ELECTRICITY FOR ALL IN INDIA

Why coal is not always king

A Report by Vasudha Foundation

VASUDHA FOUNDATION
Green ways for a good earth!

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CONTENTS

List of Tables

List of Figures

EXECUTIVE SUMMARY

Coal has always been the mainstay of the Indian electricity sector and many policymakers and analysts believe that it must remain the primary source of electricity generation for at least the next three to four decades. This view is based on the belief that a centralised electricity system based on an ever-expanding coal power generation base will ensure energy security, provide affordable energy for all and, importantly, address the issue of energy scarcity in India. In the world's third largest producer of coal (after China and the United States), coal is king. This report challenges this view and proposes an alternative approach for India.

The assumption that India has an abundance of cheap coal is mistaken. Projections assuming a 'business as usual' policy approach show demand for coal at least doubling over a twenty-year period. The proven extractable reserves are simply not adequate to meet this huge expansion in demand. Furthermore, the bulk of proven coal reserves are located in ecologically sensitive or densely populated areas of the country, meaning that it is not economically, technically, environmentally, socially or legally feasible to mine the reserves to the extent that would be required.

The acute supply shortage, coupled with the fact that domestic coal is generally of low quality, has led a number of power plants to resort to using imported coal. According to a Reserve Bank of India 2013 report, the coal imports bill adds a burden of US$18 billion every year to the country's economy. What is more, the new generation of coal-fired Ultra Mega Power Plants (UMPPs) planned by the Indian government will only be able to use high grade coal, and so will be permanently dependent on imports.

Coal is not a cheap source of electricity. The cost of electricity generation from coal is rising while the cost of renewable energy is falling. The increasing use of imported coal and the fourfold increase in the price of imported coal mean that coal power is already more expensive than many renewable electricity generation solutions. The cost of generating electricity from solar is now only marginally higher than the cost of generating electricity with a 90:10 blend of imported and domestic coal, a typical ratio for the new UMPPs. For village electrification when the village is more than 5km from the grid, the cost of supplying electricity from decentralised renewable sources is far below the costs of supplying from conventional sources when grid transmission infrastructure is taken into account.

Coal will not deliver sustainable energy for all. According to the International Energy Agency, 147 million Indians will remain without access to electricity even in 2030 if business as usual policies are followed. The pattern of household electrification rates across the country reveals a further injustice, with the coal-rich states often the ones still in darkness and with the highest levels of poverty.

Fuel shortages mean that coal-powered electricity generation is unable to meet demand, resulting in blackouts and brownouts (electricity voltage fluctuations), which particularly affect rural areas. This puts in question the belief that India's energy gap can be filled mainly by coal power. The level of power wastage through transmission, distribution and commercial losses shows the importance of investing in the electricity network as a priority, rather than in new coal-fired power stations.

The true cost of coal includes its toll on social structures and the environment. The mining, processing, transportation and burning of coal and the disposal of coal waste harm the poor or indigenous communities where they take place. Threats to these communities from coal mining include population displacement, polluted or depleted water sources and the loss of livelihoods through deforestation. Coal power plants also deplete and pollute water sources, frequently being sited in areas of water stress despite their huge appetite for water. Power plants also have more widespread health implications through their toxic particulate emissions, and contribute to climate change through the greenhouse gases they emit.

Various policies are in place intended to ensure that social and environmental concerns are taken into account when decisions are made about new developments. However, the manner in which Environmental Impact Assessment reports are published makes it difficult for communities to mobilise effective opposition. Furthermore, the recent changes to regulations mean that some expansions can now take place without any public hearings or other formal consultation.

In short, many of the arguments made in favour of coal do not hold true when subjected to closer scrutiny. This report proposes a different strategy, which would instead direct India's energy sector towards the use of sustainable, affordable renewable energy to deliver new and improved access for the energy poor.

Renewable sources have the potential to contribute a much greater share of India's energy. The contribution made by renewable sources to India's energy mix has grown at a phenomenal rate recently, leaping from 13 gigawatts (GW) in 2010 to 32 GW in March 2014, with a further 40 GW planned by 2022 in order to meet a government target. However, this total is still well below the most conservative estimates of renewable energy potential.

Renewable energy reduces emissions, improves energy security and can drive regional development. On average, every GW of additional renewable energy capacity reduces carbon dioxide (CO_2) emissions by 3.3 million tonnes a year. If CO_2 reductions are correlated with particulate emissions reductions, each GW of renewable energy capacity saves around 1,100 lives through reduced mortality. A further benefit of renewable energy is an increase in long-term energy security through the diversification of supply, reduction of import dependency, and mitigation of fuel price volatility. The promotion of renewable energy can also be an important tool for regional development within India, given that many of the states with the greatest renewable energy potential also lag in economic development.

This report recommends that India pursues a policy of diversifying energy sources, including both on-grid and off-grid solutions. A robust cost benefit analysis of coal, covering all externalities, will support policymakers' decisions to favour renewables and energy efficiency over coal power.

It will be important to invest in energy efficiency, particularly addressing transmission and distribution losses, as well as in new generation capacity. A transparent and consultative institutional and governance framework is needed to ensure that energy developments do not threaten fragile ecosystems or the rights and livelihoods of local people. The carbon tax on coal should be adjusted upwards so that it reflects the true cost of coal, with the revenue raised clearly earmarked for research and development into clean energy and environmental remediation programmes.

By following the recommendations in this report, India has the opportunity to ensure reliable access to sustainable energy for all.

1. INTRODUCTION

India is the dominant energy consumer and producer in South Asia; its energy policies matter significantly in terms of how the region as a whole will meet its energy requirements. One of the most significant problems today, as this report explores, is the continued reliance on dirty coal-fired power plants which dominate the Indian power sector.

Direct impacts resulting from the construction and operation of coal-fired power plants include emissions of particulates and hazardous chemicals, pollution of local waterways and degradation of land used for storing the by-product of burned coal, known as fly ash. The indirect impacts, which result mainly from coal mining, include degradation and destruction of land, water, forests, habitats and societies in general.

Despite being a regional energy giant, India has a low per-capita electricity consumption (879 kilowatt hours (kWh) per person per year) compared to China (3,29kWh per person) and the US (13,246kWh per person).[1] The low per-capita energy consumption in India is primarily due to the fact that a vast majority of the population does not have access to modern energy sources to deliver basic energy needs. One in four Indians does not have access to electricity; about two thirds of the population use traditional biomass for cooking. 'Energy poverty' – the inability to access sufficient energy – is one of the reasons for the low levels of development in some regions, as energy deprivation has significant health, social, environmental and economic implications.

The government is relying on coal-fired power plants to reduce the energy deficit and lift people out of energy poverty. In March 2013, it commissioned the final section of the 4,000-megawatt Tata Mundra coal power plant in Gujarat. This installation is one of sixteen planned UMPPs, each with a capacity of 4,000 megawatts or more, that represent India's big push towards coal power as the solution to its energy deficit. [2]

Tata Mundra is a shining example of modern technology. Its 'supercritical' steam generation systems are significantly more efficient than the rest of India's aging coal fleet, and it will burn less-damaging imported low-ash and low-sulphur coal. However, Tata Mundra and the other planned UMPPs highlight many of the formidable costs associated with India's decision to base its electricity generation capacity expansion on coal. Tata Mundra is just a part of the story of coal in India, the true cost of which this report will address.

The report focuses on coal use in power stations, as coal power currently provides 75% of electricity consumed in India'.[3] It is largely through power generation that the benefits and costs of coal are realised for the Indian population, offering the prospect of improved access to energy for some while elsewhere threatening health, rights and the environment. Power generation also offers an alternative path: one of decentralised renewable energy that delivers electricity access for the most marginalised, while operating in greater harmony with the environment, health and people's rights.

This report is a challenge to perceived wisdom on the supremacy of coal in India, presenting realities and trends that provide evidence to the contrary. It digs

Right: A view of Moolchand, Delhi. The area is polluted with ash from a coal-fired power plant, which threatens people's health.

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deep into the problems that surround the mining and use of coal in India, examining evidence of the environmental, social and economic implications of continued dependence on coal as the dominant source of electricity. In doing so, it also counters some of the misconceptions about alternative sources of energy, showing that a sustainable future is possible without dirty and destructive coal.

2. POWER FROM COAL

2.1. India's dependence on coal

India's dependence on coal can be seen in its electricity generation mix. As of January 2014, 139 GW (approximately 59% of the total installed capacity) came from coal-powered thermal generation.[4] The balance consists of a combination of hydro (17%), other fossil fuel (9%), nuclear (2%) and non-hydro renewable energy sources (13%). The energy delivered highlights this coal dependence to an even greater extent: in 2011, 68% of electricity generated was derived from coal.[5]

In recent years, India's electricity sector has grown at a rapid pace. Installed generation capacity has grown phenomenally post independence from some 1.4 GW in 1948 to about 236 GW in 2012. Electricity consumption in the last decade rose approximately 3.8% per annum,[6] and is continuing in a rapid upward trajectory. This growth has been fuelled in part by increased private sector participation in the sector, enabled by the reforms initiated by the Electricity Act of 2003.

