INDIA

PATHWAYS TO SUSTAINING RAPID DEVELOPMENT IN A NEW CLIMATE ECONOMY

THE **NEW** CLIMATE **ECONOMY**
The Global Commission on the Economy and Climate

ICRIER

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1. Executive Summary

In 2014 Prime Minister (PM) Narendra Modi's government was elected with a strong mandate to jumpstart rapid development that is both inclusive and sustainable. The "Make in India" initiative aims to streamline investment regulations and proposes major infrastructure expansion to support rapid growth in manufacturing, including development of smart cities and industrial corridors. Financial inclusion of the poor has significantly increased, with over 100 million new bank accounts opened in just a few months under the Jan Dhan Yojana initiative. All bank accounts are to be linked to the Aadhaar electronic ID system, which will facilitate modernisation of government service delivery and social protection programmes. Fuel subsidies have been reduced or eliminated. PM Modi said that India views global concerns about climate change as a great opportunity for working towards the well-being of its citizens, and making a positive contribution for mankind, noting that there is a need for a broader perspective on progress in clean energy generation, energy conservation and energy efficiency.[1]

This paper by the New Climate Economy's India Initiative argues that India's efforts to achieve rapid, inclusive and sustainable development have been hampered in the past by pervasive inefficiencies that arise from market, policy and institutional failures and weaknesses. Efforts to address these weaknesses in a comprehensive manner can significantly increase the pace of improvement in the well-being of the population while also better tackling environmental and climate risks. Drawing on the framework developed in the recent New Climate Economy report, *Better Growth, Better Climate*, we focus on three critical socio-economic systems where increased efficiency, investment and innovation can yield major development and environmental benefits: energy systems, agriculture and land use, and cities.[2]

1.2 India's recent development performance and its challenges

India's economic performance since the start of the 21st century provides grounds for both optimism and concern; which assessment prevails will likely turn on the policy choices made today and in the next few years.

India experienced the most sustained period of rapid growth in its economic history during the 2000s – an average of close to 9% a year between 2003/04 and 2010/11 – even taking into account a brief but sharp slowdown in 2008/09, during the global economic crisis. Rapid growth in the 2000s contributed to an unprecedented fall in poverty. The poverty headcount rate (using the national poverty line) fell from 37% in 2004/05 to 22% in 2011/12, an extraordinary decline over so short a period.

More recently growth slowed to only around 5% in 2012/13. Recent data provide inconsistent evidence as to the extent of the recovery from this slowdown. Cross-country analysis suggests that, while many countries enjoy temporary growth booms, this is nearly always followed by a "reversion to the mean" and more mediocre growth. For India to join the select group of countries that achieve sustained rapid growth over several decades will require policy-makers to provide a relentless focus on finding

and unblocking the critical obstacles and constraints to structural change and inclusive growth.

A second, broader concern is that the benefits of faster GDP growth in recent years are being undermined by unplanned harmful spill-overs from the current growth model – severe local air pollution and damage to health, rising energy insecurity due to an increasing share of coal and other energy imports, excessive drawdown of groundwater in agriculture, and the costs of a rapid but problematic urbanisation, such as periurban sprawl, congestion, pollution and reduced urban productivity. Thus, even as it grapples with the problems of how to achieve rapid and inclusive economic growth, India also has to ensure that growth is sustainable – that its natural assets are able to continue providing the resources and environmental services on which the well-being of present and future generations depends.

Some 2 million (or over 20%) of all premature deaths in India in 2010 were related to some type of environmental risk. Of these, the most important is *household air pollution* from burning solid fuels, which is estimated to be responsible for just over 1 million premature deaths. Some 49% of households in India rely on firewood for cooking, especially in rural areas. In poorly ventilated buildings, indoor smoke can be 100 times higher than acceptable levels for small particles. The health risks are especially great for women and girls who do most of the cooking. A major push to expand access to electricity and provide improved cleaner cookstoves will therefore have a significant co-benefit in terms of reduced illness and deaths from household air pollution.

Outdoor (ambient) particulate matter (PM) pollution caused an estimated 630,000 premature deaths in India in 2010. Of the 30 cities with the worst ambient $PM_{2.5}$ pollution worldwide, 15 are in India, including the top four. Estimates place a statistical value of lives prematurely lost annually in India due to ambient $PM_{2.5}$ pollution at 5.5–7.5% of GDP. Since $PM_{2.5}$ pollution and CO_2 emissions both come largely from the same source – the burning of fossil fuels – it is important to consider the large health benefits from reduced air pollution associated with abatement of CO_2 emissions. For India these benefits are estimated at US$55 per tonne of CO_2 abated, close to double the US government's estimate of US$32 per tonne for the climate change benefits of reducing CO_2 emissions. Importantly from the perspective of Indian policy-makers, the air quality benefits are not only larger, they are enjoyed in the near term; accrue locally, mostly to the country itself; and are more certain compared with climate change benefits.

In the remainder of this paper we argue that key reforms in energy, urban and agricultural policies and institutions can unlock more rapid economic growth and improved welfare for the Indian public while tackling many of the unwanted national side-effects of the existing model of growth, such as severe air pollution and growing energy insecurity. Such reforms also provide substantial avenues for India to make its due contribution to cooperative global efforts to mitigate greenhouse gas (GHG) emissions, and climate risks.

1.3 Key development challenges and opportunities in the energy sector

India consumes a relatively small amount of energy in both absolute and per capita terms compared with other major economies such as the OECD (Organisation for Economic Co-operation and Development) countries or China. But energy consumption is growing rapidly, at 4.6% per year in 2000–13, which represents a doubling in 15 years. This growth can be broken down into 7.2% annual GDP growth, minus about 2.6% annual decline in the energy intensity of GDP. Growth in energy demand in India is likely to remain robust, not only because of fast economic growth but also because of structural trends, such as increasing industrialisation and urbanisation, which tend to boost demand. Unlike China, much of India's manufacturing development still lies in the future. Domestic energy production has not kept pace with quickly rising consumption, so that energy imports have surged. Energy has become central to the country's chronic trade imbalance, with rising energy insecurity an important concern for policy-makers. India's international trade deficit for fuels averaged an annual 6.4% of GDP over 2008–12 – twice the size of its current account deficit, which averaged 3.2% of GDP annually in this period. The current account deficit has fallen recently, in part because of lower world oil prices. The country's external position nevertheless remains vulnerable to volatility in energy prices. These trends underline the importance of reforms to reduce unnecessary existing inefficiencies and waste in energy use.

Alongside fast growth in energy demand, India's energy supply has also become steadily more carbon intensive as the share of fossil fuels has risen, in particular with growing use of coal for electricity generation, and diesel and gasoline for transport. The combination of fast growth in energy demand and the rising carbon intensity of energy has resulted in the rapid increase of CO_2 emissions from energy use, averaging a little over 5.5% a year, as well as severe outdoor air pollution. Indeed, the increase in CO_2 emissions appears to have accelerated in recent years (2007–13). As a result, the long-term decline in the ratio of CO_2 to GDP appears to have slowed or halted recently. This is important because India's voluntary international commitments for emissions are couched in terms of a long-term decline in the ratio of emissions to GDP.

There are several directions in which India's mission to enhance energy efficiency and achieve a cleaner fuel mix can be intensified and broadened in scope.

As in a number of other countries, fuel and power subsidies in India originated from a desire to protect

consumers, and the poor in particular, from high and volatile energy costs. But there is a clear recognition that energy subsidies are an inefficient way of providing social protection, while also imposing significant costs on the economy and harm to the environment. Fuel subsidies are estimated to have averaged 1.4% of GDP since 2007/08. Recognising their costs, the Government of India has recently moved to reduce or eliminate fuel subsidies, as well as to raise excise taxes on petrol and diesel. The fiscal burden of fuel subsidies will also decline because of the steep fall in world oil prices in the second half of 2014. In the absence of reforms, though, the fiscal burden would increase again as and when oil prices rebound in future. And, whether prices are high or low, oil price volatility itself increases macroeconomic uncertainty, makes budgetary planning more difficult, increases risk premiums and hurts private investment and growth. The present oil price decline provides an excellent opportunity to accelerate the removal of the remaining fuel subsidies and to place the reforms of recent years on a permanent basis at a time when the impact on consumers will be limited.

India's electricity sector is rife with inefficiencies and supply bottlenecks that result in huge unmet demand, hamper economic growth, restrict access by the poor, stimulate inefficient energy consumption and worsen both local air pollution and carbon emissions. Extremely low subsidised electricity prices for agricultural users do little for agricultural productivity while stimulating excessive groundwater use and GHG emissions in agriculture. The electricity sector also suffers from extraordinary transmission and distribution losses, some 21% of electricity output in 2011, compared with just 6–7% in China and the USA. Financial losses in the electricity sector have snowballed since 2003, reaching 0.7% of GDP and 17% of the gross fiscal deficit in 2011. Losses have been met by state subsidies and, increasingly, debt borrowings, which have reached more than 10% of state GDP in several northern states. Mounting power sector debts now pose a threat to the balance sheets of financial institutions. Worsening finances in the power sector have, in turn, led to increased rationing of power supplies and a squeeze on new investment, further reducing the quality of power infrastructure and services – a vicious circle.

The 2005 World Bank Enterprise Survey for India found that one-third of firms saw power shortages as the single most important constraint on their growth. Power subsidy reform, while difficult, is not impossible. In Gujarat, for example, large farmers were recently willing to accept higher power prices in return for a more reliable power supply.

India's energy fuel mix is also far from socially optimal, once the harmful spill-overs from coal and other fossil fuels are taken into account. For example, air pollution damages and growing energy insecurity. One recent estimate suggests that the price of coal in India needs to at least double if it is to fully reflect the health and other damages associated with coal use. Yet the share of coal in total primary energy has increased from 33% in 1990 to 45% in 2012, accompanied by a rising share of expensive, foreign currency denominated coal imports for power generation.

As in the rest of the world, the cost of renewable energy has seen an unexpectedly rapid decline in recent years, some 65% over the last three years by one estimate. The cost of electricity from new power plants using imported coal could be 30–50% higher than the cost of wind and solar power by 2030. Replacing the marginal unit of energy supply from imported coal with a marginal unit from financially competitive renewable energy would allow India to secure substantial additional social benefits, such as greater energy security and a cleaner environment. Wind and solar capacity is small but rising fast. Government targets for renewable capacity are being sharply increased but still remain far below estimates of the physical potential for solar and wind in the country.

1.4 Key development challenges and opportunities in agriculture and land use

Agriculture remains an important sector of the Indian economy, providing almost half of all employment, with over two-thirds of the population still living in rural areas. From a heavy dependence on foreign food aid in the early decades after Independence, agricultural development has advanced sufficiently for India to become first self-sufficient and then a net exporter of food. However, while there has been substantial progress in improving the productive capacity of Indian agriculture over the decades since Independence, the rate of improvement has been relatively modest by international standards. There has been some acceleration in growth of the overall agricultural sector since the mid-2000s but, among other reasons for caution, productivity performance for traditional crops is lagging. Agriculture remains vulnerable to existing climatic variability and future climate change, while also driving rapid growth in groundwater extraction, something that threatens the long-term economic sustainability of the sector. Through direct and indirect channels, agriculture also generates about 30% of India's GHG emissions.

Given this backdrop, we argue that there are significant reform opportunities to achieve "triple wins" – that is, to raise farmers' incomes, to strengthen resilience to climate change and to abate GHG emissions – in particular by improving the orientation of public spending on agriculture. While there is no single, comprehensive source of information, studies suggest that the total volume of public spending on agriculture is significant and growing. The largest category of spending is on subsidies for fertiliser, power, irrigation and credit, significantly exceeding spending on rural infrastructure and agricultural research and development (R&D). Yet evidence suggests

that the economic returns on agricultural subsidies are close to zero, while those for rural infrastructure and agricultural R&D are very high. Public R&D spending and investment are also much more powerful than subsidies for the purpose of rural poverty reduction.

Not only is the present orientation of public expenditure in agriculture unhelpful for economic productivity, but it also discourages environmental sustainability. This is because agricultural subsidies tend to promote both excessive use of water as well as GHG emissions through a number of related channels. Power subsidies, for example, stimulate both high power consumption and high GHG emissions, as well as lift irrigation using tube wells, which causes excessive drawdown of groundwater and depletion of water tables. Agriculture accounts for 90% of annual freshwater withdrawals, a proportion that is unusually high by international standards and that has hardly fallen over recent decades, despite the gradual decline in the relative importance of agriculture in the economy. Overall, freshwater withdrawals now absorb over 50% of internal renewable water resources, a proportion that has risen from about one-quarter in the later 1970s.

Livestock is another agricultural sector with significant potential economic and environmental gains. India has one of the largest livestock herds in the world. Productivity is generally low, however, with average milk yields about half of the world average for example. Meanwhile, methane emissions from livestock are the largest source of agricultural GHGs in India, an outcome made worse by poor diet. There appear to be significant opportunities to boost economic returns and curb emissions by promoting better feeding and animal reproduction management to bring about a smaller, more productive herd. Opportunities to expand forest cover also offer significant opportunities for increased carbon sequestration, groundwater recharge and employment opportunities for forest communities.

1.5 Development challenges and opportunities in building more productive and inclusive cities

The Government of India has rightly focused on the potential of "smart cities" as an important driver of development. The New Climate Economy report provides evidence for this proposition by detailing how more compact, connected and well-coordinated cities promote both development and greater energy and pollution efficiency, for example through agglomeration economies: the forces through which a more dense clustering of individuals and firms in urban areas promotes more innovation and faster productivity growth. Unfortunately, there are few automatic guarantees that urban development will necessarily evolve in this way. Market failures, policies and weak institutions can lead to much less productive and less clean outcomes.

India's urban population almost doubled from 222 million in 1990 to an estimated 410 million in 2014 and is expected to reach 800 million by 2050. Cities now contribute over two-thirds of GDP, bring in over 90% of government revenue and contribute the majority of jobs. But the pattern of urbanisation is also one rife with numerous stresses and dysfunctions: rapidly expanding periurban sprawl, inadequate and unreliable urban infrastructure, high land prices, proliferating slums, growing congestion and travel times, reduced agglomeration economies, intense local air pollution and rising GHG emissions.

Rapid urban growth is occurring on many different margins and frontiers. Some of the most explosive growth is occurring in peri-urban areas, on the periphery of existing big cities. Restrictions on building per unit of land reduce the intensity with which city land is used, pushing up land prices, reducing average floor space and pushing businesses and households to seek cheaper land further and further away from city centres. Mumbai homes have only about 30 square feet per person, compared with 140 square feet per person in urban China, for example.

The dysfunctional patterns of urbanisation in India arise from a number of long-standing, deeply ingrown and mutually interlocking policy distortions and institutional weaknesses. Highly restrictive land regulations cause intense pressures for urban sprawl. Floor space indexes, which regulate the maximum allowable ratio of the gross built-up floor area to the area of a plot, are generally far lower than in many of the most economically dynamic and prosperous cities in the world, such as Shanghai, Hong Kong, New York and Tokyo. Rent control laws and the lack of a well-developed housing finance system also constrain the supply of new housing stock. Efficient functioning of land markets is also hampered by weak systems for appraising land values, determining property rights and conducting public land acquisitions.

Yet proposals to build more compact cities are countered by concerns that greater densities in urban cores would overwhelm the rickety and inadequate existing infrastructure of urban areas in terms of water supply, sewerage and sanitation, access to electricity and public transport. In 2011 only 61% of urban households had access to treated tap water. Among major Asian cities, Chennai and Delhi were ranked the two worst cities for hours of water availability. Clearly, a vast upgrading in the scale and quality of urban infrastructure is needed if India is to fully tap the potential of its cities.

Efforts to strengthen urban infrastructure and planning are in turn hampered by the weaknesses of urban governance and institutions. The Constitution defines 18 functions for devolution to the local government level. In practice, however, the allocation of responsibilities between various levels of government remains muddled. Local governments' administrative capacity and accountability to residents is limited at best, while their fiscal resources remain far below the levels needed to accomplish their tasks.

The government's intention to massively expand urban investment on "smart cities" provides a tremendous opportunity to simultaneously tackle these interlinked issues. In recent years the Jawaharlal Nehru National Urban Renewal Mission (JnNURM) has represented a major effort by central government to significantly increase the volume of resources for urban infrastructure development, while also encouraging policy and institutional reforms to improve the effectiveness with which such resources are used at both the state and urban local government level. A thorough impact evaluation of the JnNURM can help to lay the basis for a renewed and comprehensive urbanisation strategy in India.

1.6 Conclusions and policy recommendations

We highlight 11 policy recommendations that can significantly increase the pace of improvement in the well-being of the population of India while also better tackling environmental and climate risks. The political economy of such reforms is often difficult but experience from both India and other countries provides considerable hope that meaningful progress is possible.

In energy:

Complete fuel subsidy reforms: The recent steep fall in world oil prices provides an excellent opportunity to complete a comprehensive fuel subsidy reform that is sustainable over the long term, coupled with well-designed and targeted measures to protect the poor and those vulnerable from higher fuel prices.

Complete electricity sector reforms: Reforms begun in the Electricity Act (2003) need to be pushed forward to unbundle and corporatise state electricity boards, build independent regulatory bodies, reform power subsidies and set realistic prices to create financial viability. Insulating distribution companies and regulatory bodies from political interference by state governments is a vital dimension of such reforms.

Promote energy efficiency standards: The tightening of mandatory energy efficiency standards for appliances, vehicles and buildings can play an important role in improving energy efficiency and reducing harmful emissions using available cost-effective technologies.

Use fuel taxes to promote a more efficient fuel mix: The most efficient instrument to curb excessive consumption of coal and other fuels with large harmful spill-overs are fuel taxes that reflect the pollution and other harms caused by each fuel type. Such taxes also promote energy efficiency and clean energy innovation, while generating substantial fiscal revenues, potentially 6–7% of GDP in the case of India.

Policies to reduce the high cost of finance for renewable energy: Initiatives to reduce the present high cost of finance can have an important impact in stimulating private investment in renewables, for example through increased flows of concessional development financing. Such reforms can more than pay for themselves by significantly reducing the subsidy required per unit of renewable energy produced. The creation of a National Renewable Power Corporation should be considered, which could undertake major renewable investments with world-class levels of management and technological dynamism.

In agriculture and land use:

Restructure public spending in agriculture: Reorient public spending in agriculture away from subsidies for electricity, irrigation, fertiliser and credit and towards rural infrastructure, agricultural R&D and extension services – a change that would boost agricultural productivity, curb wasteful water use and reduce agricultural GHG emissions.

Better livestock management: Stronger public action is needed to improve management of animal reproduction, health and diet, measures which lead to a smaller but healthier and more productive herd, and reduce both pressure on natural resources and agricultural GHG emissions.

Scale up forestry initiatives: Existing initiatives to expand the quantity and quality of forest cover under the "Green India Mission" need to be scaled up.

In urban areas:

Use the "smart cities" initiative to:

Reform land regulations: Highly restrictive floor space indexes need to be relaxed in line with those in dynamic international cities, to permit taller buildings and greater availability of built-up space for given land areas. Reform of rent controls, better systems to appraise land values and determine property rights and a stronger housing finance system are also needed.

Expand and renew urban infrastructure: Without a coordinated expansion and refurbishment of urban infrastructure, the relaxation of land regulations would put even more pressure on already rickety and inadequate service delivery systems. A comprehensive impact evaluation of the Jawaharlal Nehru National Urban Renewal Mission (JnNURM) can lay the groundwork for a renewed and scaled-up urban investment and reform agenda.

Reform and strengthen urban local government: A much clearer allocation of responsibilities is needed for urban local governments. Administrative capacity and accountability at the local level needs to be strengthened. Local government own revenues need to be bolstered, including through reform of property taxes. Intergovernmental transfers from the centre and the states to local areas also need to be boosted, together with better monitoring and accountability to ensure enhanced resources are well spent.

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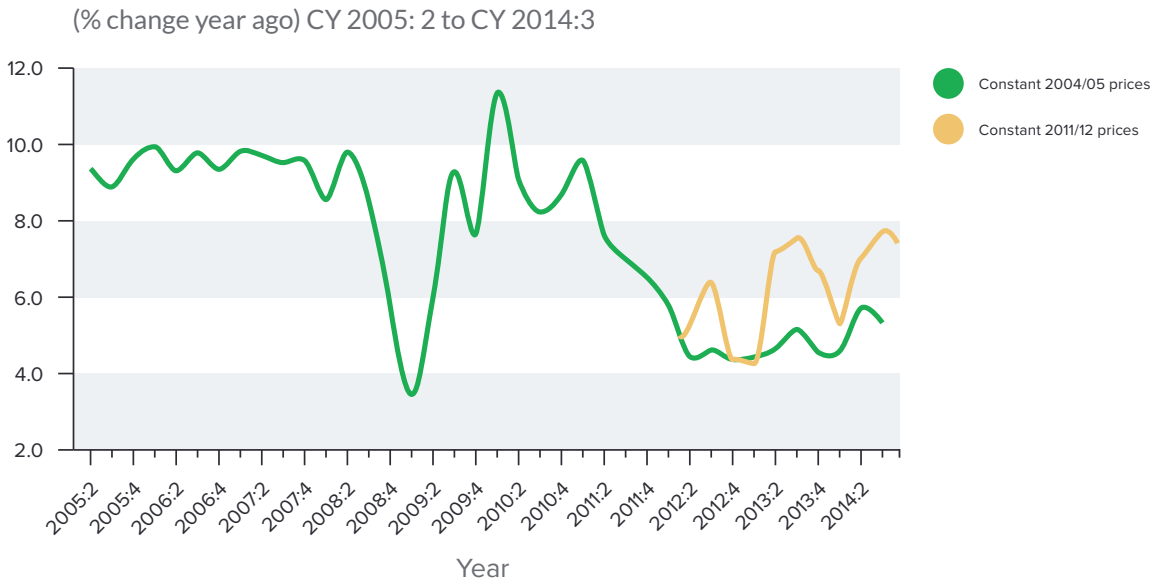
2. India's recent development performance and its challenges

India's economic performance since the start of the 21st century provides grounds for both optimism and concern. Which assessment prevails will likely turn on the policy choices made today and in the next few years.

