International Energy Agency

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Understanding Energy Challenges in India

Policies, Players and Issues

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Sun-Joo Ahn and Dagmar Graczyk

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 28 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
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Acknowledgements

This work was undertaken by the International Energy Agency (IEA) with funding from the Korea Energy Economics Institute (KEEI), Republic of Korea.

Sun-Joo Ahn and Dagmar Graczyk are the lead authors of this paper. The authors would like to thank IEA colleagues for advice, contributions, and reviews throughout the preparation of this paper. Support and direction was generously given throughout by Ulrich Benterbusch. Other colleagues whose contributions were essential include Carlos Fernandez Alvarez, Douglas Cooke, Johannes Truby and Osamu Yamanaka. Special thanks to Rebecca Gaghen and her team who designed, edited and published this paper: Muriel Custodio, Astrid Dumond, Greg Frost, Angela Gosmann, Cheryl Haines, Bertrand Sadin and Marilyn Smith.

We are also grateful to experts outside of the IEA. Indian experts who participated in our two events in New Delhi – IEA-KEEI-ORF (Observer Research Foundation) Roundtable on 23 May 2012 and IEA-KEEI-TERI (The Energy Research Institute) Workshop on 24 May 2012 – provided valuable insights to this paper. We would like to give special thanks to the International Energy Cooperation Group of the KEEI for providing support and comments throughout the preparation of this paper.

Executive summary

Numerous policy reforms over the past 20 years have shifted India's energy sector from a predominantly government-owned system towards one based on market principles, offering a more level playing field for both public and private sectors. Political complexity and a tradition of socialist economic practices, however, hindered the complete liberalisation of India's energy sector, leading to sub-optimal outcomes. In this sense, the huge blackouts that occurred in northern India in July 2012 could be seen as a consequence within the framework of incomplete market liberalisation.

The goal of providing energy access to the entire population led to well-meaning policies designed to protect the poor, but resulted in a system of untargeted producer and consumer subsidies that prevent a more thorough implementation of a well-functioning and financially-sound energy sector. In combination with an industrial policy that aims to protect the indigenous manufacturing industry through import substitution, **India now finds itself trapped halfway along the transition towards an open and well-performing energy sector.**

India's energy sector is increasingly unable to deliver a secure supply of energy amid growing demand and fuel imports. In conjunction with a rising subsidy level and systemic failure to ensure proper revenue collection along the value chain, the financial capacity of energy sector players is significantly undermined. Lack of sufficient capacity to make timely and adequate investments gives reason to fear that India is heading towards energy crises.

Increasing import dependency exposes India to greater geopolitical risks, fluctuating world market prices and intensifying international competition. Indian energy policy cannot be set in isolation and needs to account for rising global interdependence, while simultaneously communicated appropriately to the public and reflected in policy debates.

India should overhaul its current patchwork of energy policies in favour of a comprehensive and clear-cut policy that encourages economic and social development through reliable energy supplies. **There are six main challenges that need to be addressed to create a well-functioning and financially-viable energy market in India:**

- **The core capacities of players in India's energy sector – mainly, energy companies – should be improved.** Energy players need to be commercially viable, with access to adequate financial resources. Their managerial autonomy from central or state ministries is imperative for timely investment, meanwhile ownership should be properly separated from management. The key issue is not private- versus publicly-owned entities; rather, ownership should not interfere with market principles. Management must be able to freely operate based on sound market analysis and economic deliberations. These players should be enabled to embrace the latest energy technology and improve their managerial expertise.
- **Pricing mechanisms in the energy sector must ensure commercial viability and send proper signals to the market.** The current rigid pricing setting mechanism, which is de facto determined by the government, should be reformed. Sector regulators should be enabled to operate independently from political influence. End-use pricing should support the government's policy for demand-side management and facilitate a rational allocation of resources along the value-chain. Price mechanisms need to reflect realistic opportunity costs, otherwise India's energy sector will continue to operate inefficiently, burdened by the recurring fiscal and supply-side problems well-known to Indian policy makers.
- **India requires significant investment to meet its growing energy demand and provide access to all citizens**, many of which are excluded from access to modern and clean sources of energy. Investment in the energy sector should focus on adopting the latest, green growth

energy technology for India's sustainable energy future. Creating the necessary framework conditions, including moving away from import substitution policy, will be critical to attract much needed investment and to compete internationally for investment.

- **An increase in effective implementation of energy policies is required** through the improvement of bureaucratic and administrative processes to assure a timely completion of energy projects. This will also contain unnecessary cost escalation of complex projects. Furthermore, intra-ministerial and inter-governmental (between central and state governments) coordination should be enhanced.

- **Truly integrated and consistent energy policy is critical** to guide and direct India's energy sector and ensure investment. Pursuing multiple policy objectives through one energy policy can potentially undermine the actual achievement of energy policy objectives. India's legitimate policy goal to provide affordable energy to the poor should be pursued separately, through social policies and supportive government programmes, which do not impede the investment decisions and managerial practices of energy companies.
- **Strong political will is a prerequisite to successfully cope with energy sector challenges.** India should complete the unfinished reforms on its energy sector based on market-principles. Consistent political messages and effective public communication are crucial to obtain the public support for the necessary energy sector reforms.

The pace and depth of reform in the energy sub-sectors varies strongly, which causes distortions throughout the system. The overview of individual fuel sectors shows that different degrees of progresses were made in each of them over the last two decades.

- **The power sector achieved a greater degree of liberalisation, allowing private investment along the entire value chain: generation, transmission and distribution.** However, considerable parts of the sector remain under the influence of both central and state governments. The power sector faces a shortage of fuels, insufficient infrastructure and financial weakness of state-owned power companies due to distorted pricing mechanisms and a systematic weakness to enforce legitimate revenue realisation. Effective policy implementation to attract private investment is necessary to ensure a reliable and adequate access.
- **The coal sector remains the most inefficient and least open to private investment, despite coal being the country's primary source of fuel.** The near monopoly of two public companies that obstruct the necessary increase of coal production and cause serious fuel shortages should be ended. Private participation in coal mining on a level playing field with state entities should be allowed.
- **The oil and gas sector is highly liberalised to attract private investment and to increase domestic production.** However, prices of petroleum products were only partly deregulated. The government, in practice, still determines retail prices for products considered to have social value through the ownership of oil companies. Untargeted subsidies for some petroleum products fail to bring the intended benefits to the poor, and instead result in a considerable financial burden to the downstream oil companies and deter private investment in the retail sector. The prices and allocation of natural gas are also de facto determined by the government. This has resulted in continuously declining interest of private and foreign investors in India's oil and gas sector. Full deregulation of pricing coupled with targeted provision of subsidies for the poor is needed to ensure sufficient investment into the sector.
- **The renewable sector features strong private investments, which are essential to materialise the potential of renewables for supplying a clean and modern energy, particularly in rural areas.** However, government policy that imposes mandatory domestic-content requirements, particularly for the solar industry, will most likely hinder the expansion of the sector. The

growth of strong local manufacturing capacities can be achieved through more open market policies and investment in R&D, rather than relying on import substitution policies.

- **The nuclear sector is exclusively controlled by the central government and recently obtained access to the global nuclear industry and technology.** However, it faces rising public opposition over safety and environmental impacts. India's unique nuclear programme, which aims to utilise domestically abundant resources, should be carefully assessed in terms of its role in India's long-term energy security and sustainable development.

To complete the transformation of India's energy sector into an open and functioning energy market, **the country needs strong political leadership to convey clear policy messages**. Frequent populist remarks, which, for example, promise free electricity, are not conducive to creating the right public perception of **energy as a commodity, not an entitlement**. Furthermore, in the context of an increasing need for investments and the integration of India's energy sector into the global energy market, **India needs to align its energy policies and institutions with global practices.**

Introduction

Rapidly increasing energy demand and growing concern about economic and environmental consequences call for effective and thorough energy governance in India. To understand the dynamics of the energy policy framework governing India's energy sector, it is essential to comprehend the policy objectives and context in which they are placed. Three main energy policy objectives are pursued by the Indian government:

First, access to energy is the foremost goal in India's energy policy making, as nearly one-quarter of the population lacks access to electricity. This implies ensuring the supply of adequate and reliable energy to the Indian population amid growing energy demand, bolstered by economic growth. Second, energy security is driven by increasing dependence on imported fuels, which is crucial to meet the India's huge energy demand. Increased import dependence also exposes the country to greater geopolitical risks and international price volatility. Finally, India is dedicated to the mitigation of climate change, although overcoming energy poverty and ensuring economic and social development remains a top priority.

Fulfilling all three objectives is not an easy task, as they can stand in conflict with one another. For example, supplying an affordable and considerable amount of energy using low-cost energy fuels, primarily coal, potentially undermines efforts to tackle climate change and local pollution. Pursuing the utilisation of domestic resources and promoting indigenous energy technologies could help enhance energy security in the long term, but does not solve India's energy problems in the short term.

This paper provides a comprehensive overview of India's energy sector and identifies challenges towards achieving the country's energy objectives. The paper is comprised of nine Chapters. Chapters 1, 2 and 3 provide the basic understanding of India's political economy, overarching energy policy framework and key features of India's energy sector as a whole. Chapters 4 to 8 focus on individual fuel sectors: power, coal, oil and gas, renewables and nuclear. These chapters describe how each fuel sector contributes to India's energy objectives and discusses pressing issues currently facing these objectives. The comparison of the IEA *World Energy Outlook 2011* scenarios and the Indian government's projections in these chapters show how differently India's energy future can evolve based on different assumptions and circumstances. Finally, Chapter 9 discusses key energy challenges that are appearing across individual energy sectors and that are closely inter-linked with one another, pulling together the issues identified in previous chapters. This Chapter especially aims to offer a strategic perspective into India's energy sector as a whole.

Analyses and data in this paper benefited from two IEA flagship publications: the *World Energy Outlook (WEO) 2011* and *Energy Technology Perspectives (ETP) 2010,* as well as two India-specific working papers: *Technology Development Prospects for the Indian Power Sector* and *Energy Transition for Industry: India and the Global Context*. IEA data is used as a basis for historical trends and current status, and for international comparison. This paper also used the latest official data and figures that were publicly available by the Indian government at the time this paper was written.[1]

The impact and importance of India's energy policy in an integrated and interdependent global energy market is without question. A strong and sustainable energy sector in India is crucial to maintain the vibrancy of the Indian economy. This is also essential to the prosperity of the global economy.

[1] There might be some discrepancies in base years used due to the time lag of data availability.

1. Country background

India has the world's second largest population of 1.24 billion in 2011 (WDI, 2012) and the world's seventh largest landmass (IEA, 2011c). The Indian subcontinent is located in Southern Asia, bordering the Arabian Sea and the Bay of Bengal. It is an ethnically and religiously diverse society with 23 official languages, whilst English is the subsidiary official language (IEA, 2007). India has achieved rapid and remarkable economic development in the past two decades and became the world's tenth largest economy in 2011. With its relatively young population with a median age of 26.2 years, India is expected to take over China as the world's most populous nation around 2025.[2] The country, thus, has emerged as one of the most dynamic economic powers in the world. Yet there exist contradictions and complexities that posit considerable challenges to grasp the reality of India: a democratic political system co-existing with an economy with traces of socialism and a widening income gap between urban and rural areas as well as among states. This section presents a brief introduction of India's political-socio-economic landscape, aiming to provide insights into India's energy sector and the context of its energy issues.

Political system

India is a federal republic based on a parliamentary system. The president is the head of state and the prime minister is the head of government. India has a bicameral parliament system: the Council of States, or Rajya Sabha, with members chosen by state ministers and territorial assemblies; and, the House of People, or Lok Sabha, with members elected by popular vote. The president is the supreme commander of the armed forces and has the power to appoint the prime minister and the council of ministers based on advice of the prime minister. Day-to-day policy making is undertaken by the prime minister who allocates positions within the cabinet. The election cycle for parliament is five years.

The most significant trend to emerge in the last decade in India's politics is the shift from a one-party-dominated government to a multi-party coalition system. Since independence (1947), the Indian National Congress party played a dominant role in politics until it was defeated by the Bharatiya Janata Party (BJP) in 1999, a landmark event in India. Since 1999, no single party has been powerful enough to form a majority in Lok Sabha on its own. Consequently, these two parties have maintained major roles at the national level by forming and leading their own coalitions: the Congress party leading the United Progressive Alliance (UPA) and the majority in the Parliament at the moment; and, BJP leading the National Democratic Alliance (NDA).[3] In 2009, when the Congress-led UPA coalition won the general election, the coalition government was composed of 11 parties, while the NDA consisted of eight parties. These small parties have emerged as a critical part of India's political landscape, but are highly fragmented with geographical (or state), ethnic, ideological or caste bases. They also tend to focus on regional and parochial issues rather than national issues (Economist, 2009a). Still, state-based parties often exercise considerable influence on national level politics and policies beyond their states. Furthermore, the multiplication of state-based parties makes electoral results at the national level unpredictable, and the formation and resilience of election coalitions difficult (Lafebvre, 2009).

As a federal union of states, India consists of 28 states and seven union territories. The central government, or Union Government, is formed with executive, legislature and judiciary branches. The states form their own executive body under the chief minister, and legislative assembly and

[2] Based on IEA population growth projections in *WEO 2011.*

[3] Other national-level parties are Communist Party of India (CPI), Communist Party of India, Marxist (CPI(M)), and Bahujan Samaj Party (BSP).

courts. The union territories are governed by an administrator appointed by the president and are under greater control by the central government. The Indian Constitution divides the responsible areas between the central government and the states. Areas for which the constitution assigned shared responsibility to the centre and the states are called the Concurrent list. As both central and state agencies are vested with the power over the same subject, this provides a possible cause for conflict. In case there is a conflict on a concurrent subject of national importance, the central law prevails over the state laws (MOLJ, 2012).

Table 1 • Distribution of power between central and state governments

Central government	States	Shared (Concurrent)
• Defence and armed force • Foreign affairs and diplomacy • Maritime shipping and navigation • Railways • Airway • Inter-state trading and commerce • Atomic energy • Mineral and oil resources • Corporate tax • Income taxes other than agricultural income • Taxes on capital value of the assets other than agricultural land	• Public order • Police • Water • Land rights • Agriculture • Public health • Gas and gas-work • Taxes on lands and buildings • Taxes on mineral rights • Taxes on the consumption or sale of electricity	• Electricity • Contract • Education • Forest • Economic and social planning • Trade unions; industrial and labour disputes • Welfare of labour including conditions of work, provident funds, employers' liability, workmen's compensation, invalidity and old age pensions and maternity benefits

Source: Constitution of India.

Economic development

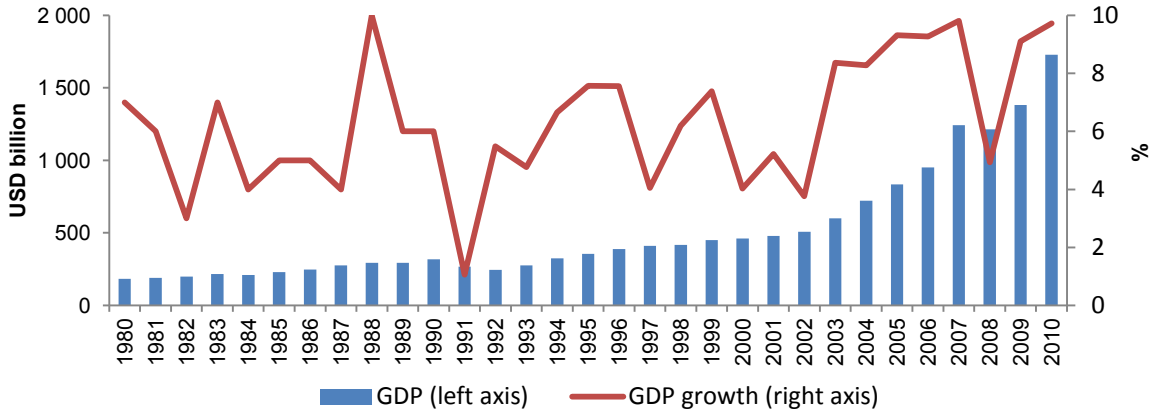
With nominal gross domestic product (GDP) of USD 1 847 billion, India was the tenth largest economy in the world in 2011. In terms of purchasing power parity (PPP), with constant 2005 USD 3 976 billion, India ranked third after the United States and China in 2011. However, India's nominal per-capita income of USD 1 489 remained much lower than other large economies. For example, it was less than one-third of China's per-capita income of USD 5 430 in 2011 (WDI, 2012).

The Indian economy is moving towards a free market economy, albeit with remaining traces of a socialist economic model. Inspired by the Soviet Union, after independence Indian policy makers infused many socialist elements into the Indian economy, including central planning, large public sectors, an import substitution approach and strict government regulations, which led to high inefficiency in the economy. Indian economic growth stagnated around 3.5% to 4% per year until major economic reforms commenced in 1991 (PC, 1995). The economy has increased at an average rate of approximately 7% since 2000. Amid the global economic recession in 2008, the Indian economy quickly rebounded and grew over 9% between 2009 and 2010.

In a series of economic reforms implemented throughout the 1990s and 2000s, the most significant is the industrial reform, or often-called New Economic Policy, effectuated in 1991. Amid India's balance of payment crisis and following intervention by the International Monetary Fund (IMF), the Indian government released a "Statement on Industrial Policy", which led to: the

abolishment of industrial licensing for all industries (except those specified[4]); the approval of foreign direct investment up to 51% foreign equity in high priority industries; the automatic permission for technology agreements related to high priority industries; reform and disinvestment of public sector enterprises; and, the amendment of India's anti-competitive law – Monopolies and Restrictive Trade Practices Act (MOI, 1991). Consequently, throughout the 1990s, privatisation and deregulation of major state-owned industries, including telecommunication and airlines were implemented as well as the liberalisation of trade under the World Trade Organization. Export of Indian products and services was encouraged and the Special Economic Zones (SEZs) policy was announced in 2000 and enacted in 2005 to attract larger foreign direct investments to India. As a result, India's export value multiplied by ten times from USD 18 billion in 1990 to USD 178 billion in fiscal year (FY) 2009/10[5] (MOF, 2011). Nation-wide economic reforms in the 1990s and 2000s brought considerable changes to India's energy sector, but were left unfinished.