Figure 1: Projections of coal demand for India under various 'business as usual' policies[7]

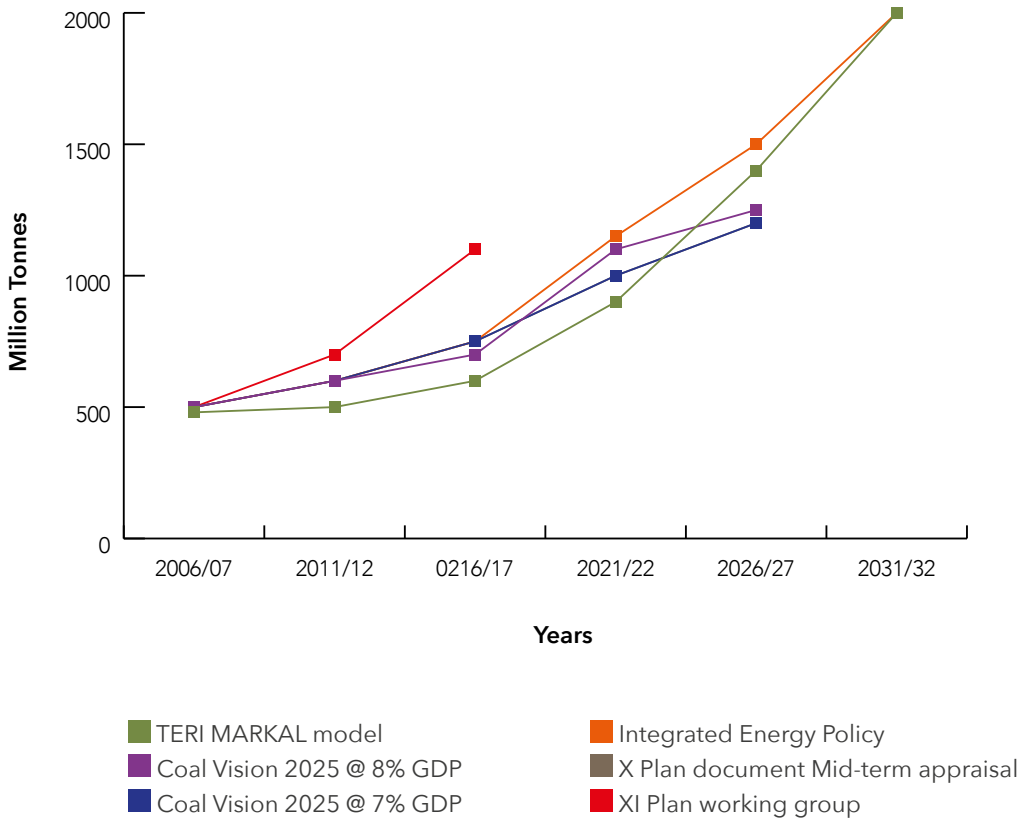


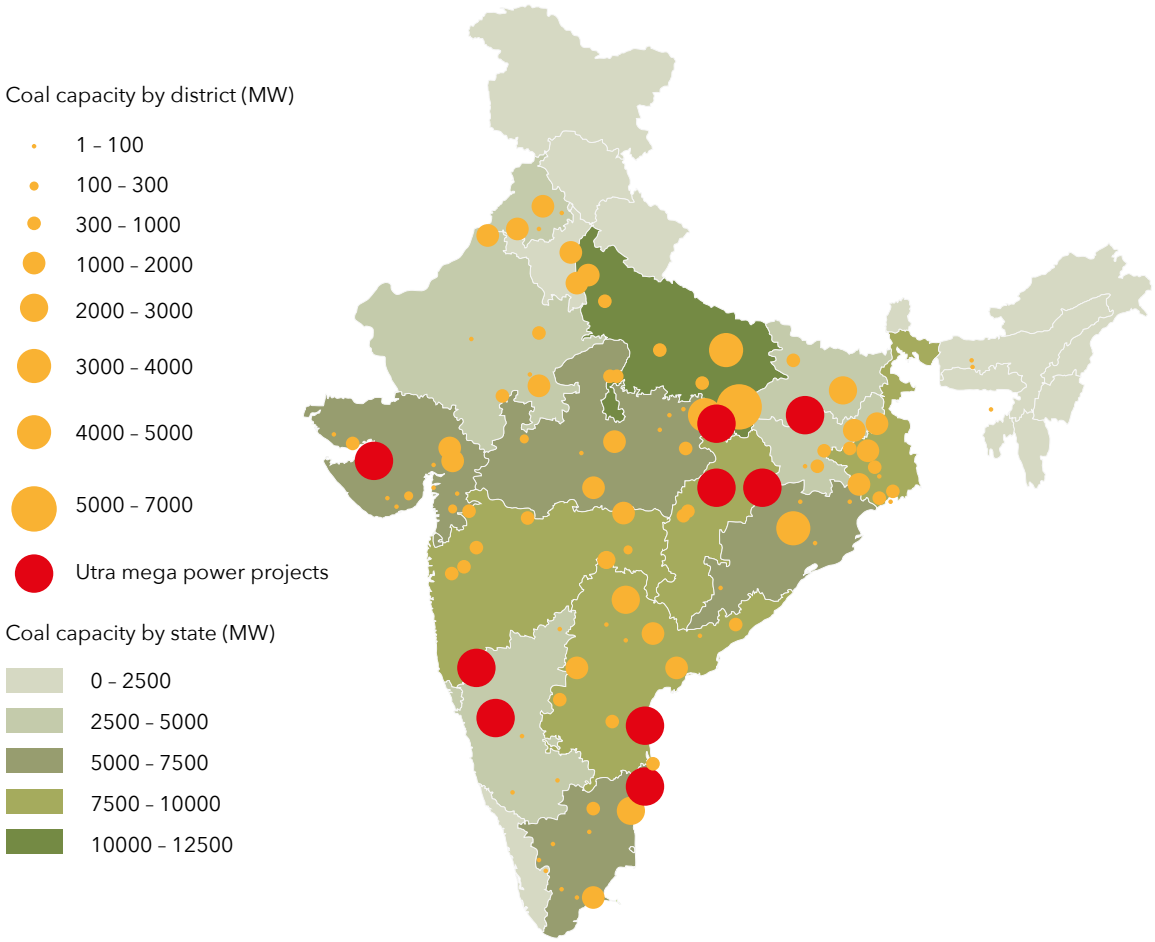
Figure 1 shows six projections of future coal demand in India based on different policy scenarios. However, these policy scenarios are all broadly 'business as usual' – that is to say, they assume that coal generation will continue to grow at an accelerating pace. They do not account for the impacts of three major issues: limited domestic coal resources, technology constraints for India's low-grade coal, and climate change.

India's indigenous coal production is not able to keep pace with demand, in terms of quality or quantity. Coal shortages are a major contributor to shortfalls in electricity generation and consequent blackouts throughout the country. Between 2008 and 2012, India imported 10 per cent of its coal. This situation is projected to worsen: the Planning Commission projects that, over the next 20 to 25 years, 11 to 45 per cent of total coal demand will have to be met by imports,[8] with implications not only for the energy sector but also for national security and finances. Prospects for increasing domestic coal output are mixed; it may be possible to overcome some constraints on production (such as the low productivity of Indian coal mines, and delays in obtaining government clearances for new mining activities), but other constraints cannot be removed without severe negative social and environmental impacts.

Ignoring these constraints, even a steep increase in domestic coal output would not solve India's electricity problems. India's latest generation of large new coal-fired power stations are called Ultra Mega Power Plants (UMPPs). Most of the planned UMPPs use 'supercritical' technology and require coal with a high calorific value and low sulphur and ash content. Most domestic coal does not meet those standards. The coastal locations of a number of the new UMPPs, shown in Figure 2, betray their reliance on imported coal.

Increased dependence on this constrained and finite resource weakens the country's energy security and will expose the electricity sector to the forces of international markets, which operate in an environment of increasing resource constraints.

Figure 2: Regional distribution of existing coal capacity in India and planned UMPPs[9]



2.2. Coal, electricity access and development

Policymakers in India have long equated energy from coal with development and growth, considering the country's coal resources to be a national asset to be exploited to deliver prosperity for Indians and lift poor people out of poverty. The government has invested heavily in coal, and India as a nation has indeed grown more prosperous. However, this growth has not benefited the underprivileged majority. Perversely, the benefits of coal exploitation – at least in terms of electrical generation – seem to be denied to those populations which are most richly endowed in terms of coal resources.