2.1 Economic growth

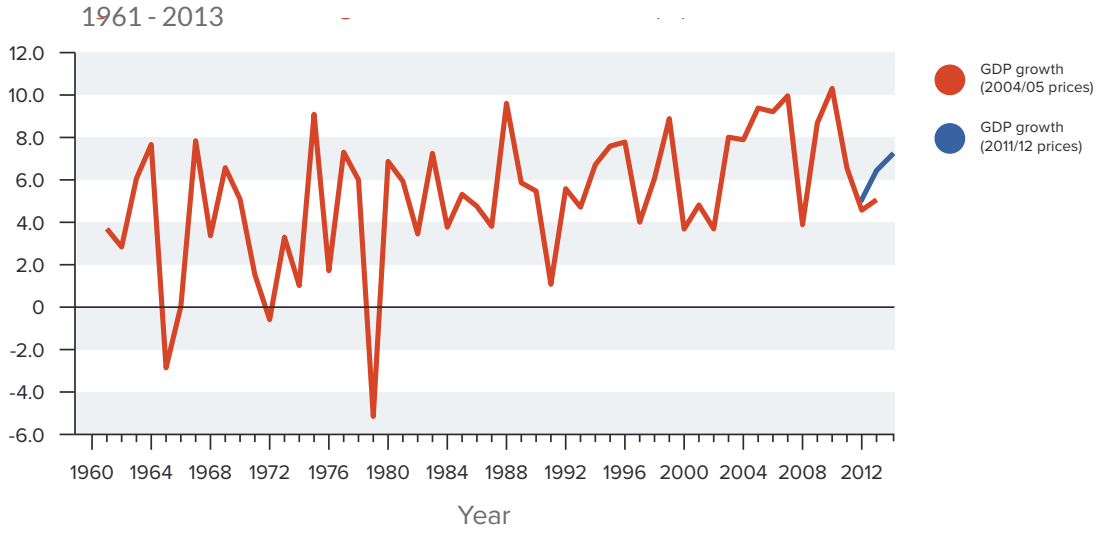
India experienced the most sustained period of rapid growth in its economic history during the 2000s – an average of close to 9% a year between 2003/04 and 2010/11, even taking into account a brief but sharp slowdown in 2008/09 during the global economic crisis (see Figure 2.1a). The growth boom in the first decade of the century came after several decades of gradually increasing growth, from less than 4% in the 1960s to 5–6% in the 1980s and 1990s, raising hopes that the country might have entered into a period of sustained growth in the 7–9% range (see Figure 2.1b).[3]

Figure 2.1a
India: quarterly real GDP growth



Source: Reserve Bank of India Database.

Figure 2.1b
India: long-term real GDP growth (%)



Source: World Bank, 2014a, CSO 2015.

These hopes for a breakthrough to sustained 'East Asian Miracle Economy'-like growth in India have been thrown into doubt by a significant slowdown from 2011/12 onwards. Growth slipped below 7% in 2011/12 and then to around 5% in 2012/13. Fixed investment spending growth in particular slid to only 1–2%, accompanied by perceptions of a stalling in reform momentum, increased policy and regulatory uncertainty, electricity and other infrastructure bottlenecks, and increased macroeconomic volatility, reflected in higher inflation and wider fiscal and balance of payments deficits. External conditions were also difficult. Growth in developed country export markets has remained sluggish after the financial crisis. Private capital flows have been volatile, with prospects of a gradual tightening of US monetary policy causing large capital outflows and exchange rate depreciation in many emerging markets, including India, in 2013.

Recent data do not provide a clear view as to the extent of recovery from the slowdown. The Central Statistical Office (CSO) recently released a new GDP series (rebased from 2004/05 to 2011/12 prices) which suggests that GDP growth in 2013/14 and 2014/15 was significantly higher than previously estimated.[4] (Figures 2.1a and 2.1b). While the new series uses more data and improved methodologies, the higher growth estimates are in some respects difficult to reconcile with a variety of other indicators which suggest continued economic weakness, for example industrial production, investment and imports. As a result, the Government of India's Economy Survey 2014-15 suggests that "Notwithstanding the new estimates, the balance of evidence and caution counsel in favour of viewing India as a recovering rather than a surging economy". [5]

Is the recent growth slowdown merely a temporary cyclical affair or could it signal the beginning of a longer period of slower growth? The latter possibility should not be discounted. Empirically, high growth that is sustained over several decades is rare. China and Korea are two outstanding examples of countries in this select group. It is much more common for developing countries to experience "spells" of both high and low growth lasting 5–15 years, sometimes characterised as "growth miracles" and "growth failures".[6] One recent analysis estimates that the median length of high-growth episodes is nine years and that it is common for high-growth episodes to be followed by "regression to the mean" in growth.[7]

There are good reasons why high-growth spells in developing countries might not be sustained. "Catch-up" growth is a basic mechanism of economic development, in which poor countries grow by importing advanced ideas and technologies, but it does not occur automatically. Achieving sustained growth requires developing countries both to strengthen fundamentals, such as human capital and institutions, and to foster the kind of structural change that sees labour, capital and entrepreneurs move from traditional to new, higher-productivity sectors. Structural change that promotes development is difficult to accomplish because it is a process fraught with both government and market failures. What works for one period may stop working when new structural problems arise. Overcoming such failures requires building strong institutions to handle change, and a constant, high-level engagement by a government that experiments with reforms, learns from mistakes, and implements what seems to work at a given time. Such dedicated reform capacity may not exist, or be present only fitfully, according to changing political conditions.[8]

This discussion suggests that for India to increase its odds of returning to high growth, it will need a relentless focus by policy-makers on finding and unblocking the critical obstacles and constraints to structural change and inclusive growth. In the remainder of this paper we argue that key reforms in energy, urban and agricultural policies and institutions can unlock more rapid economic growth and improved welfare for the Indian public while tackling many of the unwanted side-effects of the existing model of growth, such as severe air pollution and growing energy insecurity and climate risks.

While, as noted, a number of indicators suggested that economic conditions remained uneven in the first part of 2015, other developments provide some reason for greater optimism on recovery and faster growth looking forward. Perhaps the most important is political, the installation in 2014 of a new government with a strong mandate to accelerate development reforms. Macroeconomic conditions have also improved in some respects, with lower inflation, a narrowing in the current account and fiscal deficits, and a major decline in international oil prices. The Economic Survey 2014-15 argues that these conditions "have created a historic moment of opportunity to propel India onto a double-digit growth trajectory". [9]

Growth prospects and climate change

India also needs to carefully evaluate and tackle the longer-term impacts of climate change on growth and poverty reduction. Observed climate changes in India are generally consistent with the analyses and forward-looking scenarios developed in the assessment reports of the Intergovernmental Panel on Climate Change (IPCC).[10] These changes include higher mean temperatures, rising maximum and minimum temperatures, a gradually rising frequency of extreme temperature events, more pronounced variability in rainfall and more extreme precipitation events, although there is no discernible trend in average precipitation or in the frequency of cyclonic activity. A sea level rise of about 1.3 mm per year has also been estimated.[11]

Looking forward, predicted changes in the pattern of rainfall and contraction of glaciers are likely to have an adverse impact on India's already scarce water availability. Numerous studies project quite severe declines in India's agricultural yields and output as a result of climate change. In the absence of adaptation and CO_2 fertilisation benefits, a 1°C increase in mean temperature could lead to a decrease of 6 million tonnes of wheat production, for example, and the decrease could be 27.5 million tonnes with a 5°C increase in mean temperature. Simple adaptation strategies, such as changes in planting dates and crop varieties, could substantially offset these impacts for smaller temperature increases, but the efficacy of these strategies would decline for temperature increases at the upper end of the range, towards 5°C. Milk production from the country's very large dairy herd would be significantly reduced due to increased animal stress because of heat and humidity.[12]

Later sections of this report argue that there are numerous cost-effective opportunities to strengthen resilience to climate change and adaptation capacity in agriculture and the economy more generally. Similarly, there are substantial avenues for India to make its due contribution to cooperative global efforts to mitigate greenhouse gas (GHG) emissions, while pursuing its overriding commitment to development and rapid poverty reduction.

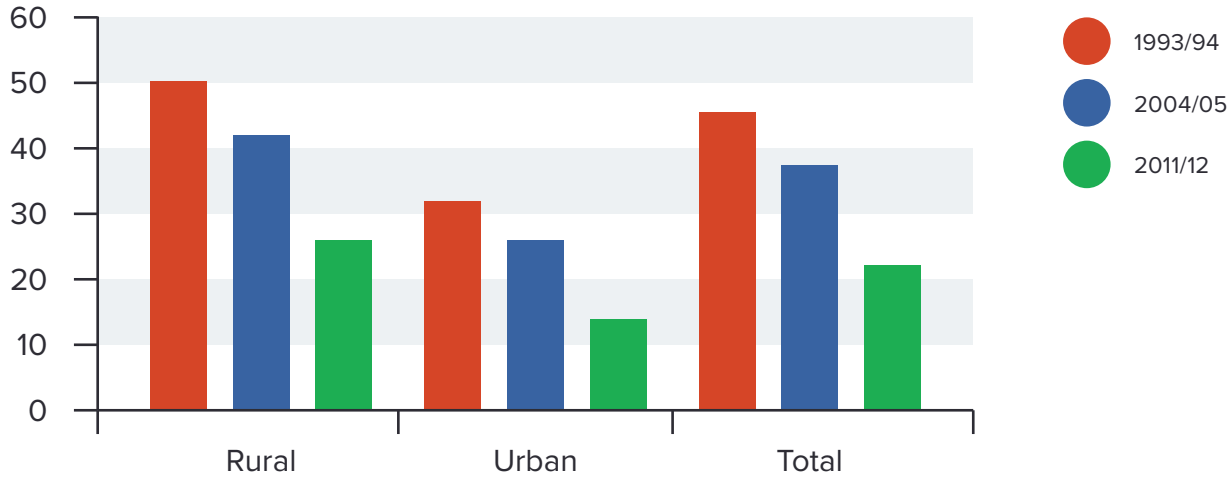
2.2. Key poverty and human development trends

Rapid growth in the 2000s contributed to an unprecedented fall in poverty. The poverty headcount rate (using the national poverty line) fell from 37% in 2004/05 to 22% in 2011/12 (see Figure 2.2a). The average annual pace of decline in the poverty rate during this period was 2.2 percentage points, three times faster than it was between 1993/94 and 2004/05. The accelerated decline in poverty occurred in both rural and urban areas. The decline in rural areas – where four-fifths of the poor live – was indeed even more rapid than in urban areas. For the first time there was also a large decline in the absolute number of poor (see Figure 2.2b on the following page).

Breaking down the decline in poverty suggests that rapid economic growth was the most important driver in poverty reduction. But changes in inequality also had an effect. In urban areas increased inequality tended to lessen the impact of fast growth in reducing poverty. In rural areas, on the contrary, a fall in inequality complemented the impact of growth in bringing about fast poverty reduction. Government policies have an important impact on the inclusiveness of growth. While the impact of general government social spending is not especially notable, educational spending to boost literacy has a strong positive impact on inclusiveness. Macroeconomic stability is also important. There is clear evidence that high inflation reduces the inclusiveness of growth in India.[13]

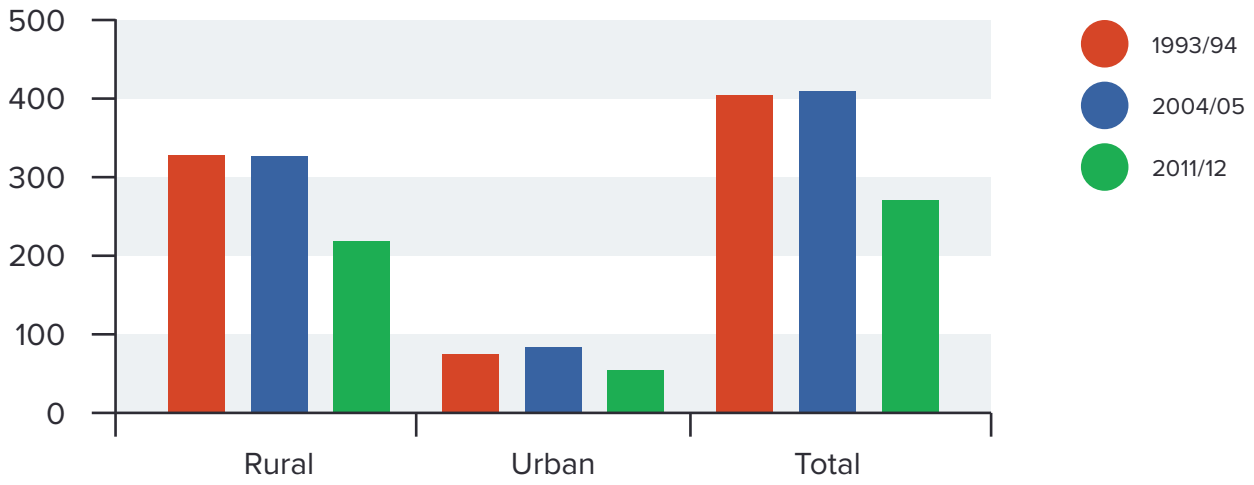
Yet much remains to be done. Using standard international benchmarks, one-third of the population continued to live below the US$1.25 a day poverty line – almost 400 million people, the largest number of absolute poor in any country. Some 68% of the population, or over 800 million people, continued to live below the US$2 a day benchmark. Many human development indicators remain inadequate, even compared with countries at the same income level. Some 43% of children under five years in India showed evidence of weight-for-age malnutrition in 2006, compared with 28% for lower- to middle-income countries as a group.[14]

Figure 2.2a
India: poverty head count ratio (%)



Source: Anand et al., 2014.[15]

Figure 2.2b
India: number of poor (millions)



Source: Anand et al., 2014.[16]

2.3. Key environmental trends – depletion of natural capital, local pollution and GHGs

Alongside these two central problems – how to achieve rapid economic growth and to ensure that it is broad-based and inclusive – India is also necessarily grappling with a third, to ensure that growth is environmentally sustainable. Even as its economy expands, India needs to ensure that its natural assets are able to continue providing the resources and environmental services on which the welfare of present and future generations relies. By one incomplete estimate natural assets comprised about 26% of India's total asset stock in 2005.[17] Yet, as in other countries, market and policy failures often result in natural assets being depleted at an excessive rate, or in natural assets such as clean air and water becoming excessively polluted, resulting in reduced national welfare. Better policies can help the country improve national welfare by reducing excessive local pollution and inefficient natural resource use while still sustaining economic growth. Efforts to reduce local air pollution can yield significant co-benefits in terms of reduced GHG emissions.

Depletion of natural capital and local air pollution trends

Depletion of natural capital in India takes a wide range of forms – erosion and degradation of agricultural soils, rapid depletion of groundwater resources (discussed further in Section 4 below on agriculture and land use), deforestation, destruction of biodiversity, and air and water pollution which cause increased illness and premature death, that is to say which deplete the country's human capital. These depletions and damages are typically not captured in standard measures of economic welfare such as GDP and are often overlooked by policy-makers.

The broad range of environmental damage and natural resource depletion in India has recently been surveyed in Mani (2014).[18] Here we focus on environmental damage to health, in particular from air pollution.

The *Global Burden of Disease* study by the World Health Organization (WHO) estimates that there were close to 10 million premature deaths from various sources in India in 2010.[19] Some 2 million of these were related to some type of environmental risk, principally household air pollution from solid fuels (just over 1 million deaths) and outdoor (ambient) particulate matter (PM) pollution (about 630,000), as well as smaller numbers related to unimproved water and sanitation, ambient ozone pollution and other risks. This means that air pollution risks are among the top risks to health in India, alongside, for example, dietary risks (1.6 million) and tobacco (1 million). There are also other serious costs in addition to premature mortality, such as chronic ill health, reduced effective time for work and leisure, and increased health system costs.

The major health risks from household and ambient air pollution are related to the release of PM and various harmful gases from the burning of traditional biomass and fossil fuels. PM pollution in particular increases the prevalence of lung cancer, chronic obstructive pulmonary disease (COPD), ischemic heart disease (from reduced blood supply) and stroke.[20]

Household or indoor air pollution from the burning of solid fuels – particularly traditional biomass such as firewood – using open fires and simple stoves for cooking and heating, is an especially serious source of illness and premature mortality in India relative to other countries. Some 49% of households in India rely on firewood for cooking, especially

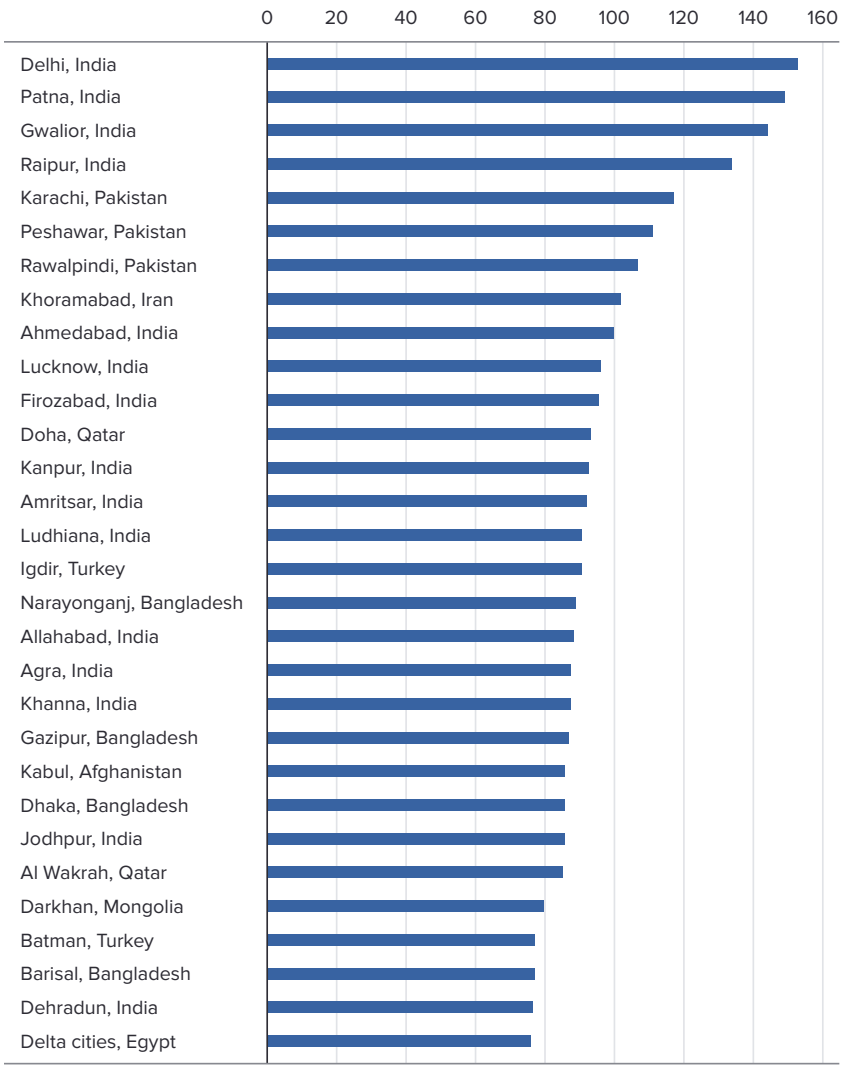
in rural areas. In poorly ventilated buildings, indoor smoke can be 100 times higher than acceptable levels for small particles. The health risks are especially great for women and girls who tend to do most cooking. The share of traditional biofuels in India's total primary energy has been gradually declining as the country moves to modern energy sources, but it is still high by international standards, around 24%. A major push to expand access to electricity and provide improved cleaner cookstoves will therefore have a significant co-benefit in terms of reduced illness and deaths from household air pollution.

The gradual shift out of traditional biofuels has been accompanied by a steady rise in the proportion of fossil fuels in primary energy. Burning these is also a source of PM and other harmful local pollutants, as well as carbon dioxide (CO_2) emissions. Ambient (outdoor) air pollution in Indian cities is now among the worst in the world. Figure 2.3 draws on WHO's Ambient Air Pollution database, which provides information on concentrations of particularly harmful $PM_{2.5}$ (fine particulate matter less than 2.5 microns in diameter) in 1,600 cities in 91 countries. Of the 30 cities in the world with the worst ambient $PM_{2.5}$ pollution, 15 are in India, including the top four in the world: Delhi, Patna, Gwalior and Raipur.[21]

Delhi's measured $PM_{2.5}$ level of around 150 micrograms per cubic metre is 15 times WHO's suggested guideline for $PM_{2.5}$. Recent studies suggest that even these estimates may be too low in some respects, with on-road exposure when travelling in an auto-rickshaw in Delhi being about 50% higher than the levels captured at fixed measuring sites.[23] The major sources of primary $PM_{2.5}$ emissions in Indian cities are estimated to be from fossil fuel consumption due to road transport (20–40%), industry (15–30%), power generation (15–20%), brick kilns (10–15%) and diesel backup generators (5–15%). Other sources include wood and waste burning, construction and road dust.[24]

Figure 2.3
Cities with the highest ambient $PM_{2.5}$ air pollution.