Figure 1 • India's economic growth (1980-2010)



Source: WDI, 2012.

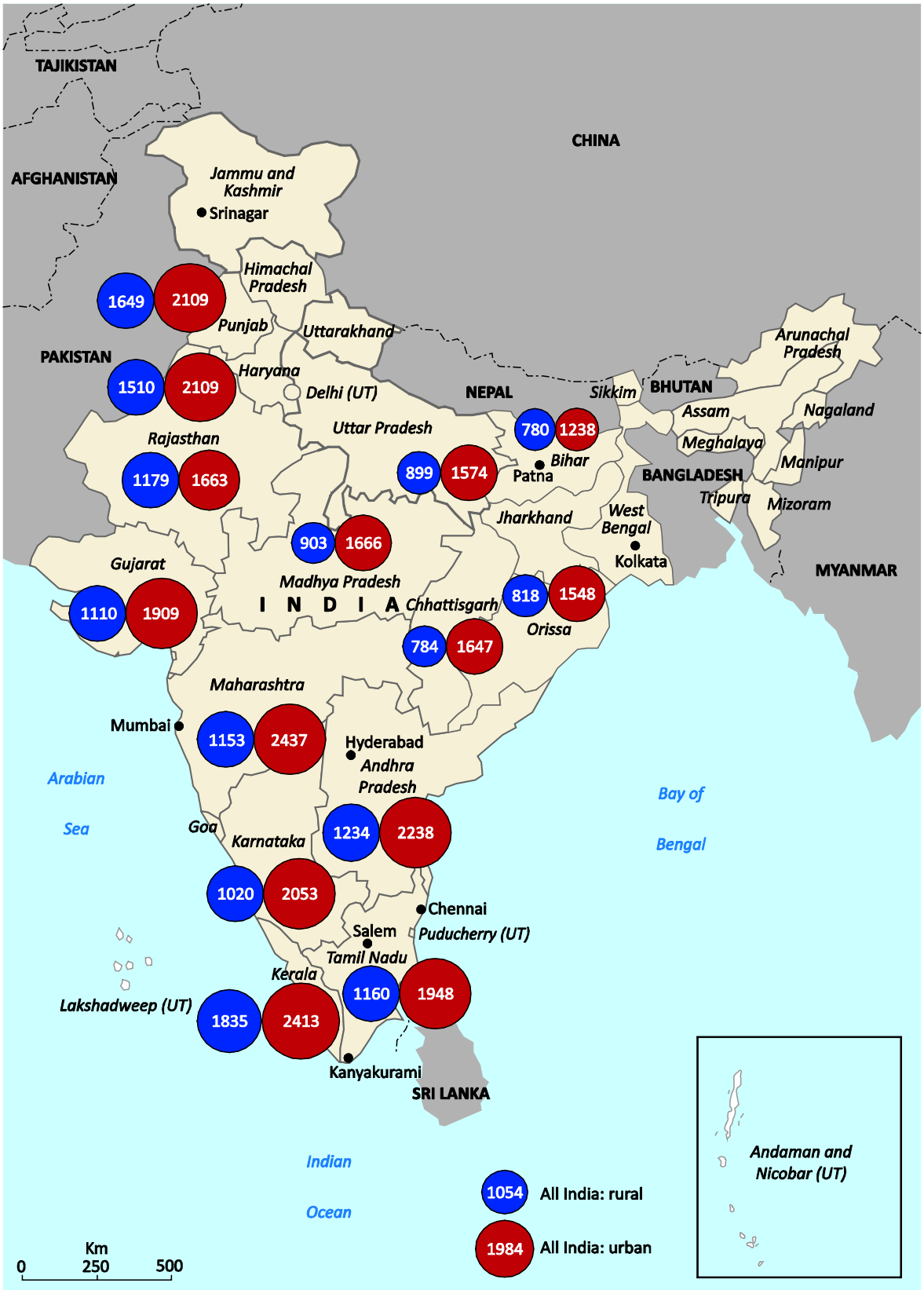
Social context

Although there has been significant progress in human development through economic growth, India still has a long way to go. It ranked 134 out of 187 countries in the 2011 United Nations Human Development Index (HDI) because of poor performance in the education and health indicators (UN HDI, 2012). Recent rapid economic growth reduced the absolute number of people living in poverty, but failed to achieve a balanced economic growth between rural and urban areas. For instance, 37.2% of the national population and 42% of the rural population live below the poverty line (BPL) of USD 1.25 PPP, whereas 26% of the urban population is considered BPL (UNDP 2011). The average urban monthly expenditure is nearly twice that of the rural level (Figure 2).

[4] These industries need compulsory government licensing and are specified in Annex II of the policy statement, which originally included energy industries such as coal and lignite, and petroleum and its distillation products but no longer the case as most of them were liberalised in 1990s and 2000s.

[5] India's fiscal year runs 1 April and ends on 31 March the following year.

Figure 2 • Average monthly per-capita expenditure: major states (INR)



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: created by the author based on MOSPI, 2011.

Considerable socio-economic imbalances exist among Indian states. For instance, state per-capita income ranges from the richest state, Goa's INR (Indian rupees) 132 719 (≈USD 3 030), the richest large state Haryana's INR 78 781 (≈USD 1 670) to Bihar's INR 16 119 (≈USD 340) (PIB, 2010a). Maharashtra with a population of 112 million and GDP of INR 8.1 trillion (≈USD 172 billion), accounts for 14.5% of India's total GDP. The state capital, Mumbai, is home to major banking, finance and insurance companies and the Bombay Stock Exchange is India's largest. Uttar Pradesh, located in the northern region, with 199 million population and GDP of INR 4.5 trillion (≈USD 96 billion) accounts for 8.3% of national GDP. It has large textile and shoe-manufacturing industries, although the majority of the population engages in agriculture. The six smallest states, Meghalaya, Manipur, Nagaland, Arunachal Pradesh, Mizoram and Sikkim, are all located in the north-east region, and together contribute only 0.6% of national GDP.

Key message • Understanding India's political economy is essential to understanding India's energy sector:

- **India is transforming into a more open and free market economy;**
- **its federal system and coalition-based politics make much-needed policy reform complex and difficult; and**
- **India must continue its economic growth to advance economic and human development and, at the same time, alleviate imbalances in economic wealth and living conditions.**

2. Energy policy framework

The Indian government as a whole plays an indispensable role in the energy sector through state-owned enterprises, public policy and market regulation, indirect guidance and personal networks. To grasp the intertwined dynamics in India's energy policy framework, comprehending not only the individual role of each ministry and government agency but also their interaction and co-ordination with other energy players is essential. Furthermore, some of the main ideas and themes that drive energy policy discourse in India should be taken into consideration. This section provides India's energy policy context, institutional arrangements and key overarching policies for better understanding of the country's energy sector.

Policy context

Understanding India's energy policy framework should begin by looking at policy contexts in which policy objectives and concepts are laid out. This will help to answer some of the questions about various decisions made by Indian policy makers. For instance, why has India adopted extensive subsidy programmes for energy products despite the fiscal burden? Why is India reluctant to actively participate in the international legal framework for climate change? How do Indian policy makers perceive rising dependence on imported energy and resulting greater exposure to geopolitical risks, and how do they try to address it? The policy objectives and concepts shed light on the rationales and motivations and eventually, energy policy making, which are to be discussed in the following chapters on the individual fuel sectors.

Policy objectives

There are three major policy objectives that India pursues: energy access, energy security and mitigation of climate change. All three objectives are closely related, but sometimes conflict with one another and are derived from the reality in India. Thus, it is challenging for India to maintain a balanced approach in pursuit of all three objectives.

Energy access

Nearly one-quarter of the population of India lacks access to electricity. It is important to understand this peculiarity of India's energy situation where the majority of potential energy demand still remains unmet, unlike most developed countries where energy demand has reached or is close to saturation stage. The Indian government recognised that economic development is being hindered as a consequence of energy poverty. Thus, providing energy access to its entire population has been a top priority of Indian policy makers for a long time, making it equally or even more important than energy security. India's major rural electrification scheme is an example of the government's determination to expand access to electricity in India's rural villages.

Energy security

Energy security takes a central position in government policy making. The emphasis of energy policy until the 1990s was on electricity shortage and unsatisfied energy needs. However, increasing dependence on imported energy sources, mainly oil, but also natural gas and coal, resulted in greater government attention to the subject. Energy security is defined comprehensively in India, as "we are energy secure when we can supply lifeline energy to all our citizens irrespective of their ability to pay for it as well as meet their effective demand for safe and convenient energy to satisfy their various needs at competitive prices, at all times and with a prescribed confidence level considering shocks and disruptions that can be reasonably expected" (PC, 2006).

From this definition, India's concern for energy security is threefold: First, India asserts that energy is a lifeline to all citizens, which should be factored into its energy security strategy. Second, India is anxious about sudden increases in global energy prices as they undermine the availability of energy to its people and exacerbate the national financial burden. Finally, there is a concern about possible abrupt supply disruption, which has led to efforts to diversify supply and fuel and acquire overseas assets.

Climate change

There is well-accepted recognition of the impacts of climate change among Indian policy makers and the general public, although priority is given to economic and social development. India is a signatory to the United Nations Framework Convention on Climate Change (UNFCC), but is not obliged to contain its carbon emissions as an Annex II country. Regarding international attempts to establish an internationally-binding regime to curb carbon emissions, India finds it unacceptable, stating that most emissions were produced by developed countries and that India needs economic development and industrialisation. India's per-capita emissions are only one-third of the world average and 14% of per-capita emissions of OECD member countries. India took a leading role in the G77 during the COP 15 in 2009, denouncing any attempt by industrialised countries to impose carbon reduction targets on developing countries.

That said, India is increasingly engaged in reducing carbon emissions and alleviating environmental degradation. India announced its National Action Plan on Climate Change in 2008, and during COP15 in Copenhagen in 2009, India's environment minister reconfirmed India's goal to reduce carbon emissions per unit of GDP by 20% to 25% below 2005 levels by 2020. Frequent flooding and droughts, deforestation and desertification as well as possible glacial melting in the Himalayas have focused on climate change and provide strong impetus towards India's transition to a low-carbon economy.

Policy concepts

This section explores policy concepts, which are helpful to comprehend the motivation and rationale affecting certain energy policy objectives or initiatives. They are rooted in certain Indian historical and cultural traditions. Foremost are the ideas of India's first prime minister, Jawaharlal Nehru, who was the key architect of India's political and economic structure, and left a significant lasting impact. His vision for pan-Asian solidarity and the non-aligned movement in 1950s and 1960s was based on core principles, including non-interference in internal affairs and equality and mutual benefits. He was also committed to promoting self-reliance and chose import substitution as an economic strategy (Mathew, 2003). The policy concepts based on Nehru's ideas can still be frequently observed in policy documents and politicians' rhetoric; they are self-sufficiency, non-interference and inclusive development.

Self-sufficiency

Self-sufficiency or energy independence is a frequently occurring theme in the energy policy dialogue in India (Madan, 2006). This is a useful concept to understand India's approach to energy security. Although India adopted strategies of supply or fuel diversification to enhance energy security, it has placed a stronger emphasis on maximum utilisation of domestic sources, including hydrocarbon, thorium and renewables. In 2007, former Indian President APJ Abdul Kalam announced an ambitious plan to realise energy independence based on hydro, nuclear and renewable energy, stating "we need to graduate from [talking about] energy security to [attaining] energy independence" (FE, 2007a).

However, the pursuit of self-sufficiency led to India's current over-reliance on state-owned enterprises in the energy sector, which was recognised by the Indian government. "The institutional

structure in the public sector that we have so assiduously built up during the last 55 years or so to promote self-sufficiency and self-reliance in energy, has led to a monopolistic market structure and led to the systemic infirmities that are inherent in cases of majority public ownership of an enterprise" (PC, 2006).

Non-interference

Nehru's notion of non-interference retains a considerable influence on India's policy making (Price, 2011). As demonstrated by India's non-participation in the Non-Proliferation Treaty to its reluctance to support US sanctions on Iran, non-interference by outsiders and the protection of Indian sovereignty are fundamental features of Indian domestic and foreign policy.

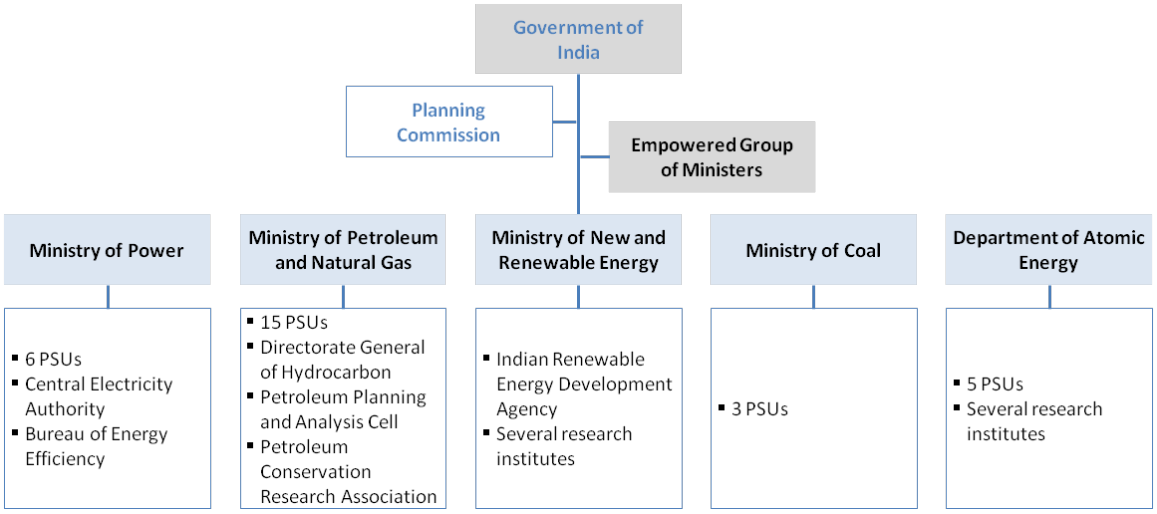
Inclusive development

The concept of inclusive development can be broadly defined as "growth coupled with equal opportunities" (Rauniyar, 2009). Also called inclusive growth, inclusive development appears frequently in recent policy documents and policy discourse, which is attributable to the widening income inequality in the country notwithstanding economic development. For instance, the theme of the approach paper for India's 12th Five-Year Plan is "Faster, sustainable, more inclusive growth" (PC, 2012b).

Institutional arrangements

There are a number of players in India's energy sector. With the Planning Commission at the top, five ministries are in charge of energy policy for individual fuel sectors, and other ministries and state governments directly and indirectly have influence on energy policy.

Figure 3 • Institutional structure of energy administration in India



Note: PSU = Public Sector Undertaking refers to state-owned enterprises in India.

Planning Commission

The Planning Commission was constituted by a resolution of the government of India in 1950 with Jawaharlal Nehru as the first chairman to accelerate economic development by allocating national resources efficiently and ensuring opportunities to all. The Planning Commission has responsibilities to assess national resources, to determine priorities and formulate plans. The role

of the Planning Commission is essential as it formulates the five-year plans and monitors their implementation based on consultation with the central ministries and state governments in the process, yet it lacks the power to implement the policies. The Prime Minister of India is the chairman and gives direction to the commission on all major policy issues, whilst there is a deputy chairman and full-time members who function as a composite body through several specialised divisions. The authority and significance of the Planning Commission can be seen in the fact that the deputy chairman holds the rank of a Union Cabinet Minister and all full-time Members and Member-Secretaries are at the rank of a Union Minister of State (PC, 2011a).

The role and relevance of the Planning Commission is increasingly questioned in discussions on whether India still needs top-down, centralised policy planning in the post-liberalisation era (Bagchi, 2007). However, the commission's often provoking, intellectual approach to India's urgent issues still has merits, and its co-ordinative and indicative role has been essential, especially with a view to the multiple stakeholders and fragmented interests in policy making.

Empowered Group of Ministers (EGOM)

EGOM is a collective decision making mechanism with permanent members. In case a policy issue requires the involvement of more than one ministry, a group of relevant ministers is formed with the prime minister's approval. The membership composition changes with the issue at hand. The objective of formation of the EGOM is, first to bring the imminent issue into the policy discussion, to ensure better co-ordination among ministries, to reflect on various aspects relating to the policy issue, and lastly to expedite the decision making process. There usually is one minister who leads the group. The composition of EGOM (Table 2) indicates the complexity and intertwinement of multi-ministerial interests over one specific issue.

Table 2 • Key existing empowered groups of ministers on energy-related issues

Name	Task	Composition
EGOM Gas Pricing and Commercial Utilisation of Gas	To consider and decide issue of commercial utilisation of gas under New Exploration Licensing Policy and other related matters	Minister of Defence Minister of Home Affairs Minister of Power Minister of Petroleum and Natural Gas Minister of Chemicals and Fertilizers Minister of Law and Justice & Minister of Minority Affairs Deputy Chairman of Planning Commission Minister of State in the Ministry of Finance
EGOM on Ultra Mega Power Project	To facilitate expeditious decisions in all matters concerning Ultra Mega Power Projects	Minister of Defence Minister of Power Minister of Coal Minister of Law and Justice & Minister of Minority Affairs Deputy Chairman of Planning Commission Minister of State of the Ministry of Environment and Forests Minister of State in the Ministry of Finance

Source: CABSEC, 2012.

Five energy-related ministries

Policy making and implementation in the energy sector is split among five ministries, and several government commissions and agencies. Previously, the Ministry of Energy existed, with separate departments for power, coal and non-conventional energy sources. Through national economic reforms, the ministry was divided into three separate ministries in 1992: the **Ministry of Power (MOP)** is responsible for the power sector along the entire value chain; the **Ministry of Coal**

(MOC) has responsibilities for policies on exploration and development of coal reserves; and the **Ministry of New and Renewable Energy (MNRE)** carries out national programmes to increase renewables including wind, solar and small hydro. In addition, the **Ministry of Petroleum and Natural Gas (MOPNG)** oversees all aspects of the oil and natural gas sector, including exploration, production, marketing and import/export. The **Department of Atomic Energy (DAE)**, under the direct charge of Prime Minister, is responsible for all aspects of India's nuclear policy.