The importance of energy access

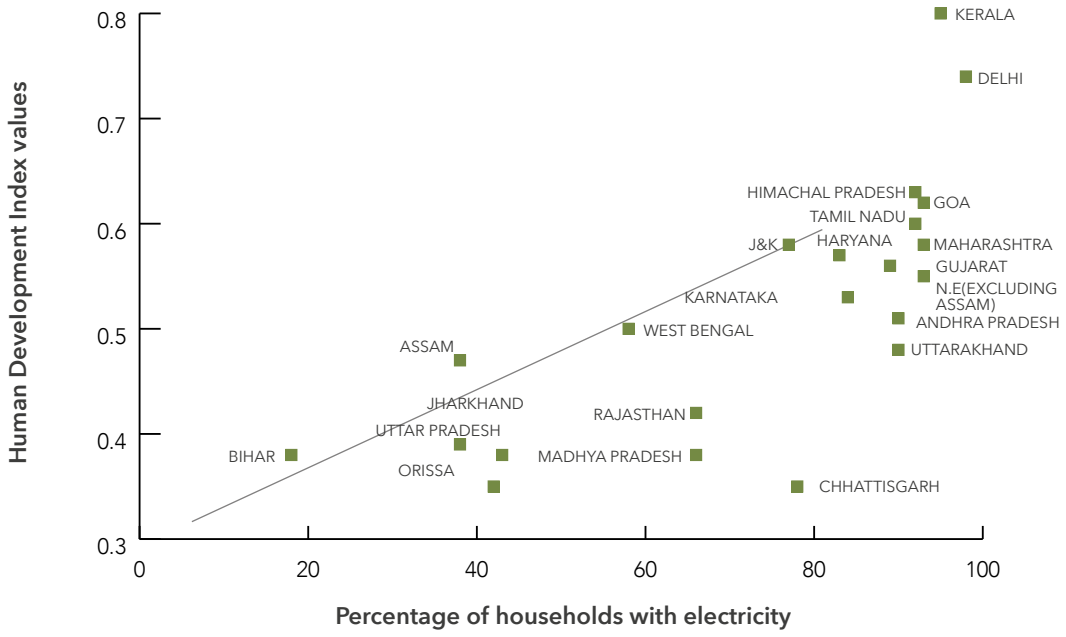
Modern energy services are crucial to human wellbeing and to a country's economic development, being essential for the provision of clean water, sanitation and healthcare as well as reliable and efficient lighting, heating, cooking, mechanical power, transport and telecommunications services.[10]

Electricity, while not the only form of energy that can deliver these services, is unique in its versatility and potential for convenience and safety.

The lack of modern and affordable forms of energy (including electricity) adversely affects agricultural and economic productivity and opportunities for income generation, with impacts in terms of malnutrition, low earnings, and a lack of surplus cash amongst affected communities.[11] The inability to pay for electricity generation equipment, electrical devices or the power itself is a key contributor to the vicious cycle that ensures that poor people remain poor.

The Human Development Index, a composite measure of health, education and income indicators, shows a positive correlation with household electrification – see Figure 3. This relationship suggests that improving access to clean and affordable energy is critical to improving the overall human development in those areas which are most lacking.

Figure 3: Relationship between household electrification and human development



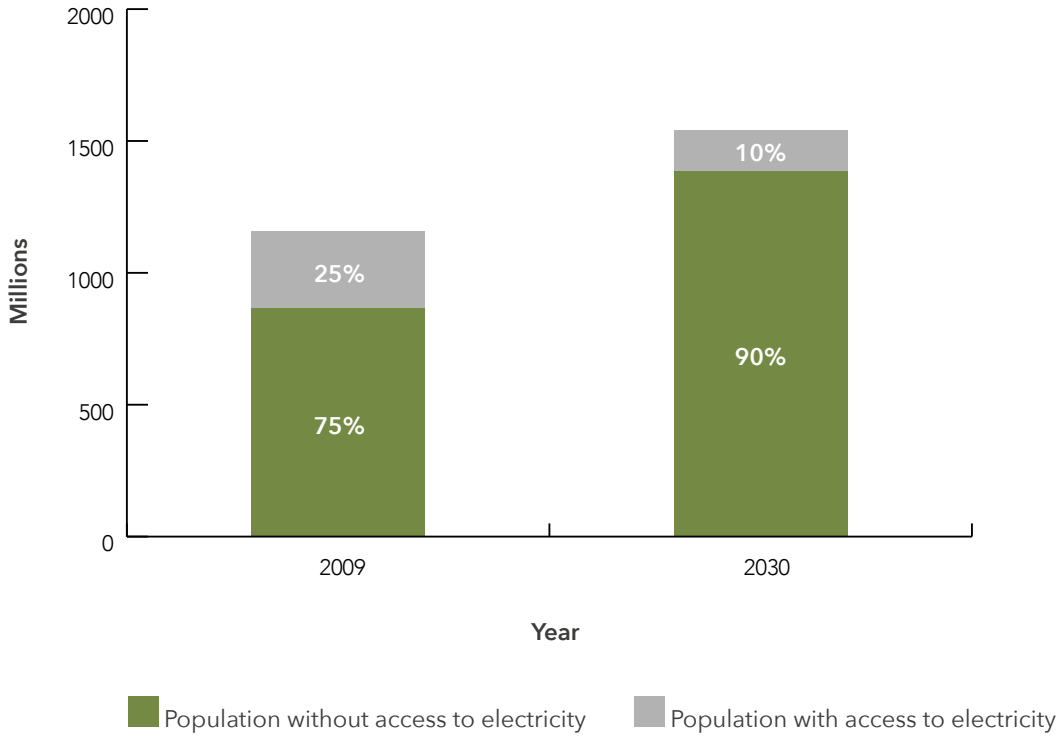
Electrification and inequality

Despite the emphasis on increasing installed electricity generation capacity (predominantly through the building of new coal-fired power plants), projections show that many millions of Indians still have no prospect of electricity access in the medium term.

Existing policies and provisions, including the Electricity Act 2003 and Rural Electrification Policy 2006, have merely facilitated the expansion of the installed capacity in the sector rather than providing access to those that are deprived of electricity. Almost 33 per cent of the country's population is still waiting for access to electricity and per capita electricity consumption stands at approximately 879 kWh,[12] far below the world average of almost 3,000 kWh.

According to the International Energy Agency, 147 million Indians will remain without access to electricity even in 2030[13] - see Figure 4. This will represent a dismal failure on the part of the government to achieve its own targets. Historical targets aimed for 100% village electrification by 2010 and 100% household electrification by 2012. These targets were accompanied by a statement of intent to provide free electricity connections to all families living below the poverty line. The government has not announced new targets, although in the 2014 election campaign some political parties promised 100% household electrification by 2015.

Figure 4: Percentage of population with and without access to electricity: 2009 data and 2030 projection



Some of the states with the greatest coal-fired generation capacity – such as Uttar Pradesh and West Bengal – are also the poorest in terms of per capita income

The pattern of household electrification rates across the country reveals a further injustice. The coal-rich states, considered to be India's electricity 'hub', are still in the dark and suffering from abject poverty. Figure 5 shows that some of the areas with the densest concentrations of coal power plants also have the lowest rates of household electrification. The rapid rate of urbanisation and migration to India's major cities will ensure that these more rural regions continue to be deprioritised for grid connection and extension. Despite the fact that thermal electricity generation capacity increased by more than 100 per cent between 2002 and 2013 (from 72 GW to 153 GW), the number of rural households reached by electricity increased by only 6.4 per cent during the same period.

Figure 6 shows that some of the states with the greatest coal-fired generation capacity – such as Uttar Pradesh and West Bengal – are also the poorest in terms of per capita income. The installation and operation of coal power plants does not go hand in hand with wealth creation and wealth does not 'trickle down'.

Figure 5: Household electrification rates around major coal fired power plants
(Household electrification data from 2011 Census and power plant data from Central Electricity Authority, 2013)