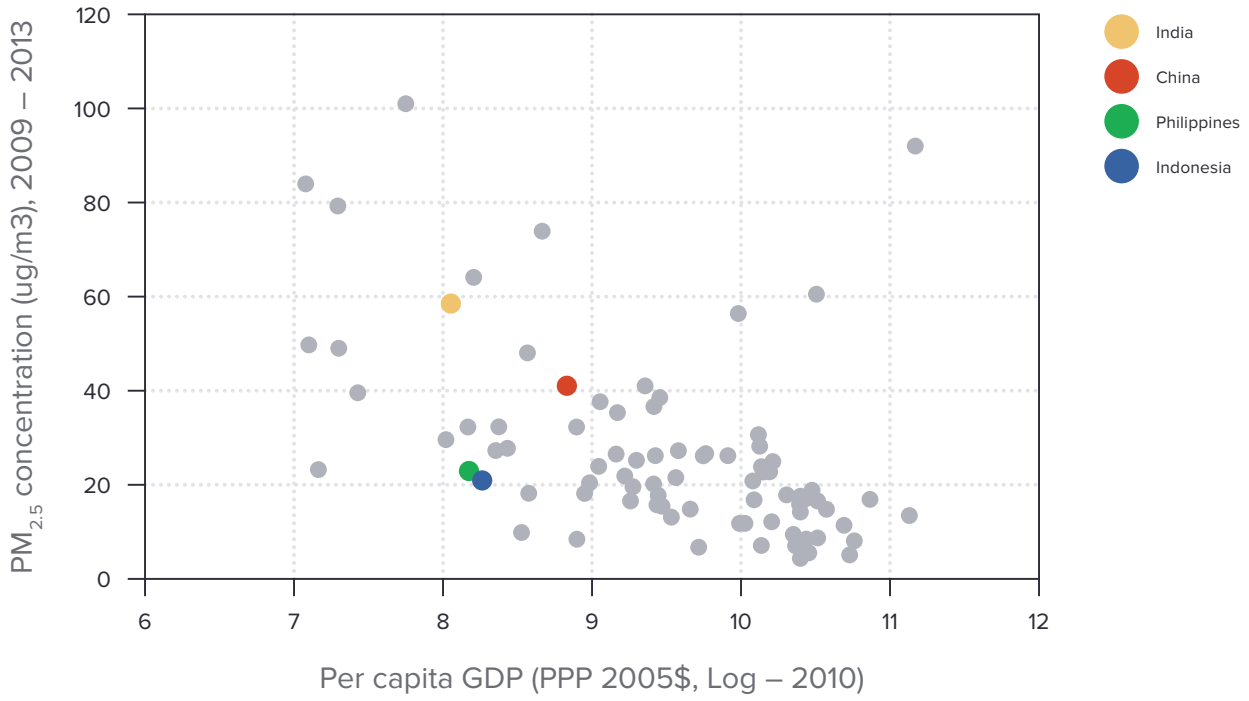
Top 30 cities, 2009–13 (ug/m3)



Source: WHO, 2014.[22]

Figure 2.4

Ambient $PM_{2.5}$ air pollution (ug/m3) and per capita GDP



Source: WHO, 2014; World Bank, 2014a.[25]

Figure 2.4 plots national averages for ambient $PM_{2.5}$ pollution for a cross-section of countries against their per capita GDP in 2010. There is some tendency for countries with higher per capita incomes to have lower $PM_{2.5}$ pollution. But there is also a wide range of pollution outcomes at any given income level. In particular, India's $PM_{2.5}$ pollution level is exceptionally high even for countries at or near its per capita income levels. Fast-growing lower-middle-income countries like Indonesia and Philippines, for example, have $PM_{2.5}$ levels of about one-third those in Indian cities. This suggests that there may be considerable scope for better policies to reduce ambient air pollution, improve health and boost overall social welfare in India without significant costs in terms of productivity and output.

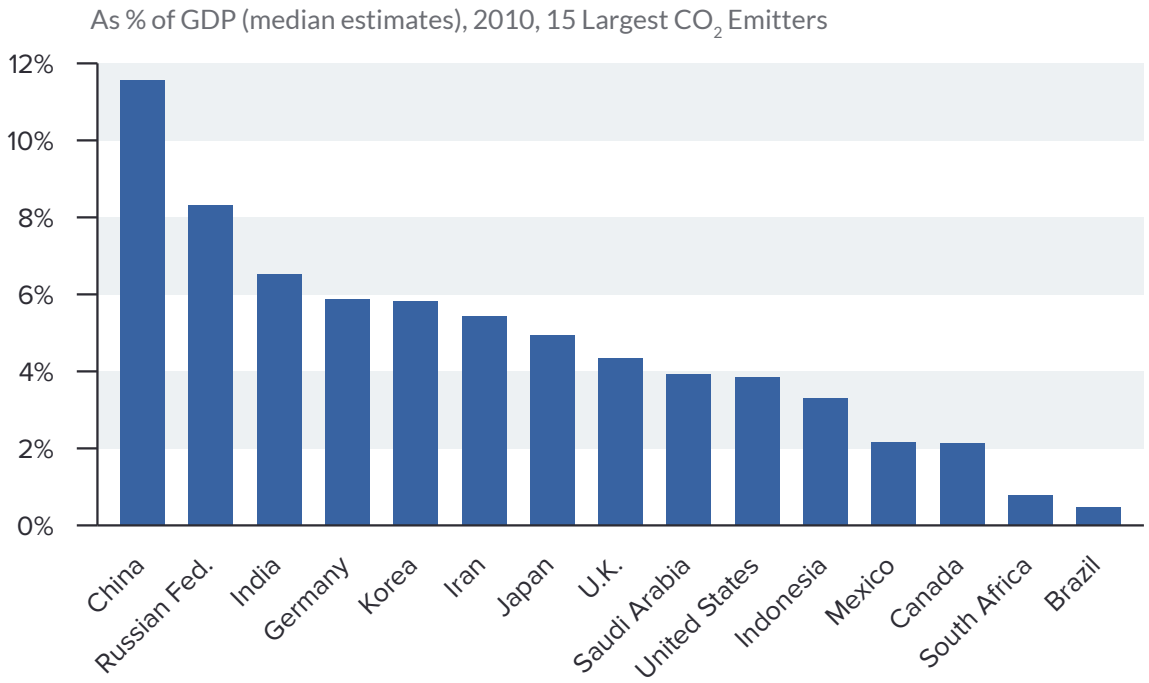
With such high $PM_{2.5}$ concentrations in its cities, it is not surprising that India also has a high estimated national rate of premature death from ambient PM pollution, 51 per 100,000 population in 2010, which puts it in the top 25% of countries. China, which has lower (although still high) concentrations of ambient $PM_{2.5}$ in its cities (see Figure 2.4 above), has a higher estimated mortality rate from ambient $PM_{2.5}$ than India, 92 per 100,000.[26] One possible reason for this difference is that China is more urbanised than India, so that a higher proportion of its population is exposed to ambient PM pollution. China's experience holds a stark warning for India: if it fails to significantly reduce its exceptionally high levels of $PM_{2.5}$ pollution, India's death rates from this risk source are likely to escalate sharply as the country continues its rapid urbanisation and industrialisation, and as an ever larger proportion of the population are affected by severe urban air pollution (see Section 5 below on cities).

The economic cost of ambient PM pollution is already high. Estimates prepared for the New Climate Economy Report using a cross-country "Value of Statistical Life" methodology place a value on lives prematurely lost in India due to ambient $PM_{2.5}$ pollution as equivalent to 6.5% of GDP in 2010, with a 95% confidence interval of 5.5–7.5% of GDP. Figure 2.5 shows such valuations of lives lost due to PM pollution scaled by GDP for the top 15 CO_2 emitting countries in the world. According to this metric, India had the third highest value of lives lost from this source relative to GDP in this group of countries, coming after China and the Russian Federation.[27]

Since $PM_{2.5}$ pollution and CO_2 emissions both come largely from the same source – the burning of fossil fuels – it is also illuminating to calculate the monetary value of lives lost from PM pollution per tonne of CO_2 emitted. With some caveats, this indicator provides an estimate of the potential health benefits per tonne of CO_2 abatement. Studies for the New Climate Economy Report estimate that for India such health benefits amounted to about US$55 per tonne of CO_2 abated in 2010. This is close to double the US government's estimate of US$32 per tonne as the climate

Figure 2.5

Valuation of mortality from outdoor $PM_{2.5}$ exposure



Source: Hamilton, 2014.[28]

benefit of reducing CO_2 emissions.[29] These estimates rather significantly change the cost-benefit calculus of reducing CO_2 emissions in India. First, adding the health benefits of reduced PM pollution almost triples the overall benefits from reducing CO_2 emissions in India. Further, and importantly from the perspective of Indian policy-makers, the air quality benefits are enjoyed in the near term; accrue locally, mostly to the country itself; and are more certain compared with climate change benefits.

An important complication is that there may be alternative policies that generate a different set of benefits. For example, a significant volume of local air pollution can be mitigated by so-called "end of pipe" methods that do not reduce GHG emissions, such as sulphur scrubbers fitted to the smokestacks of power plants. Studies suggest, however, that if countries pursue ambitious air pollution reduction targets, then "end of pipe" methods are unlikely to be enough. It would still be necessary to adopt methods – for example improved energy efficiency or reducing the proportion of coal in the country's fuel mix – that also reduce GHG emissions. One study considered an illustrative scenario in which countries sought to reduce premature air pollution-related deaths in 2050 by 25% compared with 2005. To achieve this ambitious air pollution target it was found optimal to use a combination of air pollution reduction and CO_2 mitigation policies. This combination also yielded large CO_2 reductions by 2050, falling by 38% in the OECD, 61% in China and 42% in India, compared with a baseline without mitigation policies.[30] A survey of the co-benefits of low-carbon strategies notes that a strategy which reduced CO_2 emissions in India by 40% by 2030 would also reduce the loss of life expectancy from $PM_{2.5}$ pollution by about a quarter.[31]

Greenhouse gas emissions

By international comparison, India's emissions of GHGs are relatively small in both absolute and per capita terms. But they are growing rapidly.

India's total GHG emissions were an estimated 2,486 million tonnes of CO_2 equivalent (Mt CO_2e) in 2011, about 5.7% of world total emissions, compared with 42% and 24% for OECD countries and China respectively. India's GHG emissions were 2 t CO_2e per capita in 2011, compared with 7.9 tonnes in China and 14.9 tonnes in OECD countries. GHG emissions were, however, growing at a robust 4.4% annual average pace in 2000/11, much faster than in OECD countries, where there was hardly any growth in emissions over this period, and almost twice as fast as in non-OECD countries other than China.[32]

CO_2 emissions comprised 75% of India's total GHG emissions in 2011, primarily from combustion of fossil fuels, with methane and nitrous oxide emissions contributing another 20% and 4% respectively. CO_2 emissions are also the fastest growing of the major GHGs in India, reflected in a steadily rising share in total emissions. We discuss CO_2 emissions from energy use in more detail in Section 3 below on energy.

3. Key development challenges and opportunities in the energy sector

By global standards India consumes rather a small amount of energy in both absolute and per capita terms. Energy consumption is now growing at quite rapid rates from these low starting points, however, and demand for energy services is likely to continue to grow for several decades more if the country succeeds in achieving its goals of sustained fast economic growth and development. Yet efforts to meet even today's relatively low levels of energy demand are already creating significant macroeconomic, financial and environmental stresses. This would appear to be an opportune time for a fresh review and rethink of how India is to meet its burgeoning energy demands in the decades ahead.

3.1 Overview of energy consumption trends

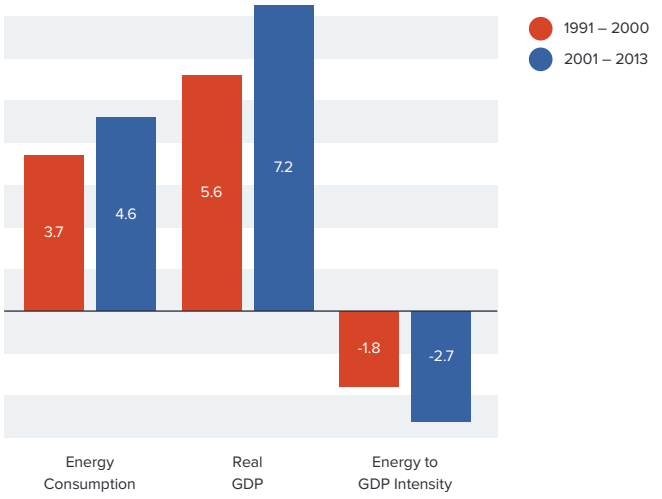
India's primary energy consumption was an estimated 815 million tonnes of oil equivalent (mtoe) in 2013, about 6% of world energy consumption, compared, for example, with the OECD and China's respective 40% and 22% shares. In per capita terms, energy consumption was 643 kg of oil equivalent, one-third of the world per capita average, or 16% of the per capita level in OECD countries. Electricity consumption is even more limited compared to international levels – 683 kWh per capita in 2011, a little more than 20% of the world average and only 8% of the OECD average. Some 301 million people lacked access to electricity altogether in 2010, 25% of the population, the vast majority being in rural areas.[33] As noted, lack of access to clean cooking fuels contributed to high levels of premature death and illness from indoor household air pollution. Even for those with access to electricity, power outages and blackouts are common. On 30 and 31 July 2012 severe blackouts affected over 620 million people in northern and eastern India, thought to be the largest outage ever worldwide.

These international comparisons suggest that, as development proceeds, India's demands for energy services and electricity are likely to rise dramatically from the present relatively low levels. Growth in India's energy consumption has indeed accelerated in the 2000s, rising to a compound annual average of 4.6% in 2000–13 from 3.7% in the 1990s. An annual growth rate of 4.6% represents a doubling of energy consumption every 15 years. This pace was much more rapid than in the OECD (where energy consumption actually contracted slightly in 2000–13), or in non-OECD countries other than China (where energy consumption grew on average 3.3% a year in this period).

We can break down growth in India's energy consumption in a simple way as the sum of growth in real GDP (a key driver of energy demand) and growth in the energy intensity of GDP (the amount of energy consumed per dollar of real GDP). Following this approach, India's 4.6% annual growth in energy consumption in 2000–13 can be broken down into 7.2% annual GDP growth minus a 2.7% annual decline in the energy intensity of GDP, as shown in Figure 3.1. This figure indicates that the acceleration in India's energy consumption in the 2000s was driven by faster GDP growth, which was only partially offset by a somewhat faster pace of decline in the energy intensity of GDP.

Figure 3.1
India: energy consumption and drivers

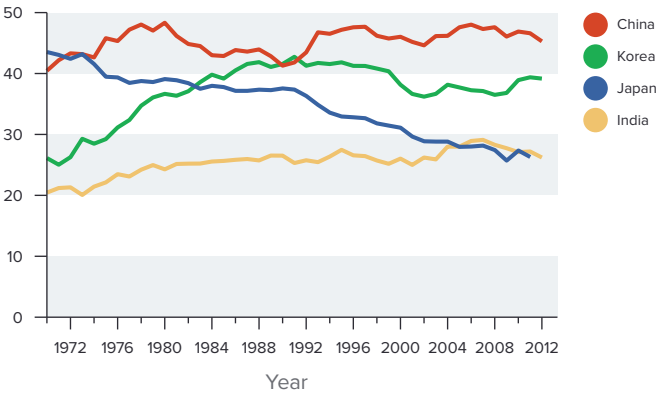
Compound Annual Average Growth (%)



Sources: World Bank, 2014a; CSO 2015 IEA, 2014a; BP, 2014.[34]

Figure 3.2
Four Asian economies: industrial value added

(As % of GDP) 1970-2012



Source: World Bank, 2014a.[35]

Energy intensity of GDP – technology, policies and structural change

The pace of decline in India's energy intensity so far in the 2000s (2.7%) was higher than the median pace of energy intensity decline across all countries in this period, which was just under 1.5% a year. More worryingly, there appears to have been some slowing in the pace of the decline of energy intensity in India between the earlier and later parts of the 2000s: energy intensity fell at 3.5% a year in 2000–06, but at a slower 1.9% in 2006–13. Such differences can have a big impact over time. If the economy is growing at 7% a year, then energy consumption in 15 years' time would be one-third higher if the pace of energy intensity decline were only 1% rather than 3%.

The evolution of energy intensity is likely to have significant implications for the potential growth of the economy, the balance of payments, GHG emissions and the environment. Energy intensity of GDP in turn reflects a complex mix of economic, technological, sectoral and structural factors. These include, on the one hand, the technical efficiency of energy use within specific production processes and for the consumer goods used by households, something which is generally improving over time as a part of global technological progress. Actual energy efficiency is often well below the technological maximum feasible, however, because, for example, the costs of the best technology may simply exceed the benefits of using it. But energy efficiency may also be low because of policy distortions such as energy subsidies and a variety of other market and institutional failures that lead to energy consumption that is excessively high from the perspective of social welfare, and often even from the perspective of private profitability – the so-called energy efficiency gap.[36] Section 3.2 below argues that there are substantial opportunities in India to improve energy efficiency in ways that would benefit both the economy and the environment.

Energy intensity of GDP is also affected by broad structural changes in the economy. The income elasticity of demand for energy tends to vary with income per capita. This elasticity – the percentage change in per capita energy consumption for a given change in per capita GDP – tends to rise as countries go from low-income to middle-income status, as India has been doing. This rise occurs because of factors such as the rise in the share of output of energy-intensive industry relative to agriculture, and increasing urbanisation, which has a more energy-intensive pattern than life in rural areas. Energy demand also tends to climb rapidly when people move out of absolute poverty, when they first gain access to electricity and make first-time purchases of a whole array of household electrical appliances, such as electrical lighting, refrigerators, cookers, fans, air-conditioners, TVs, radios, music systems and so on. As the income elasticity of energy demand increases, the energy intensity (the share of energy in GDP) tends to fall less slowly and may even rise. Later, as countries move from middle-income to high-income status, the income elasticity of energy demand tends to fall as the economy becomes increasingly based on services, urbanisation is completed and absolute poverty is long eradicated.[37]

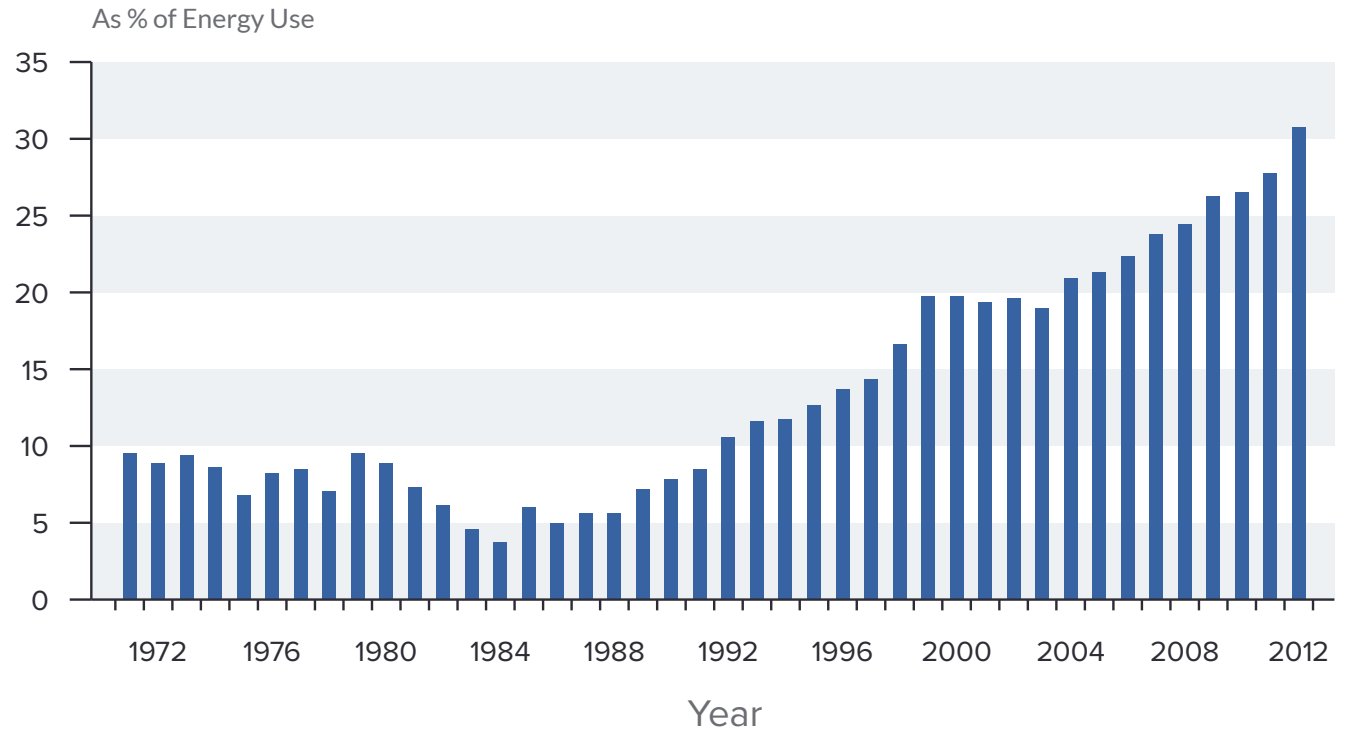
These broad tendencies of course do not mean that countries are doomed to follow a pre-determined path. Policy choices make an enormous difference. Nevertheless, in the absence of strong policies to manage demand and promote energy efficiency, it appears likely that many of these structural forces – industrialisation, urbanisation, falling poverty and rising energy access – could create pressures to push India's energy intensity and energy demand higher in the years ahead.