Criticism against having five different ministries has stipulated that "all are bent on to protecting their narrow turf" (FE, 2012a), instead of acting in conformity with national energy objectives. Considering the ever-increasing necessity of forming alliances to win election and of rewarding the party-cadre with ministerial positions, however, the chance for one unified energy ministry is remote (Madan, 2006). That said, in principle, each ministry can dedicate itself to their designated fuel sector, without being sidelined and marginalised by other dominant fuel interests. This preconditions integrated policy planning and effective policy co-ordination. A detailed description of the five energy-related ministries and state governments is provided later in relation to their respective role and function in each fuel sector.

State governments

The influence of the central government on energy policy at the state level is limited. The Indian parliament cannot legislate over certain aspects of this sector in the states. In general, as in most federal systems, the states are responsible for implementing national laws, but can also issue state laws and regulations of application in their own territory. State governments have their own energy departments to manage the particular energy issues and market conditions in their states. Thus, state governments have considerable responsibilities in the energy sector, especially in the power sector where the responsibility is shared between the Center and the states under the Indian Constitution. As a result, the evolution of power sector reforms and the level of penetration of renewable energy sources differ widely among states (IEA, 2007).

Other related ministries

Ministry of External Affairs

The Ministry of External Affairs (MEA) has become increasingly active in energy security-related policy. In 2007, MEA created an Energy Security Division to serve as a nodal point in the ministry for energy security and to closely co-ordinate with the concerned Ministries and support their international engagement through appropriate diplomatic interventions (PIB, 2007b).

Ministry of Finance

Responsible for national taxation, financial legislation and budget planning and allocation, the Ministry of Finance (MOF) plays a significant role in energy policy and markets. MOF decides on the budget allocation for five-year plans, which determine the directions of energy policy. For instance, in the FY 2012/13 budget, MOF decided to grant full exemptions on basic customs duty to natural gas, LNG and uranium concentrate (PIB, 2012a) in order to lower feedstock costs for gas-based and nuclear power plants. Additionally, based on the energy subsidy decided by MOPNG, MOF transfers the subsidy to oil marketing companies in the form of cash and bonds. MOF also provides funding and financial incentives to various renewable and other energy technologies.

Ministry of Environment and Forests

Ministry of Environment and Forests (MOEF) is responsible for the planning, promotion, co-ordination and oversight of the implementation of India's environmental and forestry policies

and programmes. The role of MOEF is crucial for the development of infrastructure as it has the authority to impose a moratorium on projects based on their environmental impact. In particular, the MOEF used to decide on so-called "go" and "no-go" areas for coal mining in forested zones. Coal mining development is prohibited in no-go areas, resulting in further hindrance to expansion of coal production. The no-go classification was dismantled owing to strong protests from the coal ministry and industry in 2011. (FE, 2011a) MOEF is now considering introducing a different categorisation for non-exploration areas. (TOI, 2012a) The MOEF also approves and administers Clean Development Mechanism (CDM) projects in India.

Ministry of Rural Development

The Ministry of Rural Development (MORD) has three main tasks: improving social conditions in rural areas, management of land resources, and management of drinking water and sanitation at the national level. It co-ordinates with state nodal agencies. The MORD's Department of Land Resources is the nodal agency for National Policy on Resettlement and Rehabilitation (R&R), which requires adequate compensation for all involuntary displacement of people, which often occurs due to energy and infrastructure projects. Obtaining clearance on a compensation package is required for projects, but states often have different R&R policies from that of the Centre. Compensation disputes are hard to settle with land owners and dwellers whose livelihood depends on the land, hence land acquisition and rehabilitation has become an increasingly complex process. As a result, a number of projects for coal mining, power plants, and other large-scale industry experienced considerable delays in their project schedule. To facilitate the process, the Land Acquisition, Rehabilitation and Resettlement Bill (LARR) was proposed by the MORD but failed to pass in parliament in 2011 (MORD, 2011).

Ministry of Science and Technology

Ministry of Science and Technology (MOST) is in charge of national R&D policy and investment for innovation and distribution of technologies including energy technology. For instance, MOST and the Department of Energy of the United States agreed to jointly fund USD 100 million for a Joint Clean Energy R&D Centre to focus on three priority areas: biofuels, solar energy, and building energy efficiency in 2011 (US DOE, 2011).

Key energy policies

In this section, overarching energy policies are discussed. The specific energy policies for each fuel sector are discussed in the following chapters.

Integrated Energy Policy 2008

The Integrated Energy Policy (IEP) is the first comprehensive energy policy by the Indian government and oversees all energy sectors. The prime minister directed the Planning Commission to form an expert committee "to prepare an integrated energy policy linked with sustainable development that covers all sources of energy and addresses all aspects of energy use and supply including energy security, access and availability, affordability and pricing, as well as efficiency and environmental concerns" (PC, 2006). The committee was set up in 2004; the draft report was released in August 2006; and, the cabinet finally approved the report in December 2008.

One of the major salient features of the IEP is the focus on ensuring the transition to market economy where private companies compete on a fair footing with with public companies, stating "both the tax structure and regulatory philosophy applied in each energy sector should be consistent with the overall energy policy [and] should provide a level playing field to all players

whether public or private" (PIB, 2008b). It also stresses transparent and targeted subsidies and proper energy pricing to send the right signal to producers and consumers. The targets set by the IEP run to FY 2031/32 and serve as a benchmark for various government policies.

The amount of energy India needs to sustain high economic growth of 8% to 9% per year over the next 25 years (until 2032) was addressed by the IEP by looking beyond the traditional five-year cycle to determine how India could best meet its enormous energy demand. The IEP also addresses multifaceted energy problems the country must resolve to ensure efficient and sustainable use of energy, stating that "India must pursue technologies that maximise energy efficiency, demand side management and conservation" (PC, 2006). The IEP presents long-term goals for all energy sectors, not in an insulated and disconnected way, but rather in an "integrated" and comprehensive manner. It also offers various scenarios based on different energy mixes and implementation of demand-side management. One of the key directions set for the long-term energy strategy is the validation of coal as a primary energy source for the long term and the necessity of ensuring coal supply with consistent quality. Power sector reform was strongly emphasised in relation to cost reduction and rationalisation of fuel prices. The approach for energy security was based on greater exploration or utilisation of domestic resources, namely oil, gas, coal, thorium and renewables. As mentioned previously, the IEP linked energy security with energy access, saying "India cannot be energy secure if her people remain without secure supply for lifeline needs." The IEP discussed issues of climate change and increasing environmental degradation in India, but made it clear that India would contain its carbon emissions if compensated for the additional costs involved.

Five-year plans

The Indian government implements economic policy through five-year plans that are developed, executed and monitored by the Planning Commission. When it comes to energy, the five-year plan has direct impact on energy sector development as it lays out energy demand projections and key issues. The 1st Five-Year Plan was introduced in 1951. The first eight five-year plans largely focused on growing the public sector with massive investments in basic and heavy industries, especially the power sector, but since the 9th Five-Year Plan (FYP 1997-2002), the emphasis was shifted to providing indicative directions and less on the predominance of the public sector (PC, 2012a). For instance, the 9th Five-Year Plan stressed the commercial viability of the energy sector and the role of the private sector.

Traditionally, setting the GDP growth rate has been the central objective, although official targets set in the five-year plan are often underachieved. The average annual growth rate for the 11th Plan (FYP 2007-12) is expected to be 8.2%, compared to the official target of 9%, assuming FY 2011/12 growth at 8%[6](PC, 2012b). The 12th Five-Year Plan has not yet been officially announced, but the Planning Commission's approach paper for the 12th Five-Year Plan stated that the plan (FYP 2012-17) will target 9% growth (PC, 2012b). However, it was recently reported that the government considers 9% growth not feasible amid the global economic downturn and is now considering lowering the growth target to 8% to 8.5% (ET, 2012i). The role of the states in meeting targets in five-year plans is important. Many focus areas in the 12th Five-Year Plan, such as the power sector, require direct involvement and support from state governments. Recognising this necessity, for the first time, a consultation was held between the Planning Commission and Vice Chairmen of Planning Boards and Planning Secretaries of the States in July 2012, which traditionally meets with chief ministers from all states (PIB, 2012h).

Five-year plans usually consist of one policy document comprising chapters on each area, such as health, education and infrastructure, and each ministry devises concrete policies for implementation.

[6] India's actual GDP growth for FY 2011/12 was reportedly 6.5% (WSJ, 2012).

For energy, working groups are established by each energy-related ministry to provide more detailed targets with specific initiatives and budget allocations. Half-way through the plan period, the Planning Commission conducts a mid-term appraisal (MTA) to assess the progress and feasibility of achieving the planned targets, and often revises them. The mid-term appraisal for the 11th Five-Year Plan was held and approved in 2010. The main limitation of five-year plans are their disconnection from the actual annual budget allocation. It sets physical targets to achieve during the plan period, but does not always present fiscal implications.

National Action Plan on Climate Change

The National Action Plan on Climate Change (NAPCC) was prepared under the guidance and direction of the Prime Minister's Council on Climate Change and released in 2008 to achieve "a sustainable development path that simultaneously advances economic and environmental objectives" (PIB, 2008a). The NAPCC formed through India's realisation of the necessity of comprehensive and urgent initiatives to address climate change and environmental issues at the national level. It also reflected India's intention to behave as a responsible member of the international community, as well as its rejection to be burdened with emission reductions on par with developed countries. The NAPCC argues that its success would be enhanced if "developed countries affirm their responsibility for accumulated greenhouse gas emissions and fulfil their commitments under the UNFCCC, to transfer new and additional financial resources and climate friendly technologies to support both adaptation and mitigation in developing countries" (PC, 2008).

One concept presented in the NAPCC is based on per-capita carbon emission, stating that each person in the world has "an equal entitlement" to the global atmosphere and committing that India's per-capita emission will not exceed the level of developed countries at any point (PC, 2008). The idea of equality and one of India's key energy policy objectives – energy access – were reiterated in the NAPCC that called for protection of the poor and vulnerable parts of society through an inclusive and sustainable development strategy.

The NAPCC has eight Missions to achieve these principles, two of which are directly energy-related: the Jawaharlal Nehru National Solar Mission (JNNSM) and the National Mission for Enhanced Energy Efficiency (NMEEE). The JNNSM, implemented by the MNRE, is a supply-side effort aiming to significantly increase the share of solar energy in the total energy mix. The NMEEE, implemented by the Bureau of Energy Efficiency, is based on demand-side management. It expects that a series of programmes and schemes would result in a saving of 10 gigawatt (GW) by the end of 11th Plan in 2012. The NMEEE initiatives to enhance energy efficiency include a market-based mechanism, energy efficient appliances and financial mechanism to support demand-side management programmes. Other Missions also have indirect implications on energy sector. For instance, the National Mission on Sustainable Habitat aims to improve energy efficiency in the building sector.

Key message • Energy policy framework in India establishes the context in which the role of energy players and policy issues are shaped and change:

- **India pursues three key objectives in its energy policy: energy access, energy security and climate change;**
- **understanding the intertwined dynamics of energy stakeholders and multiple interests is crucial to understanding India's energy sector; and**
- **the three main energy policies in India – the Integrated Energy Policy, five-year plans and National Action Plan on Climate Change – are designed to deal with growing challenges in the country's energy sector and establish a workable path to achieve India's three energy objectives.**

3. Overview of the energy sector

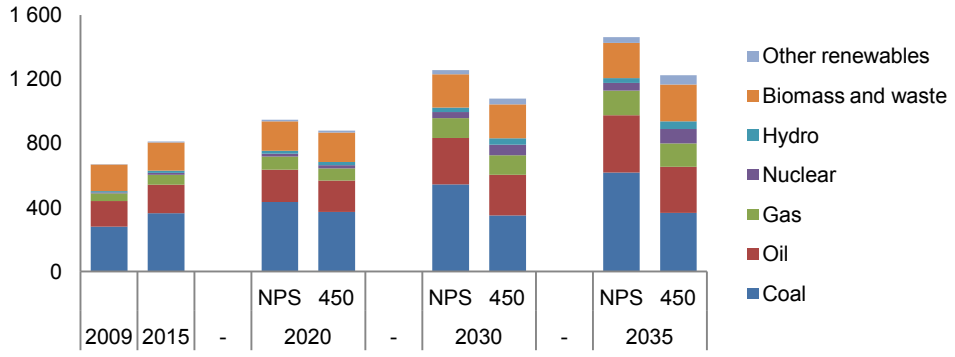
In 2009, India had the third largest energy demand in the world after China and the United States and just ahead of Russia. As *World Energy Outlook (WEO) 2011* shows, India's energy demand more than doubled from 319 million tones of oil equivalent (Mtoe) in 1990 to 669 Mtoe in 2009. Notably, India's per-capita energy consumption is still at a much lower level than that of developed countries and even of some developing countries. Its per-capita energy consumption is 0.58 (toe/capita), compared to the world average of 1.8, OECD of 4.28, China of 1.7 and Africa of 0.67 in 2009 (IEA, 2011b). The low per-capita energy consumption level indicates that India's energy demand still has a long way to reach saturation. With a growing economy and a 1.24 billion population aspiring for a better quality of life, India's energy demand growth is inevitable. The question is at what scale and speed India's energy demand will expand and which fuels and technologies it will use. This is the key for understanding the future landscape of India's and eventually the world energy market.

Energy demand

The New Policies Scenario (NPS), the central scenario of *WEO 2011*, shows how the future might look on the basis of the incorporation of broad policy commitments and plans announced by countries to tackle energy security, climate change and other pressing energy-related challenges. The 450 Scenario of *WEO 2011* sets out an energy pathway consistent with a 50% chance of meeting the goal of limiting the increase in average global temperature to 2°C, compared with pre-industrial levels.

The NPS projects that India's demand continues will grow quickly, reaching 1 464 Mtoe in 2035, increasing by a compound annual growth rate (CAGR) of 3.1% from 2009 to 2035, which is more than double the world's energy demand at a CAGR of 1.3% for the same period. India's share in world energy demand increases from 5.5% in 2009 to 8.6% in 2035. The growth would come from all fuels. The largest demand growth would come from coal, almost tripling from 280 Mtoe in 2009 to 618 Mtoe in 2035 at a CAGR of 3.1%. Oil demand would show a considerable growth from 159 Mtoe to 356 Mtoe at 3.1%. For natural gas, it would increase from 49 Mtoe in 2009 to 154 Mtoe in 2035. Nuclear demand would reach 48 Mtoe in 2035 from 5 Mtoe in 2009 while renewable demand grows from 2 Mtoe in 2009 to 36 Mtoe. India's huge energy demand increase would be based mainly on hydrocarbons.

Figure 4 • Total primary energy demand (TPED) in India, 2009-35 (Mtoe)



Source: IEA, 2011a.

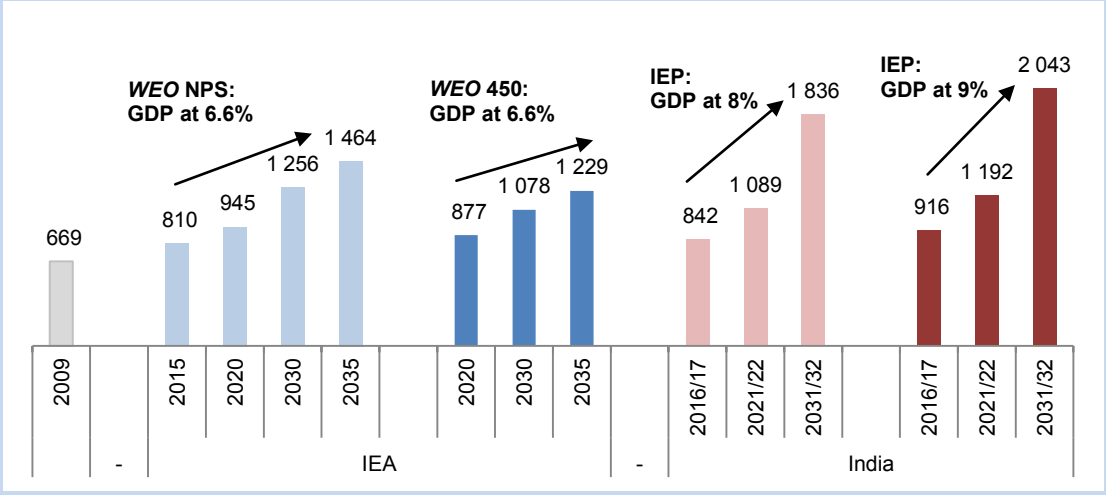
The 450 Scenario projects that energy demand would reach 1 223 Mtoe in 2035, which is 17% less than under the NPS. Coal demand is much lower at 365 Mtoe, almost half of the NPS

projection. The demand for nuclear energy would double in the 450 Scenario to 90 Mtoe, growing at a CAGR of 11.9% from 2009 to 2035, and renewable demand would increase to 57 Mtoe. However, even under the 450 Scenario, which implies greater expansion of renewables and nuclear, the growth of hydrocarbon energy at 311 Mtoe from 2009 to 2035 remains substantial.

It is important to note that in 2009, 289 million Indians lived without access to electricity and 836 million people without modern fuel for cooking and heating (IEA 2011a). Unsatisfied energy demand is the key source of projected growth of demand in India, which will accelerate in tandem with the country's economic growth.

Box 1 • Projections for total primary energy demand: *WEO 2011* versus IEP (Mtoe)

Although the IEP was drafted in 2006 and has not been revised since then, it serves as the guiding document for Indian energy policies. It is important to understand the differences in long-term projections made in the *WEO 2011* and the IEP of the Planning Commission for total energy demand. Discrepancies are the result of the different assumptions used, notably GDP growth rate and population growth.[7] The *WEO 2011*, for instance, assumes that India's GDP growth is on average 7.7% between 2009 and 2020 and 6.6% between 2009 and 2035, while the official Indian GDP growth target used in the IEP is 8% and 9%. Furthermore, the *WEO 2011* projects that India's population would grow to 1 511 million by 2035 and the IEP projection states 1 468 million by FY 2031/32. The IEP projections indicate that India would have enormous energy demand growth by FY 2031/32, which would be nearly twice that of the IEA projection for the year 2030. It should be noted that Indian projections are based on "one possible scenario", which the IEP does not consider preferential.



Sources: IEA, 2011a; PC, 2006.