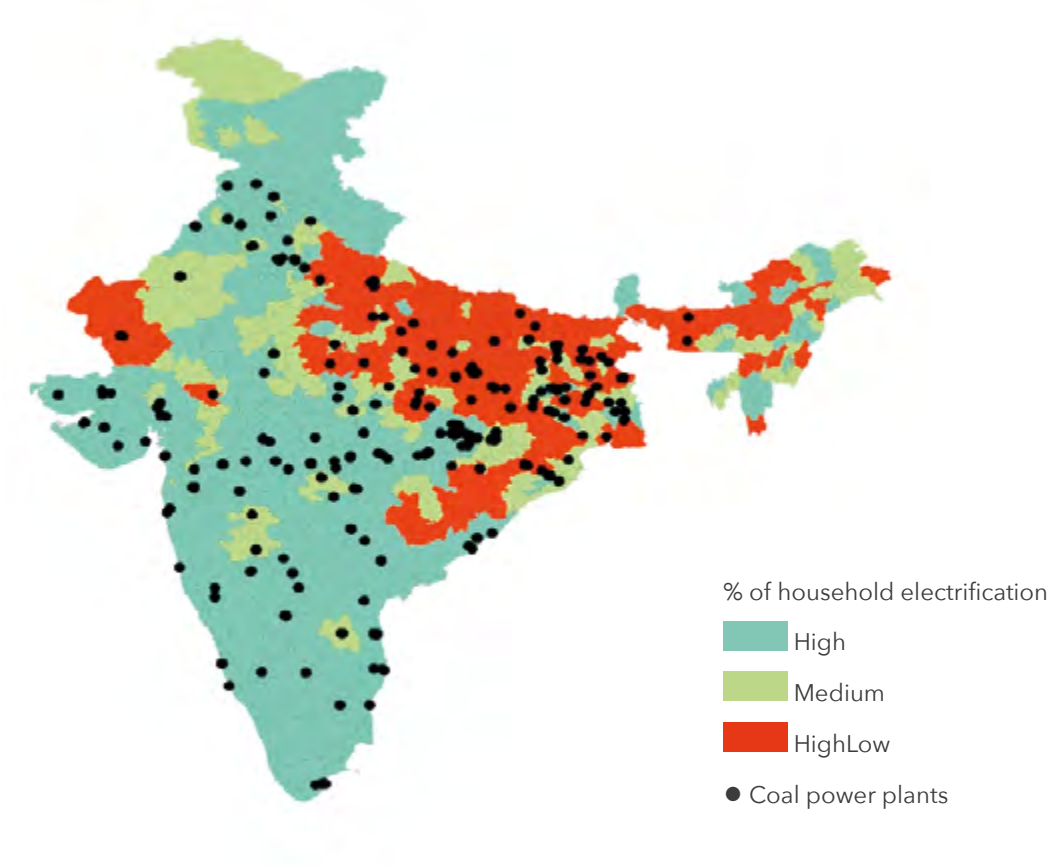
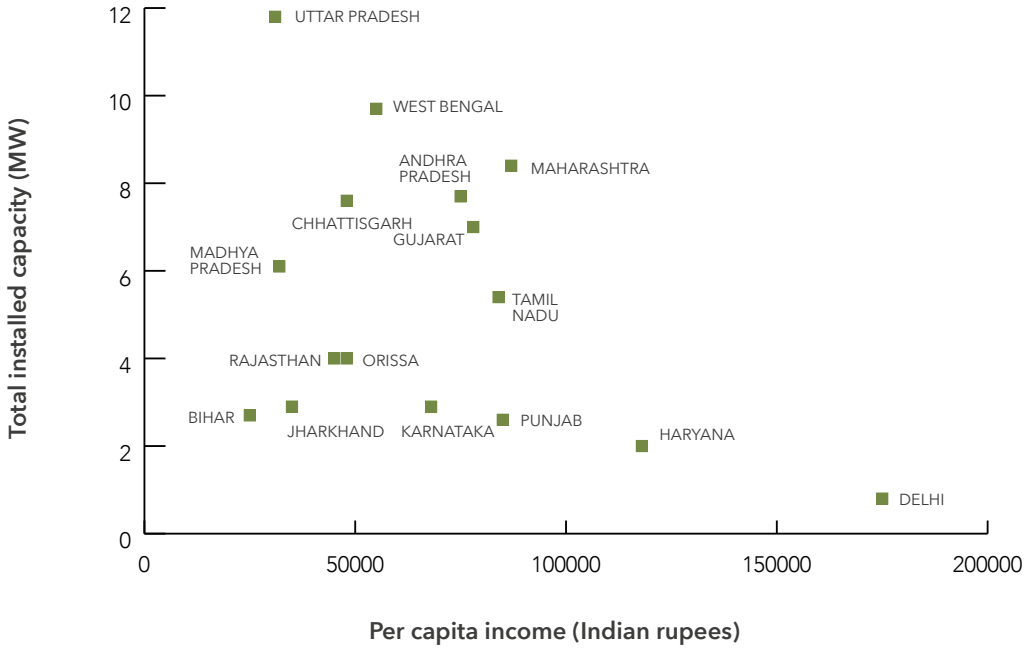


Figure 6: Relationship between state per capita income and total installed coal power capacity
(State per capita GDP data from the Planning Commission and installed coal power capacity data from Central Electricity Authority, 2013)

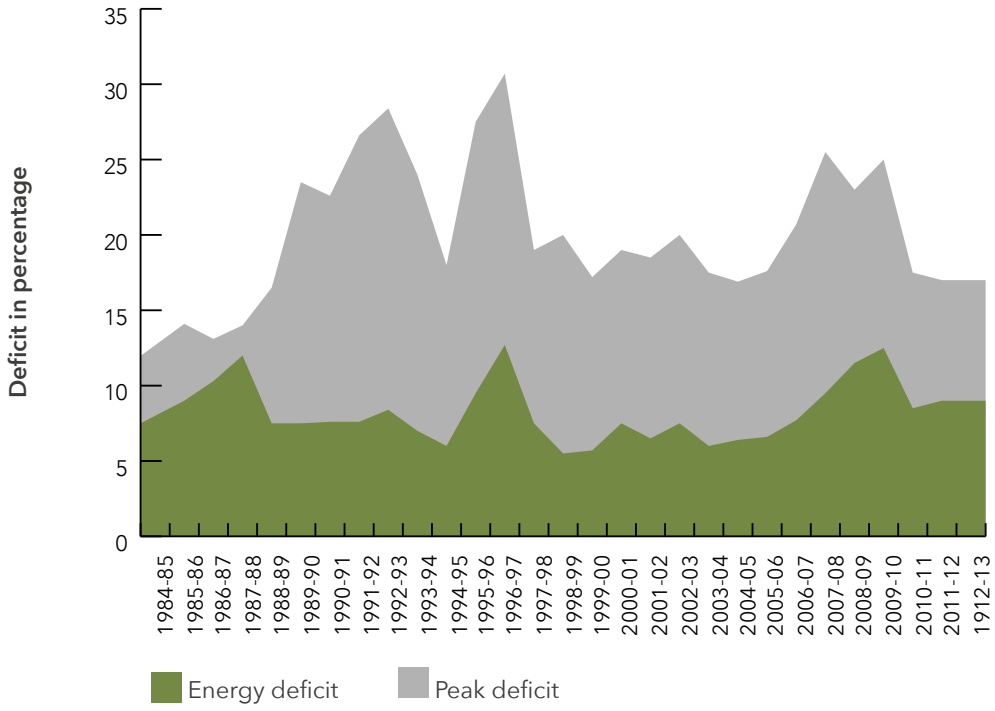


Limitations of the Indian electricity system

So far, government policies for the electricity sector have not succeeded in resolving issues such as transmission and distribution losses, power quality and the gap between supply and demand. These issues act to reduce the level of energy access experienced by those who have a grid connection through availability and reliability problems (scheduled and unscheduled blackouts), voltage and frequency instability, and affordability.

Despite increased installed capacity over the years, there remains a significant gap between demand and supply of electricity, as illustrated by Figure 7. According to Central Electricity Authority estimates, in 2012-13 the peak demand was 160 GW, compared with an actual availability of 144 GW,[15] leading to an overall peak deficit of 10.4 per cent. The impacts of power deficit are around 2 per cent of India's GDP.[16] The most severe supply-demand 'crunches' occur during coal shortages, highlighting the need for additional non-coal-fired generation. These shortages are partly responsible for the low average coal plant load factor in 2013 of 68 per cent.

Figure 7: Chronic gap energy supply and demand 1984-2013 (Data from Annual Load Generation Balance Reports from the Central Electricity Authority[17])



The effects of the power deficit are not equally shared across the population. In general, supplies to rural areas are interrupted in order to meet demand in cities and urban centres, a phenomenon that looks set to worsen as urbanisation increases the emphasis on cities and towns. Furthermore, power shortage is not uniform across states because of differences in the quality of governance and the effective implementation of demand management. States that have effectively enforced energy conservation and renewable energy norms, such as the mandatory installation of solar water heaters and the use of energy-efficient water pumping systems, have comparatively low daily peak demand shortages.[18]

The transmission and distribution losses associated with India's electricity system continue to be amongst the highest in the world. Almost a quarter of all power generated is lost through network inefficiencies, theft and inaccurate metering, with further losses occurring through wastage by those who benefit from cheap or even free electricity (see Table 1). These losses drive up the cost of electricity for all users, taking tariffs beyond the reach of the poorest people. It is therefore essential to match investment in generation capacity (whether renewable or non-renewable) with investment in power transmission and distribution, including off-grid systems where these are most appropriate. Without this focus, India may invest more and more in new coal-fired generation while reaping diminishing economic and developmental benefits.

Table 1: Losses from India's transmission and distribution networks

Year	T&D Losses (%)	AT&C Losses (%)
2004-05	31.25	34.33
2005-06	30.42	33.02
2006-07	28.65	30.62
2007-08	27.20	29.45
2008-09	25.47	27.37
2009-10	25.39	26.58
2010-11	23.97	26.15

T&D losses: transmission and distribution losses: energy dissipated in the conductors and equipment used for transmission, transformation and distribution of power. Can be described as 'technical' losses.

AT&C losses: aggregate technical and commercial losses: T&D losses plus the additional energy that is 'lost' in terms of revenue to the supplier through theft, defective metering and errors in estimating unmetered supplies.

The magnitude of the problems that prevent the benefits of electrification from being realised for the majority reveal the fallacy of relying on increased coal-fired generation and grid connections to deliver electricity access. A balanced strategy is needed to drive improvements in availability, reliability and quality which are necessary to deliver full electricity access to the entire population.

2.3. The myth of cheap coal

The conventional belief that electricity generated from coal is cheap is now being questioned in India for two reasons.

First, the quantification of all the externalities associated with coal, such as air pollution, land degradation and depletion and pollution of water, has led to a reassessment of the economics of coal power. These costs are explored in more detail in Section 3 of this report.

Second, policymakers are waking up to the fact that India's coal reserves, though huge, may not be sufficient to meet the growing demands of electricity generation. India's continued reliance on coal will necessitate the import of significant quantities of coal at high and volatile prices. According to a Reserve Bank of India 2013 report[19], the Coal Imports Bill has already added a burden of US$18 billion on the country. The Tata Mundra UMPP had to renegotiate its power purchase agreement with the state electricity regulator before commissioning due to a four-fold increase in the price of coal imported from Indonesia.