Figure 3.2 above shows that the share of industry in India's GDP has risen slowly from 20% in 1970 to about 26% in 2012. The figure also shows some Asian comparators. Industry is 46% of GDP in China, an upper-middle-income country, although this is exceptionally high compared with other upper-middle income countries, and is a cause of concern to Chinese policy-makers, who view it as a source of imbalance and environmental stress in China's development path. The industry share is also exceptionally high – just under 40% – in Korea, a high-income emerging economy. While India would probably not reach Korean or Chinese levels of industry share, there are reasons to think its industry share will nevertheless trend higher. Broadly, the historical cross-country pattern is for industry shares to rise, until per capita GDP levels are 2–3 times higher than they are in India at present. Industry in India is also likely to have been especially held back by some of the major economic distortions of the past and present, for example excessive government regulation and state ownership in industry; restrictive labour regulations and weak physical infrastructure and logistics. The relaxation of these constraints may benefit industry disproportionately going forward. Urbanisation (discussed in Section 5 below) will also remain buoyant.

Rising energy imports and energy insecurity

Domestic energy production has failed to keep pace with quickly rising consumption. As a result energy imports have surged, reaching 245 million tonnes of oil equivalent in 2012, or 31% of total primary energy consumption, up from less than 10% in 1990 (see Figure 3.3). Energy has become a central element in the country's chronic trade imbalance, and energy insecurity an important concern for policy-makers. India's international trade imbalance for fuels averaged 6.4% of GDP in the five years 2008–12 – twice the size of its current account deficit, which averaged 3.2% of GDP in this period.[38]

Figure 3.3
India: energy imports, net 1971–201



Source: World Bank, 2014a; IEA, 2014a.[39]

This discussion suggests that, other things being equal, the underlying structural forces of industrialisation, urbanisation and poverty reduction are likely to bolster energy demand and hamper the speed with which the energy intensity of GDP can be reduced. These trends underline the importance of reforms to reduce unnecessary existing inefficiencies and waste in energy use. Recent energy scenarios by India's Planning Commission highlight just how big a difference policies can make. As compared with a "Least Effort" policy pathway, a "Determined Effort" pathway would reduce energy demand in 2047 by 19% and CO_2 emissions by one-third. The level of energy import dependence in 2047 under "Determined Effort" is only 14% compared with 84% under a "Least Effort" policy scenario.[40]

3.2 Energy efficiency and demand management

Energy sector reforms can play a major role in helping India to meet its development challenges. There are numerous opportunities to substantially improve energy efficiency in India that are worthwhile from both the economic and environmental perspectives. India's National Mission on Enhanced Energy Efficiency (NMEEE) is one of the eight national missions set out in the country's 2008 National Action Plan for Climate Change. The mission, which is operationalised through the Bureau of Energy Efficiency, has four thrust areas: the Perform, Achieve and Trade (PAT) scheme for trading energy efficiency savings among the country's largest energy consuming plants; the Market Transformation for Energy Efficiency (MTEE), which focuses on energy efficiency programmes and building codes; the Energy Efficiency Financing Program; and the Framework for Energy Efficient Economic Development.

This section discusses several directions in which the country's mission to enhance energy efficiency can be intensified and broadened in scope, including reform of fuel subsidies, electricity sector reform, and more vigorous use of energy efficiency standards.

Fuel subsidy reform

As in many developing countries, fuel and power subsidies in India arose from a desire to protect consumers, especially poor households, from high and volatile energy costs. There is a clear recognition now, however, that such subsidies are an inefficient method of providing social protection, while imposing significant costs on the economy and harm to the environment. Economic inefficiencies include wasteful direct use of energy at all levels whether in production or final consumption, excessive consumption of goods and services that use energy intensively and inefficient concentration of capital and labour in sectors producing such goods. Subsidies also stimulate higher fiscal deficits and a diversion of

public expenditure away from more productive uses such as infrastructure, education or health, and increased energy imports and trade deficits. Not least, fossil fuel subsidies reduce incentives for innovation in clean energy technologies. With excessive burning of these fuels also comes higher levels of local air pollution, damage to the health of the public and rising CO_2 emissions. Recognition of these problems has led a growing number of countries to attempt reform of energy subsidies. Successful reforms in the 1990s and 2000s included Brazil, Chile, Kenya, Philippines and Turkey.[41]

This section discusses India's fuel subsidies while electricity subsidies in agriculture are discussed in the next section and Section 4 below. The system of fuel subsidies in India has been implemented through centrally administered selling prices that can be charged by downstream oil marketing companies (OMCs) for diesel, kerosene and LPG. (Petrol subsidies were eliminated in 2010.) Losses to the companies are covered through a per unit subsidy (for kerosene and LPG), ad hoc subsidies from the government budget to cover "under-recoveries", and through borrowing by the OMCs.

The size of fuel subsidies has fluctuated significantly from year to year, in particular as a result of fluctuations in international fuel prices and the price of fuel imports. Fuel subsidies are estimated to have averaged 1.4% of GDP since 2007/08 and are estimated at about that level in 2012/13.[42] Fuel subsidies alone represented some 13.7% of India's budget expenditure in 2012/13. The level of subsidies fell sharply in 2014/15 as a result of the steep fall in world oil prices in the second half of the calendar year 2014. In the absence of reforms, however, subsidies could also swing higher in future in the event of an upswing in international prices. International oil prices are inherently volatile. Countries with significant fuel subsidies are therefore exposed to large swings in the fiscal position of the government.

Most of the benefit of fuel subsidies in India goes to higher-income groups. A study by the International Monetary Fund (IMF) finds that the bottom two deciles of the income distribution in India allocate 1.6% of their total expenditures to fuel, while the top two deciles allocate nearly 6%. In absolute terms the top income decile spends more than 20 times as much on fuel as the lowest income decile on a per capita basis.[43]

With growing awareness of their economic and environmental costs, the government has moved to scale back fuel subsidies in recent years using a number of fuel-specific measures. As noted, petrol prices were liberalised in 2010. Diesel prices were increased by Rs3.50 a litre in September 2012 and then periodically increased in small amounts from January 2013 onwards. Subsidies for bulk consumers were also eliminated. With falling international oil prices, under-recoveries on diesel switched to a small over-recovery by late in the calendar year 2014, allowing the government to remove diesel price controls altogether in October 2014.

Per unit subsidies for LPG and kerosene have generally been higher than for other fuels because of their greater sensitivity for the poor. While paying a per unit subsidy on LPG and also controlling the selling price, the government has aimed to limit the total fiscal impact by restricting the number of cylinders of LPG that households can buy at the subsidised price. The government announced in October 2014 that LPG selling prices would vary with international prices from 2014/15 onwards. The government has also followed a policy of gradually reducing the supply of kerosene through the public distribution system.

Since October 2014 the government has also taken advantage of falling international oil prices to increase excise taxes on petrol and diesel. Excise duty on branded petrol, for example, was increased from 10 to 18 rupees per litre by January 2015. Previously the coal cess had also been doubled to 100 rupees per ton. The government estimates that the subsidy reforms and fuel excise tax increases since October 2014 have implicitly created substantial carbon prices for petrol and diesel respectively of about $140 and $64 per ton of CO_2.[44]

The present interlude of low world oil prices provides an excellent opportunity to accelerate the removal of remaining fuel subsidies in a carefully sequenced, equitable and sustainable manner. Reform of kerosene and LPG subsidies would need to be handled would have the greatest impact on lower-income groups and would need to be combined with social protection measures to offset the impact on the poor and most vulnerable. The possibility of transforming various in-kind subsidies into cash transfers is being actively studied in India. Elimination of fuel subsidies could then be undertaken alongside a broader modernisation of India's social protection framework, putting in place the institutions and information systems for a modern system of cash transfers that would help to alleviate the impacts of future volatility in world energy prices, among other risks facing the poor.

Power subsidies and electricity sector reforms

India's electricity sector is rife with inefficiencies and supply bottlenecks that result in huge unmet demand, hamper economic growth, restrict access by the poor, stimulate inefficient energy consumption and worsen both local air pollution and carbon emissions.

As a matter of policy, state electricity boards have long provided electricity to agricultural consumers at extremely low subsidised prices. In 2013/14 these were estimated at only about 40% of the prices paid by industrial and commercial users.[45] Section 4 below notes how such electrical power subsidies do little to increase agricultural productivity, while they encourage excessive use of

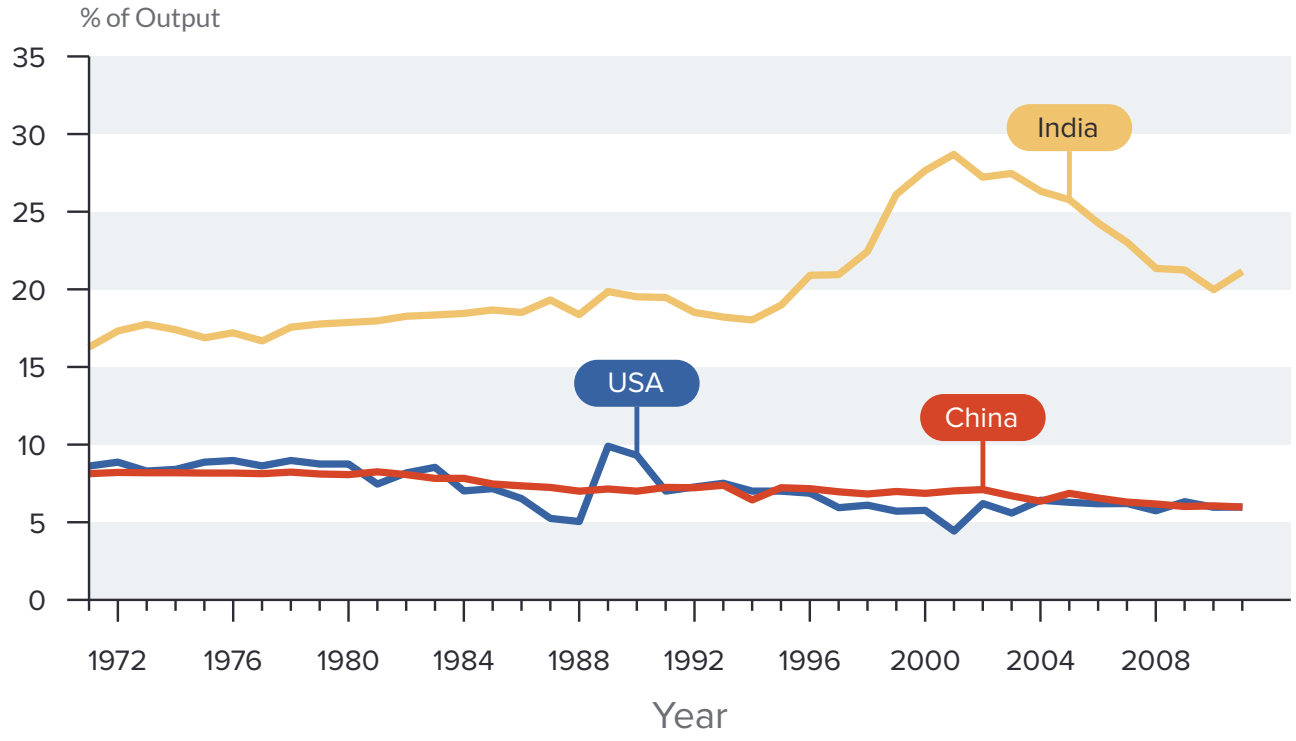
well pumps and groundwater consumption, as well as stimulating CO_2 and methane emissions through various channels. Electricity distribution companies have little freedom to adjust prices flexibly according to market conditions, for example during peak demand periods. Increasingly, average billed tariffs have failed to keep up with costs.

In addition to such inefficiencies that arise as a matter of pricing policy, the electricity sector also suffers from extraordinarily high transmission and distribution losses, estimated at 21% of electricity output in 2011, compared with just 6–7% in China and the USA (see Figure 3.4). For the most part these losses have two causes. Technical losses refer to power that is generated but lost in transit due to weak power infrastructure and poor operations and maintenance. This reflects a pure waste of resources. Commercial losses, by contrast, refer to power that is delivered and consumed but for which distribution companies are underpaid due to theft and inefficiencies in billing and collection.[46]

The Electricity Act (2003) attempted to address inefficiencies in the electricity sector by promoting greater competition and strengthening institutions, especially in transmission and distribution. Reform is still a work in progress, though. Despite improvement on several fronts, financial losses in the electricity sector have snowballed since 2003, reaching Rs618 billion (US$14 billion) in 2011, concentrated overwhelmingly among distribution companies at the state level. This amounted to 0.7% of GDP and 17% of the gross fiscal deficit. A breakdown of losses suggests that technical distribution losses are the largest factor, but that failure to raise electricity tariffs to keep up with cost recovery has been an increasingly important factor since 2003. Losses have been met by state subsidies, and, increasingly, debt borrowings, which have reached more than 10% of state GDP in several northern states. Mounting power sector debts now pose a threat to the balance sheets of financial institutions.[48]

Worsening finances in the power sector have led to increased rationing of power supplies, as well as a squeeze on new investment and a further reduction in the quality of power infrastructure and services – a vicious circle. One consequence, the massive power blackout in northern and eastern States in 2012, has already been mentioned. Power shortages indeed pose a significant drag on growth and economic efficiency nationally. The 2005 World Bank Enterprise Survey for India found that one-third of firms saw power shortages as the single most important constraint on their growth. Large firms have adapted to power shortages by installing their own diesel-powered generation units, but smaller firms, without the scale economies or financial resources for in-house generation, have suffered the most, as have households, even those nominally on the grid.[49]

Figure 3.4
Electricity T&D losses 1971-2011



Source: World Bank, 2014a.[47]

Thorough reforms to address inefficiencies in the power sector therefore appear to be a major opportunity to boost economic performance while mitigating local air pollution and CO_2 emissions. For example, Planning Commission estimates suggest that with (very high) 9% GDP growth, India's power generation requirements would be 2359 TWh in 2030, assuming transmission and distribution losses fall from the current 21% to 15%. Reducing these losses to 7% (around the current rates for China and the USA) would, it is estimated, reduce baseline GHG emissions from the power sector by 201 Mt CO_2e in 2030.[50]

Power subsidy reform, while difficult, is not impossible. In Gujarat, for example, large farmers were recently willing to accept higher power prices in return for a more reliable power supply. Numerous technical solutions are available to tackle problems of high transmission and distribution losses. However, the most important reforms needed are those of institutions and governance, in particular to push forward the approach of the Electricity Act (2003) in terms of unbundling and corporatising state electricity boards, building independent regulatory bodies at the state and central levels, scaling back subsidies and setting realistic prices to create financial viability and developing a performance-oriented culture in the sector. Insulating distribution companies and regulatory bodies from political interference by state governments is a vital political economy dimension of reform.[51]

Energy efficiency standards

Appliance standards: The residential sector is the fastest growing source of electricity demand in India, driven by urbanisation and rising incomes. The total housing stock is rising rapidly, and with it first-time appliance purchases. Appliance ownership remains far below saturation levels, however, and as in other developing countries, once purchased, appliances tend to be used over long periods before they are replaced. The vast expansion in the stock of appliances in India over the next decade, say, will lock in levels of energy consumption and GHG emissions over an even longer horizon. Policies to manage residential energy demand and promote appliance energy efficiency are therefore vitally important for both economic and environmental reasons.[52]

Engineering-economic estimates suggest that the adoption of existing cost-effective energy-efficient appliance technologies could result in large reductions in India's energy consumption and GHG emissions. One estimate is that the adoption of energy-efficient technologies for just three appliance groups – air conditioning, standby power and refrigerators – would reduce India's power consumption in 2030 by 95 TWh, and GHG emissions by 100 Mt CO_2e per year.[53] These estimates are conservative in the sense that they assume efficiency levels already envisaged in the current efficiency ratings of India's Bureau of Energy Efficiency (BEE) and exclude existing so-called super-high efficiency options.

Increases in energy efficiency generally lead to a "rebound effect", that is, to some increase in appliance and energy use due to a fall in the effective price of energy. However, while the rebound effect tends to partially offset the net reduction in energy demand from efficiency improvements, it does improve welfare and expand the total amount of energy services available to the public.[54]

There is often a large gap between the availability of appliances that are cost-effective and energy efficient and their widespread adoption by consumers – the so-called "energy efficiency gap", which has been widely discussed in the research literature. There are nevertheless a range of policy instruments that can be used to encourage more rapid diffusion of energy-efficient appliances in India. Mandatory minimum energy efficiency standards may be an especially effective tool in the Indian context of a boom in purchases by first-time buyers. Engineering evidence suggests that minimum standards could be increased without significant increases in manufacturing costs. The risk of cost increases could be mitigated by linking minimum performance standards to the level of the most efficient models that are already commercially available, as in Japan's "Top Runner" efficiency programme.[55] Nevertheless, there remain valid concerns that standards could result in higher prices that put appliances out of reach of poor first-time buyers. Minimum standards can be complemented with financial incentives to encourage energy demand management and appliance efficiency, for example through consumer rebates.

Transport sector energy standards: The transport sector's demand for energy is among the fastest-growing sources of energy demand in India but has not received much attention in the country's efforts to improve energy efficiency. Energy demand in the transport sector can be viewed as the product of three factors: total transport activity (measured in, say, passenger-kms), the shares of various transport modes (e.g. public transportation, cars, trucks etc.), and the energy used per passenger-km for each transport mode. The first two of these relate closely to the structure of cities and are considered further in the discussion about cities in Section 5. Reform of fuel subsidies will clearly be important to encourage more efficient energy use in transport. Fuel efficiency standards for new cars have been proposed by the Bureau of Energy Efficiency but no action has so far been taken. The prompt introduction of such standards would be an important step towards better management of energy demand in the transport sector, subject to the concerns about higher vehicle prices, as already noted for appliances.

In an industrial setting the country's nascent energy efficiency certificate trading system (Perform, Achieve, Trade) has shown potential. Expansion of the scheme from

the very largest industrial units to medium- and smaller-sized firms may prove challenging because of the less standardised outputs of smaller units, requiring a broader menu of potential policy options.

3.3. Overview of the energy supply mix and carbon intensity trends

India has seen a transformation in the composition of its energy supply in the decades since Independence – away from the previous overwhelming reliance on traditional biofuels consumed in villages by a rural population, towards modern energy sources, primarily fossil fuels, which now comprise almost 75% of total primary energy, with coal alone comprising 45% of primary energy (see Figures 3.5a and 3.5b). Table 3.1 provides further detail on the composition of primary energy in India in 2012 and its change since 1990. The aggregate share of modern non-fossil fuel power sources, such as nuclear, hydro, wind and solar, increased only modestly from 2.5% to 2.9% over the period from 1990 to 2012. Fast growth in renewables such as solar and wind was offset by only slow growth in hydropower.

The long-term change in India's energy mix conforms to a broad "energy transition" that has historically tended to occur as countries move from very low per capita income levels into the middle-income range, accompanied by a rise in the carbon intensity of energy and in carbon emissions themselves.[56] Carbon emissions per unit of energy consumed tend to be low in poor, largely agricultural economies because people rely primarily on burning wood, wood waste and other biomass fuels for energy. The burning of biomass only releases CO_2 accumulated by plants during their lifecycle and therefore does not add to atmospheric concentrations of CO_2. Protocols and guidelines by the IPCC and other standard-setting bodies therefore treat biomass fuels as neutral with respect to CO_2 emissions. With rising per capita incomes and industrialisation, the economy becomes more dependent on modern forms of energy, in particular fossil fuels, which have historically provided greater energy density, constancy of flow, flexibility, transportability and ease of control than traditional combustible biomass.

This is a far from uniform process, however. Carbon intensities of energy vary widely at similar levels of per capita income. They are high in China and India, for example, because of the exceptionally high proportion of coal in these countries' energy mixes. To the extent that the transition to modern energy can be supplied with modern non-CO_2 emitting fuels – hydro, geo-thermal, nuclear, solar, wind etc. – the rise in CO_2 intensity can be moderated. Brazil, an upper-middle-income country, has a CO_2 to energy intensity ratio much lower than other countries at its level of development because of plentiful hydropower. In addition there is some tendency for carbon intensity to fall at higher income levels, as countries shift away from coal and adopt policies to reduce local air pollution from burning fossil fuels, as well as to reduce CO_2 emissions for climate mitigation reasons, opening the door to greater use of modern clean technologies.