Energy mix

The energy mix is the snapshot of a country's dependency on each energy source and provides a good indication of a country's energy challenges. Since economic reforms in 1991, India has experienced a major transformation of its energy mix. The most notable change in the country's energy mix since then was the shift from biomass to other energy sources, particularly coal. The reduction of biomass consumption coincides with India's economic development and growing urbanisation over the past two decades. Biomass and other wastes such as fuel wood and animal waste are widely used for cooking and heating purposes by low income households, primarily in rural areas.

[7] For more explanation on the differences in assumptions, see IEA, 2011c, pp. 59-60.

In 2009, India's largest primary energy source was coal, with a share of 42%. The second largest source was biomass at 25%, decreased from 42% in 1990. In 2009, oil represented 24% and natural gas 7%. Other fuels, such as nuclear, hydro and other renewables, have a rather small share in the total fuel mix.

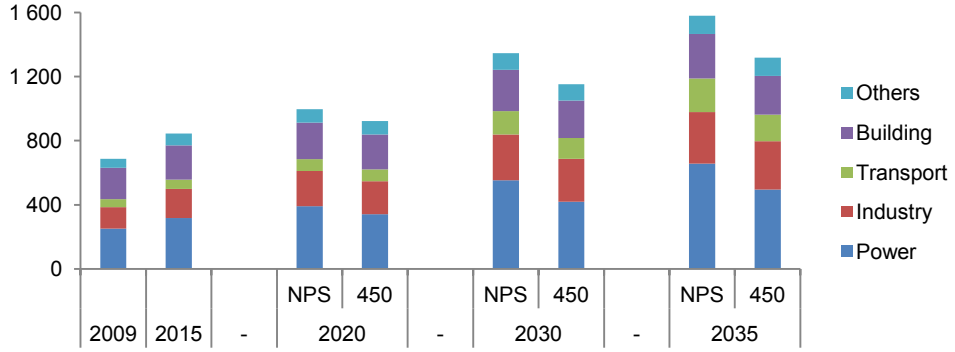
The *WEO 2011* projects that under the NPS, the current energy mix would not experience a dramatic change by 2035, with coal remaining the dominant fuel at the same 42% share. The share of biomass would decrease to 15%, as an outcome of poverty reduction, urbanisation and increasing demand for modern fuels. Other fuels would maintain similar shares in 2035. On the contrary, the 450 Scenario projects a declining share of coal to 30% in 2035 with a greater share of nuclear and renewables of 7% and 5% in the energy mix.

Sectoral energy demand

Sectoral energy demand reflects the economic structure of a country. In 1990, the building sector was India's largest energy consumer, representing 42% of India's total primary energy demand (TPED), using biomass as the major fuel. The share of buildings dropped to 29% in 2009 and will decrease to about 18% in 2035. The industry sector consumed approximately 22% of TPED in 1990 and will remain similar until 2035.

The power sector has been the primary force behind energy demand growth in India. Its share expanded from 23% to 38% of TPED from 1990 to 2009. This was attributable to soaring demand for electricity for industry uses and residential/commercial activities. With this trend, the share of the power sector will continue growing to almost 42% in 2035 under NPS. The transport sector represented 8% of energy in 1990 and will reach 14% in 2035 under NPS, a small but significant growth, as 90% of transport energy consumption will be based on oil. The sectoral consumption trend will be largely maintained under 450 Scenario (Figure 5).

Figure 5 • Sectoral demand, 2009-35 (Mtoe)



Note: *WEO 2011* provides only one projection for 2015.

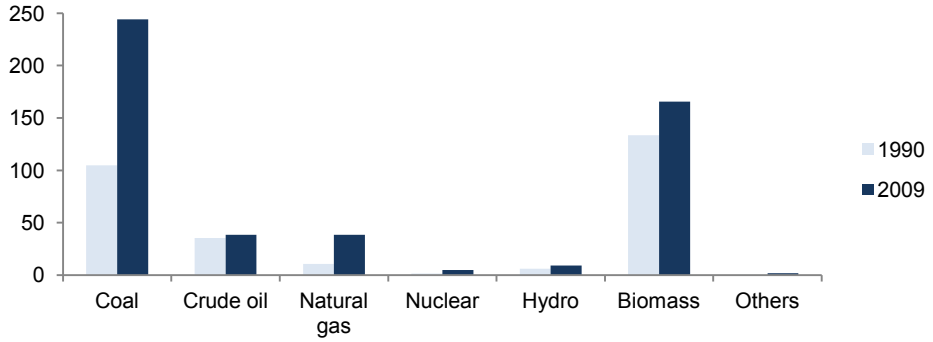
Source: IEA, 2011a.

Energy supply

Domestic energy production in India grew from 291 Mtoe in 1990 to 502 Mtoe in 2009 at a CAGR of 2.9%. Considering India's demand growth at a CAGR of 4% for the same duration, domestic supply could not keep up with the demand. Biomass was the largest production source with 46% share in 1990, but dropped to 33% in 2009. The largest production volume addition came from coal production, which increased from 104 Mtoe in 1990 to 244 Mtoe in 2009 at a CAGR 4.6%. Coal also represented almost half of total domestic energy production. The fastest growing fuel is, however, natural gas, which increased domestic energy production to 38 Mtoe in 2009 from

10 Mtoe in 1990 at a CAGR of 7.0%. On the other hand, crude oil production growth remained at CAGR 0.5% for the same period, whilst crude demand increased by 5.1%.

Figure 6 • Energy production (Mtoe)

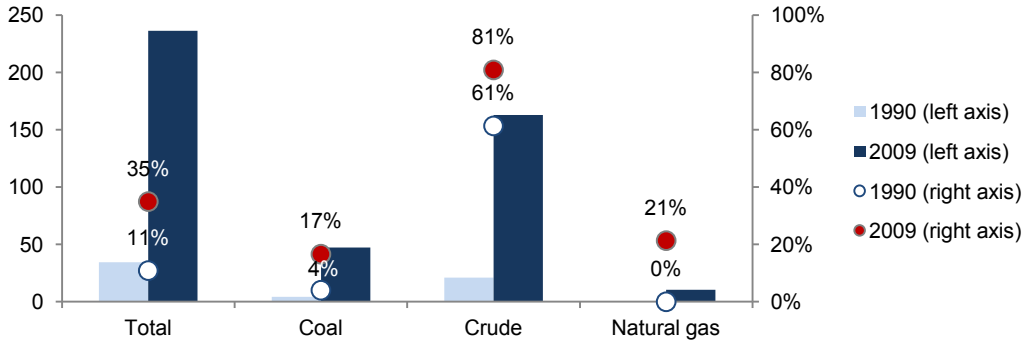


Source: IEA database.

Import dependence

As the growth in energy demand outpaced domestic energy production, India's dependence on imported energy intensified. From 1990 to 2009, as total energy imports increased from 34 Mtoe to 236 Mtoe, India's import dependence increased from 11% to 35%. The largest source of import increase was crude oil, representing 70% of the total increase. India imported only 21 Mtoe of crude oil in 1990, but its dependence on foreign crude oil was already high at 61%. The absolute volume of imported crude reached 162 Mtoe or 81% of India's crude demand in 2009. Natural gas imports were zero in 1990 and increased to 10 Mtoe or 21% of total natural gas demand in 2009 (IEA Statistics). It is noteworthy that India only imports LNG and not piped gas. As such, the availability and affordability of imported energy has become a key factor in determining India's energy demand growth.

Figure 7 • Energy imports and import dependence (Mtoe)



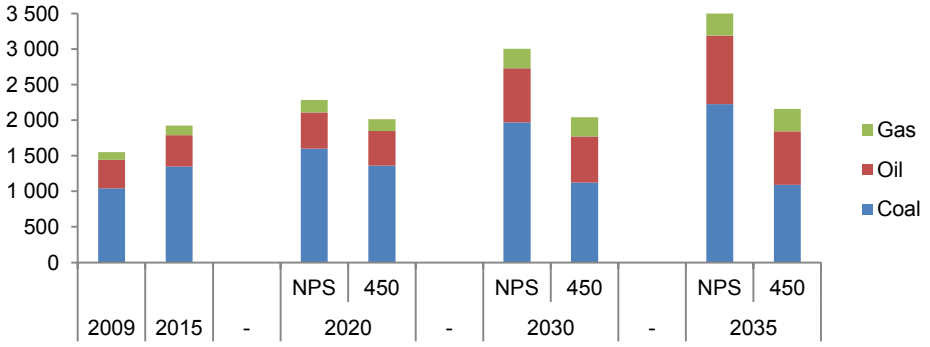
Source: IEA database.

Carbon emissions

India was the third largest CO_2 emitter in the world in 2009, following China and the United States and slightly ahead of Russia. Its carbon emissions of 593 million tonnes carbon dioxide ($MtCO_2$) or 2.8% of global emission in 1990 almost tripled to 1 548 $MtCO_2$ or 5.4% in 2009. This growth rate is much higher than the world's average; India's emissions between 1990 and 2009 grew by a CAGR of 5.2% vis-à-vis 1.7% for the world. This is due to increased coal consumption, which represented 67% of the emissions increase from 1990 to 2009.

Under the NPS, India's carbon emissions increase to 3 535 $MtCO_2$ in 2035 at a CAGR of 3.2%, responsible for 8% of global emission of 43 320 $MtCO_2$. Emissions from coal combustion would be 2 227 $MtCO_2$ or 63% of India's total emissions. Under the 450 Scenario, India's emissions growth would slow to a CAGR of 1.3%, reaching 2 159 $MtCO_2$ in 2035. The share of coal-based emissions would decrease to 51%, decreasing dramatically to 1 093 $MtCO_2$, which is near to the same level as in 2009. Such projections of a massive increase of carbon emissions in India raise concerns about their impact on global climate change.

Figure 8 • Carbon emissions in India, 1990-2035 ($MtCO_2$)



Source: IEA, 2011a.

It is important to mention that India's per-capita carbon emissions of 1.37 tonnes carbon dioxide (tCO_2/capita) were much lower than those of other countries in 2009. The world average was 4.29 (tCO_2/capita), compared to China at 5.14 and the United States at 16.90. The *WEO 2011* NPS assumes that in 2035, when India is projected to be the world's most populous nation with 1.511 billion people[8], India's per-capita carbon emissions could reach 2.34 (tCO_2/capita), which is higher than at present but still substantially lower than the world average of 4.25, with China's per-capita CO_2 emissions at 7.39 and the United States' at 12.03 in 2035. The 450 Scenario projects that they would be 1.43 (tCO_2/capita) for India, 3.59 for China, 5.98 for the United States and 2.52 globally.

Key message • India's economic development and the necessity of continued economic growth should be taken into consideration when assessing the country's future energy demand and carbon emissions:

- **India has substantially low per-capita energy consumption and per-capita carbon emissions in comparison with other countries;**
- **India must expand its energy supply to provide universal access to modern energy and maintain economic growth;**
- **India's growing dependence on foreign energy sources has serious policy implications for its energy security; and**
- **its coal-centred energy mix and rising carbon emissions will create serious challenges for India's sustainable development.**

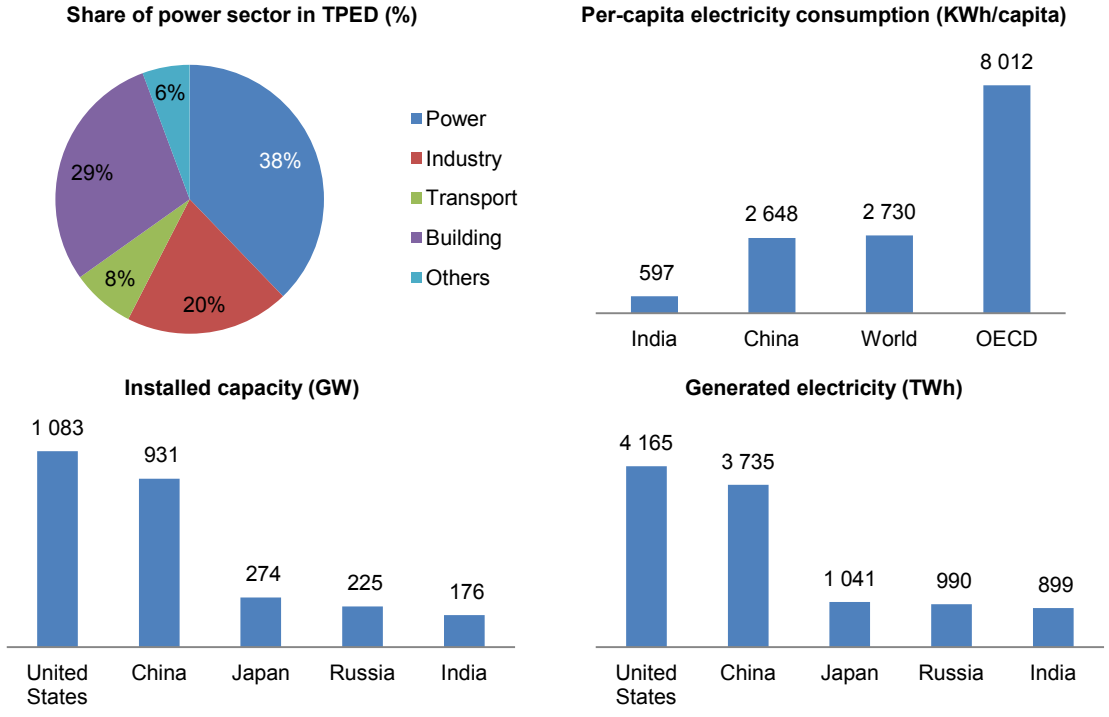
[8] *WEO 2011* estimates that China's population would be 1.387 billion in 2035.

4. Power sector

In India, electricity is still not available to the entire population; nearly 25% or 289 million Indians lack access to electricity. As such, the power sector has been at the centre of India's energy policy. The development of the power sector is closely tied with India's energy policy objectives of universal energy access and energy security. India had already built the world's fifth largest installed capacity for power generation as of 2009 and almost tripled electricity generation from 289 terawatt hour (TWh) to 899 TWh from 1990 to 2009 (IEA, 2011a). Yet its per-capita electricity consumption remains at merely one fifth of the world average and 7% of OECD countries' level, demonstrating the sheer magnitude of challenges faced by the Indian government in developing this important sector (Figure 9).

Furthermore, the power sector is a decisive factor in the evolution of India's energy sector. In 2009, the power sector represented 38% of India's TPED; this share is expected to increase to 47% in 2035 according to the *WEO 2011*. For these reasons, this section begins with the power sector before looking at the other fuel sectors. It reviews the continued efforts of the Indian government over the past two decades to make the power sector more competitive and open. Yet the central and state governments still exercise a significant influence on this sector. Today India's power sector still suffers from the very problems that it has been trying to address – financial non-viability and inadequate investment – and now faces a serious fuel shortage. In addition to a comprehensive overview of the power sector, this paper focuses on the other key energy challenges that India urgently needs to address to continue its economic and social development.

Figure 9 • Snapshot of India's power sector



Sources: IEA database; IEA, 2011a.

Policy framework

India's power sector had been a monolithic system that was tightly regulated and dominated by vertically-integrated state utilities until economic reforms began in 1991. The state electricity

boards (SEBs) controlled the entire electricity supply chain from generation, transmission to distribution within a given state. However, a distorted tariff structure and high transmission and commercial losses resulted in near bankruptcy of the SEBs and insufficient and unreliable electricity supply.

Key policies

In the 1990s, a series of power sector reforms made the sector more open and competitive through deregulation and encouragement of private investment (IEA, 2002a). In 1991, private investment was allowed into power generation and distribution (TGOI, 1991), whilst transmission remained closed to private participation until 1998. The **Mega Power Policy 1995** was introduced to accelerate investment in power generation by giving plants with above 1 000 megawatt (MW) capacity additional incentives. The Power Trading Company was formed to act as an intermediary between the private mega power plants and the SEBs (MOP, 1995).[9] The **Electricity Regulatory Commission Act 1998** constituted the Central Electricity Regulatory Commission (CERC) and encouraged the states to establish their own State Electricity Regulatory Commissions (SERCs) to regulate and rationalise the tariffs. The considerable policy efforts in the power sector during the 1990s, however, had limited achievements. The power sector remained commercially unviable with little private investment until a number of new policies followed in the 2000s.

Electricity Act 2003

This act created a consolidated policy framework for generation, transmission, distribution, trading and consumption of electricity based on market-based mechanisms (Thakur, 2005). The main features of the act are fivefold. First, it encouraged more competition in the sector by unbundling SEBs into generation, transmission and distribution utilities. Second, thermal generation and captive generation were de-licensed. Third, non-discriminatory open access in transmission was granted to all generators to ensure fairness. Fourth, mandatory metering, stringent punishment of electricity theft and multi-year tariffs were introduced to curb financial losses of SEBs. Furthermore, state governments were enabled to provide an advance subsidy to certain target groups through their budgets if the tariff were to be set lower than the regulated tariff. Finally, the act included a purchase obligation of renewable-based electricity (discussed in Chapter 7). The amendment of this Act in 2007 loosened some reformative features including the elimination of the cross-subsidy that levies surcharges on industrial consumers to subsidise other groups, particularly agricultural consumers (MOP, 2003).

The act also mandated the preparation of two key policies. The **National Electricity Policy 2005** provided detailed initiatives and programmes to carry out the mandates of the Electricity Act 2003 (TGOI, 2005). It addressed issues including rural electrification, recovery of cost of services and targeted subsidies and energy conservation. The **National Tariff Policy 2006** aimed to strengthen the financial viability of the sector and to attract investments. It guaranteed a 16% rate of return on investment from 2001 to 2004 and 14% return for 2004 onwards (CERC, 2008). The Multi-Year Tariff (MYT) framework created an important structural incentive aimed at minimising risks for utilities and consumers and reducing the systemic losses. Also, the Tariff Policy required state governments to implement the Availability Based Tariff (ABT), a two-part tariff with a fixed charge and a separate energy charge, by 2006 to promote transparent and efficient performance in the power sector. However, only a number of states actually implemented the ABT (FOR, 2009).

[9] Only the projects supplying electricity to more than one state were eligible to the benefits. However, the revised policy in 2009 removed this mandatory condition of inter-state sale of power to attract more investment (Ministry of Power, Office Memorandum, 14 December 2009).