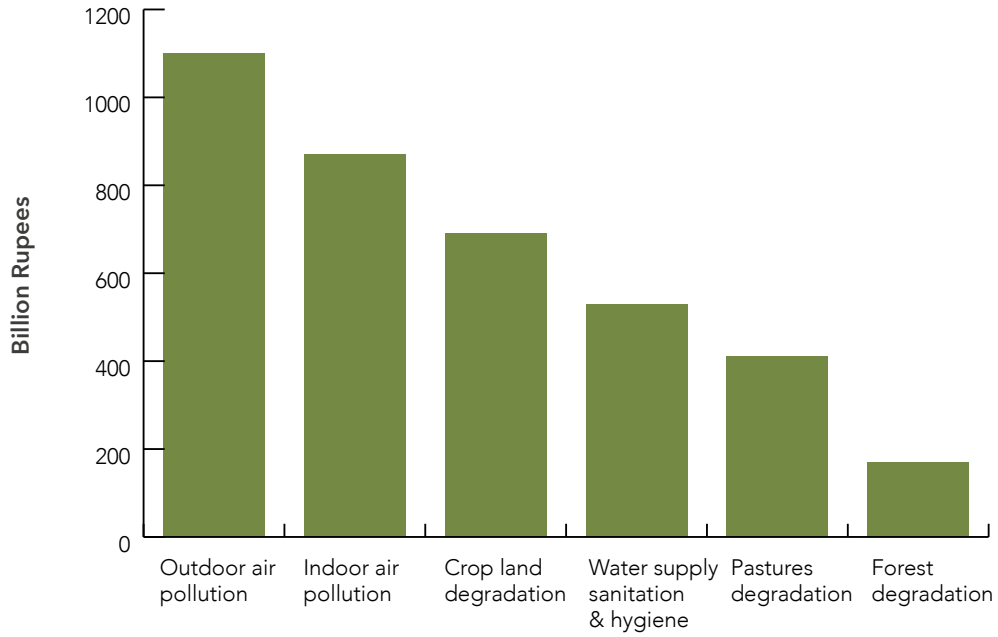
One reason why power from coal will not deliver electricity for all is that the technology relies on a system of highly centralised generation. In the medium term, many communities will be too remote to connect to the grid at reasonable cost. The needs of these communities call for the promotion of decentralised electricity supply systems such as mini-grids and solar home systems. Renewable energy sources such as solar, small hydro and biomass are well suited to off-grid systems and are low-cost and locally available.

3. SOCIAL AND ENVIRONMENTAL IMPACTS OF COAL MINING AND COAL POWER PLANTS

The mining, processing, transportation and burning of coal and the disposal of coal waste are polluting, wasteful, and harm the poor or indigenous communities where they take place. This is a form of social and environmental injustice as poor communities often have fewer resources with which to protect their lands and livelihoods. Threats to these communities from coal mining include population displacement, polluted or depleted water sources and the loss of livelihoods through deforestation. Coal power plants also deplete and pollute water sources. Power plants have more widespread health implications through their emissions of toxic substances and particulates, and contribute to the global phenomenon of climate change through their greenhouse gas emissions.
To add to the injustice, the communities who bear the brunt of pollution, health hazards and degraded lands often do not reap the benefit, as electricity and other resources derived from coal are transported out of the area to power cities and industry elsewhere.

A 2013 World Bank report provides an overview of the staggering impacts of growth based on fossil fuel-derived energy on the economy, the environment and society. Figure 8 shows the estimated costs of six types of environmental degradation.

Figure 8: Annual cost of environmental degradation in India[20]



The report has estimated the total annual cost of environmental degradation in India to be in the region of Rs. 3.75 trillion (US $80 billion) in 2009, which is equivalent to 5.7 per cent of GDP[21]. The worst contributor was outdoor air pollution arising from particulate matter.

Power plants have widespread health implications through their emissions of toxic substances and particulates, and contribute to the global phenomenon of climate change through their greenhouse gas emissions.

3.1. Impacts of coal mining

Land degradation and deforestation

Coal mining and related activities are responsible for the temporary and permanent degradation of the land around which they are sited. Four relatively small states – Odisha, Jharkhand, Chhattisgarh and West Bengal – account for the majority of India's coal production. Potential land use conflicts are already making the development of new coal mines and distribution infrastructure difficult.

The granting of 'forest clearances' (permission to clear forest) is evidence of the scale of destruction. In India's latest Five Year Plan period (2007-11), forest clearances were granted, fully or in principle, for the 'diversion' of 31,500 hectares (ha) of forest for coal mining.[22] This represents a significant acceleration compared to the preceding plan period (2002-07), when less than 30,000 ha were approved for all mining projects, not just coal.

Deforestation is most severe where surface coal is mined, but underground mines nevertheless require a significant land area for infrastructure, coal storage and waste disposal. Forest cover loss from large-scale coal mining in central and eastern India has negatively impacted the survival of wildlife, especially tigers and elephants. It is important to preserve these forests not only for their flora and fauna but also because they have served as homes and providers of livelihoods for tribal people over centuries.

A further problem caused by underground mining is land subsidence, which can damage structures in neighbouring areas.

Communities and displacement

An estimated 21 million people have been displaced by development projects between 1951 and 1991.[23] Mining of all minerals has been the second-largest cause of displacement (after irrigation and hydropower), with an estimated 2.55 million people displaced, of whom 55 per cent are members of scheduled tribes.[24] A new law, The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013, has now come into force to improve the way land is acquired and how the populations affected are compensated and resettled.

But even with better resettlement and rehabilitation provision, displaced people still face multi-dimensional human, social and economic impacts, including breakdown of family and community structures, exacerbated class and caste conflicts, increased vulnerability of women, children and the elderly, loss of livelihoods and deterioration of the local economic situation due to disruption.[25]

Impacts on water resources

The mining and washing of coal and associated activities significantly impact water resources. This is of particular concern as many coal mines are in regions with water scarcity.[26] Opencast mines can affect the level of underground aquifers in surrounding areas, while runoff from mines and coal washeries can result in significant groundwater pollution.[27] The water runoff from coal washeries carries heavy metals that affect aquatic flora and fauna in rivers, lakes and oceans. Acid mine drainage (the draining of acidic water resulting from sulphur in the coal and associated strata) can pollute local water bodies. This is an important issue in the north-eastern coalfields, which have high sulphur content.

Mining and transporting the vast tonnage of coal used creates significant hazards, both to workers and the public, through emissions of mercury and other toxic constituents within unburned coal

The regulatory framework governing the impacts of mining on water systems remains unchanged since 2005. Furthermore, authorities have extremely low capacities to monitor and enforce the conditions on which environmental clearances were granted, while mining and electricity companies exert lobbying pressure on the authorities to go slow on regulating environmental conditions.

3.2. Impacts of coal power plants

Coal-fired power comes with significant costs to environment and human health. Fly ash residue and pollutants settle on and contaminate soil, being especially harmful to agricultural activities.

Combustion of coal releases emissions of sulphur dioxide (SO_2), nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO), volatile organic compounds (VOCs), and various trace metals such as mercury, which can disperse over large areas. Chronic and acute exposure to these pollutants has health impacts that include respiratory illnesses, compromised immune systems, cardiovascular conditions and premature death.

While India has some regulations for thermal power plant discharges and fly ash storage, the implementation and monitoring of adherence to these regulations is a huge challenge. In 2006-07, 28 per cent of plants failed to comply.[28]

Local health impacts

Mining and transporting the vast tonnage of coal used creates significant hazards, both to workers and the public, through emissions of mercury and other toxic constituents within unburned coal.

However air pollution from coal burning is thought to create the largest health burdens in terms of heart and respiratory diseases. The major killer among the air pollutants from coal combustion is PM2.5[29] (particles smaller than 0.0025mm in diameter), which due to their extremely small size are able to travel deep into the respiratory tract and reach the lungs. Excessive exposure to these particles affects lung function and also causes asthma and heart disease.[30] A study by Greenpeace India and Conservation Action Trust estimates the monetary cost for India of premature mortality due to PM pollution to be in excess of INR 160 billion to 230 billion (US$3.3-4.6 billion) per year. Table 2 gives an overview of the estimated annual health impacts and health costs of PM pollution across several effect categories.[31]

The worst air pollution impacts are felt over the states of Delhi, Haryana, Maharashtra, Madhya Pradesh and Chhattisgarh, the Indo-Gangetic plain, and most of central India. Adverse impacts are especially severe for elderly people, children and those with respiratory disease. In addition, the poor, minority groups, and people who live in areas downwind of multiple power plants are likely to be disproportionately exposed to the health risks of fine particle pollution. As shown in Figure 9, the plume of particulate matter over India coincides with the locations of coal mining and thermal power plants. Acid rain-causing air pollution and scattered fly ash also contaminate water and vegetation in the surrounding forests and other habitats.

Children collect cenosphere, a byproduct of coal combustion, from an ash pond at Bhusawal thermal power station, Maharashtra. Villagers work long hours to collect cenosphere to sell to private companies. The ash pond is close to water sources that villagers depend on for water for household use and farming. Toxic fly ash residue can pollute water and soil, and regulations for its management are poorly enforced.