Figure 3.5a
India: composition of total primary energy

(% of Shares) 1971-2012

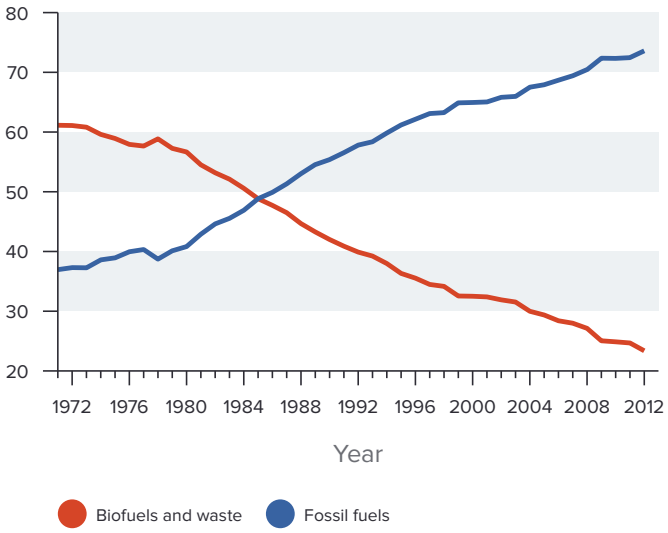
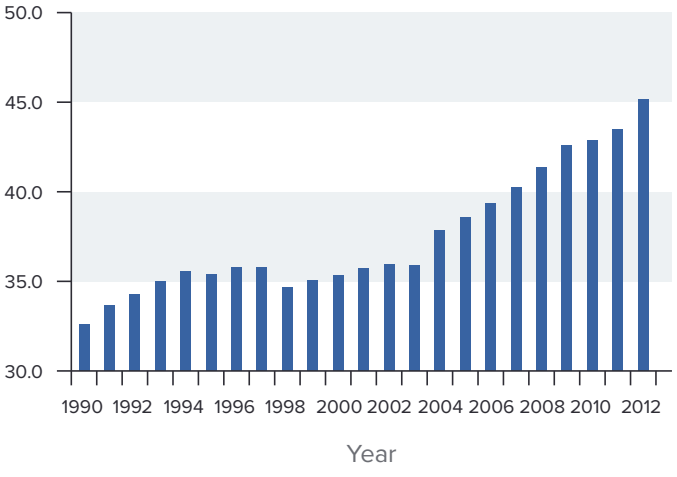


Figure 3.5b
India: share of coal in total primary energy

1990-2012



Source: IEA, 2014a; World Bank, 2014a.

Table 3.1

India: total primary energy demand and fuel mix - 1990 and 2012

	1990		2012		1990-2012
	Mtoe [1]	% of TPED [2]	Mtoe	% of TPED	% CAAGR [3]
TPED	317	100	788	100	4.2
Bioenergy	133	42.2	185	23.5	1.5
Total Fossil Fuel	175	55.4	570	73.7	5.5
Coal	103	32.7	354	45.0	5.8
Oil	61	19.3	177	22.5	5.0
Natural Gas	11	3.4	49	6.2	7.1
Total non-fossil [4]	8	2.5	23	2.9	4.9
Nuclear	2	0.5	9	1.1	7.9
Hydro	6	1.9	11	1.4	2.6
Other	0	0.0	3	0.4	29.5
Memo Items					
Real GDP growth					6.4
Energy to GDP [5]	299		191		-2.0
CO_2 emissions	580		1953		5.7
CO_2 to energy [6]	1.83		2.48		1.4

Source: IEA, 2014b, World Energy Outlook 2014, for energy and CO_2 emission data. Authors' calculations for other Memo Items. (1) Million tonnes of oil equivalent. (2) Total primary energy demand. (3) % compound annual average growth rate. (4) Total non-fossil fuel energy excluding bioenergy. (5) Energy to GDP intensity –kg of oil equivalent per US$1000 GDP (2005 constant PPP). (6) CO_2 to energy intensity – kg per kg of oil equivalent energy use.

CO_2 emissions and CO_2 intensity of energy

India's carbon intensity of energy has been rising for decades as the country has increased fossil fuel consumption relative to traditional biofuels, in particular with rising use of coal for electricity generation, and diesel and gasoline for transport. This shift is an important contributor to the rapid growth in India's CO_2 emissions, as well as to urban outdoor air pollution. Figure 3.6 shows that CO_2 emissions from energy were rising at an average 5.6% a year in both the 1990s and 2000–13, among the fastest internationally. We can make a simple breakdown of CO_2 emission growth as the sum of growth in total energy consumption and growth in the CO_2 intensity of energy (units of CO_2 emissions per unit of energy consumed). Figure 3.6 shows that fast growth in overall energy consumption – discussed in Section 3.1 above – was clearly a major driver of emission growth. But rising CO_2 intensity of energy was also an important contributor. Around the world the median rate of change in CO_2 to energy intensity was approximately zero in the 2000s. In other words half of all countries experienced a falling CO_2 to energy intensity in this period and half a rising CO_2 to energy intensity. India was among the latter group, with an increasingly CO_2-rich fuel mix.

The comparison between the 1990s and the period 2000–2013 in Figure 3.6 may also obscure some more recent and worrying trends. India's CO_2 emission growth rate accelerated to an estimated 7% a year in the recent period 2006–13, from 4% a year in 2000–06. This was not due to faster GDP growth but, rather, to a slowdown in the pace of reduction in the energy to GDP intensity (leading to faster growth in total energy demand), and faster growth in the CO_2 to energy intensity. The reasons for the former trend are unclear and need more investigation. The reason for the latter appears to be a more rapid increase in the use of coal, in particular in the power sector. This trend is likely to be connected to government policy, in particular the opening of the power generation sector after 2006 for private firms to construct, own and operate large-scale thermal power plants, including the 4 gigawatt (GW) Ultra Mega Power Projects (UMPP).[58]

Figure 3.6
India: CO_2 emissions and drivers

Compound Annual Average Growth (%)

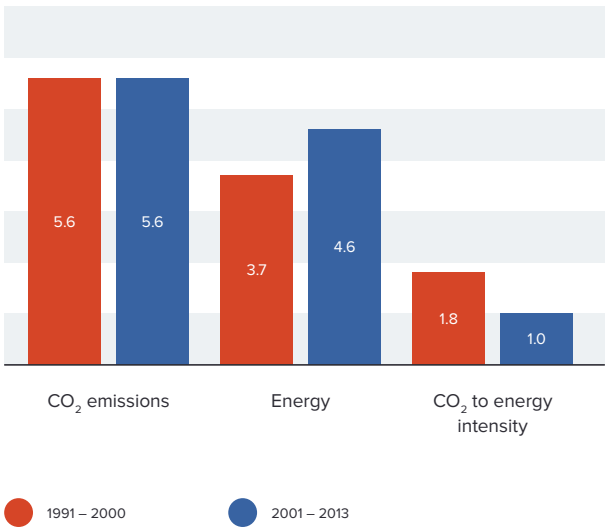
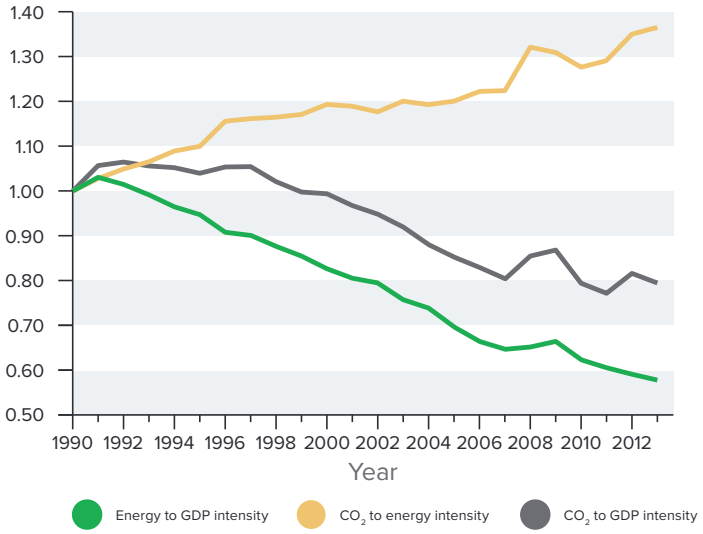


Figure 3.7
India: CO_2 to GDP intensity and drivers

1990-2013. (Indexes = 1 in 1990)



Source for Figures 3.6 and 3.7: World Bank 2014a; CSO 2015. IEA 2014a; BP 2014; Boden et al. 2013. NCE staff calculations.[57]

We can summarise these recent trends by looking at the evolution of another macro-level indicator, the CO_2 intensity of GDP (CO_2 emissions in kg per rupee of real GDP). This is a particularly important indicator because the voluntary international commitments that India has set for emissions are expressed in terms of a long-term decline in the ratio of emissions to GDP. Figure 3.7 shows that CO_2 to GDP was falling between the early 1990s and the mid-2000s, but that this progress has largely halted in the recent period 2006–13. Figure 3.7 also shows the two factors that drive the CO_2 to GDP intensity, which we have already discussed, the energy to GDP intensity and the CO_2 to energy intensity.[59]

3.4 Opportunities to increase efficiency of India's energy supply mix

Where does all this leave India? It seems fair to say that the performance of the energy sector has been unsatisfactory and leaves India exposed to significant vulnerabilities. Despite the ramp-up in coal-fired power generation capacity since the mid-2000s, power supply remains subject to serious shortages and blackouts. In addition to the severe inefficiencies in power distribution discussed earlier, it has proven difficult to increase domestic coal production because of numerous institutional and technical difficulties. This has led to a surge in expensive foreign currency denominated net coal imports, which rose more than sixfold from 13.9 mtoe in 2000 to 88.5 mtoe in 2012, contributing to sharply increased energy insecurity. Some Indian private sector power generators are attempting to develop vertically integrated coal mining operations in Australia as a source of supply, but it has been estimated that the cost of such supplies will be much higher than the rates negotiated with the government under long-term power purchase agreements (PPAs), and could be as much as 30–50% higher than the cost of wind and solar power by 2020, especially given the rapid ongoing fall in the cost of renewables. (See discussion of renewables below).

Faced with the dilemma of running coal-fired power plants at well below optimal utilisation rates or importing expensive foreign coal, numbers of private firms in the generation sector are reporting financial losses.[60] Even with proposed improvements in the efficiency of Indian domestic coal, the marginal unit of supply is likely to remain imported coal. In this context, the substitution of financially competitive renewable energy for imported coal at the margin will have important economic and social benefits for India, such as greater energy security and a cleaner environment.

The severe local externalities associated with rising use of coal and other fossil fuels – for example, health damages associated with local air pollution, congestion and increased accidents – are harms suffered by the residents of India which are not reflected in the price of these fuels. As a result these fuels are over-consumed, reducing India's overall social welfare. These damages are quite separate from and in addition to the global harms associated with climate change. The IMF recently estimated the size of the local damages associated with the use of fossil fuels. The results are striking. In many countries, including India, the local damages from fossil fuels are much greater than the global climate change-related damages. For India, the local damages from coal use in 2010 were estimated at U$5–6 per gigajoule, which compares with a global average price of coal of about US$5 per gigajoule. These damages are large enough to cover or exceed the existing cost gap with cleaner forms of energy such as wind or solar. Local damages from petroleum were estimated at US$0.60–0.70 per litre and from diesel at US$0.40–0.50 per litre.[61]

From the perspective of maximising India's own social efficiency and social welfare it is important that all the social costs and benefits of different fuels be taken into account in determining the optimal energy mix for the country. Given the size of the local harms associated with coal and other fossil fuels there is little doubt that India could improve its welfare by putting a much greater emphasis on improving energy efficiency and on developing modern non-fossil fuel power sources, such as nuclear, hydro, wind and solar. To reiterate, such a course is desirable purely from the viewpoint of India's own welfare. Global benefits in terms of reduced climate risk would be additional co-benefits to these Indian national benefits.

The most efficient instruments to achieve a more socially optimal fuel mix are fuel taxes that reflect the pollution and harms caused by each fuel type. In addition to reducing local damages, such taxes would also raise significant government revenues, providing resources to reduce other more distorting taxes, to increase productive development spending or to fund cash transfers to compensate poor fuel consumers. The IMF calculates that optimal fuel taxes for coal, diesel, gasoline and natural gas would generate government fiscal revenues worth 6–7% of GDP in India.[62] As noted, the government has significantly increased excise taxes on petrol and diesel since October 2014. It also increased the cess on coal but recognizes that "there is still a long way to go with potential large gains still to be reaped from reform of coal pricing".[63] The use of fuel taxes to promote a more efficient fuel mix can be complemented with other instruments, such as regulation, concessional development financing and public investment policies to encourage alternative clean energy sources, as discussed below.

It is sometimes argued that such a course, which takes into account environmental and other externalities, is simply too costly for a developing country in terms of their overriding objective of economic growth. Note, however, that a lack of environmental regulation in a country is

implicitly a way of discriminating against some sections of the country's own population in favour of others. It is in effect a form of subsidy to highly polluting firms at the expense of a less healthy public, and less polluting firms. In addition, the exclusive use of GDP as a yardstick to measure the welfare effects of reform can be misleading. The effect on GDP might include a potential loss in measured output of goods and services, but not other types of changes in welfare, for example in improved health. Policy-makers should supplement GDP effects with estimates of broader welfare gains, which can also be estimated in monetary terms, albeit sometimes only approximately.

Low-carbon energy alternatives

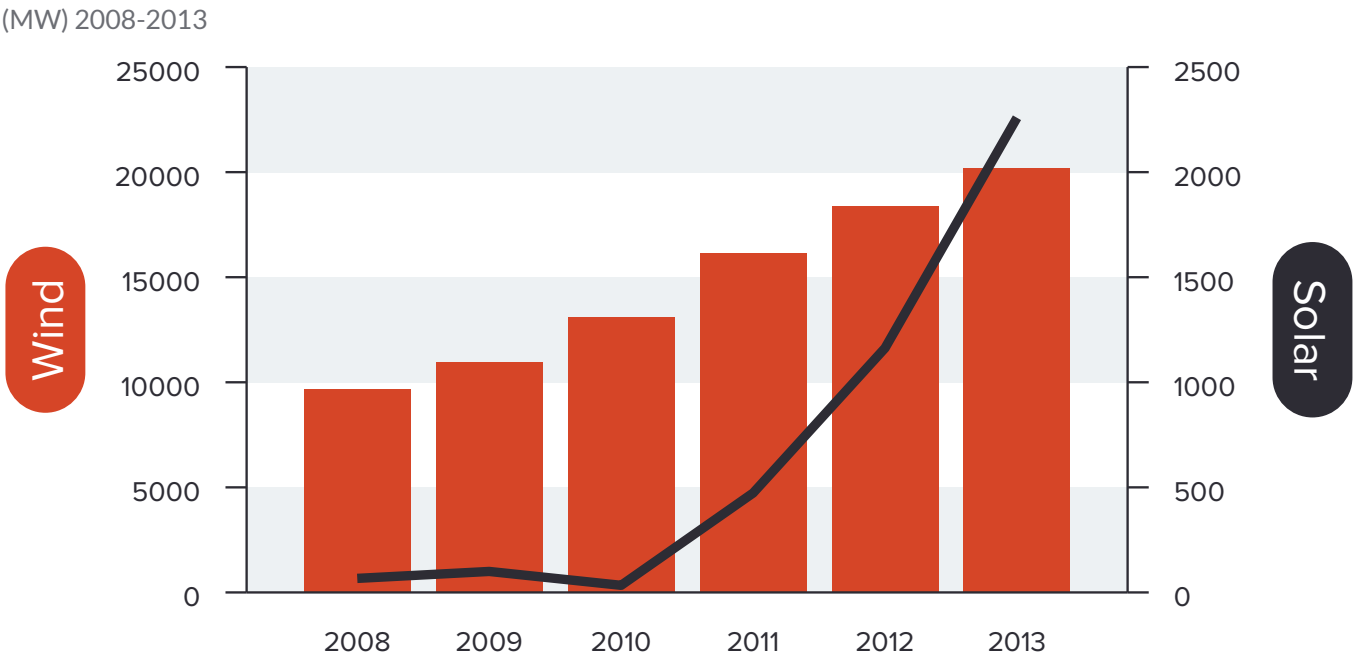
It is sometimes said that energy efficiency is the cheapest form of alternative energy. Since Section 3.2 above discussed India's energy efficiency opportunities, we focus here on other clean energy sources. As documented extensively in the *New Climate Economy Report*, global energy supply technology is changing rapidly. Renewable energy has seen unexpectedly fast cost declines. These changes are overturning many previous assumptions about relative energy costs, and broadening the set of cost-effective low-carbon energy options available to countries. In 1990 wind power was three to four times more expensive than fossil-fuel electricity but since then costs have dropped by half or more while performance has improved dramatically. In a number of countries the cost of electricity from onshore wind is now on a par or lower than fossil fuel alternatives. Solar PV is costlier but is now just half the cost it was in 2010. At least 53 solar PV plants over 50 MW were operating by early 2014 in at least 13 countries. Several planned projects are now considered competitive without subsidies.[64]

India is also witnessing these global trends. The cost of solar electricity generation has come down by 65% over the last three years. Bids at an October 2014 auction for solar projects in Andhra Pradesh fell to as low as Rs5.25 per kWh and, although for technical reasons some recent auction prices may not be sustainable in the short run, there are clear expectations that wind prices (in particular), but also solar prices, are already becoming or will soon become competitive with imported coal.[65]

Wind and solar generating capacity is still small but rising fast. Wind capacity doubled to 20 GW between 2009 and 2013, while solar, although much smaller, is rising much faster, increasing by almost five times in just two years, to reach 2.3 GW in 2013 (see Figure 3.8).

The newly elected government has signalled a strong commitment to rapidly expanding clean energy sources. Previous National Solar Mission targets of reaching 20 GW by 2022 have been increased to 100 GW in the same timeframe.[67] The physical potential for renewables generation in India is very large. A recent estimate by the Ministry of New and Renewable Energy puts India's potential solar capacity at 749 GW.[68] Estimates of total wind power capacity by Lawrence Berkeley National

Figure 3.8
India: installed wind and solar capacity



Source: BP, 2014.[66]

Laboratory have estimated India's total wind energy capacity at 2,000 GW or even higher.

As large as India's renewables capacity may be, many difficult policy and institutional reforms will be needed to make the rapid expansion of renewable power a reality. Renewables expansion is hampered by the high cost of capital and problems of land acquisition in the country. India's unreliable and inefficient transmission network will need to be upgraded and expanded to allow tapping of power from new wind and solar sites.

The high cost of financing is likely to be the single most important impediment to expanding renewable energy in India, and one where carefully designed reforms could have an important impact on accelerating investment in this sector. Renewable energy projects are especially sensitive to financing costs because 85–95% of the total discounted lifetime cost of these projects are upfront capital costs, compared with only one-third for gas projects, for example. At the same time, debt costs in fast-growing developing countries like India tend to be much higher than in developed countries, due to strong competing demand for investible funds, higher risks, higher inflation and immature financial markets. While renewable energy projects in the US or Europe can typically borrow at 5-7%, fixed for a 10–15-year term, a similar project in India could see borrowing, if it were available, charged at up to 12-14%, raising project costs by as much as a third.

The government may consider several options for tackling the problem of high financing costs in renewable energy projects in India, in particular by increasing the flow of concessional domestic debt to renewable projects, for example through the creation or strengthening of development banking institutions. This approach could well cost much less – up to 30% less – than the total of other types of fiscal supports typically provided by governments for renewable energy projects, for example feed-in tariffs, tax credits, accelerated depreciation benefits and direct subsidies.[69] A public sector approach can also be considered, for example with the creation of a National Renewable Power Corporation to undertake major renewable investments with world-class levels of management and technological dynamism. In all these approaches it will be important to build in strong regulatory, governance and project selection mechanisms to reduce the risk that scarce public resources are squandered because of cronyism or other governance failures.[70]

Scenarios for India's energy consumption and CO_2 emissions to 2030

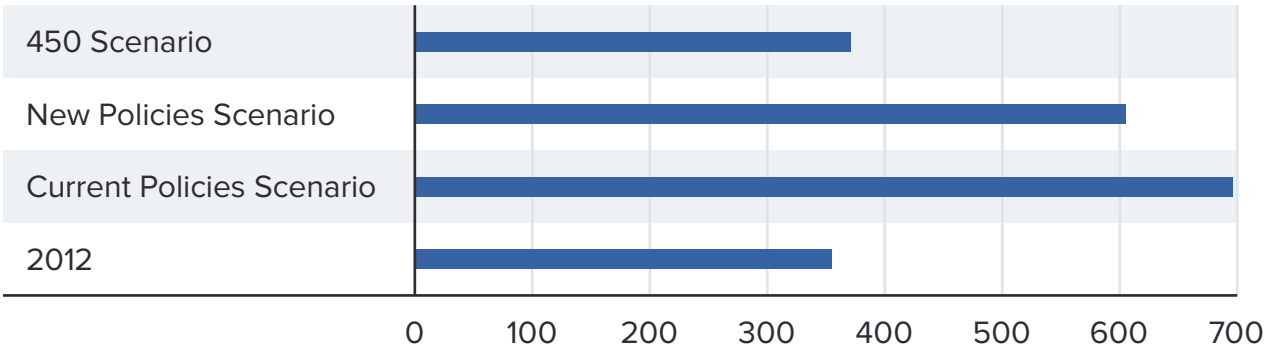
It is important to recall that, even with strong reforms, national energy systems contain a high degree of inertia and take a long time to restructure from one energy paradigm to another. Nevertheless, the pace at which the transition to energy efficiency and non-fossil fuel power sources takes hold will make a huge difference in the levels of CO_2 and local air pollution, the health of the public, and the nation's energy security.