Ultra Mega Power Projects (UMPP) 2005

Launched in 2005 to accelerate power capacity expansion, UMPPs are coal-based power plant projects with over 4 000 MW capacity using supercritical technology and awarded through competitive tariff-based bidding (MOP, 2007b). They are inter-state power projects using either domestic coal from dedicated captive blocks, or imported coal for coastal projects. The most distinct aspect of UMPPs is that many statutory/administrative clearances are obtained prior to award of the project. A Special Purpose Vehicle (SPV) is created and designated for each UMPP. The SPV is in charge of completing the necessary activities including acquisition of land, obtaining coal blocks, receiving environment, forest and water clearances and arranging the off-take/sale of power contract. The aim is to shorten the project time significantly. Once the competitive bidding process is completed, the CERC approves the award of the UMPP and the tariff. A total of 16 UMPPs were envisaged, of which four were awarded so far and only Mundra unit, inter alia, has been commissioned (PFC, 2012).

The first UMPP by Tata Power in Mundra, Gujarat, was awarded in 2007 (CERC, 2007), leading to the commissioning of the first 800 MW sized supercritical unit in March 2012 (BS, 2012). However, it faced enormous problems due to an unexpected and retroactive price hike of imported coal from Indonesia and its inability to increase the tariff, which was bid based on long-term coal prices agreed in 2006 with Indonesia, under the Power Purchase Agreement (PPA) with distribution companies.

Rural Electrification Policy 2006

This Policy aimed to provide access to electricity to all households by 2009 (later revised to 2012) and reliable power supply at reasonable rates. The Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) was the key scheme launched in 2005. The 11th Five-Year Plan aimed to electrify 115 000 un-electrified villages and 23.4 million BPL households by 2012. A large portion of Indians without access to electricity fall under the BPL. Bihar, Jharkhand, Orissa and Uttar Pradesh, compose 76% of un-electrified villages. Over half of all BPL households reside in Andhra Pradesh, Bihar, Jharkhand, Orissa and West Bengal. As of the end of 2011, almost 91% of targeted villages and 77% of BPL households respectively had been electrified (MOP, 2011b). However, it should be noted that electrification does not guarantee a reliable and daylong supply of electricity due to rampant nation-wide power shortage.

Key players

Power is on the Concurrent list of the Indian Constitution, with central and state governments sharing responsibility. Until the 5th Five-Year Plan (FYP 1974-79) that created electricity utilities (*e.g.* NTPC) under the central government, state governments were solely in charge of power sector development through the SEBs monopolising generation, transmission and distribution, which was intended as per the Electricity (Supply) Act of 1948 to facilitate power sector development (PC, 2006). As an outcome of the Electricity Act 2003 and unbundling of SEBs, a multitude of market players emerged in India's power sector. An appreciation of their roles, functions and interactions as well as their limitations would be a first step towards understanding the characteristics of India's power sector (Figure 10).

Ministry of Power (MOP)

The Ministry of Power (MOP) is responsible for planning, formulation, implementation and monitoring of power sector policy. It oversees and co-ordinates two statutory bodies and six PSUs, which cover thermal and hydro power generation, transmission and distribution and financing (MOP, 2012b). Central Electricity Authority (CEA) has a key role in short- and long-term policy planning and co-ordination for the power sector as an advisory body for the central government. It also monitors the implementation of MOP programmes and specifies technical standards required in power system (IEA, 2011c).

- The **Bureau of Energy Efficiency (BEE)** was established in 2002 as per the Energy Conservation Act of 2001. BEE's primary objective is to promote energy saving measures and improve the country's energy intensity. The BEE's main tasks include demand side management, labelling and standards, and development of energy auditing and energy performance evaluation mechanism.
- The **National Thermal Power Corporation (NTPC)** is the largest thermal power generation company in India, with 28 power plants and 36 GW installed capacity. It was established in 1975 as a central generation utility to supply electricity to multiple states and to supplement the SEB-dominated generation sector. It also has a "Maharatna status", which allows it to make an investment decision up to about USD 1 billion (or INR 50 billion) without explicit government approval (NTPC, 2012).
- The **Rural Electrification Corporation (REC)** was created to provide financial assistance and loans to state governments for rural electrification projects. REC as a nodal agency received an approved budget of total INR 280 billion (or USD 5.5 billion) for capital subsidy for the 11th Five-Year Plan.
- The **Power Grid Corporation of India (POWERGRID)** is mandated to establish the national electricity transmission network, or "National Grid", to operate the regional power grids and improve reliability, stability and security of the transmission sector. POWERGRID has several joint ventures (JV) for transmission in different regions. In 2010, **Power System Operation Corporation Limited (POSOCO)**, as a wholly owned subsidiary of POWERGRID, was formed to operate National and Regional Load Dispatch Centres to achieve the maximum economy and efficiency in the operation of the National Grid (POSOCO, 2012).
- **Other PSUs,** such as the **North Eastern Electric Power Corporation (NEEPCO)** was established to develop the power sector in India's north-east region. Despite the region's high endowment of hydro and natural gas, its power sector still remains underdeveloped. The NEEPCO has installed capacity of 1 130 MW, representing 55% of installed capacity in the north-east region (NEEPCO, 2012). The **National Hydroelectric Power Corporation (NHPC)** is responsible for developing large hydro, tidal, geothermal and wind based electricity (NHPC, 2012). It operates 14 hydro plants with a total capacity of 5 295 MW (NHPC, 2011). The mission of **Power Finance Corporation (PFC)** is to act as the primary financial development institution dedicated to the growth and development of the power sector by selecting and providing financial assistance to power projects (PFC, 2012).

State governments

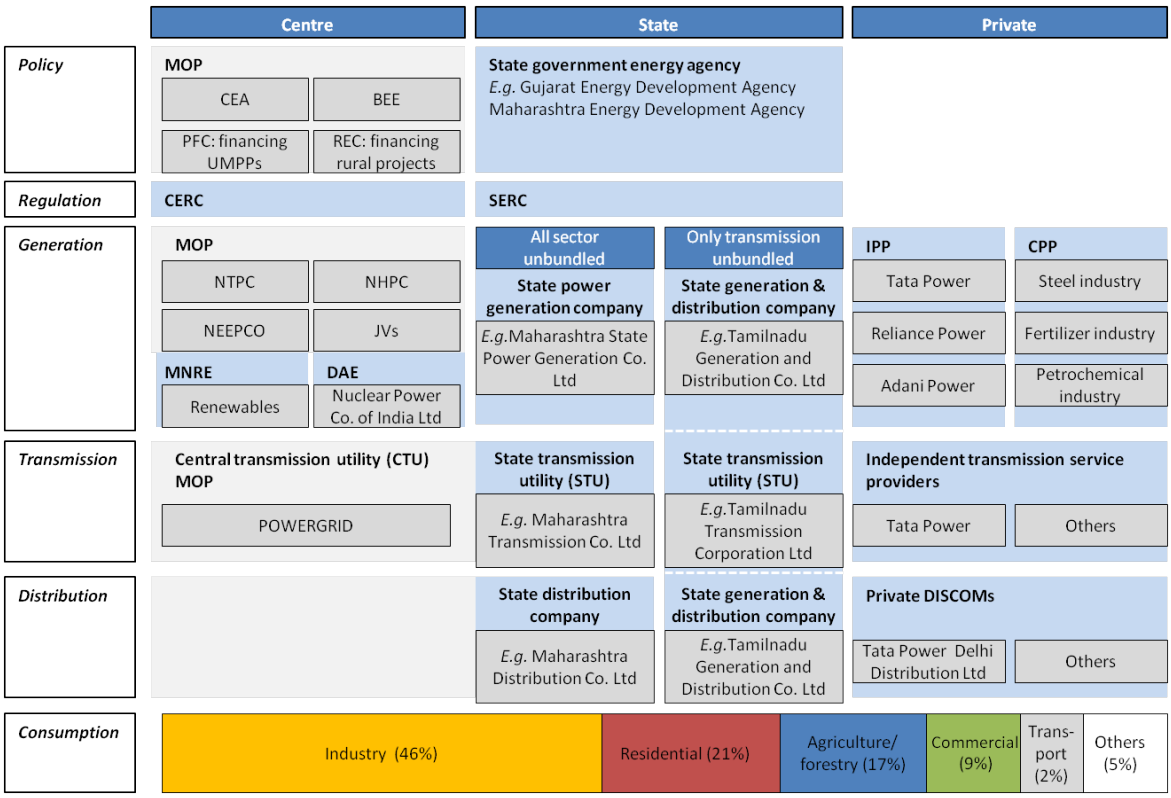
Under the constitution, state governments play a critical role in the power sector. However, mounting financial losses of SEBs have demonstrated the limitations of the SEB-oriented strategy for power sector development, which led to the unbundling of SEBs in 2003. Each SEB was to be broken into a number of enterprises at each segment under the holding company. However, numerous SEBs have not yet been unbundled and the degree of sector liberalisation varies by state: some states unbundled each segment and others separated only the transmission part (Figure 10). In 2012, the share of installed capacity owned by state governments was nearly 43% (CEA, 2012a) and state utilities practically dominate the transmission and distribution segments.

Regulatory commissions

Under the Electricity Regulatory Act of 1998, the Central Electricity Regulatory Commission (CERC) was created as an autonomous statutory body. The CERC regulates tariffs of generating companies owned or controlled by the central government, as well as independent power producers (IPPs) that supply more than one state and inter-state transmission tariffs, while also advising the central government in the formulation of tariff policy. It also has the power to issue

licenses for inter-state transmission companies and electricity traders, and the authority to settle disputes involving generation or transmission licensees. The act also introduced a provision that state governments can create their own State Electricity Regulatory Commissions (SERCs). The SERC determines the tariff for electricity (wholesale, bulk and retail) and the tariff for intra-state transmission facilities within its respective state. For better policy co-ordination, the chairpersons of CERC and the SERCs have met since 2005 at the annual Forum of Regulators (FOR), which is a key platform to assess the implementation of government initiatives at the state level and to make policy recommendations to the MOP (FOR, 2009).

Figure 10 • Key players in the power sector



Sources: MOP, 2012b; IEA database; MSEB, 2012; TNEB, 2012.

Independent power producers (IPPs)

The Electricity Act of 2003 allows IPPs to sell generated electricity to consumers via open access to the grid. As of 2012, IPPs own a total capacity of approximately 27 GW or 15% of total capacity, excluding renewables (CEA, 2012b). IPPs usually sell their electricity based on long-term contracts with distribution companies. The government is currently considering the creation of merchant power producers that generate and sell electricity on an ad hoc basis to fill the supply-demand gap in the market at a specific time (MOP, 2007a).

Captive power plants (CPPs)

Captive power plants are owned by industry to generate electricity mainly for self-consumption. The Electricity Act allows CPPs the right to open access to transmission lines to transfer self-generated electricity to destinations for their own use and to sell surplus electricity to the grid at an agreed tariff. Some energy-intensive industries, including fertilizer, petrochemical and the steel/iron industry, established CPPs to ensure a stable supply of electricity. Counting only units with over 1 MW capacity, total capacity of captive power was 31 GW in FY 2010/11 (MOP, 2012).

State transmission utility (STU) and distribution companies (DISCOMs)

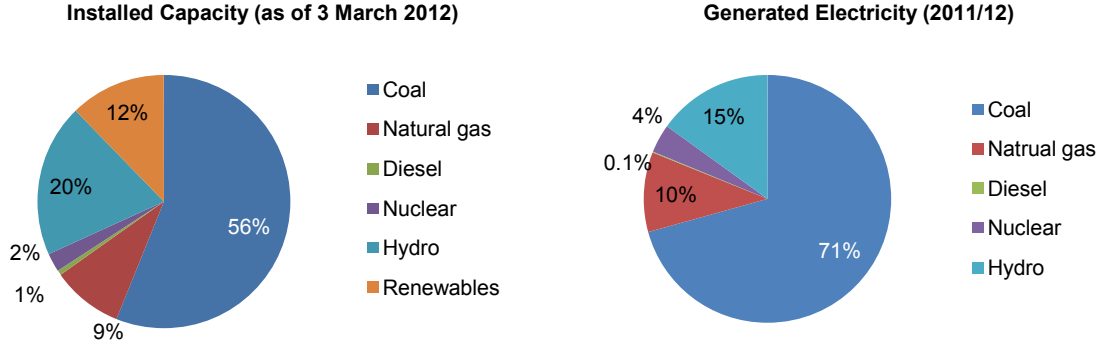
Although the transmission and distribution segments were opened to the private sector, they are still mostly run by state companies. STUs are in charge of intra-state transmission and not allowed to participate in power trading under the Electricity Act of 2003. Although STUs should provide open access to all generators including IPPs, they remain reluctant to do so out of fear of losing customers to private generators (IEA, 2007). Distribution companies, or DISCOMS, in most states face escalating financial losses due to a rigid tariff system and high transmission and commercial losses, which is why this segment is less attractive to private investors. State DISCOMs receive subsidies and bailouts from both state and central government to survive, which leads to increasing necessity for further power sector reform. Tata Power Delhi Distribution Limited is one of few examples for private participation in this segment.

Supply

Installed capacity and generation

In 2012, total installed capacity in India was 199 GW and the generated electricity (excluding renewable) was 876 TWh in FY 2011/12 (CEA, 2012h). Coal represents 112 GW or 56% of total installed capacity and 71% of total generated electricity. Hydro is the second largest source, accounting for 20% of installed capacity and generating 15% of electricity (Figure 11).

Figure 11 • India's power generation by fuel

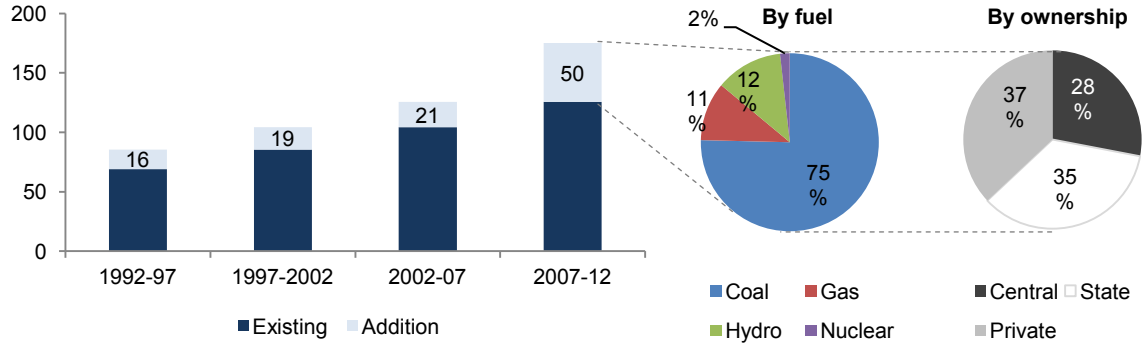


Note: renewable-based electricity is not included in the MOP data for generated electricity.
Sources: CEA, 2012a; CEA, 2012h.

The targeted capacity addition for the 11th Five-Year Plan under the responsibility of the MOP was initially 78.7 GW but was revised down to 62.3 GW due to the slow implementation during the mid-term appraisal.[10] The actual capacity addition during the 11th Plan was about 50 GW, which was still the largest addition ever during all five-year plan periods. Almost 86% of added capacity is thermal based, which highlights the importance of securing coal and gas supply for the new plants. The contribution of the private sector to the capacity addition, nearly 37%, is also noteworthy (Figure 12). Despite this record capacity addition, India still had a shortage of 9.8% of electricity supply during peak time in 2010 and 2011, as only 110 GW of demand was met out of a peak demand of 122 GW. This supply-demand gap is anticipated to grow even larger, reaching 12.9% or 17.5 GW shortage in FY 2011/12 (CEA, 2012c).

[10] Please note that this target for power sector does not include renewable-based generation capacity as renewables are under the Ministry of New and Renewable Energy.

Figure 12 • Installed capacity addition by fuel, 1992-2012 (GW)

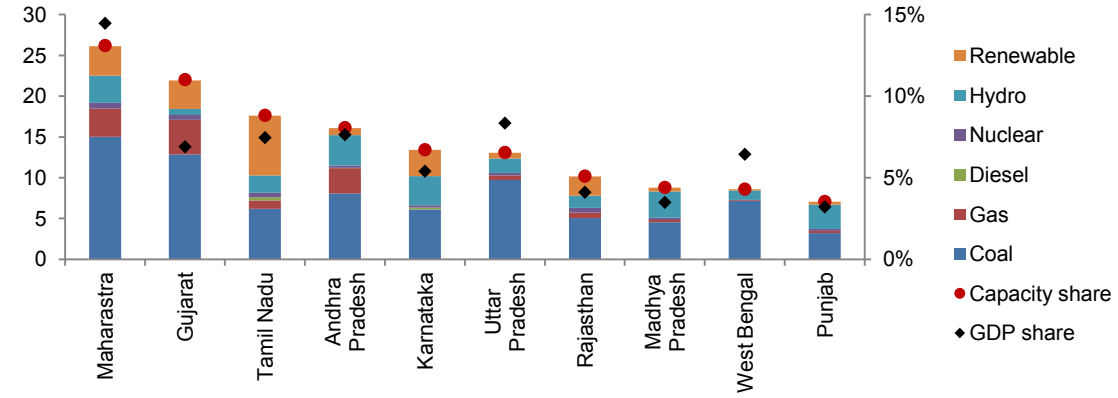


Note: renewable-based capacity is not included here and discussed in the following chapter.
Sources: CEA, 2012a; MOP, 2007a.

Regional distribution of capacity

There is a high degree of regional concentration of power generation capacity in India. Most of the installed capacity is located in the western region, representing 32% of total capacity, 35% of coal and 45% of gas-based capacity. Maharashtra, which is the largest economic state in terms of GDP and represents 9% of the Indian population, has 26 GW or 13% of national capacity. It is followed by Gujarat, also a western state, which represents 22 GW or 11% of India's total installed capacity. The top ten states account for 72% of total installed capacity (Figure 13). In contrast, the north-east region, consisting of seven small states with 3.8% of India's population (MHA, 2011), has a combined 2.4 GW or 1.2% of India's total capacity. As previously mentioned, NEEPCO was established to develop power generation capacity in this region, but it experienced a peak shortage of 18.5% in FY 2010/11, the highest among regions (CEA, 2012c). Figure 13 underlines the close link between electricity capacity and a state's economic performance.