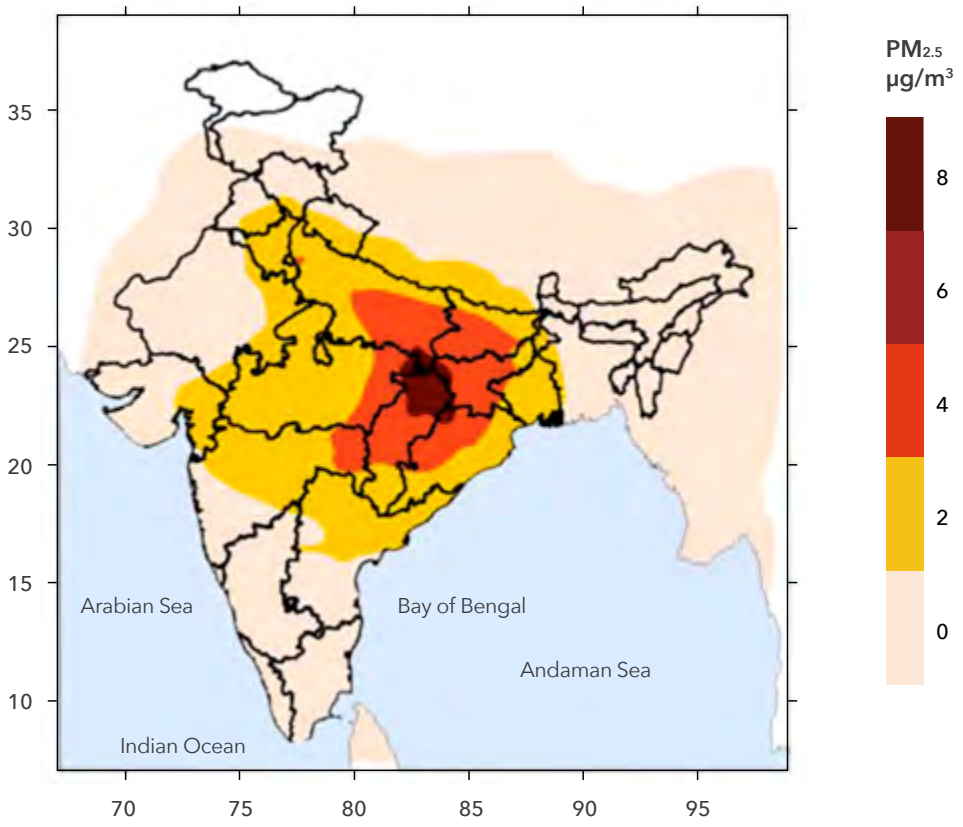
Table 2: Estimated annual health impacts and associated costs due to PM pollution from coal[32]

Effect	Number of people affected	Health costs (in million rupees)*	Health costs (million US$)**
Total premature mortality	80,000 to 115,000	160,000-230,000	3300-4600
Child mortality (under 5)	10,000	21,000	420
Respiratory symptoms	625 million	62,000	1200
Chronic bronchitis	170,000	9,000	170
Chest discomforts	8.4 million	1700	35
Asthma attacks	20.9 million	21,000	420
Emergency room visits	900,000	3,200	60
Restricted activity days	160 million	80,000	1600

** Applied conversion rate of 1US$ = 50 rupees

Several studies have found that surface and groundwater around thermal power plants is contaminated with leachates, heavy metals and other poisonous effluents

Figure 9: Areas affected by PM 2.5

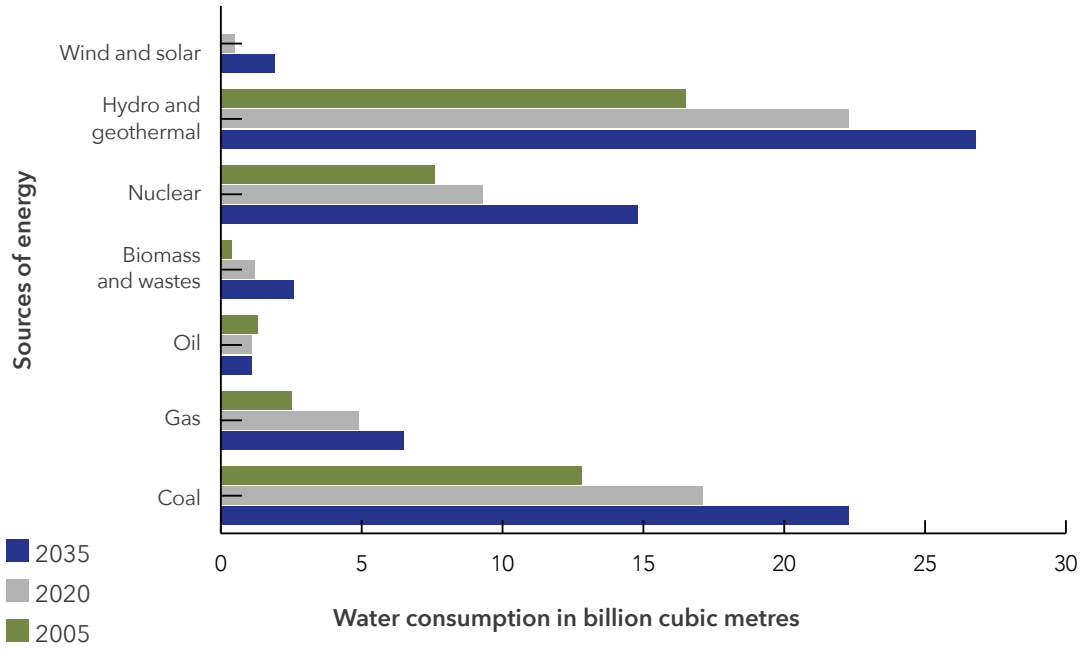


Impacts on water resources

Thermal power generation is an extremely water intensive process. Water is used heavily for washing coal and in the cooling towers of the plants. Large quantities of water are also used for carrying ash from the plants to the ash ponds or pits. Several studies have found that surface and groundwater around thermal power plants is contaminated with leachates, heavy metals and other poisonous effluents. This excessive consumption and contamination leads not just to water pollution but also to the eventual destruction of the water table.

A report from the Federation of Indian Chambers of Commerce and Industry Water Mission estimates that thermal power plants in India consume approximately 35 billion cubic metres of water annually, which accounts for 87.8 per cent of total industrial water use.[33] Another study estimated the consumption of various power generation technologies in 2005 and projected future consumption in 2020 and 2035, with steep increases expected from coal, hydro and geothermal power. These projections are shown in Figure 10, which clearly demonstrates that thermal generation technologies (including coal, gas and nuclear power plants) use many times more water than India's most promising non-hydro renewable energy sources: wind and solar.

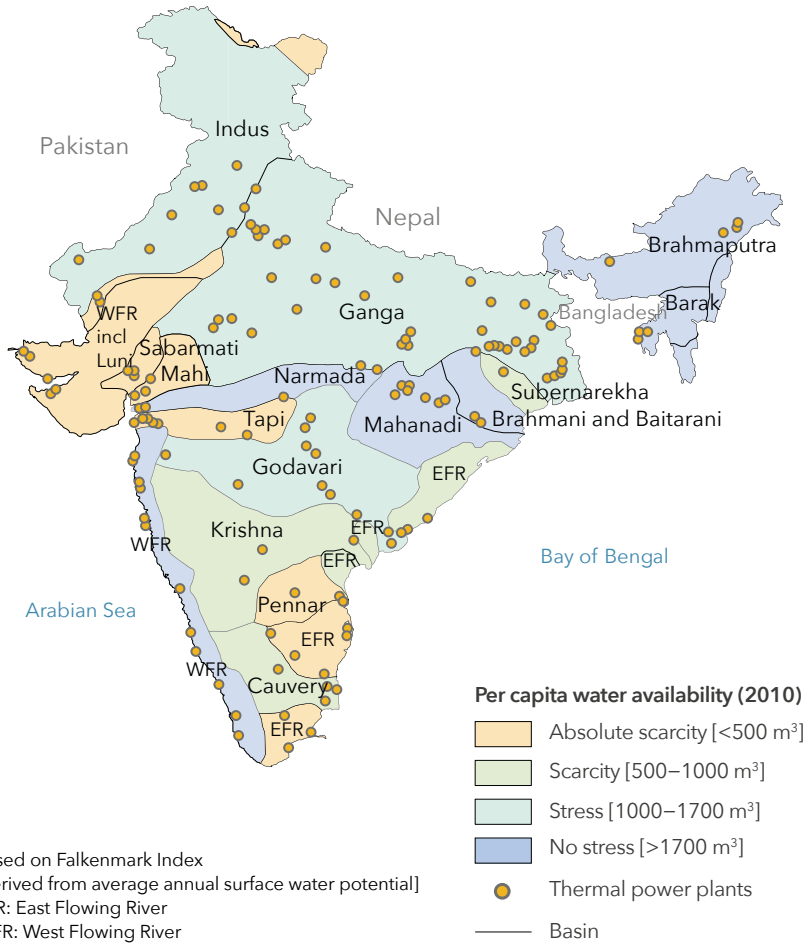
Figure 10: Water consumption projections for various power generation technologies[34]



In light of the above, it is pertinent to look at the water stress levels in regions that have the highest concentration of coal-fired power plants. Figure 11 shows that many coal-fired power plants are located in areas that suffer from water scarcity and stress, and even areas defined as suffering from 'absolute scarcity' (with less than 500 cubic metres of water per person per year).