Long-range scenarios of energy demand and supply are affected by tremendous uncertainties about future technologies, economic and social context and policies, among other factors, all of which often contribute to significant differences in scenarios from various authoritative sources. With these caveats, it is useful to consider energy scenarios for India in 2030 prepared by the International Energy Agency (IEA) in its *World Energy Outlook 2014* (see Figures 3.9a and 3.9b).[71] The "Current Policies Scenario" is a business-as-usual scenario, which assumes only those policies and implementing measures that had been formally adopted as of mid-2014. In this scenario fossil fuels, coal consumption and CO_2 emissions all double between 2012 and 2030, with CO_2 emissions reaching almost 4 billion tonnes. The "New Policies Scenario" assumes that relevant policy proposals that had not been adopted by mid-2014 are also implemented, while the "450 Scenario" assumes a much stronger set of measures adopted as part of a global initiative to limit the increase in global temperatures to 2°C. These scenarios assume increasingly rapid gains in energy efficiency and an increasingly large rise in the share of low-carbon fuels such as wind, solar, and nuclear. In the "450 Scenario", coal consumption is not much higher in 2030 than in 2012, and is much lower than in the "Current Policies Scenario", showing the potential for outcomes where powerful development gains are combined with much better environmental outcomes.

All three IEA scenarios assume 6.4% annual GDP growth, the same as the historical trend in the period 1990–2012, but lower than official goals of 8–9% growth. Faster growth without strong policy measures to increase energy efficiency and clean energy sources would result in even more dramatic increases in coal use, energy insecurity and pollution. These comments underline the urgency for India to build strong low-carbon initiatives integrally into its growth agenda.

Figure 3.9a
India: coal consumption

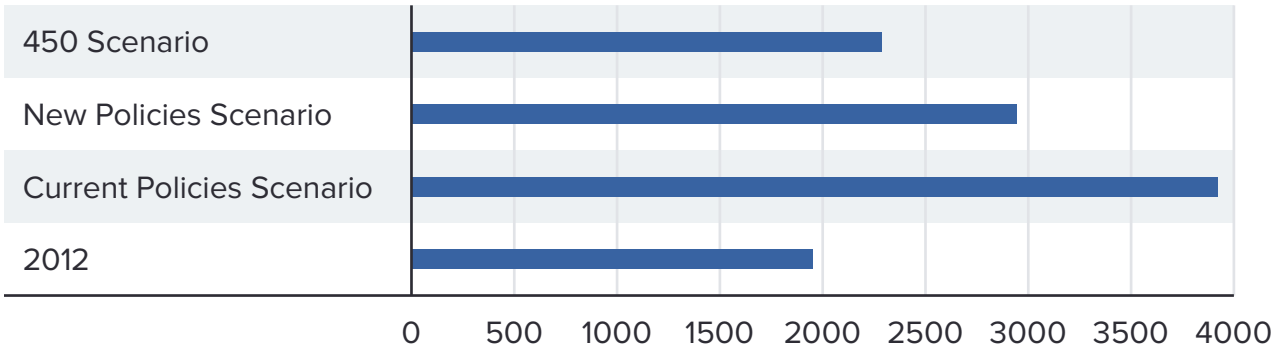
IEA Scenarios to 2030 (Mtoe)



Source: IEA, 2014b.[72]

Figure 3.9b
India: CO_2 emissions from energy

IEA Scenarios to 2030 (Mt)



Source: IEA, 2014b.[73]

4. Key development challenges and opportunities in agriculture and land use

The *New Climate Economy Report* observes that the traditional model of agriculture and land use in developing countries is under pressure due to growing land and water scarcity, deforestation, over-grazing and soil degradation. These are also regions where agricultural productivity is already being affected by existing climate variability and will be most seriously reduced by climate change. It argues that there are significant reform opportunities to achieve "triple wins" – that is, to raise farmers' incomes, to strengthen resilience to climate change, and to abate GHG emissions. Such gains can be achieved by the application of modern agricultural technologies and practices that boost crop and livestock productivity, and which economise on inputs such as land, water and fertilisers. Exploiting such opportunities will require policy reforms, coordination and institution-building to overcome existing policy failures, for example subsidies that seriously distort resource use in agriculture, and to address market failures, such as lack of public goods and property rights.[74]

In this section we demonstrate that Indian agriculture exhibits broad opportunities for reforms that can achieve "triple wins".

4.1 Key features of Indian agriculture

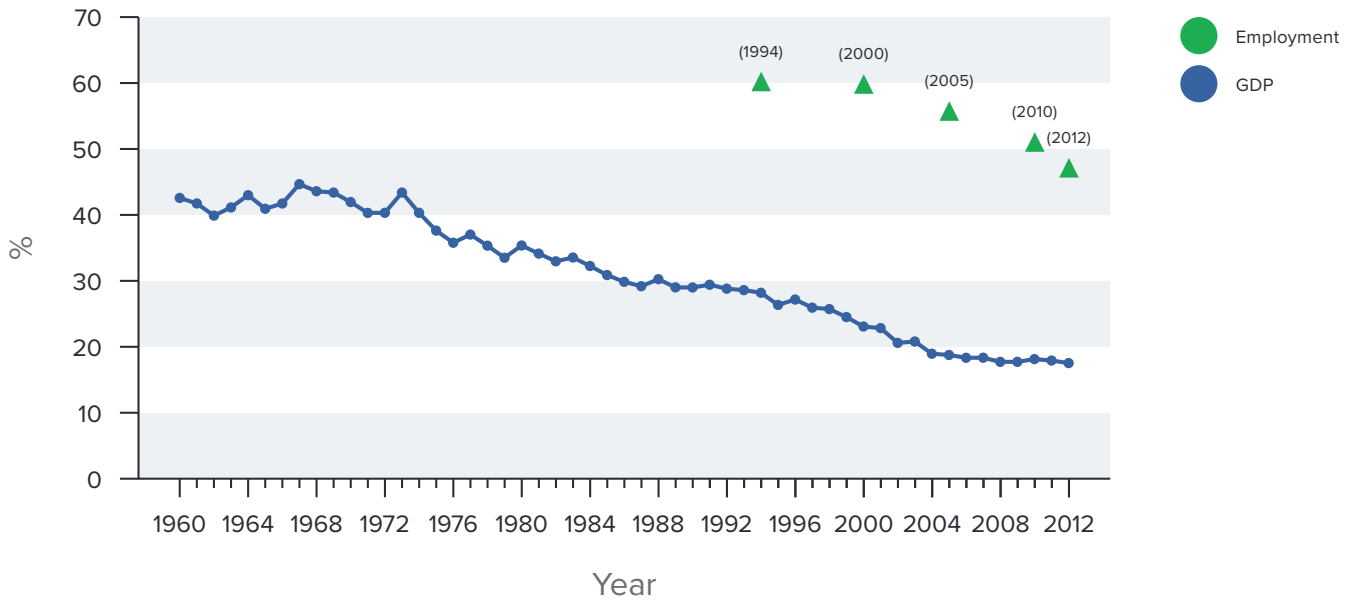
Agriculture remains an important sector of the Indian economy. While the share of agriculture and allied activities in GDP has fallen slowly, from over 40% in the 1960s to about 17% today, almost half of all employment is still in this sector, and over two-thirds of the population still live in rural areas (see Figure 4.1). (By way of contrast, in a recently developed Asian economy, Korea, the share of agriculture in GDP and in employment, is 3% and 7% respectively.)

From a heavy dependence on foreign food aid in the early decades after independence, agricultural development has advanced sufficiently for India to become first self-sufficient and then a net exporter of food. Output of food grains has reached around 260 MT, together with large volumes of other diversified agricultural crops.

Despite these advances, agriculture faces numerous challenges, many of which are only likely to become more pressing with time. Notwithstanding rising food production, malnutrition in the country remains relatively high, as noted in the earlier discussion of human development. Demand for food is likely to both grow more rapidly and become more diverse with rising living standards, urbanisation and population growth, placing more pressure on agricultural supply capacity. While poverty has fallen rapidly over the past decade, over 200 million people remain below the national poverty line in rural areas, while large additional numbers subsist near it. Sustained rapid growth in agriculture will be needed to provide a continued increase in opportunities and living standards for the large numbers of rural poor and near poor.

Yet, as discussed below, agricultural productivity growth has generally been modest and the sector remains hampered by weak technical capacity, numerous sources of inefficiency and growing pressure on environmental sustainability, in particular the water and land resources on which the sector depends. Agriculture in India is still highly dependent on rainfall. As a result, production remains highly sensitive to weather shocks and existing climatic variability, a problem that will get worse as the effects of human-induced climate change are felt over

Figure 4.1
India: agriculture share of GDP and employment 1960-2012 (%)



World Bank, 2014a. World Development Indicators 2014.[71]

the coming decades. (The potential impacts of climate change on India, primarily through agriculture, were noted in Section 2 above.) At the same time, a range of public subsidies and other policy distortions encourage excessive extraction and wasteful use of groundwater, contributing to declines in water table levels. Agriculture accounts for 90% of annual freshwater withdrawals, a proportion that is unusually high by international standards and that has hardly fallen over recent decades, despite the gradual decline in the relative importance of agriculture in the economy. Overall freshwater withdrawals now absorb over 50% of internal renewable water resources {defined as internal river flows and groundwater from rainfall), a proportion that has risen from about one-quarter in the late 1970s.

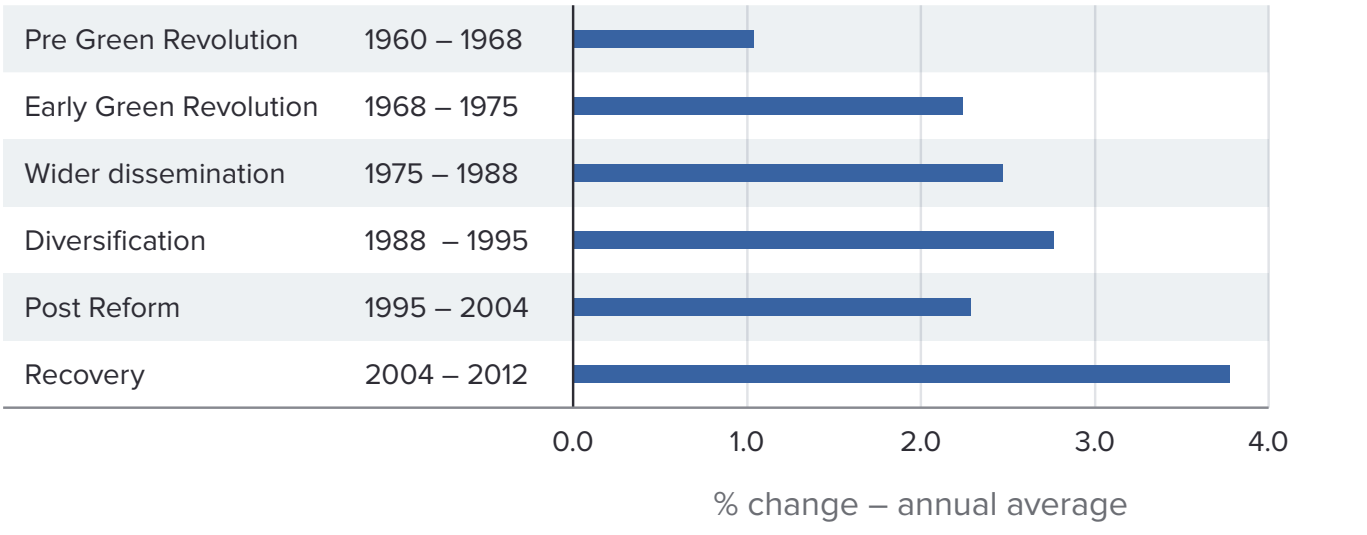
4.2 Output growth and productivity trends

Output (real value added) in agriculture and allied activities in India rose by an average 2.7% a year in 1960–2012, which was modest compared with, say, 4.3% a year in China and 3.4% a year in Brazil and Indonesia over the same period. Agricultural growth does nevertheless appear to have strengthened over time. Application of the "Green Revolution" package of high yielding seeds, irrigation, fertilisers and pesticides, together with diversification in crops, helped boost trend growth from only around 1% a year in much of the 1960s to 2.8% a year in the period 1988–95. After a slowing in the mid-1990s and early 2000s, growth rebounded to a relatively strong 3.8% trend rate in 2004–2012 (see Figure 4.2).

Welcome as the rebound in agricultural growth since the mid-2000s is, a closer look at recent performance indicates a number of reasons for caution in drawing prematurely or excessively optimistic conclusions.

First, the most persuasive reason for the slowdown in growth from the mid-1990s to the mid-2000s appears to be an unusual sequence of sustained negative rainfall shocks in this period. This underlines the continued sensitivity of Indian agriculture to climatic variations and the need to strengthen resilience to future climate change. To some extent a part of the recent growth pick-up may simply be due to rainfall returning to more normal patterns.[76] Second, a recent study that breaks down agricultural growth between increases in area, yield per hectare, diversification of crops and increases in the real price of agricultural products finds that real

Figure 4.2
India: growth in agriculture and allied services



Source: After World Bank, 2014c.[75]

price increases played a particularly significant role in measured agricultural value added growth in the period after 2005, due in part to hefty increases in real Minimum Support Prices for wheat and rice in this period. Whatever their other merits, increases in real prices for agricultural products are not a sustainable source of rising long-term agricultural productivity growth. Third, the same study finds that the contribution of increases in yield per hectare to overall output growth has slowed since the 1990s for many important crops (see Table 4.1).[77]

A broader measure of productivity is provided by Total Factor Productivity (TFP), which looks at output relative to a comprehensive bundle of inputs (land, labour, capital etc.) and is generally seen as reflecting the contributions of technology (the quality of inputs) and efficiency (how efficiently inputs are used). A recent World Bank study attempts to synthesise the results of a number of specialised studies of TFP in Indian agriculture and arrives at some tentative conclusions. First, the specialised studies of TFP do suggest an acceleration in agricultural TFP growth after the mid-2000s, although the time horizon studied is short (generally about five years), so there is a need for caution in judging the robustness of the revival and the extent to which it may reflect only a rebound from earlier negative rainfall shocks. Second, agricultural TFP growth over the long run has been primarily driven by technology improvements while efficiency has stagnated and may have even declined in more recent years. Third, TFP growth for traditional crops (cereals, pulses, oilseeds, sugarcane and cotton) is found to be much lower than for the agricultural sector as a whole, suggesting that diversification into higher value added horticulture and livestock sectors has played an important role in overall productivity growth. The stagnation of TFP growth in traditional crops and in efficiency appears to have occurred despite a substantial increase in policy support for agriculture (see below) and despite the bulk of this support being directed at traditional crops. This suggests that there is a lot of room to improve the effectiveness of public policy support for agriculture.[78]

Table 4.1
India: yields of important crops

	Annual average growth (%)		
Crop	1980s	1990s	2000/01-2009/10
Rice	3.15	1.21	1.42
Wheat	3.24	1.82	0.73
Maize	2.04	2.22	2.27
Gram	2.48	1.53	1.16
Soybean	5.27	1.91	1.71
Cotton	4.21	-1.4	10.29
Sugarcane	0.21	0.79	0.59
Fruits	-2.21	1.81	-1.48
Vegetables	-2.46	0.38	1.31

Source: Birthal et al., 2014.[79]

4.3 GHG emissions in agriculture

Agriculture is a major contributor to India's GHG emissions. Direct emissions from agriculture are estimated at 334.4 Mt CO_2 equivalent in 2007, comprising 17.6% of India's total emissions.[80] Of these, by far the largest are emissions from the livestock sector, mostly methane from the digestion process in animals. (see Table 4.2). Other major sources are methane emissions from rice cultivation and nitrous oxide emissions from various methods of soil management, for example application of fertilisers.

Agriculture also contributes to GHG emissions through indirect channels. The most important source are GHGs emitted from fossil fuels used to produce electricity consumed in agriculture, which comprises about 18% of all electricity consumed in the country (see Table 4.2). Lift irrigation in tube wells is a major driver of electricity demand in agriculture. Other fuels consumed in agriculture – for example, diesel for pump sets, tractors and other equipment – and energy consumed in fertiliser production are also significant sources of GHGs. According to these estimates, direct and indirect emissions related to agriculture together amount to around 519 Mt of CO_2 equivalent, or about 30% of the country's total CO_2 emissions.[81]

4.4 Opportunities to strengthen agricultural productivity and sustainability in India

The preceding brief review suggests that, while there has been substantial progress in improving the productive capacity of Indian agriculture over the decades since Independence, the rate of improvement has been relatively modest by international standards. There has been some acceleration in growth of the overall agricultural sector since the mid-2000s but, among other reasons for caution, productivity performance for traditional crops is lagging. Agriculture remains vulnerable to existing climatic variability and future climate change, while also driving rapid growth in groundwater extraction, something that threatens the long-term economic

Table 4.2

GHG emissions from agricultural production and consumption (in $MtCO_2e$)

Agricultural Production Related (Direct) Emissions ($MtCO_2e$)	
Livestock	212.10
Rice Cultivation	69.87
Soil Management	43.40
Burning of Crop Residues	6.61
Manure Management	2.44
Sub-Total	**334.41**
Agricultural Production Related (Indirect) Emissions ($MtCO_2e$)	
Use of Electricity	130.63
Use of Other Energy	33.66
Energy Use in Fertilizer Production	20.57
Sub-Total	**184.86**
Grand Total	**519.27**

Source: INCCA, 2010b; Hoda and Swain, 2014.[82]

sustainability of the sector. Through direct and indirect channels agriculture also generates about 30% of India's GHG emissions.

This section briefly discusses the scope for policy reforms that can strengthen the economic performance and resilience of Indian agriculture while also helping to abate its GHG emissions. Such an approach is also relevant given India's current climate policy position, which is to focus on measures that yield GHG emission mitigation in agriculture as co-benefits of development, rather than to approach agricultural mitigation as an end in itself.[83]

We comment first on the broad framework of public expenditure in agriculture, the distorted incentives created in this framework and the potential for efficiency-enhancing expenditure reforms. We then briefly review other specific reforms.

Agricultural public expenditure and its impact on productivity and sustainability

While there is no single, comprehensive source of information, studies suggest that the total volume of public spending on agriculture is significant and growing. One study aims to estimate not only public investment but all types of public spending aimed at benefiting agriculture, both in the agricultural sector and in other sectors. This broader aggregate is estimated to have been equivalent to about 35% of agricultural GDP in 2009/10, up sharply from 20% in 1995/96. Public investment was estimated to make up less than a quarter of the wider aggregate. Public spending on agricultural R&D, education and extension services was an even more miniscule 0.7% of agricultural GDP.[84] By contrast, input subsidies are a major form of public expenditure on agriculture. Another study estimated that input subsidies for agriculture totalled US$28 billion in 2011/12, or 8.9% of agricultural GDP, which, although not directly comparable with estimates from other sources, appears to be significantly larger than public investment. Subsidies for fertiliser were estimated at US$13.7 billion, for power at US$6.5 billion, for irrigation at US$4.7 billion, and for credit at US$2.5 billion in 2011/12.[85]

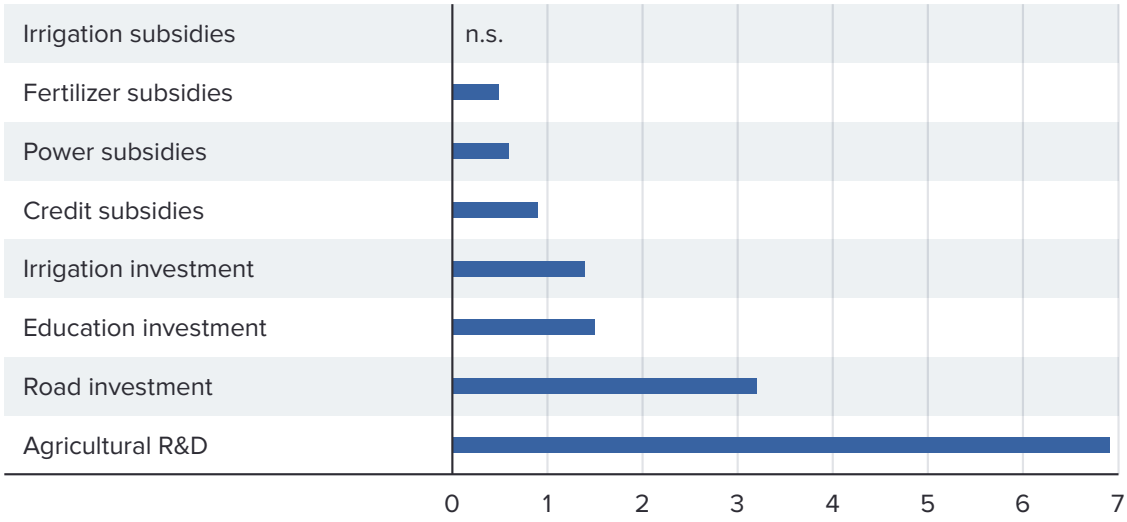
What impact does agricultural public expenditure have on agricultural productivity and sustainability in India? Consider economic impacts first. Economic returns to subsidies had fallen quite sharply by the 1990s.[86] Figure 4.3a shows that estimated benefit–cost ratios for fertiliser, power and credit subsidies, in terms of rupees of agricultural GDP generated for a rupee of spending, had fallen to less than 1 by the 1990s (and were statistically not significant for irrigation subsidies). Meanwhile, benefit–cost ratios for agricultural R&D have risen over time so that, by the 1990s, one rupee of R&D spending was estimated to generate almost Rs7 in additional GDP. Estimated benefit–cost ratios were also greater than 1 for public spending on roads, education and irrigation (primarily surface irrigation projects rather than lift irrigation using tube wells). Figure 4.3b shows that public R&D spending and investment were also much more powerful than subsidies for the purpose of rural poverty reduction.[87]

These results suggest that there is considerable scope to improve the *economic* effectiveness of public spending on agriculture by reallocating spending away from low-yielding subsidies (currently the largest item of spending) towards high-yielding agricultural R&D (currently one of the smallest) and other spending on education, extension services and rural infrastructure.