Figure 13 • Top ten states by installed capacity, 2012 (GW)



Sources: CEA, 2012a; PIB, 2010a.

Each state has its own unique energy mix, mostly derived from its own resource endowment, existing infrastructure and policy initiatives. For instance, Gujarat has a relatively large gas-based installed capacity, accounting for nearly a quarter of India's total gas capacity. It is attributable to Gujarat's proximity to significant gas fields and LNG terminals in Hazira and Dahej, which are India's only two operating terminals. 84% of West Bengal and 74% of Uttar Pradesh's installed capacity are coal-based, reflecting their large coal reserves, whilst 42% of Punjab's installed capacity is hydro-based with its abundant water resources. Tamil Nadu has a high share of

renewable-based installed capacity of almost 42% due to the state government's strong initiatives on promoting renewable energy.

The regional concentration of generation capacity results in a greater gap between power supply and demand, while different fuel mixes cause varying peak seasons. For instance, the anticipated peak demand season in FY 2011/12 for the northern region is summer (July and August) and for the western region is October, while the national peak occurs in March. Hydro rich states in the northern region, including Himachal Pradesh, and Jammu and Kashmir, have a surplus of electricity during monsoon season, but face shortages during winter when precipitation is low (CEA, 2012c). The regional concentration of power capacity in a few states risks perpetuating the uneven economic development across the country and to mitigate this imbalance, a well-integrated national grid is essential.

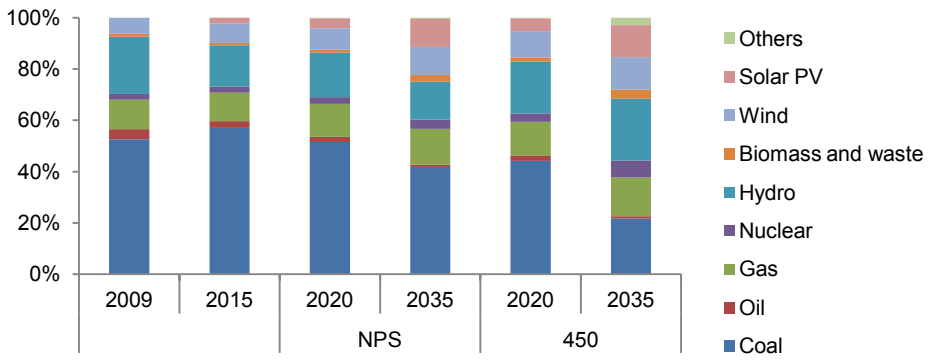
Capacity targets and projections

MOP's 12th Five-Year Plan (FYP 2012-17) targets power capacity addition totalling 76 GW. The breakdown of the target by fuel is: 62.7 GW or 83% of new capacity would be coal-based, of which 40 GW, or 56% comes from the private sector (Figure 14). Due to a decline in domestic gas production, approximately 1 GW of gas capacity would be added, although the MOP states that about 13 GW of gas capacity are under construction and could be operational during the 12th Five-Year Plan. Notably, no private investment in gas capacity is planned (MOP, 2012). Renewable and nuclear capacity additions will be discussed separately in following chapters.

Under the *WEO 2011* NPS, total power capacity would reach 779 GW in 2035, compared to 763 GW under the 450 Scenario. Both scenarios contain two major findings. First, India needs to expand its installed capacity significantly over the coming two decades. To reach 779 GW in 2035, capacity must grow at a CAGR of 5.9 % or over 20 GW per year from 2009 through 2035. Considering the largest addition per year so far was about 18 GW in FY 2011/12, this scale of expansion would pose a considerable challenge to the Indian government.

Furthermore, the fuel mix for power generation would remain almost unchanged, despite an absolute growth of capacity in every fuel. Coal would remain the dominant fuel with its share of 52% in 2009 falling to 42% of total capacity under the NPS. Only with considerable augmentation of renewables under the 450 Scenario would the coal share decrease to 22% in 2035. The current share of 11% of gas-based power generation would reach 14% to 15% share in 2035 under both scenarios. Nuclear had only a 2% share in 2009, and would reach a 4% share under the NPS or 7% under the 450 Scenario in 2035. Renewable-based power capacity, excluding hydro and biomass, was only 6% in 2009 but would reach 23% under the NPS and 29% under the 450 Scenario in 2035 (Figure 14).

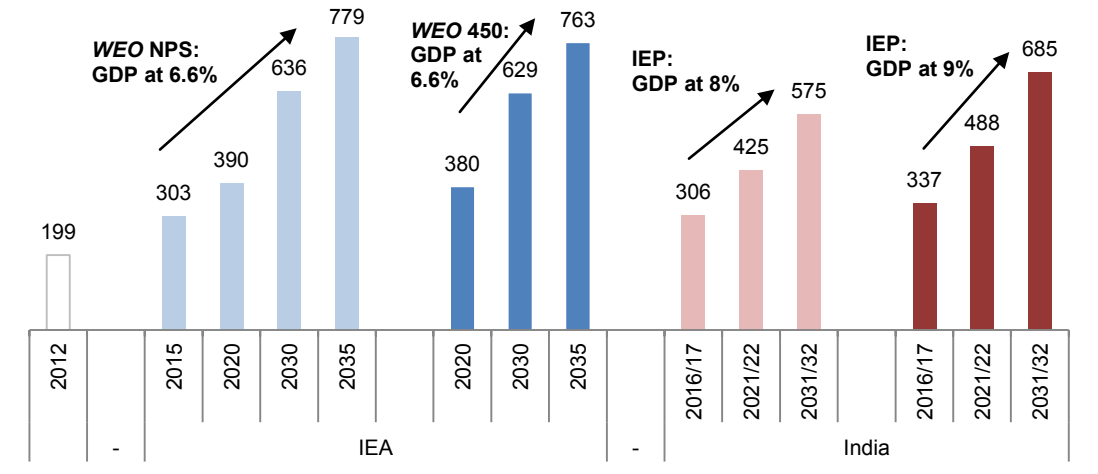
Figure 14 • Projections for installed generation capacity: New Policy Scenario versus 450 Scenario



Source: IEA, 2011a.

Box 2 • Projections for required power generation capacity: *WEO 2011* versus IEP (GW)

The *WEO 2011* projects that India's power generation capacity would reach 779 GW under the NPS and 763 GW under the 450 Scenario. This is based on GDP growth assumption at a CAGR of 6.6% from 2009 to 2035. India's IEP presents different prospects: at an annual average GDP growth at 8% and 9%, India's power generation capacity would reach 575 GW in 2031 and 685 GW in 2032. Despite a lower GDP rate, India's electricity demand would grow substantially under IEA projections, encapsulating the sheer scale of necessary power sector growth in India.



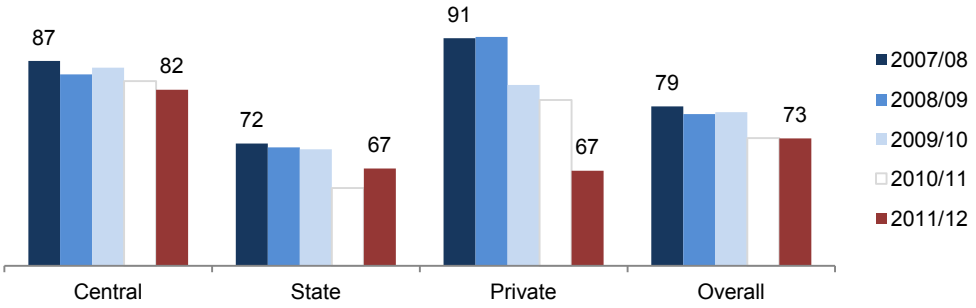
Sources: IEA, 2011a; PC,2006.

Operational efficiency

India's overall electricity generation efficiency remains relatively low compared to other countries. 20% of operational thermal power units are more than 25 years old and another 40% are more than 15 years, but less than 25 years old (CEA, 2009). Nearly all of India's coal-fired power plants are subcritical, with average efficiency of about 34%, compared to 37% for subcritical plants in China and 39% for subcritical plants in the United States (IEA, 2011a). India put its first supercritical 660 MW power plant by NTPC into operation in 2011. The 12th Five-Year Plan foresees about 40% of new coal power plants using supercritical technology (Mathur, 2011). Also it is mandatory for UMPPs to adopt supercritical technology to improve fuel efficiency. However, a majority of new capacity would remain a subcritical grade.

Another aspect of India's low operational efficiency is the plant load factor (PLF), which refers to the utilisation rate of operational plants. The nation-wide thermal PLF slowly improved to approximately 78% in 2007 and 2008, from below 70% in the 1990s. However, it decreased in recent years to around 73% in FY 2010/11 and FY 2011/12 (MOP, 2011a; CEA, 2012b). Interestingly, the PLF of state-generating companies is much lower at 68% compared to 82% for publically-owned central government-generating companies. Another finding is that the PLF of private power plants is also deteriorating, from over 90% in FY 2007/08 and FY 2008/09 to 67% in FY 2011/12. The low PLF is partly caused by unexpected and unscheduled maintenance of ageing plants, and the delayed operational stabilisation of new plants. However, the main cause is the shortage of coal and gas supply and the poor quality of coal supplied (IEA, 2011a). Private power plants, especially those that are gas fired, represent 37% of total gas capacity and have been hit hard by fuel shortages, since private plants receive lower priority vis-à-vis the central and state utilities in government gas allocation. The PLF of private gas plants in FY 2011/12 was 58%, which is lower than central gas plants of 63% and private thermal plants of 69% (CEA, 2012a). The low PLF undermines the financial performance of generating companies and reduces the volume of generated electricity.

Figure 15 • Plant load factors, FYP 2007-12 (%)



Sources: MOP, 2011a; CEA, 2012b.

Transmission

India's transmission network has a two-tier structure: intra-state and local grids are managed by State Transmission Utilities (STUs), while inter-state grids belong to POWERGRID. India still needs to establish a national grid through integration of its existing regional grids, which have a varied level of installed capacity and fuel mix, as mentioned earlier. A well-integrated national transmission network is a key to ensuring even development among regions and optimum utilisation of generation resources, and to managing varying peak demand across regions (CEA, 2012e).

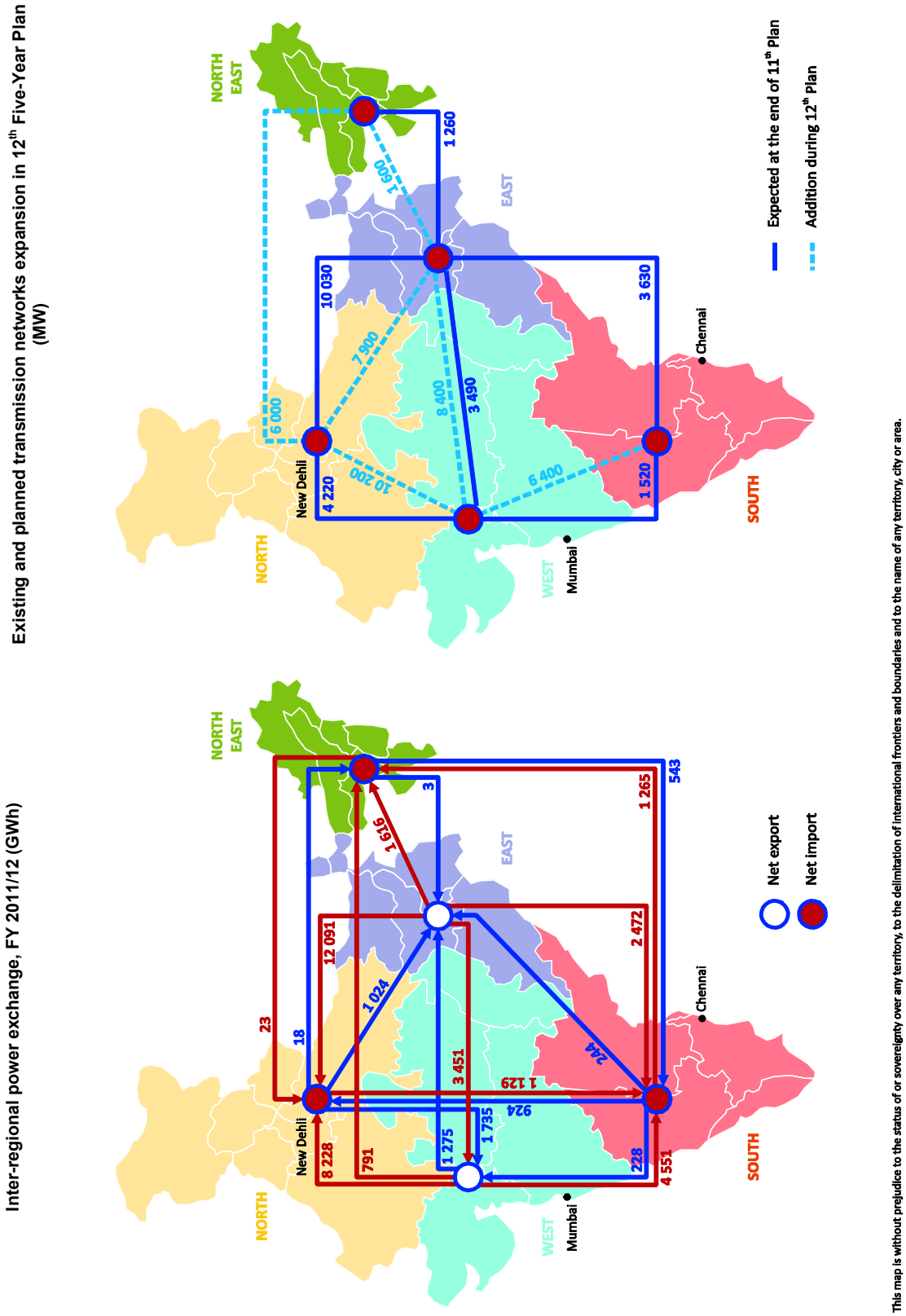
Regional power grid

India's power transmission system is divided into five regional grids: northern, north-eastern, eastern, southern and western regions. Since August 2006, four regional grids have been fully integrated (IEA, 2011c) with the exception of the southern grid that is to be synchronised with these grids by 2014 (CEA, 2012e). The proposed inter-regional transmission capacity expansion focuses on increasing connectivity between deficit regions (northern and southern) and surplus regions (western and eastern) (Figure 16).

POWERGRID, as a Central Transmission Utility (CTU), has a mandate of "establishment and operation of regional and national power grids to facilitate transfer of power within and across the regions with reliability, security and economy, on sound commercial principles". It was targeted to reach an inter-regional transmission capacity of 32.6 GW by the end of the 11th Five-Year Plan. However, the expected capacity by the end of the 11th Plan would be 25.6 GW. The target set in the 12th Plan is to add 39.9 GW capacity, reaching a total inter-regional capacity 65.5 GW at the end of the 12th Plan (CEA, 2012e) (Figure 16).

The transmission sector requires a greater public sector role. Private companies have two routes to invest in transmission, either as an Independent Private Transmission Company with 100% equity ownership or through a joint venture (JV) with CTU/STU with a maximum of 74% private equity (MOP, 2012b). Transmission projects are awarded through competitive tariff-based bidding under the supervision of the CERC. However, actual private investment remains low, due to high upfront capital investment needed to construct transmission lines and low margins under the competitive bidding process, as well as a cumbersome administrative process to acquire land. The only public-private partnership (PPP) project, based on a 51:49 JV between POWERGRID and Tata Power, is a 1 200 km transmission project that has been operational since 2007 (PC, 2010; Tata, 2012). To attract more private investment, the Indian government introduced a viability gap funding scheme that provides grants to PPP transmission projects from both central and state government (FE, 2012c).

Figure 16 • National grid in India



Note: GWh = gigawatt-hour.

Sources: IEA work based on CEA, 2012d and CEA, 2012e.

Distribution

The distribution sector in India is still largely controlled by state companies and its reform is crucial for the commercial viability of the power sector. The central government bailed out the SEBs in FY 2001/02, when some SEBs defaulted on payments to NTPC and NHPC. In 2011, state DISCOMs sought another bailout from the central government (FE, 2011b).

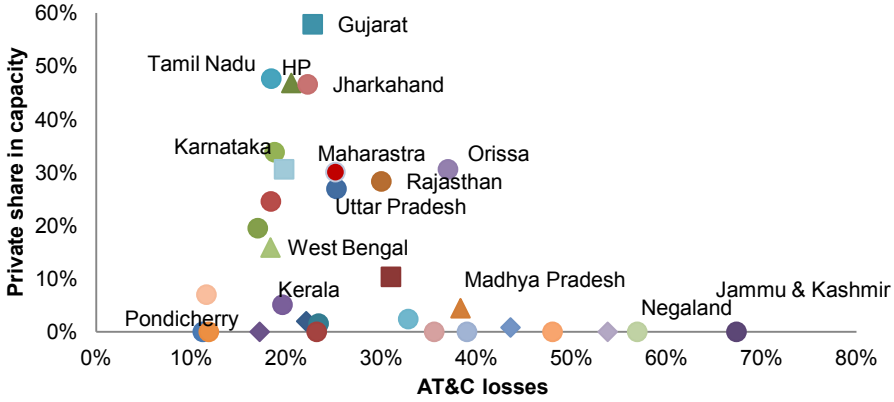
Aggregated transmission and commercial (AT&C) losses

The financial predicament of state DISCOMs is mainly due to AT&C losses. The AT&C includes not only the technical losses incurred during transmission, but also revenue losses at the distribution/ retail end due to various causes. There are mainly four types of financial losses (PC, 2006):

- theft occurred by illegal tapping of transmission lines or tampering/damaging of meters;
- non/under-billing in which distribution companies fail to bill the consumers the proper amount;
- non-payment in which consumers who are billed fail to make a payment; and
- misclassification of consumers in which consumers are mistakenly categorised as subsidised users, namely agricultural consumers, and wrongly receive benefits.