Thermal generation technologies (including coal, gas and nuclear power plants) use many times more water than India's most promising non-hydro renewable energy sources: wind and solar.

Figure 11: Water stress levels of major river basins in India[35]



Based on Falkenmark Index
[derived from average annual surface water potential]
EFR: East Flowing River
WFR: West Flowing River

Sources: Water scarcity map developed by the Water and Resources Institute using Central Water Commission (2010) and IDFC (2011) data; and power plant location plotting done by the Institute for Global Environmental Strategies (IGES) using the Global Energy Observatory database.

Besides chemical pollution and water extraction, coastal power plants have been found to adversely affect marine ecosystems through the release of hot water into the sea. This affects fishermen and communities which depend on the sea for their livelihoods.

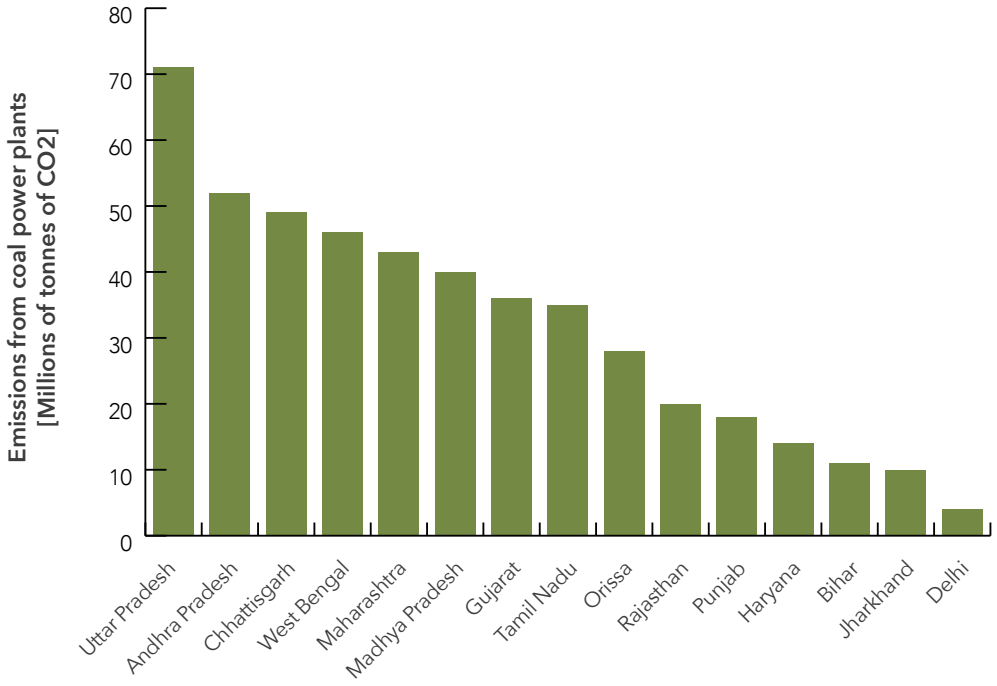
Climate change

Globally, coal power plants are the biggest source of manmade carbon dioxide (CO_2) emissions. In India up to 40 per cent of current CO_2 emissions come from coal power stations. These emissions (1.7 billion tonnes in 2011)[36] make India the third largest emitter of CO_2 after China and the US, with emissions expected to grow significantly over the next two decades.

Figure 12 shows how these emissions are shared across the coal power producing states. The five states with the greatest coal generation capacity also have the highest CO_2 emissions.

India's rural population of nearly 700 million directly depends on climate-sensitive sectors and natural resources for their subsistence and livelihoods

Figure 12: Estimated emissions from coal power plants by state[37]



India's rural population of nearly 700 million directly depends on climate-sensitive sectors (agriculture, forests and fisheries) and natural resources (water, biodiversity, mangroves, coastal zones, grasslands) for their subsistence and livelihoods. Farmers, forest dwellers, fisher-folk, and nomadic shepherds have very low capacity to adapt to changes in the climate.[38] Sea level rise and storm surges (made more likely by manmade climate change) risk causing saltwater intrusion in coastal areas, damaging agriculture and degrading groundwater quality. Abrupt changes to the monsoon cycle could precipitate major crises, triggering more frequent droughts as well as greater flooding in large parts of India.

3.3. Coal and community self-determination

India adopted the Environment Impact Assessment (EIA) Notification Act of 1994 as a way to formally address social and environmental concerns as part of environmental decision making. Nevertheless, over the years the prioritisation of infrastructure development and the dilution of regulation have had predictable consequences. Today, two decades after the Act was passed, environmental clearances continue to be given despite opposition from communities and NGOs.

The Environment Protection Act, 1986 and rulings of various courts have ensured that EIA reports have to be accessible to the public before a public hearing. However, the reports are mostly published in English, a language that 99 per cent of the tribal population does not understand, and hence it is very difficult for villagers or tribal communities to decipher the impacts on their lives and environment. It can be argued that the manner in which the EIA reports are published actively discourages people from participating in the process.

In January 2014, the Ministry of Environment and Forests passed an order allowing existing coal mines of a certain size to expand their capacity by up to 50 per cent without being obliged to conduct public hearings with affected communities, currently the only formal means

of consultation. As public opposition to specific projects is becoming increasingly intense – leading to such incidents as police firing on demonstrators – it is growing more evident that the peoples' voices and choices are not being heard.

Analysis by the Delhi-based EIA Resource and Response Center shows that none of the coal power projects or coal mines that were up for environmental clearance have ever been rejected or declined by the expert committee. This fact shows a complete disregard of not only the EIA process, but also of the public views regarding development on their lands.

Despite sound legislative, administrative and procedural set-up, EIA has not yet evolved satisfactorily in India. EIA is used as a project justification tool rather than as a tool to contribute to achieving sustainable development. A proper public consultation process can add value to development projects, not erode them, and give people choices about the kind of projects they want in their vicinity.

As public opposition to specific projects is becoming increasingly intense – leading to such incidents as police firing on demonstrators – it is growing more evident that the peoples' voices and choices are not being heard.

4. DECENTRALISED RENEWABLE ENERGY: A WIN-WIN SOLUTION FOR COMMUNITIES

Historically, renewable energy technologies have been perceived as expensive and inefficient, making energy users – both on-grid and off-grid – dependent on natural systems beyond human control. However, a detailed analysis of the actual cost of generation from conventional systems compared with decentralised off-grid renewable electricity indicates the reverse. In grid-connected context, renewable sources are now able to compete successfully with conventional electricity generation in India due to a policy that gives a rebate on transmission costs for renewable electricity generation.

Figure 13: Cost comparison of low carbon solutions with high carbon, business as usual, energy projects[39]

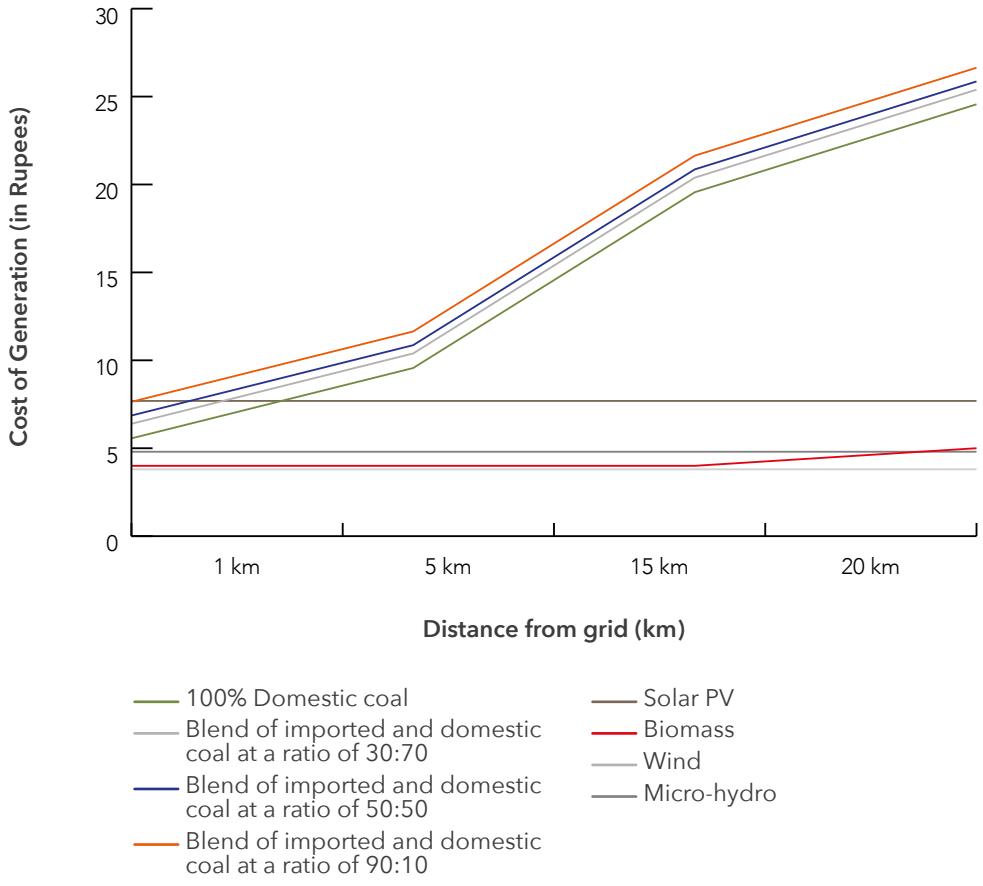


Figure 13 shows the costs associated with generation, transmission and distribution based on distance from the grid for electricity from a variety of renewable energy sources as well as a range of coal fuel blends (domestic coal being significantly cheaper than imported coal). The total contribution of renewables (excluding large hydro) to the installed electrical generation capacity has jumped from a mere 13 GW in 2010 to 32 GW in March 2014. The breakdown of this total by technology is given in Table 3. However, these totals are well below even the most conservative estimates of renewable energy's potential.