Figure 4.3a

India: agricultural public expenditures, 1990s: returns in agricultural GDP

(Rs per Rs Spent)

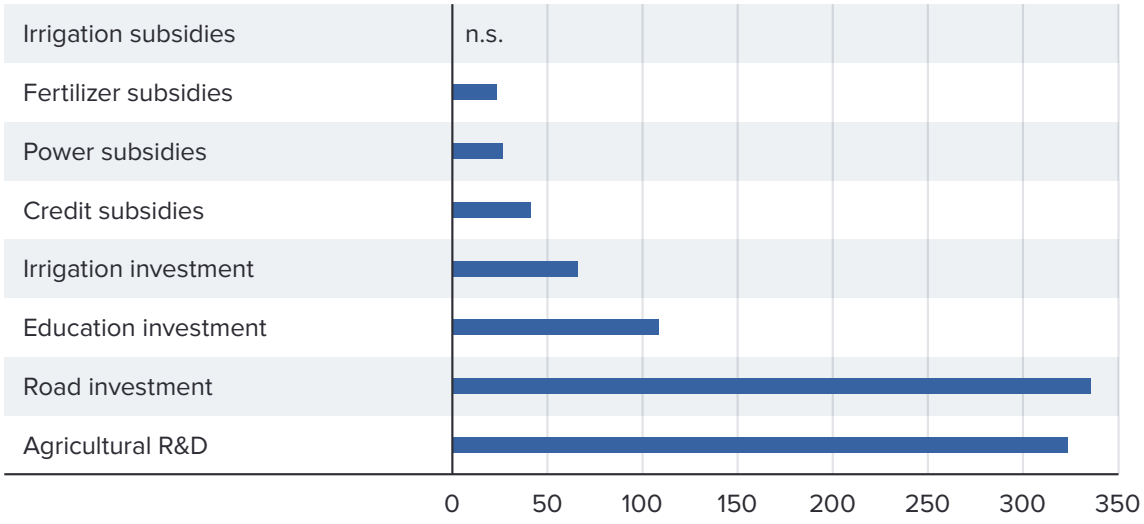


Source: Fan et al., 2008.[88]

Figure 4.3b

India: agricultural public expenditure, 1990s: returns in poverty reduction

(Decline in number of poor Million RS Spent)



Source: Fan et al., 2008.[89]

Importantly, such a reorientation would also help to increase the *environmental sustainability* of Indian agriculture. That is because subsidies for power, fertiliser, credit and irrigation tend to damage resilience – primarily by stimulating excessive water consumption – and promote GHG emissions. For example, power subsidies stimulate both high power consumption and hence high GHG emissions in power production, as well as lift irrigation using tube wells, which causes excessive drawing down of groundwater and depletion of water tables. A recent study estimates that a 10% reduction in power subsidies would lead to a 6.7% reduction in groundwater extraction. It also finds evidence that low electricity prices increase the probability that groundwater usage is pushed through critical thresholds, for example from normal to critical (where usage is 75% of recharge) or from critical to over-exploited (where usage is greater than recharge). There is also evidence that power subsidies encourage greater production of water-intensive crops, such as rice and sugar cane, primarily by increasing the acreage devoted to such crops rather than any increase

in yields. As noted above, rice production is an important source of methane emissions. Not surprisingly, areas that have seen the greatest increase in water-intensive crops, for example the northwest and mid-west, are also experiencing the greatest groundwater depletion.[90]

Other subsidies, such as credit subsidies, also interact with power subsidies to further encourage tube well deployment and groundwater depletion. High fertiliser subsidies on domestically produced urea relative to other nutrients cause unbalanced fertiliser use, which, beyond certain thresholds, results in lower land and labour productivity. Fertiliser use is also a source of nitrous oxide emissions, a GHG.

The political economy of subsidy reform is not easy. Nevertheless, the evidence in this section suggests that a reorientation of public spending away from subsidies towards productive spending on R&D, education and infrastructure would have substantial benefits for agricultural productivity and rural production. Such a reorientation would also greatly strengthen resilience to climate change by encouraging much greater care and economy in the use of a scarce resource, water, as well as help to abate GHG emissions linked to agriculture through various channels.

Livestock

India has among the largest livestock herds in the world. Productivity is generally low, however. Average milk yields are about one-half of the world average, for example. Due in part to religious sensitivities about slaughter of cattle, the number of unproductive animals (in particular males) is high and growing. As noted above, methane emissions from livestock are the largest source of agricultural GHGs in India, an outcome made worse by the high cellulose content of crop residues, the animal's chief diet. The large number of animals also reduces resilience by adding to demands on the country's scarce water resources. Public spending in support of the livestock sector is low and declining.

Adequately resourced public initiatives in the livestock sector could help increase animal productivity while controlling total numbers, strengthen resilience and reduce GHG emissions. A better quality of animal diets would help boost milk and other product yields and farmer income, while also reducing methane emissions by improving the digestibility of animal feeds. Equally important, better animal health and reproduction management can help in particular to reduce the number of male calves and overall herd size (through semen sexing in artificial insemination for example), while increasing the proportion of healthy and productive animals. A smaller, healthier herd will reduce emissions, reduce pressure on water and other natural resources and make animals more resilient to climate change.[91]

Forestry

While there are numerous opportunities for mitigation in agriculture, the potential for sequestration of CO_2 in forestry is likely to be much larger. Already announced objectives under the "Green India Mission" look to expand forest cover and improve the quality of cover over some 10 million hectares over the next 10 years, which would have an annual mitigation potential of 55 Mt CO_2 equivalent. The announced measures represent only a small fraction of what could be undertaken over the longer term. For example, current programmes to improve canopy density in moderately dense forests cover only 1.5 million hectares out of a total 32 million hectares of such forests. Forestry initiatives would also strengthen resilience by increasing infiltration, groundwater recharge and stream flows, and also expand economic opportunities for 275 million people who constitute forest communities.

Other key reform opportunities

Rice cultivation: As noted, a decrease in power and other subsidies would reduce uneconomic incentives for crops like rice, which is both water intensive and a source of methane. There is, in addition, much scope for expanded use of new methods of cultivation, such as the System of Rice Intensification (SRI), which sharply reduces water usage, thereby lessening methane emissions and improving resilience, while also boosting output.

Water management: The potential for subsidy reform to greatly increase efficiency in use of water has already been noted. In addition, there are technological improvements that need to be much more extensively promoted. These include more energy-efficient water pumps and micro-irrigation methods such as drip and sprinkler irrigation.

The accompanying paper by Hoda and Swain (2014) estimates that the reforms and initiatives in agriculture and livestock discussed here have the potential to reduce GHG emissions by around 105 Mt CO_2 equivalent in 10 years and perhaps 165 Mt CO_2e in 20 years.[92]

Adaptation strategies in agriculture and forestry: The preceding discussion has noted both the expected severe impact of climate change on Indian agriculture (Section 2.1), as well as numerous opportunities to strengthen adaptation in agriculture and forestry. A number of government programmes and statements have placed adaptation needs in a more systematic framework. The National Action Plan on Climate Change includes three missions – the National Mission on Sustainable Agriculture (NMSA), the National Water Mission (NWM) and the National Mission for a Green India (GIM) – that are relevant for adaptation in agriculture and forestry.[93] The accompanying paper by Hoda and Swain (2014) provides further details.[94]

5. Key development challenges and opportunities in building more productive and inclusive cities

The Government of India has rightly focused on the potential of "smart cities" as an important driver of development. *The New Climate Economy Report* provides evidence for this proposition by detailing how more compact, connected and well-coordinated cities promote both development and greater energy and pollution efficiency.[95] With the right policies and institutions, urbanisation and economic development are mutually reinforcing. The clustering together of individuals and firms in urban areas facilitates innovation and productivity and economic growth through a variety of agglomeration economies. The geographic density of economic activity is found to be a powerful influence on productivity, broadly confirming the role of agglomeration economies, and showing that more compact cities can have economic development advantages. Employment density is found to explain over half of the variation in labour productivity across US states, for example. At the same time, cities are also drivers of energy consumption and GHG emissions, generating about 70% of the global total of each.[96] Crucially, more compact, connected and well-coordinated cities allow significantly greater energy efficiency and lower emissions per unit of economic activity.[97]

Unfortunately, there are few automatic guarantees that urban development will necessarily evolve in ways that maximise agglomeration economies and productivity while curbing GHG emissions, local air pollution and congestion. The dominant growth pattern in many urban areas – including many Indian cities – is characterised by unmanaged sprawl and increasing car use.[98] The fact that individuals and firms often do not take into account the full economic and social benefits of more compact, vibrant and connected urban centres creates a bias towards more urban sprawl. Other market failures also contribute, such as the lack of pricing for externalities such as air pollution, congestion or road traffic accidents (a major source of death and injury, particularly in developing countries). Lack of city-level institutional and planning capacity tends to work in the same direction. Policy failures include building regulations, infrastructure financing models or urban tax codes that implicitly subsidise sprawl. Once a city starts to sprawl, it creates its own logic for further sprawl, by shaping household expectations about dwelling space and commute time; and building up a political economy of property developers and transport providers. Alongside climate change, urban sprawl is one of the most significant examples of a market failure worldwide.

5.1 Overview of urbanisation trends in India

India's urban population almost doubled from 222 million in 1990 to an estimated 410 million in 2014, or from 26% to 32% of the total population. Cities now contribute over two-thirds of GDP, bring in over 90% of government revenue and generate the majority of jobs. But the pattern of urbanisation is also one rife with numerous stresses and dysfunctions: rapidly expanding urban sprawl, inadequate and unreliable urban infrastructure, high land prices, proliferating slums, growing congestion and travel times, intense local air pollution and rising GHG emissions.[99] According to United Nations projections, India's urban population is expected to exceed 800 million by 2050, when it is projected to comprise about half the country's population (about where China is today).[100] Clearly, just how this future urbanisation comes about will have a great bearing on the pace and quality of India's development as a whole.

Figure 5.1 maps the fairly tight cross-country correlation between per capita GDP and urbanisation. India's urbanisation is somewhat on the low side for a country at its income level, within this cross-country distribution. It has been argued, though, that India's apparently low urbanisation ratio is to some extent a statistical artefact, created by an official classification of urban areas that is much more stringent than in most other countries. The downward bias in urban statistics is increased by long delays in redrawing of municipal boundaries for fast-growing new areas on the edges of existing metropolitan areas, one of the major modes of urbanisation in India. Of 2,750 new towns that arose in 2000–11, over 90% were so-called "census towns", which have all the characteristics of a town but lack the statutory status. Studies by the World Bank that use a globally comparable definition of urbanisation estimate that India is already over 50% urbanised. Such a finding would underline even more emphatically the central importance of urbanisation for India's development.[101]

Figure 5.1
Urbanisation and per capita GDP - 2010

Source: World Bank 2014a.[102]

Urban growth dynamics

Rapid urban growth is occurring on many different margins and frontiers. Population in cities of 5–10 million people grew by 35% in 2000–11, while that in secondary cities of 1–5 million people grew even faster. The three major metropolitan areas or megacities (Mumbai, Delhi, Kolkata) saw the slowest increase, a 15% rise in population in 2000–11, although this may be misleading since one of the most striking urban trends in India is the rapid growth of urban areas on the periphery of the existing big cities. Such peri-urban growth is occurring as agricultural or fallow land is converted on a large scale to commercial, industrial or residential uses, commonly in areas without municipal government and generally without infrastructure services for water, sewerage, power or public transport. The already noted rapid growth of unchartered "census towns" also commonly occurs without formal local government structures or infrastructure services, and also contributes to the pattern of peri-urban growth. In 2000–11, one-third of India's new towns sprung up within a 50 km neighbourhood of existing cities containing more than 1 million people.[103]

Costs of urban development patterns in India

The rapid, often chaotic pattern of periurban development in India differs in some respects from some common definitions of urban sprawl, which refer to a process in which a city with low population density spreads over a large and growing area. Indian cities, by contrast, have high population density. By one estimate Mumbai and Kolkata are the first and second most densely populated large cities in the world, with Chennai the eighth.

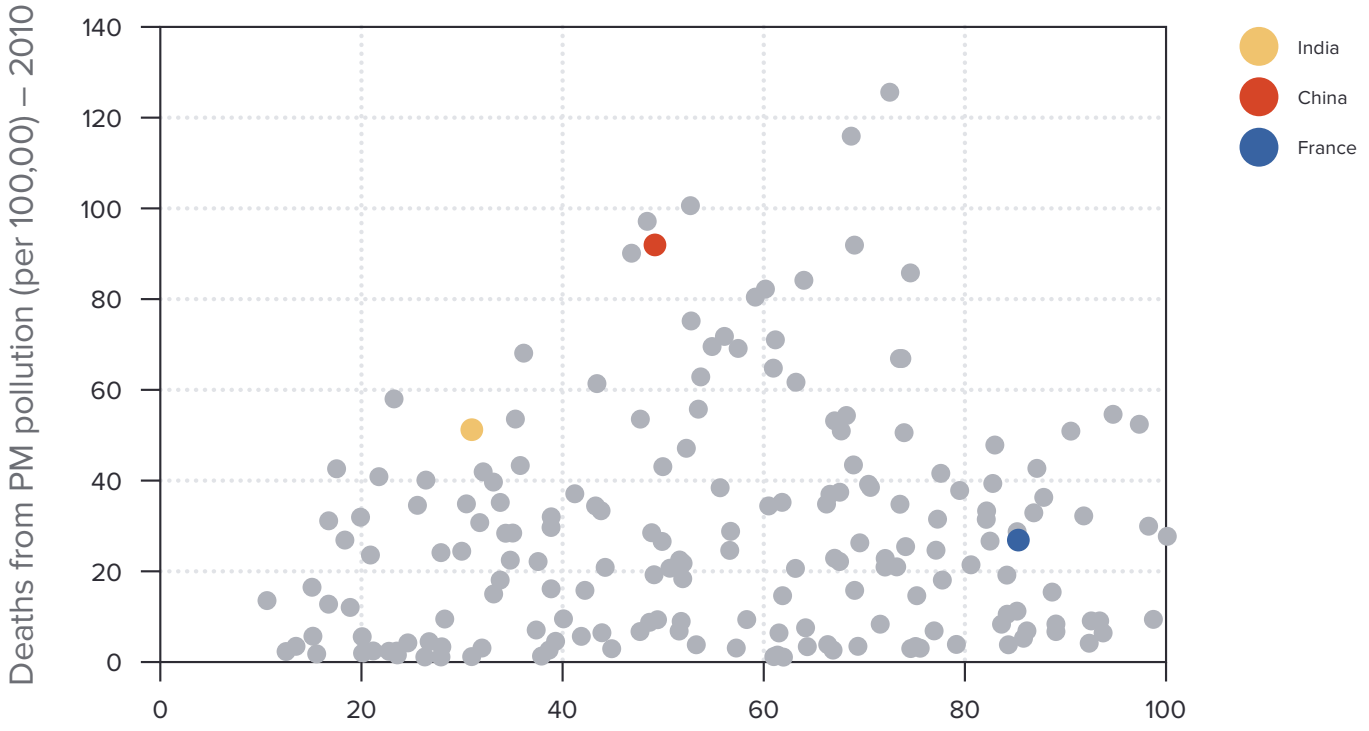
A characteristic feature of urban development in India, however, is low density in the amount of building floor area per square metre or kilometre of city space. As we explain further in Section 5.2 below, land regulations in India greatly restrict the construction of tall buildings. Such regulations and the resulting low availability of built-up space generate pervasive and generally harmful consequences. The intensity with which businesses and households can use land is severely constrained, reducing agglomeration economies, labour productivity and the carrying capacity of Indian cities. Land prices are extremely high, in places like Mumbai among the

highest in the world, higher than in much richer cities like Singapore and Shanghai, while the average floor spaces available to businesses and households are far more cramped than elsewhere. Mumbai homes have only about 30 square feet per person, compared with 140 square feet per person in urban China. Slums grow as the poor are unable to find low cost housing. And urban sprawl proliferates as businesses and households are forced to seek cheaper land further and further out in city peripheries.[104]

Sprawl in turn generates a variety of high social costs. Commuting times increase. One study of Bangalore estimated that restrictions on floor space had increased the distance from the city centre to the periphery by 50%, from 8 km to 12 km. Combined with a general lack of affordable and well-connected public mass transportation systems, urban sprawl encourages rapid conventional motorisation (see below), contributing to severe traffic congestion, resulting in average journey speeds that are barely faster than riding a bicycle. In Bangalore increased commuting times were estimated to cost 1.5–4.5% of household income, excluding lost productivity from longer commutes and reduced agglomeration effects in the city centre. Another recent study across a sample of more than 450 Indian cities also finds a significant negative relationship between the extent of restrictions on floor space and the compactness of city shape and size. It finds that the welfare costs of a less compact city shape are sizeable: a one standard deviation increase in the length of the average commute (about 225 km more over the course of one year on average) entails a welfare loss equivalent to a 5% decrease in income.[105]

The Indian model of increased urban sprawl and conventional motorisation also contribute to increased energy consumption, urban air pollution and GHG emissions. The large impacts of air pollution on health in India were discussed in Section 2 above. As noted, India is in the upper quintile of countries for deaths per 100,000 from ambient particulate matter pollution. Figure 5.2 suggests that there is no cross-country correlation between urbanisation and deaths per 100,000 from ambient particulate matter (PM) pollution. The figure is consistent with the idea that it is not urbanisation as such that is associated with health damages from pollution, but rather it is the form of urbanisation, together with policies and other factors, that has more influence on deaths from PM pollution. As argued in Section 2, a continuation of India's current model of rapid urbanisation with high levels of $PM_{2.5}$ concentrations would risk a severe increase in the rate of premature deaths attributed to ambient PM pollution.

Figure 5.2
Urbanisation and deaths from ambient PM pollution - 2010



Source: IHME, 2014; World Bank 2014a.[106]

It is likely that the form of urbanisation in India, urban sprawl and its costs, are hindering India from fully realising the economic agglomeration benefits of urbanisation. International experience suggests that the concentration of economic activity in major metropolitan areas (to exploit agglomeration benefits) continues until developing countries reach a per capita income of US$7,000–10,000. In India, however, the share of activity in the seven major metropolitan areas has stalled since the early 1990s, even though India's current per capita income is only in the US$1,000–2,000 range. The fastest growth in manufacturing, in particular high-tech and export manufacturing, is occurring not in metropolitan cores, where they would experience the greatest agglomeration benefits, but rather in the more scattered, far-flung and poorly served suburban towns and villages. This indirect evidence is suggestive that Indian manufacturing firms are forgoing significant potential agglomeration benefits to avoid the even larger potential land and other costs of operating in dysfunctional core metropolitan areas.[107]

Weak urban infrastructure

Indian cities struggle with severe infrastructure deficits, which generally worsen down the social gradient, from rich to poor, and down the spatial gradient, from core metropolitan areas to smaller and more distant cities and peripheral areas.

Urban water supply is marked by inadequate coverage, intermittency, low pressure and poor quality. In 2011 only 71% of urban households had access to tap water and only 61% to treated tap water. The proportion falls to less than 50% in small and medium cities. Nationally, some 27% of urban households depend on (frequently contaminated) groundwater sources through wells and hand pumps, contributing to the nationwide pressure on declining water tables discussed in Section 4 on agriculture. A striking example is the city of Faridabad, which is located downstream from Delhi on the Yamuna River, but which relies almost entirely on piped groundwater, since the discharge of untreated waste by Delhi makes it prohibitively expensive to treat the highly polluted river water. Among major Asian cities Chennai and Delhi were ranked the two worst cities in terms of hours of water availability.[108]

Sewerage and sanitation are another pressing concern in Indian cities. In 2011 only 81% of urban households had a toilet facility within their premises, and only a third of urban household toilets were connected to sewerage systems, with the remainder disposing of untreated sewage into the ground or into surface water. Overall, only about 14% of sewage from Indian cities was treated. Over 50 million urban dwellers defecate in the open. A 2008 study by the Ministry of Urban Development found that 190 out of 423 cities were in a state of emergency regarding sanitation and public health, while none could be classed as healthy or clean.

Access to electricity is far better in cities than in rural areas, with about 90% of urban households using electricity for lighting. As noted in Section 3 on the energy sector, however, it is the low quality of electricity access and frequent power outages that are a serious concern for many urban households.

Weak public transportation options in most Indian cities have encouraged rapid growth in private motor vehicle ownership, which has aggravated the social costs of urban sprawl, for example congestion, longer travel times, local air pollution and GHG emissions. The number of vehicles rose at 5–9 times the rate of growth in the urban population between 1980 and 2011, with the fastest growth in two-wheelers. Vehicle ownership is, however, lower in metropolitan areas with relatively well-developed public transport systems, such as Kolkata and Mumbai (respectively, 44 and 102 vehicles per 1,000 people), than in cities like Delhi with a less well-developed transport network (493 per 1,000). Fast-growing smaller industrial cities with even less well-developed public transportation systems, such as Ludhiana and Coimbatore, exhibit vehicle ownership rates much higher even than Delhi.