The nation-wide AT&C were 31% in FY 2010/11 (PC, 2011b). Losses are very high compared to the most efficient countries including South Korea (4%) and Japan (5%), and other emerging economies such as Brazil (17%), China (5%) and Indonesia (10%) in 2009 (WDI, 2012). The total AT&C loss is estimated to be equivalent to 1.5% of India's GDP (CEA, 2010) or approximately USD 17 billion in terms of 2010 GDP. AT&C losses have a close linkage to private investment; states with high losses have low private share in power capacity (Figure 17). Investors view high AT&C losses not only as a risk undermining commercial viability, but also as showing weak institutional credibility and high regulatory risk.

Figure 17 • AT&C losses & private investment in states



Source: IEA work based on CEA, 2012a and PIB, 2011.

The Accelerated Power Development & Reform Programme (APDRP) was launched in 2001 to strengthen the sub-transmission and distribution network and to reduce the AT&C losses to 15% in five years. Without achieving this target, the ARDRP was restructured by the MOP (called R-APDRP) and re-launched in 2008 as one of the main policy initiatives of the 11th Plan. Focusing on building baseline data and adopting IT applications, it aims to reduce AT&C losses by 3% per year for utilities having over 30% AT&C losses and by 1.5% per year for those who having less than 30% (MOP, 2012b). Many state governments adopted new regulations and technologies to improve tariff billing and collection practices. Smart grids have recently received increasing attention from policy makers and private investors.

Box 3 • Smart grids in India

The Indian government is increasingly interested in adopting innovative technology including smart grids to enhance grid integration. The India Smart Grid Forum was launched by the minister of power in 2010 and subsequently the Indian Smart Grid Task Force was set up to create a roadmap for development of smart grids in India. India looks at smart grids with a view to the benefits for the distribution level, as one of the components of smart grids is smart metering/advance metering infrastructure. (PIB, 2010b) Smart grids could help contain the huge commercial losses from which Indian state power distribution companies suffer. But India's goal goes beyond the distribution level. An innovative and interactive power system will result in the moderation of peak load, hence the reduction of required power generation capacity, and better integration of renewable-based electricity to the grid. India is one of the founding members of the IEA International Smart Grid Action Network Implementing Agreement since 2011.

Trading and pricing

There are three main pricing mechanisms in India's power market. First, state generation utilities sell electricity to DISCOMs based on long-term contracts at the prices decided by SERCs or PPAs, in the case of UMPPs. Pricing is generally based on a cost-plus principle. A cross-subsidy structure is applied here in which surcharges are levied on industrial consumers to subsidise other consumers, particularly in agriculture. Second, short-term bilateral contracts are mainly used by traders for inter-state or inter-regional power purchase through open access. These two mechanisms cover most of the electricity sold in India, as 91.1% was sold through long-term contracts and 8.8% through short-term contracts in 2009 (Kumar, 2011). A spot market has emerged since the opening of two power exchanges (India Energy Exchange and Power Exchange India) in 2008.

In the case of the end-user tariff, the CERC and SERCs set the tariff in reflection of the fuel price. However, in practice, due to political sensitivity, regulators are overly cautious about increasing the tariff too frequently or too steeply, even if an increase is needed because of a hike in the cost of fuel. As a result, power tariffs are overall below the generation cost, which exacerbates the financial condition of the power sector (MOP, 2012a). At the same time, under the cross-subsidy structure, industrial uses are already heavily burdened with high electricity tariffs to subsidise agricultural and other consumers. So any further price increases for industry could trigger a switch to captive production, leaving already insolvent DISCOMs with even more subsidised users (Joseph, 2010).

Sectoral consumption

As previously shown, India's per-capita electricity consumption is much lower than in OECD member countries. As of 2009, only 21% of electricity was consumed by the country's industry sector and 10% by the building sector. Among OECD countries, the shares were 30% for the industry sector and 42% for the building sector. The *WEO 2011* NPS projects that electricity use in these sectors will become more commonplace, reaching 31% in the industry sector and 28% in the building sector by 2035.

The largest consumer of electricity in India was the industry sector, representing 50% of total electricity consumption in 2009 (IEA database), followed by the residential sector with a share of 19% and the commercial sector with 7%. According to the *ETP 2010* Baseline Scenario, industry would remain the largest power consumer at 49% share, while the residential sector would increase by 25% and the commercial sector by 14% in 2030 (IEA, 2010d).

In the long term, India's total electricity consumption would increase significantly. *WEO 2011* projects that India's electricity generation would reach 3 264 TWh in 2035 under the NPS. The IEP, India's own projection, suggests an even higher consumption increase, reaching 3 880 TWh and 4 806 TWh in FY 2031/32. This implies that India's electricity consumption in FY 2031/32 would reach a level close to the 2009 electricity consumption of China (3 735 TWh) and the United States (4 165 TWh). The reason for the substantial gap between IEA and IEP projections is mainly because of a different GDP growth rate. In light of the rapid increase of power consumption in India, greater policy attention has been given to demand-side management, which is a shift from the earlier mainly supply-oriented energy policy in India.

Box 4 • Energy efficiency in India

Energy efficiency has emerged as one of the key policy priorities in India's energy sector since the enactment of Energy Conservation Act 2001. Subsequently, the Bureau of Energy Efficiency (BEE) was established in 2002 under the MOP with the mission to assist in developing policies and strategies to primarily reduce the energy intensity of the Indian economy. The State Designated Agencies (SDA)s are statutory bodies set up by states to implement energy conservation measures at the state level; one of the BEE's tasks is to strengthen the institutional capacity of SDAs. Since its inception, the BEE has made considerable achievements in institutionalising energy conservation measures such as standards and labelling programmes and issuance of an energy efficient building code.

One concept introduced in India is a "negawatt," referring to a negative Megawatt as a result of reducing energy needs. The IEP pointed out that "a unit of energy saved by a user is greater than a unit produced as it saves on production, transport, transmission and distribution losses." On this basis, the IEP suggests that Energy Service Companies as a negawatt producer may be given the same incentives as other renewable companies. The IEA *ETP 2010* analysis also confirms the huge potential of India's energy saving. A combined 42% of emission reduction in India during 2010-50 would come from energy efficiency improvements in power generation and end-use fuel and electricity consumption.

The NMEEE commenced in 2010 under the MOP and BEE. It is likely to achieve about 23 Mtoe of fuel savings in coal, gas and petroleum products by FY 2014/15 as well as over 19 GW of avoided capacity addition. The centrepiece of NMEEE is the Perform, Achieve and Trade (PAT) scheme, which aims to improve energy efficiency in energy intensive industry through market-based, cost-effective mechanisms. It was included in the amendment to the 2001 Act in 2010 along with the introduction of energy saving certificates. Under the PAT scheme, eight energy-intensive industries, including power, iron& steel, cement, fertilizer and aluminium, will have mandatory participation in the first phase, with an expected reduction of expecting 5.4% of energy consumption by energy intensive industries in three years (BEE, 2012).

One of the major challenges for energy efficiency improvements in India is the wide difference in energy efficiency levels among different industries and among companies even in the same industry (IEA, 2011d). On the one hand, India has world-class, large-scale companies with modern, highly efficient facilities. On the other hand, there are small and medium size companies that use outdated and very inefficient processes. Different approaches and technologies need to be applied in consideration to the varying conditions of industry and companies.

The challenges to India's power sector are evident. It needs massive investment to substantially expand its generation capacity and eventually, to make the sector efficient and commercially viable. The following section discusses the key issues that need to be addressed by the Indian government with great urgency to ensure that development of the power sector is in line with its expectation for national economic growth.

Issues

Insufficient fuel supply

A shortage of coal and natural gas supplies for power generation is a pressing issue in India's power sector. There are two main causes for insufficient coal supply: flattening domestic production derived from delayed mining development as a result of impediments such as slow land acquisition and strict environmental clearance; and, the restrained import of coal to account for the shortage of domestic coal due to inadequate import infrastructure and price disparity. The blending of imported coal also has technical limitations due to the mixing of different qualities. For gas, domestic production is also declining. The high expectation of production prospects from India's Krishna Godavari basin has waned since 2010 after production peaked, but then declined nearly by half (ET, 2012b). The importing of gas is also difficult because of pricing and infrastructure issues. Each of these subjects will be discussed further in the following chapters.

The direct impact of the shortage of coal and gas is manifested in the power plants sitting idle or operating at lower than optimal levels. Such shortages undermine investors' confidence in India's power sector, as the profitability of investments is being questioned. To resolve the shortage problem, the Indian government has applied a mandatory allocation of domestic coal and gas to the power sector through the New Coal Distribution Policy and Gas Utilisation Policy. However, this serves only as a temporary solution without substantial expansion of domestic and import supply.

Pricing

The major issue on pricing is its inability to send a proper signal to suppliers and consumers to effect intended behavioural changes. For instance, the cost-plus principle does not incentivise generators to improve and invest in energy efficiency. Furthermore, current stiff pricing mechanism limits the choice of policy instruments for demand-side management. Untargeted subsidy mechanisms, under which power tariffs are kept artificially low, does not necessarily reach the most needed, while it fails to send proper pricing signals to those who can adjust consumption to price changes. Similarly, it undermines the cost-recovery prospect of investment. The recent issue with the PPA of the Mundra UMPP is a case in point. Changed regulation by the Indonesian government for its coal export tariff resulted in an unexpected increase of imported coal costs. The generation cost assumed in the bidding in 2006 will now nearly triple, but under the PPA, escalated fuel costs are not allowed to be passed through to the end-user price. The question is how much flexibility should be allowed in the pricing system to assure investment profitability. In sum, the pricing mechanism needs to be rationalised to reflect the changing costs of electricity and to provide sufficient incentives to investors to enter India's power business.

Infrastructure

Infrastructure here broadly refers to not only physical facilities of transmission and distribution networks, but also necessary equipment and services for power companies. Assurances of reliable capacity expansions of infrastructure at every stage in the power industry value chain is crucial to avoid bottlenecks in supply. As mentioned earlier, India's fuel supply infrastructure, ranging from import facilities to transportation, remains constrained.

Domestic companies that manufacture generation equipment are facing huge constraints. Recently, Chinese equipment supplies have taken a larger share of the Indian market at the expense of Bharat Heavy Electricals Ltd (BHEL) and other Indian companies. BHEL, the leading public enterprise for power plant equipment, had a 62% of share in India's installed power generation capacity in 2011 (BHEL, 2012). However, orders placed for Chinese equipment reached 36.8 GW

in first couple of years in the 11th Five-Year Plan, compared to the 62 GW capacity addition target for the entire 11th Plan (PC, 2010). The underlying reasons for Chinese companies' successful penetration into the Indian market is not only their lower prices, but also their better on-time delivery records and cheaper financing bundled with equipment (Forbes, 2011). Chinese goods have become increasingly attractive to UMPP operators seeking opportunities for cost reduction. In response, the Indian government is currently considering a ban on UMPP use of imported equipment (ET, 2012a), which would increase generation cost, and contradict UMPP's competitive tariff bidding process to lower costs. More importantly, it is uncertain whether domestic suppliers have adequate capacity to meet the increased demand for power plant equipment, which might create another potential bottleneck in power capacity expansion in India.

Investment

Private investment in India's power sector is on the rise. Installed capacity owned by the private sector in 2012 was nearly 54 GW or 27% of India's total capacity (including renewables), which is a significant increase from the 12% share, or about 17 GW, at the end of the 10th Five-Year Plan. Nearly 43% of privately owned capacity is coal-based, with renewables and gas-based capacity representing 38% and 12% respectively. The nominal thermal capacity addition by the private sector is approximately 21.7 GW during the 11th Five-Year Plan, which is above the target of 17.3 GW. This is rather impressive considering the central government achieved only 68% of their capacity addition targets, while the states achieved only 61%.

Private investment in the power sector remains below expectation and should be increased. The *WEO 2011* projects that India would need investment of USD 999 billion for power plants and another USD 632 billion for transmission and distribution infrastructure from 2011 to 2035, implying that an investment of nearly USD 67 billion will be required each year. Investment for coal-fired power plants needs USD 347 billion throughout 2011 to 2035, representing nearly 35% of total investment. Considering INR 4 796 billion (≈USD 90 billion) was likely spent on capacity addition throughout the entire 11th Five-Year Plan, this figure is not easily affordable. The 12th Five-Year Plan stipulates that private investment would take up about 50% of required funding for capacity addition out of total required funding of INR 3 542 billion (≈USD 70 billion) (MOP, 2012a).

Concern remains about the regional concentration of private investment in a few states. Currently, 42% of all private power plants are located in the western region. Gujarat has 23% of India's private power plants, making the private share almost 58% of its capacity. Eastern and north-eastern regions, where power capacity additions are needed, have a share of 8% (eastern) and 0.04% (north-eastern) in terms of private ownership (CEA, 2012a). Proper incentives should be offered to private investors in these regions for a more balanced addition of power capacity in India.

To encourage private investment, the investment risks that were discussed earlier should be resolved. The experience of Adani Power, a newcomer to India's power market, could encapsulate the totality of the investment challenge in India, from lack of infrastructure and fuel shortages, to bureaucratic red tapes. The private company won the bidding for a power plant in Maharashtra in 2009 including the right to develop coal mines, but discovered regulatory and logistical obstacles to supply coal domestically to its power plant. In order to import coal rather than rely on Indian coal, it chose to create its own vertically integrated supply chain including coal mines in Indonesia, two cargo ships, India's first private railroad, and the private Mundra port, as it found that to ship coal 4 000 miles by sea is cheaper and sometimes even faster than to transport it 1 000 miles by train in India (NYT, 2011). Private investors who are interested in power projects in India should be ready to do all required business on their own, if necessary.

Finally, India's power policy makers need to maintain consistent and clear policy messages. Imposing an import ban on cheaper foreign equipment in the absence of assured sufficient

domestic capacity contradicts the original policy objective of ensuring the most competitive power projects and can confuse investors. Furthermore, frequent rhetoric about "free electricity" (IE, 2012b) in some states where power companies suffer from huge financial losses does not help create public understanding that electricity is a commodity worthy of payment. Discouraging this populist approach to the power sector could be the first step towards a commercially-viable power sector.

Key message • To meet its enormous power demand, India requires the effective implementation of power sector policies, as well as clear and consistent political messaging to attract investment:

- **India's power generation capacity would continue to increase substantially, by 76 GW under the 12th Five-Year Plan (FYP 2012-17);**
- **fossil fuels, especially coal, will remain dominant in India's power sector;**
- **in addition to capacity expansion, India needs to improve the management of each segment throughout the entire sector, starting with low operational efficiency in generation and high financial losses in distribution;**
- **the development of adequate fuel supply and supporting infrastructure is required to attract investment and ensure reliable power supply; and**
- **making the sector financially viable will be essential to meet growing demand and provide sufficient electricity to all.**

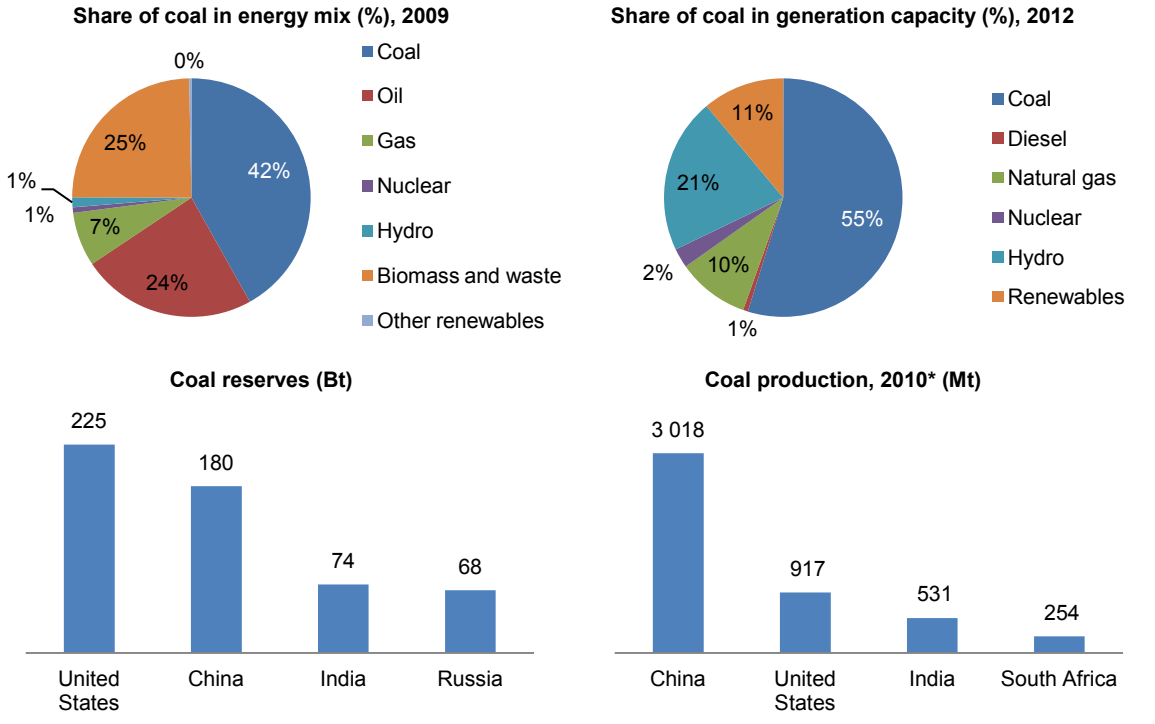
5. Coal sector

Coal is the primary source of energy in India. Representing over 40% of India's energy mix in 2009, 56% of installed power capacity and nearly 70% of generated electricity in 2012, coal is a key cornerstone of India's energy supply. This is attributable to India's vast coal potentials. As of 2010, India had the third largest hard coal reserves, after the United States and China (BGR, 2011). India was also the world's third largest coal producer and consumer in 2011 after China and the United States, and is expected to become the second largest consumer by 2025, surpassing the United States (BP, 2012; IEA, 2011a).

With electricity demand dramatically increasing, so will demand for coal. Yet the coal sector remains the most controlled and perhaps least efficient of all energy sectors in India. Currently, two state-owned companies maintain a near-monopoly of India's coal production, representing a share of almost 90% and leaving very limited room for private companies to participate. Furthermore, domestic coal production has been stagnating in recent years and failed to achieve the production targets of the 11th Plan. Due to coal supply shortages, India's power plants are operating at much lower than optimal levels, causing shortfalls in electricity generation. In addition, uncertain prospects for expansion of coal production have led to reluctance in much-needed power sector investment.