Table 3: Renewable energy capacity by source, March 2014[40]

Energy Source	Installed capacity
Wind	21 GW
Small hydro	4 GW
Biomass (including bagasse cogeneration)	4 GW
Solar	3 GW
Total	32 GW

The Indian government has set a target of increasing renewable energy installed capacity by a further 40 GW by 2022.[41] However, renewable sources account for just 12.25 per cent of India's energy generation at present.[42] Accelerating the use of renewable electricity is indispensable if India is to meet its commitments to reduce carbon intensity. On average, every 1 GW of additional renewable energy capacity reduces CO_2 emissions by 3.3 million tonnes a year.[43] Local ancillary benefits in terms of reduced mortality and morbidity from lower particulate concentrations are estimated at 334 lives saved for each million tonnes of carbon abated.

By focusing on increasing generation capacity by bringing new coal power plants online, the Indian government is missing the boat as regards the other benefits that India's huge renewable energy potential can bring. Development of renewable energy sources can increase energy security in the long term by diversifying supply, reducing import dependence and mitigating fuel price volatility. Conversely, at current usage coal reserves are projected to be depleted in 45 years and the increase in demand for coal throughout Asia is expected to drive global coal prices ever upwards.

The promotion of renewable energy can also be an important tool for regional economic development within India. Many of the states endowed with rich renewable energy potential (Arunachal Pradesh, Himachal Pradesh, Orissa, Uttarakhand) lag in economic development. Investing in renewable energy in these states can promote local industrial development and generate additional state income through the sale of renewable energy trading certificates to other states.

The coal industry is a major employer in India. However, a system based on the exploitation of renewable energy has the potential to generate even more jobs. Furthermore, these jobs would be inherently long term and sustainable, unlike employment associated with domestic coal.

5. CONCLUSION

Many policymakers see coal as the 'go to' energy source for India's economic future. Coal is sometimes called the 'poor people's resource for energy access'. The huge cost this dirty resource incurs on communities, environment and the climate is often overlooked, as is its inability to meet India's long-term energy needs. Destruction and damage attend every stage of the life cycle of coal power, starting with mining, which causes widespread deforestation, soil erosion, water shortages and pollution.

Burning coal in thermal power stations leaves a similar trail of harm, leaving a permanent mark on water bodies, soil, and human life while emitting colossal volumes of greenhouse gases. Many power plants operate in areas of high water stress, their appetite for cooling water taking away life-sustaining resources from local communities and destroying farmers' livelihoods. Pollutants from chimneys threaten public health; fine dust particles are a major cause of lung disease.

Many of India's coal mines and power plants are located in areas inhabited by tribal people and populations belonging to scheduled castes. The negative impacts of coal exploitation leave the social fabric of such areas vulnerable to total breakdown. Once coal resources are depleted, communities are left with abandoned mines and devastated lands.

While the costs with respect to the environment and climate change can be estimated in monetary terms, it is impossible to attach a cost to the social destruction wreaked by coal mining and use in power plants. In India, the main argument for coal extraction and burning is its potential to deliver much-needed increases in energy access. The evidence outlined in this report shows that the states with coal mines and power plants not only tend to report below average per-capita income and other development indicators, but don't even benefit in terms of increased electrification.

The pursuit of social justice, including gender equity, drives policymakers and investors to promote increased energy access. In parallel, the development of social justice plays a paramount role in the achievement of energy access. Thus, efforts to bring improved energy services to the poor don't only have to enhance the supply of energy, they also have to include programmes and policies that provide an enabling environment in terms of economic, financial, cultural and institutional factors. Past experience has shown that increasing installed capacity of power generation alone cannot achieve energy access; rather, this objective requires a localised approach and the selection of renewable energy. Some specific recommendations for securing a clean and equitable energy future for India's poor, without harming the environment or human health (including through climate change), are given below:

- **Diversification of energy sources:** It is important not to rely too heavily on coal as a primary source of electricity generation. This is critical given that the Indian coal-fired power plants are already being run on imported coal, and the idea of coal as a domestically-available and cheap resource no longer holds ground. Even a pure economic analysis shows the imperative for India to invest in renewable energy, and both grid and off-grid solutions.

- **Mainstreaming robust cost-benefit analysis** of coal extraction and burning, inclusive of social and environmental costs, and similar analysis for alternative options for electricity generation. Costs factored into the analysis would include the displacement of communities and impacts on health and livelihoods.

- **Developing transparent and consultative institutional and governance frameworks:** Existing requirements for the consultation processes that should accompany the awarding of environmental and forest clearances are ineffective. It is important to institute a transparent and consultative environmental decision-making process which follows a bottom-up approach.

Public participation is a means of enabling citizens to provide inputs once basic transparency norms are established and implemented. New requirements for public participation are needed, and those which are already legally mandated must be implemented in earnest. In the coal sector, this would be applicable in at least the following situations:

  - Meaningful public participation regarding starting new mines in a particular area and rehabilitating citizens in that area;

  - Involving citizens in the monitoring of on-going projects to ensure that local environmental damage is minimised and, where unavoidable, adequately compensated for.

- **Reaping the benefits of energy efficiency:** Before adding more coal-based generation capacity, it is vital that India first prioritises energy efficiency, energy conservation and loss reduction, particularly in the transmission and distribution system.

- **Offering equity:** Affected people can be offered a financial share in the coal projects for which their land has been acquired. This will ensure that they continue to receive the benefits of the development taking place on their land. It would also reduce the pressure on economically displaced people to take hazardous jobs in the mining sector.

- **Implementing a robust carbon tax on coal:** In 2010, India established a nationwide carbon tax which applied to coal consumption. The rate was set at 50 rupees (US$1.07) per tonne of coal produced in or imported to India. The revenue raised is earmarked for the National Clean Energy Funds for research and innovation in clean energy technologies and environmental remedial programmes. These taxes will be more effective if they more closely reflect the true cost of coal. In many cases, this would make the extraction and burning of coal prohibitively expensive. Meanwhile, the cost of renewable energy generation would be untaxed and expected to fall and fall.

- **Shifting coal subsidies:** The Indian government spends approximately US$19 billion on energy subsidies annually,[44] commonly citing two main justifications: the promotion of overall economic development and the targeting of benefits to poorer members of the population. The extent to which subsidies achieve either of these ends is highly questionable. It is critically important to remove those subsidies and use the money to deploy and scale up renewable energy technologies, which will be cheaper for the country in an economic sense and more beneficial socially and environmentally.

- **Stop investing in obsolete technologies:** Continued investments in coal fired power plants is sure to become an economic, social and climate liability in the medium to long period and therefore, policy makers need to factor in this aspect in any energy planning exercise and plan its investments accordingly. With the falling prices of alternate and clean sources of energy, particularly that of solar, coupled with rising prices of coal, there is already a trend setting in, where the role of coal in the energy mix is already started to fall. This trend is likely to reach the level of coal having a very little role to play in a low carbon world. From an Indian perspective, it is all the more a reason for its energy planners to look at alternate

and clean sources of energy, as investing in coal and the kind of infrastructure that ties a country to a centralised electricity system alone is not likely to address the issue of energy access at an affordable cost to rural communities. With adequate investments and right focus on the most suitable source of energy to address energy access, the cost of providing 24 hour energy services to rural communities through decentralised renewable energy options, would be even more cost effective than the conventional system of electricity.

Overall, what is conclusively required is a complete reform of the power sector. Setting unenforceable targets for the growth of clean energy is not enough. To ensure that the targets are met and can deliver energy services for all, and that the crucial link between energy services and national development is forged and maintained, there needs to be a fundamental rethink about the energy sector as a whole: the goals and expectations, the roles of institutions that operate, manage and govern it, and – very importantly – the role of peripheral institutions. Fifty years ago, India created an effective institutional framework that delivered the infrastructure and capacity necessary to adopt large-scale use of coal for electricity generation. In this decade, it needs to do the same thing for both on-grid and off-grid renewable energy generation in order that the country can make the transition from coal dependence to sustainable energy for all. A smart, results-oriented institutional framework could also help in reducing the financial stress that blights India's electricity utilities.

This report is a call to action. The evidence presented has demonstrated the technical inadequacy of coal power to meet India's energy needs – especially those of the poor – in anything but the short term. The report has explored in detail the externalities that, when considered together, reveal the true cost of coal for those living near mines and power plants, and for the planet at large through coal's contribution to climate change. However, there exists a win-win solution to the problem of electricity supply for those most in need. The alternative solution of decentralised renewable energy is not only cost-effective, but offers the best prospects for ensuring reliable and sustainable energy access for all.

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