Clearly, a vast upgrading in the scale and quality of urban infrastructure is needed if India is to fully tap the potential of its cities. The government's High Powered Expert Committee Report of 2011 estimated that urban infrastructure spending of about Rs39 trillion (in 2009–10 prices, or about US$800 billion) was needed over the next 20 years to meet a defined set of service delivery standards for water supply, sewerage, solid waste, urban roads and urban mass transit.[109] Another study by McKinsey Global Institute estimated that there was an overall urban investment need of US$1.2 trillion over 20 years, which would encompass such elements as 700–900 million square metres of new commercial and residential space (the equivalent of a new Chicago every year), 2.5 billion square metres of paved road and 7,400 kilometres of metros and subways (both being 20 times the capacity built over the last decade).[110]

As we discuss further in Section 5.2 below, to be effective such an infrastructure push needs to combined with broad reforms of land regulations (in particular), as well as of urban government institutions that would implement and manage infrastructure. It is important to stress that not only does good infrastructure promote more compact cities, but more compact cities also reduce the cost of infrastructure and improve its productivity. The need to build certain kinds of infrastructure, such as motorways, is reduced or eliminated altogether, the fixed costs of building water, sewerage and other systems in outlying areas are reduced, and existing or new infrastructure in city cores can be used more intensively, reducing average costs. One analysis suggests that urban sprawl generates external costs of US$400 billion annually in the United States.[111] Combined with complementary reform policies,

infrastructure investment can play a central role in developing Indian cities that are not only more productive but also far more energy efficient, clean and enjoyable to live in.

5.2 Opportunities to foster a more productive, clean urbanisation in India

The dysfunctional patterns of urbanisation in India noted in the previous section arise from a number of long-standing, deeply ingrown and mutually interlocking policy distortions and institutional weaknesses. Highly restrictive land regulations cause intense pressures for urban sprawl. Yet proposals to build more compact cities are countered by the undoubted fact that greater densities in urban cores would overwhelm the rickety and inadequate existing infrastructure of these areas. Efforts to strengthen urban infrastructure and planning are in turn stymied by the weaknesses of urban governance and institutions. This creates a difficult challenge for reformers, who will need to proceed simultaneously on many interlinked fronts.

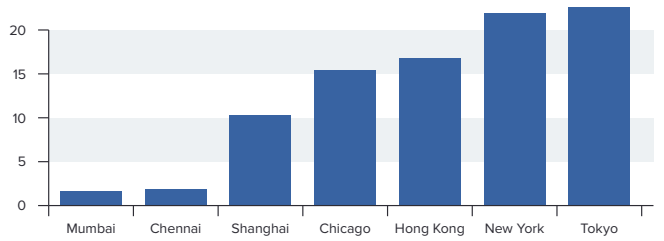
Land regulations

Perhaps the most consequential policy distortion in India's land markets is the widespread use of the FSI (floor space index) to regulate urban density. The FSI (also known as the FAR or floor area ratio) sets the maximum allowable ratio of the building gross floor area to the area of the plot. In much of Mumbai, for example, the FSI has been set at 1.33 for decades. This means that a builder could use two-thirds of a plot to put up a building with a maximum height of two storeys, or one-third of the plot for a building with four storeys. There has been some easing of FSIs recently, especially outside the traditional downtown areas, but, on the whole, changes have been modest and FSIs lower than 2 are common across Indian cities. Figure 5.3 shows that Indian FSIs are generally very low compared with those in many of the most economically dynamic and prosperous cities in the world, such as Shanghai, Hong Kong, New York and Tokyo. The impact of these policy distortions in encouraging costly urban sprawl has been discussed in Section 5.1 above.[112]

Other regulations, such as maximum building heights, set back requirements and plot-coverage ratios also sharply limit the intensity with which households and businesses are able to make use of available land. Rent control laws and the lack of a well-developed housing finance system also constrain the supply of new housing stock. Efficient functioning of land markets is hampered by weak systems for appraising land values, determining property rights and conducting public land acquisitions.

The need for reform of land regulations to promote more compact cities and productive urbanisation has increasingly become a part of the India policy debate. It is nevertheless often argued with considerable plausibility

Figure 5.3
Floor space indexes in central business districts



Source: World Bank 2013.[113]

that reforms of land regulations on their own will fail to achieve improved productivity and greener development because the increased urban population densities they are designed to achieve would overwhelm the already rickety urban infrastructure of Indian cities (discussed earlier in Section 5.1). This problem points to the need for careful coordination of land regulation reforms with development of infrastructure services.

The Jawaharlal Nehru National Urban Renewal Mission (JnNURM), launched in 2005, represents a major recognition and effort to move forward urban infrastructure development in coordination with reform of land regulations. While there has not yet been a comprehensive impact evaluation of the JnNURM, initial reviews of results have highlighted challenges in project selection and implementation capacity at the level of urban local governments. The need to expand urban infrastructure and reform land regulations in a coordinated way thus also points to the need to reform and strengthen urban governments, which must necessarily be key partners in urban planning, land markets and infrastructure development.[114]

Urban governance

The theory of fiscal federalism suggests that where the benefits of public goods or infrastructure are mostly enjoyed in a particular jurisdiction, such as an urban area, the provision of those public goods is best undertaken by the local government of that jurisdiction or area. This local authority – being the one "closest to the ground" – should be the level of government that is best informed about and best able to determine the specific needs of its area. Local government is likely to be able to perform its tasks most effectively where it is most accountable to residents, and residents will have more incentives to hold the local government accountable when they bear the cost of local services through local taxes and user fees, at least at the margin. Nevertheless, there are also rationales for intergovernmental fiscal transfers from higher levels of government to local governments. Economies of scale

make it simply more efficient to collect certain taxes at the central or provincial (state) level and to transfer revenues to local governments through transfers. There may also be an equity argument where the national government wants to ensure that local areas enjoy a roughly similar level of public services regardless of their relative wealth or poverty.[115]

Urban government in India can best be described as in a state of partial or incomplete decentralisation. The Constitution Seventy-fourth Amendment Act (1992; CAA) for the first time gave municipal bodies a constitutional status as a third tier of government, although they remain a responsibility of the States. The Act defined 18 functions for devolution to local-government level. In practice, however, the allocation of responsibilities between various levels of government remains muddled. Local governments' administrative capacity and accountability to residents is limited at best, while their fiscal resources remain far below levels needed to accomplish their tasks.[116]

First, the devolution of responsibilities to local government is too often an unfunded mandate, with local governments left bereft of revenues with which to tackle the large and growing infrastructure deficits of urban areas. The Zakaria Committee of 1963 established expenditure norms for adequate service delivery but by 2001 it was estimated that larger Indian cities were spending not even a quarter of the Zakaria Committee norms in inflation-adjusted terms. The total revenues of Indian local governments amounted to only 0.94% of GDP in 2007/08, which is low by international standards. By contrast, municipal revenues in Brazil are over 7% of GDP.[117]

On the one hand local governments have found it difficult to mobilise their own taxes and user fees, while on the other hand, intergovernmental transfers to local governments from the states and centre have also been inadequate to their needs. The own revenues of India's local governments were only 0.5% of GDP in 2007/08 (compared with 2–3% in Brazil), while intergovernmental transfers were only 0.4% of GDP. Property taxes are the primary own revenue source available to local governments but have suffered from poor collections and lack of buoyancy, due to a lack of systems to appraise current land values, outmoded tax assessment methods based on rental value rather than area, and widespread tax evasion, among other factors. The fact that reforms can bring major returns was shown in Bangalore, however, where reform of the property tax led to a near 80% surge in revenues between 2007/08 and 2008/09. Property tax reforms that focus on taxing land values rather than building space can be particularly effective in promoting compact development.

As regards intergovernmental transfers, the Constitution requires states to establish State Finance Commissions to determine the allocation of state revenues to local governments but often these Finance Commissions have not been established or their recommendations have simply not been implemented. Intergovernmental transfers to local governments have remained opaque, ad hoc and inadequate. Cities with a more secure revenue base – either from own revenues or transfers – are likely to secure better credit ratings and greater access to private capital for urban infrastructure investment. This can create a virtuous circle, with more vibrant urban growth generating more revenues.

Second, apart from the financing of local government expenditure, the allocation of responsibilities between various levels of government itself often remains unclear and confused, hampering effectiveness in urban service delivery. Being at the discretion of the states, there is considerable variation in the extent to which functions have actually been devolved to local government. Low administrative capacity in local governments provides states with a convenient reason to limit devolution.

Third, there is little effort to foster accountability of local government officials to area residents. Elected local officials often have little control over key decisions such as staffing, which remains in the hands of the state governments. Institutions to elicit participation by local residents remain underdeveloped.

The government's intention to massively expand urban investment on "smart cities" provides a tremendous opportunity to simultaneously tackle the key interlinked issues affecting India's urban development. Valuable lessons can be drawn from the experience of the Jawaharlal Nehru National Urban Renewal Mission (JnNURM). The latter represents a major effort by central government to significantly increase the volume of resources for urban infrastructure development, while also encouraging policy and institutional reforms to improve the effectiveness with which such resources are used at both the state and urban local-government level. JnNURM has aimed to foster such municipal reforms as strengthening local government accounting systems, improving property tax collection through the use of Geographical Information Systems (GIS) and by increasing user charges to cover operating and maintenance expenses. Overall though, states have sometimes been reluctant to undertake the reforms proposed under the programme, while weak execution capacity at the urban local-government level has created a large gap between projects approved and completed. Only 227 out of 650 projects approved in 2006–13 were completed.[118] A thorough impact evaluation of the JnNURM can help to lay the basis for a renewed and comprehensive "smart cities" urbanisation strategy encompassing policy reforms of land regulations and markets, strengthening institutions of urban governance and a greatly expanded urban infrastructure development.

6. Conclusions and policy recommendations

Rapid GDP growth helped to lift close to 140 million people in India out of poverty between 2004/05 and 2011/12. Growth slid to only about 5% in 2012/13, however, the lowest in the last decade, accompanied by a sharply lower investment growth, due to increased policy and regulatory uncertainty and "execution bottlenecks" in large infrastructure projects, among other factors. The pace of recovery from the slowdown is uneven and uncertain. Restoring rapid growth is crucial to further sustained progress on poverty reduction. India's new government, which came to power on the promise of better economic management, faces definite challenges in reviving growth – but also significant opportunities to reshape the growth model.

India still accounts for 30% of those living in extreme poverty in the world. With shrinking fiscal space, the government needs to ensure that spending on poverty reduction is better targeted and much more effective than in the past. Until now, besides growth, various food, energy and fertiliser subsidies have been the preferred instruments to address distributive concerns. According to the National Accounts Statistics, these subsidies exceeded 4% of GDP at current prices.[119] A familiar criticism of the subsidy regime in India (and indeed elsewhere) has been its poor targeting and the distortions it introduces in the economic system. Fuel subsidies are inefficient for social protection since a large share of the benefits go to higher-income groups. In the rural areas subsidies contribute to excessive consumption of groundwater and fuel with damaging consequences for the environment. Better targeting through direct transfers can address these problems while at the same time enhancing the efficiency of resource use.

The new government is grappling with how to go beyond piecemeal reforms to find a template for much bigger, transformative changes. A competitive democracy and a weak state have often been cited as reasons for the lack of deeper structural and fiscal reforms. Within the next year or so there is a golden opportunity for the new government to build consensus for strong structural and fiscal reform to signal intent.

Rapid growth is absolutely paramount for India. But the choice of the path for growth will also be fundamental, determining the structural transformations that accompany growth, as well as its inclusiveness and environmental sustainability in the long run. By 2031, when India's urban population is expected to exceed 600 million, 75% of India's GDP and 70% of all net new jobs are expected to come from its cities. Land use and energy demand due to extensive urbanisation will require better planning since public policies associated with urban structure matter. How cities develop over the next few decades will be determined by policy choices that are made today. Apart from less congestion and pollution, more compact urban forms are known to upgrade growth and economic efficiency by reducing the costs of infrastructure and improving agglomeration productivity.

India's latest national plan aims for faster, more inclusive and sustainable growth. Cities and energy systems call for investments in land and other long-lived infrastructure and are largely irreversible. Decisions about these will determine whether India will achieve the aim of faster, inclusive and sustainable growth. The troubles that countries like China have had with severe local air pollution in the recent past ought to counsel caution. China is now taking strong action to clean up its cities. India's future too lies in compact cities that are less polluted and are not congested, in efficient and robust agricultural practices and in a secure and clean energy system that meets the development needs of the country. By focusing on making good choices about energy systems, land use and cities, India can boost development and reduce poverty in a sustainable manner.

The following paragraphs draw on the detailed discussion in earlier parts of this report to list 11 important areas for reform. The political economy of such reforms is often difficult but experience from both India and other countries provides considerable hope that meaningful progress is possible.

6.1 Energy systems

Fuel subsidy reforms: With growing awareness of their economic and environmental costs, the Government of India has moved to reduce or eliminate fuel subsidies in recent years. The steep fall in world oil prices in the second half of 2014 provides an opportunity to accelerate the removal of remaining fuel subsidies and to place the ad hoc reforms of recent years on a permanent basis at a time when the impact on consumers will be limited. A plan to complete the reform of fuel subsidies needs to be carefully sequenced, equitable and sustainable over the long term, for example even in times when world oil prices may be high. Subsidy reforms should be coupled with well-designed and targeted measures to protect the poor and vulnerable from higher fuel prices. Elimination of fuel subsidies can be undertaken in the context of a broad modernisation of India's social protection framework, putting in place the institutions and information systems (such as the Aadhaar programme) for a modern system of social protection based on cash transfers.

Power subsidy and electricity sector reforms: Reforms to address large and widespread inefficiencies in the power sector present a major opportunity to boost India's economic performance while mitigating local air pollution and CO_2 emissions. Numerous technical options are available to tackle problems of high transmission and distribution losses but these may not yield the desired results unless they are combined with more important reforms of institutions and governance in the electricity distribution sector. Reforms begun in the Electricity Act (2003) need to be pushed forward to unbundle and corporatise state electricity boards, build independent regulatory bodies at the state and central levels, scale back power subsidies and set realistic prices to create financial viability and develop a performance-oriented culture in the sector. The complex political economy problem of how to insulate distribution companies and regulatory bodies from political interference by state governments is a vital dimension of such reforms.

Energy efficiency standards: Engineering-economic estimates suggest that adoption of already available cost-effective technologies could result in significant reductions in India's energy consumption, local air pollution and GHG emissions. The introduction or tightening up of mandatory minimum energy efficiency standards for appliances, vehicles and buildings can play an important role in securing these reductions, combined according to circumstances with fiscal incentives, voluntary codes and expanded information initiatives. Government administrative capacity may need to be strengthened to ensure robust enforcement of standards, as well as careful monitoring and impact evaluation to ensure that standards do not cause unnecessary cost increases or become obsolete in the face of technological progress.

Fuel taxes to promote a more efficient fuel mix: India's rising reliance on fossil fuels, and coal in particular, has resulted in growing energy insecurity and other severe local externalities, such as the health damages associated with local air pollution, congestion and increased accidents. These costs affect the residents of India but are insufficiently reflected in the price of fuels, causing them to be over-consumed and reducing India's overall social welfare. These costs are quite separate from and in addition to the global harms associated with climate change. The most efficient instruments to achieve a more socially optimal fuel mix are fuel taxes that reflect the pollution and other harms caused by each fuel type. Such taxes also promote energy efficiency and clean energy innovation, and can raise significant government revenues, providing resources to reduce other more distorting taxes, to increase productive development spending or to fund cash transfers to protect poor fuel consumers. The government has increased excise taxes on petrol and diesel since October 2014, but, as noted in the Economic Survey 2014-15, there are still large efficiency gains to be reaped from significantly higher taxation of coal, the most damaging type of fossil fuels.

Policies to reduce the high cost of finance for renewable energy: While coal will remain an inevitably large part of India's fuel mix, investment in non-fossil fuel power sources, such as solar, wind, nuclear and hydro, needs to be sharply boosted. Government initiatives to reduce the present high cost of finance for renewable projects can have an important impact in stimulating private investment in renewables, for example through increased flows of concessional development financing. Such reforms can more than pay for themselves by significantly reducing the subsidy required per unit of renewable energy produced. The creation of a National Renewable Power Corporation should be considered, to undertake major renewable investments with world-class levels of management and technological dynamism.

6.2 Land use and agriculture

Restructure public spending on agriculture: Public spending on agriculture in India is heavily tilted towards input subsidies for electricity, fertilisers and irrigation. These subsidies do little to raise agricultural productivity while they encourage highly wasteful use of scarce groundwater, damage resilience and stimulate GHG emissions. A reorientation of public spending away from subsidies towards spending on agricultural R&D, extension services, rural infrastructure and education would have substantial benefits for agricultural productivity while conserving precious groundwater and mitigating GHG emissions. The political economy of agricultural subsidy reform is undoubtedly difficult, but could to some extent be handled if farmers are compensated by credible and tangible improvements in public service delivery and better infrastructure. Although it is wealthier farmers who garner disproportionate benefits from agricultural subsidies, potential adverse impacts of subsidy removal on the rural poor should be addressed through a modern, nationwide system of social protection that needs to be developed not only for this purpose but as a key element in India's broader agenda for equitable development.

Livestock sector reforms: India has among the largest livestock herds in the world, but one which has low productivity, and also represents the largest source of agricultural GHGs. Stronger public initiatives are needed to improve management of animal reproduction, health and diet, including measures that lead to a smaller but healthier and more productive herd, reducing both pressure on natural resources and agricultural GHG emissions.

Forestry initiatives: Existing initiatives to expand the quantity and quality of forest cover under the "Green India Mission" need to be scaled up. The benefits include strengthened resilience by increasing infiltration, groundwater recharge and stream flows, increased economic opportunities for forest communities and increased sequestration of CO_2.

6.3 Cities

Reform land regulations: : Costly and often chaotic urban development in India is linked to long-standing and mutually interlocking policy distortions and institutional weaknesses, including perverse land regulations, inadequate urban infrastructure and weak systems for urban local government. Reforms to achieve more compact, productive and green cities will need to move in a coordinated way on these key fronts. Highly restrictive floor space indexes (FSI) need to be relaxed in line with standards prevailing in dynamic international cities, to permit much taller buildings and much greater availability of built-up space for given land areas. Reforms of rent control laws, better systems to appraise land values and determine property rights and a more developed housing finance system are also needed.

Expand and renew urban infrastructure: Indian cities struggle with severe infrastructure deficits for water supply, sewerage, sanitation, electrical power and urban transportation. Without a coordinated expansion and refurbishment of urban infrastructure, any reforms of land regulations that increase built-up areas and population density would put even more pressure on already rickety and inadequate service delivery systems. The Jawaharlal Nehru National Urban Renewal Mission (JnNURM), launched in 2005, represented a major recognition and effort to move forward urban infrastructure development in coordination with reform of land regulations. A comprehensive impact evaluation of the JnNURM is needed to draw lessons, improve effectiveness and lay the groundwork for a renewed and scaled-up urban investment and reform agenda. Initial reviews of results have highlighted challenges in project selection and implementation capacity at the level of urban local governments.

Reform and strengthen urban local government: Urban government in India can best be described as in a state of partial or incomplete decentralisation. While the Constitution defines 18 functions for devolution to local government, in practice, however, the allocation of responsibilities between various levels of government remains muddled. Local governments' administrative capacity and accountability to residents is limited at best, while their fiscal resources remain far below the levels needed to accomplish their tasks. A much clearer allocation of responsibilities is needed, especially between state and urban local governments, while administrative capacity and accountability at the local level needs to be strengthened. Urban local governments need access to much greater resources to deliver on the tasks with which they have been mandated. Local government own revenues need to be bolstered, including through reform of property taxes in particular. Intergovernmental transfers from the state level and the centre also need to be boosted, together with better monitoring and accountability to ensure enhanced resources are well spent.

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Acknowledgements

Paper prepared by Milan Brahmbhatt (World Resources Institute) and Rajat Kathuria (ICRIER) for the New Climate Economy India Initiative. Comments are gratefully acknowledged from Ferzina Banaji, Manish Bapna, Christopher Delgado, Nick Godfrey, Per Klevnäs, Muthukumara Mani, Helen Mountford and David Nelson.

The New Climate Economy

The Global Commission on the Economy and Climate, and its flagship project **The New Climate Economy,** were set up to help governments, businesses and society make better-informed decisions on how to achieve economic prosperity and development while also addressing climate change.

This programme of work was commissioned in 2013 by the governments of seven countries: **Colombia, Ethiopia, Indonesia, Norway, South Korea, Sweden** and the **United Kingdom.** The Commission has operated as an independent body and, while benefiting from the support of the seven governments, has been given full freedom to reach its own conclusions.

The Commission's programme of work has been conducted by a global partnership of eight leading research institutes: World Resources Institute (WRI, Managing Partner), Climate Policy Initiative (CPI), Ethiopian Development Research Institute (EDRI), Global Green Growth Institute (GGGI), Indian Council for Research on International Economic Relations (ICRIER), LSE Cities, Stockholm Environment Institute (SEI) and Tsinghua University.

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978-0-9906845-9-6