to take a leap towards a zero fossil fuel future.

The interest in creating large-scale energy battery storage devices soared recently, with the announcement of Tesla's GW storage development. This will have a significant impact on the prices and quantity of storage. A report by Navigant Research stated that 362.8 MW of energy storage projects were announced worldwide in 2013-2014[32], mostly in developed countries where the share of RE in the grid is growing fast. The report further stated that installed energy storage for the grid and ancillary services is expected to grow, globally, from 538 MW in 2014 to 21 GW by 2024. The cost of storage is still high but is expected to fall as market demand grows and greater investment flows into research and development through to 2030.

In this way, outlining an ambitious RE expansion and seeking international support would be win-win for both India and the world. India, as outlined, is already taking a number of steps to increase RE capacity. In the IESS, 2047 model used, the baseline assumes that, by 2022, approximately 67 GW of additional solar and wind capacity will be added, which in 2032 would be approximately 135 GW. The coal capacity in this scenario continues to expand and will be around 475 GW. The model as designed assumes that, to overcome intermittent supply of RE in the grid, the addition of RE will need to balance the power-generation capacity, which is based on fossil fuels. Reducing coal-based capacity increases the need for balancing power capacity to absorb RE. This, again, highlights the need for smart grid and storage technology investments.

An alternative scenario with a faster deployment of RE was developed within the IESS, 2047 model. In this scenario, the RE capacity by 2032 is 330 GW of solar and wind and the coal-based capacity starts decreasing from 2017 onwards. Significant medium-or-large hydro capacities (additional 75 GW) and additional gas capacity (42 GW) are required to balance the high penetration of RE in the grid. Additional gas increases the import requirements and thus reduces energy security. In this scenario, the GHG emissions are lower by 740 $MtCO_2e$.

Achieving this requires strong investments in strengthening the grid and using smart grid technologies to absorb greater RE share in the grid. At the same time, this would also require a significant investment in creating grid storage. These efforts would have to be complemented by clearly outlining a vision for the phasing out of coal-based production. Our recommendation is that the Indian Government should set 2025 as a phase-out date for coal-based power plants; that is, no coal fire plant should be built in India after this date. This would send a clear signal of intent to the coal industry, as well as to investors in RE. A long-term vision would enable clear assessment of investments in the coal sector and help to divert investments to RE.

The options presented here are not exhaustive, but highlight some of the key areas in which actions would help reduce energy demand and make a shift to RE. These options would require financial and technological support for implementation but would significantly help India reduce the future costs of mitigation by creating a more favourable transition path to a zero carbon economy. If all these options were implemented, approximately 938 $MtCO_2e$ emissions could be achieved by 2032.

Table 4: Summary of conditional emissions reduction contributions that India can deliver if supported with finance and technology.

Emissions reduction from building energy efficiency standards	100 $MtCO_2e$
Electric vehicles and better freight logistics	98 $MtCO_2e$
Shift to RE-based electricity generation	740 $MtCO_2e$
Total potential GHG reduction from above measures	938 $MtCO_2e$

Conclusions

Due to its large population, India contributes significantly to global GHG emissions, despite a very low level of development and low per capita emissions. With India's ambitious growth plans, treading the development path followed by developed countries would lead to a significant increase in GHG emissions. Studies put India's emissions at 9-11 $GtCO_2e$ in 2050. This level of emission in 2020 would see India contributing 30%-75% of the total acceptable level of global emissions, as stipulated by IPCC AR5.[33] Even by 2030, and after taking measures to reduce emissions in line with equitable share, India's share of global emissions would be of the order of 10%.

Thus India's responsibility to reduce emissions would increase manifold from 2030 and would continue to increase as GHG emissions continued to grow. India is addressing its GHG emissions and has a window of opportunity to transfer to a more sustainable development path en route to a zero emission economy in the future.

The analysis provided shows that there are significant opportunities to reduce GHG emissions through energy demand-management measures. These measures would enable enhanced energy security, savings in the creation of energy infrastructure and would help address environmental issues in the country. The economic and sustainable development benefits of these options would be sizeable for India.

The GHG emissions reduction from these energy-efficiency measures alone would be far greater than India's equitable share of global reduction. The quick gain options could help reduce emissions by 19% below BAU by 2032, which is an intensity reduction of 55% on 2005. These options will still require a significant effort from the Indian Government and society, in terms of creating an enabling environment and innovative financing models to channel investments into these options, as well as developing the right people to operate and manage them. It would require an enhanced flow of investment, but most of the options are beneficial – from the perspective of the individual, and wider society.

An aggressive shift to RE would be an important step towards a rapid transformation to 100% RE use in India. The cost of RE is declining and to be able to take advantage of it in near future requires India to invest in a smart grid and to avoid locking into a fossil fuel-based energy system. Present negotiations provide a window of opportunity to enlist international support for the creation of this infrastructure. This, along with shifting of energy demand from solid and liquid fossil fuels to electricity, is important in the long run for achieving zero emissions. These measures, with international financial and technological support, could reduce GHG emissions by another 15%. Translated to emission intensity targets, this indicates a 62% reduction in emission intensity by 2032, on 2005.

The assessment here doesn't cover the reductions possible through afforestation and reforestation (Green Mission); reducing hydrofluorocarbon (HFC) emissions (India has submitted a proposal for HFC phase-out under Montreal Protocol which could enable a move to lower GHG and lower ozone depletion (ODP) substances), and a technology switch in energy-intensive industries. Most of these measures would require financial support for implementation. Operationalising some of these would allow India to achieve an even lower emissions growth rate.

We recommend India increases its INDC by making four important contributions:

- an **unconditional** contribution of 47% emissions intensity reduction, compared with 2005, by 2030
- an additional 15% reduction in emissions intensity by 2030, ie, 65% emission intensity reduction, compared with 2005, **conditional** on receiving financial and technical support
- a **conditional** offer to stop construction of coal-based power plants beyond 2025 if support is made available to increase the share of RE in the system

- meaningful partnership and collaboration with countries to develop and deploy clean energy solutions jointly and to develop new technologies to accelerate further the transition to a low-carbon future.

We note that India has already entered into a number of partnerships in clean energy development and deployment, with various countries such as the US, Japan, China and Germany. These partnerships include ensuring financial investment flows into India for RE including waste-to-energy systems, energy efficiency, clean and affordable public transportation systems and smart city programmes, among others.

We very much welcome these developments and encourage India to enter into more such partnerships with both developed and developing countries, ensuring North-South cooperation and South-South Cooperation. In particular, we support partnership with African countries that are also seeking technical and financial cooperation and partnership on low-carbon and sustainable development. India has announced the International Agency for Solar Technologies and Applications (INSTA) as a solar alliance in partnership with Solar Resource Rich Countries. The new agency aims to ensure universal access to affordable, reliable and modern energy services by increasing the share of RE in global energy mix. Such South-South cooperation can scale up RE in shortest possible time overcoming the existing challenges with respect to costs to consumers, investments in RE and technology transfer. By already committing US$90 million as an initial investment, in spite of resource scarcity, India has conveyed its genuine intentions to find a long-term solution to challenge of climate change. Such intentions from developing countries are commendable and should be encouraged in global policy frameworks.

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3. The analysis presented here is based on the Climate Equity Reference Project's equity reference calculator. This is an online effort-sharing calculator that takes historical responsibility, national capability and development needs into account to calculate each country's fair share of the total climate effort, based on user-specified technical and equity-related settings. For more information, see climateequityreference.org
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