As stated in Chapter 3, India's coal-centred energy landscape will not change dramatically over the next 30 years. India's heavy dependence on coal has environmental and social costs, however, efficient and sustainable development of the coal sector can mitigate negative externalities to a certain degree, bringing India on to a more reliable and cleaner energy path. This section focuses on assessing India's coal sector and highlighting urgent issues that need to be addressed by policy makers. It focuses on whether the current system is capable to deliver India's primary fuel to its people.

Figure 18 • Snapshot of India's coal sector



*Estimate.
Sources: IEA, 2011a; CEA, 2012a; BGR, 2011; IEA database.

Policy framework

Key policies

India's private coal mining companies were nationalised under the **Coal Mines (Nationalisation) Act 1973**, which aimed "to ensure the rational, co-ordinated and scientific development and utilisation of coal resources consistent with the growing requirements of the country" (MOC, 1973). Only the central government or its subsidiary companies were allowed to own and operate coal mines. Subsequently, Coal India Limited (CIL) was established in 1975. The amendment of the Act in 1976 permitted companies in iron/steel and the power industry to produce coal from designated mines for their end-use, or so-called captive consumption. The **National Mineral Policy 1993** aimed to encourage foreign and private investment in India's mineral sector. Eligibility for captive production was expanded to cement producers and coal washing, later to coal gasification and liquefaction in its amendment in 2007 (PIB, 2007a).

Colliery Control Order 2000

As per the 1945 Colliery Control Order, the Ministry of Coal and Mines was empowered to control the price and distribution of coal and subsidies to companies. In the absence of direct contractual relations between mining companies and buyers, the ministry required that coal producers distribute their products to the SEBs (IEA, 2002b). The Colliery Control Order 2000 or Coal Linkage Policy deregulated prices for all coal qualities but distribution remained controlled by the government. Two Standing Linkage Committees (Short-Term and Long-Term) decided on coal distribution to the power, cement and steel industries until 2007.

New Coal Distribution Policy 2007

The New Coal Distribution Policy (NCDP) was introduced to facilitate supply of assured quantities of coal to consumers of core and non-core sectors at pre-determined prices (PIB, 2007c). The key feature was the introduction of a Fuel Supply Agreement (FSA) regime replacing the linkage system. Under the legally binding FSAs, 100% of coal requirements for the power and fertilizer sectors will be met by coal companies and 75% of coal requirements for other large consumers will be provided as well. The NCDP also devised a Letter of Assurance (LOA) for coal supply for project developers, which is to be converted to FSA upon achievement of certain milestones in a project. LOAs and FSAs are granted by the Standing Linkage Committee (Long-Term) to power, steel and cement sector consumers and LOAs to other consumers are issued by CIL, while the Standing Linkage Committee (Short-Term) was abolished in July 2010 under the NCDP. Importantly, NCDP empowered CIL to import coal to fulfill its supply commitments. The NCDP mandated all the existing consumers to enter into FSAs with coal producers within six months.

The NCDP, however, resulted in huge burdens to CIL against the backdrop of its stagnating coal production. First, as a FSA is a legal obligation, failing to honour its supply commitments entails an expensive penalty payment by CIL to consumers. Second, importing coal to fulfil its commitment turned out to be an enormous challenge, mainly due to the price disparity. Power producers became reluctant to take imported coal. Consequently, CIL has refused to sign a new FSA since March 2009, with 1 184 standing FSAs for a total of 304.80 Mt for the power sector (MOC, 2012a). As an interim arrangement, CIL has used memoranda of understandings (MOUs) to supply coal to power companies, in which CIL's obligation is reduced to 50%, despite resistance from the power

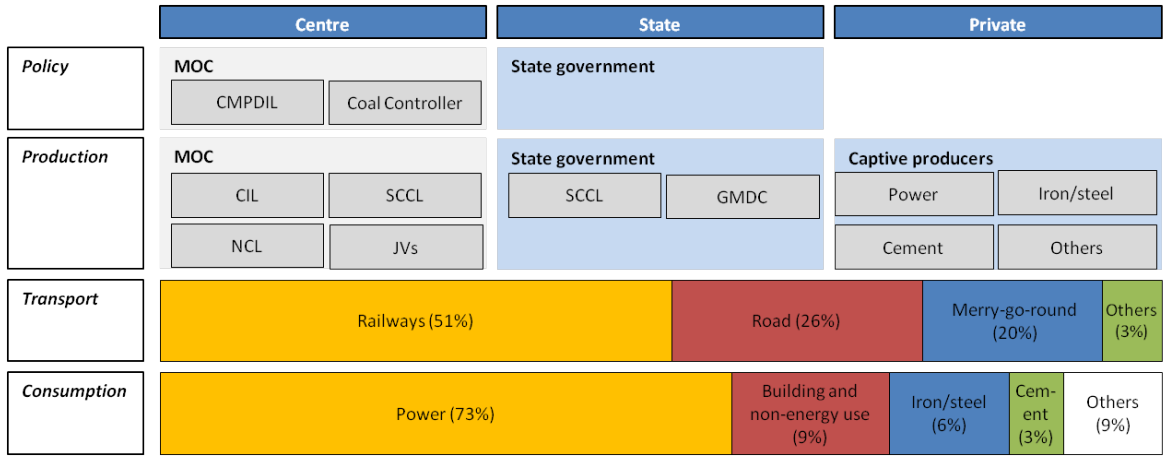
sector (BS, 2011a).[11] The NCDP, under which coal is distributed by the government, is an example for India's insufficient reliance on the market mechanism.

Coal Mines (Amendment) Bill 2000

This bill intends to allow non-captive coal mining by Indian companies on par with the CIL, in order to increase domestic coal production. This bill is still pending as of 2012 after being introduced to Parliament in 2000. The major obstacle has been the coal industry trade union which has demanded a withdrawal of the bill, insisting that increased production should be made by the nationalised coal companies through greater government budgetary support (MOC website).

Key Players

Figure 19 • Key players in the coal sector



Sources: IEA database; MOC, 2012b.

Ministry of Coal (MOC)

The MOC is responsible for all aspects of the coal sector including determining policies and strategies in respect to exploration and development of coal and lignite reserves, permitting coal projects and deciding on coal-related issues including production, supply distribution and, in practice, prices. It also allocates coal blocks to captive producers. The **Coal Controller**, under the MOC, functions as a semi-regulator granting permission for opening of coal mines, setting standards and procedures relating to coal mining, inspecting the quality of produced coal and collecting coal-related data. There are three coal producing PSUs under MOC's administrative control and they are under tight supervision of the MOC. For instance, senior officials of the MOC are members of the Board of Directors at CIL and NLC.

- The **Coal India Limited (CIL)** is the largest coal producer in the world by manpower and output and is responsible for the entire Indian mining sector (IEA, 2007). It was formed as a holding company with eight direct subsidiary companies. CIL produces about 80% of domestic coal and employs more than 370 000 people. It also has the Maharatna status, same as NTPC, which gives CIL autonomy to make investments up to USD 1 billion without explicit government approval. The company went public in 2010, divesting 10% of the government share for nearly

[11] It was reported that CIL was using the MOU to reduce its supply commitment by 50% whereas the NCDP obliges coal producers to supply 100% of agreed quantity of coal to power sector. Clause 7 of the MOU says "The quantum of supply of indigenous coal under the agreement shall be at the sole discretion of the seller, but not exceed 50% of the annual contracted quantity in any case."

USD 3.3 billion, making it the largest Initial Public Offering in India to date (Bloomberg, 2010). The remaining 90% share is owned by the government.

- The **Singareni Collieries Company Limited (SCCL),** India's oldest mining company, mainly supplying coal to southern India. Since 1960 it has been jointly managed by Andhra Pradesh and the central government. It produces approximately 8% of India's coal production. 76% of its produced coal is dispatched to coal-based power plants in Maharashtra, Andhra Pradesh and Karnataka. (SCCL, 2012) **Neyveli Lignite Corporation Limited (NLC)** is a lignite mining company based in Tamil Nadu and owned by the central government (93%) and administered through the MOC (NLC, 2012).

Captive producers

Since 1976, both public and private companies requiring a large and stable supply of coal in key industries are allowed to operate coal mines in India. Those industries are iron/steel, power, cement, and coal gasification and liquefaction. The produced coal is only for self-consumption and is not commercially tradable or exportable; surpluses can be only sold to CIL. The share of captive production was 10% of total production in FY 2011/12 (MOC, 2011b). As of 2010, out of a total of 208 captive blocks with nearly 50 billion tonnes (Bt) of coal reserves, 100 blocks were assigned to private companies and 96 and 12 blocks were allocated to PSUs and UMPPs respectively. In FY 2010/11, however, only 28 blocks actually started production (MOC, 2011b).

State governments

As the Indian Constitution places mineral resources on the Union list, the main responsibility for India's coal sector falls under the central government and hence, the MOC. Albeit restricted, state governments still exercise a considerable influence on coal mining. State governments have rights to issue mining licenses and leases within their states, which are prerequisites to obtaining final approval from the MOC. Some states have their own mineral mining company, such as Gujarat Mineral Development Corporation Ltd that focuses on lignite. The Mines and Minerals (Development and Regulation) Act 2011 calls for establishment of a National Mining Regulatory Authority to advise on the revision of royalty rates and to set standards for the mining sector. It allows state governments to establish a similar organisation at the state level, which is expected to provide state governments with greater authority on mining.

Ministry of Power and NTPC

The power sector is the largest consumer of coal in India, representing about 75% of total consumption. NTPC alone consumes 137 million tonnes (Mt) or 25% of domestically produced coal in FY 2010/11 (NTPC, 2011), making it the largest single coal user in India. Given the critical importance of coal supply to power plants, MOP and NTPC have closely co-ordinated, but sometimes conflicting, relations with MOC and CIL.

Ministry of Environment and Forest (MOEF)

The MOEF is responsible for issuing environmental and forestry clearances, which are critical statutory permissions to be obtained before implementation of coal projects. The official timeframe to obtain permissions is 150 to 210 days, but usually takes two to six years, which results in considerable delays in project implementation and further shortfall in coal production (PC, 2010). Currently, 180 coal projects are awaiting forestry clearance from MOEF; MOC blames this as the major cause for delays in making its new mines operational (PIB, 2012b). As mentioned earlier, the MOEF had a significant influence on coal development projects through assigning "go" and "no-go" areas in forested zones until the categorisation was dismantled in 2011 through strong resistance from coal ministry and industry. However, another categorisation for non-exploration areas is now under consideration by MOEF (TOI, 2012a).

Indian Railways

Railways transported 51% of India's coal in FY 2010/11 (CIL, 2011), which is operated by Indian Railways, a PSU under the Ministry of Railways. Coal is the largest source of freight of Indian Railways and accounted for 45% of freight revenue in FY 2010/11 (IR, 2011). Delays in railroad projects, especially expansion of railway capacity, is causing bottlenecks of coal supply in India. In FY 2010/11, out of total 424 Mt dispatched by CIL, only 216 Mt was transported by railways to its consumers, compared to the target of 256 Mt in FY 2010/11 (CIL, 2011), owning to unavailability of rakes. However, the Railway Ministry rejected this view and argued that the low dispatch rate was caused by low coal production (FE, 2012d).

Supply

Reserves

According to international data, India has the third largest hard coal reserves[12] in the world with about 74 Bt. In terms of total hard coal resources, India has the world's seventh largest with 171 Bt or 1% of the world's share. India's lignite[13] reserves are 4.8 Bt (BGR, 2011).

Box 5 • Does India have enough coal?

For Indian coal reserves, different data provided by several institutions could have important implications on the country's coal future, as well as its entire energy sector. The conventional perception of India's coal is its abundance. The 11th Five-Year Plan states that if all resources were to be utilised, the current level of production could be sustained for 140 years, albeit without consideration into technical and economical feasibility. The MOC's report shows that "extractable" reserves (that can be recovered/mined depending on the mining method and technology deployed in the mine) estimated by CIL's subsidiary, Central Mine Planning and Design Institute, are much less than its "proved" reserve estimation (MOC, 2005).

Several experts have cautioned against the "myth of abundance" in regard to India's actual coal availability. The IEP warned that "large estimates of total coal resources give a false sense of security because current and foreseeable technologies convert only a small fraction of the total resource into the mineable category" (PC, 2006). The 11th Five-Year Plan indicated that extractable coal reserves will run out in approximately 45 years if India's coal production continues to grow at 5% per year. (*WEO 2011* projects that Indian coals demand would increase at a CAGR of 4.1% throughout 2009 to 2035.) One expert argued that CIL can only sustain the current level of production for 45 years and "India does not have adequate extractable coal reserves required either to meet current incremental demand or to make long-term supply commitments" (Batra, 2011). Others questioned the actual accessibility of some coal reserves and CIL's technical capability to develop and produce the proven coal reserves (Madan, 2006). This different data leads to questions; is the current coal shortage temporary, or more fundamentally, does it imply that India might not have sufficient coal resources to meet its long-term energy demands?

[12] "Reserve" means proven volumes of energy resources that are economically exploitable at current prices and using current technology. In comparison, "resource" means proven amounts of energy resources that cannot be exploited for technical and/or economic reasons, as well as unproven, but geologically possible, energy resources that could be exploitable in future (BGR, 2011).

[13] Lignite is raw coal with an energy content less than 16 500 kJ/kg, in comparison to hard coal that has an energy content of more than 16 500 kJ/kg (BGR, 2011).

Estimated coal reserves of India

	BGR	BP	EIA	India (proved)	India (extractable)
Reserve (Bt)	74.6	60.6	61.8	93	52.24
R/P ratio (year)[1]	138	103	114	172	97
R/P ratio (year)[2]	104	85	86	130	73

[1] Based on 2011 production.

[2] Based on 2016/17 production target.

Sources: BGR, 2011; BP, 2012; US EIA, 2012; MOC, 2005.

India's hard coal resources are estimated even greater at 248 Bt to a depth of 1 200 meters, of which 60% lie within 300 m of the surface, making them potentially exploitable by surface mining technology. Approximately 38% of resources or 93 Bt is called "proved coal reserves" (MOC, 2005). It should be noted that the "Indian classification system is primarily based on geological evaluations without assessing the quality, mineability, or extractability of deposits" (Chikkatur, 2008) (Box 5).

Most of India's coal resources are located in the eastern part of the country. Together the states of Jkarhand, Chhattisgarh and Orissa account for 70% of the country's coal resources. This geographical mismatch between major coal mines and high demand markets in western and southern India, as well as coal transportation by railroad, are some of the major challenges facing India's coal sector.

Production

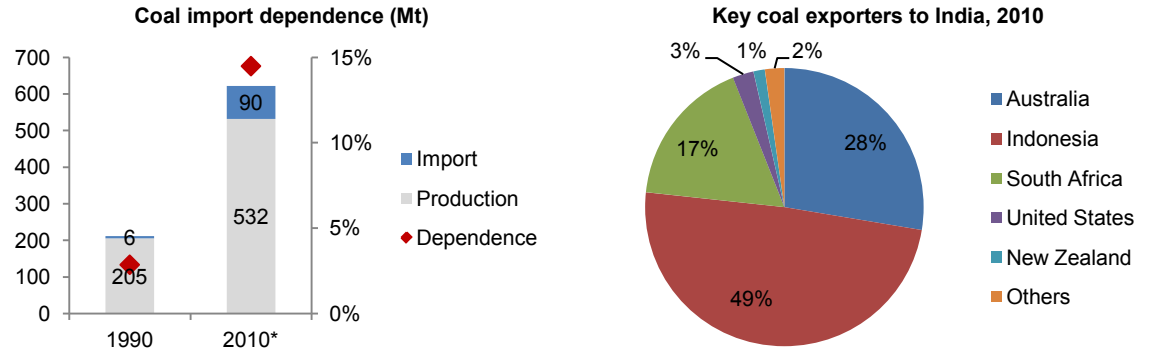
With the world's third largest produced volume in 2010, India's domestic coal production more than doubled from 205 Mt in 1990 to 532 Mt in 2010, but has plateaued in recent years. The 11th Five-Year Plan augmented coal production to 680 Mt by FY 2011/12, but this was later revised down to 629 Mt as per the 11th medium-term appraisal (PC, 2010). This was mainly due to stagnating production by CIL whose production was 435 Mt in FY 2011/12 vis-à-vis the original target of 520 Mt (MOC, 2011b). The 12th Five-Year Plan aims to increase coal production to 715 Mt in FY 2016/17, a 33% increase from the current level (MOC, 2011b). The share of CIL production was 81% in FY 2011/12, but will reach approximately 78% at the end of the 12th Five-Year Plan. Captive producers and others contributed nearly 10% to total production in FY 2011/12 and, producing about 102 Mt, this would increase to 14 % (MOC, 2011b).

Current mining in India is limited to a depth of less than 300 m while 40% of India's reserves are beyond this depth and, as a result, nearly 90% of CIL's coal mines are opencast (MOC, 2011b). Opencast mining typically has lower production costs and is less dangerous for workers. But it also causes considerable environmental destruction of the surrounding ecosystem, acid mine drainage, erosion of soil and particularly deforestation of the mining area. The issue has emerged whether the coal industry is failing to reach efficient and optimal exploration given its current mining methods. It has also been pointed out that underground coal mining has the potential of reducing the environmental damage (PC, 2012b). However, India's coal industry does not have advanced technology to explore and produce underground beyond 300 m at the moment (PC, 2006). For instance, longwall technology, one of the advanced underground mining technologies, was not actively embraced in India due to the collapse of some installations in 1989 and 1997 (Ghose, 2003), but Indian companies have started to reintroduce this technology in recent years (Hindu, 2008). India will need to accelerate the adoption of advanced underground mining technology to increase its productivity and output.

Import

Traditionally, India imported a very small volume of coal. In 1990, India's coal import rate was 3% and all imported coal was coking coal, which is rare in India. In 2010, the absolute volume of India's coal import reached 90 Mt or 14% of total coal demand (IEA database). About one third or 30 Mt of imported coal was coking coal, whose demand grew fast due to the expansion of the steel and iron industry in India. For coal imports, India spent nearly USD 9.3 billion in 2010, a considerable increase from 1990 when India spent USD 416 million on coal imports. As of 2010, based on import volume, Indonesia was the largest source of imported coal, representing 49%, followed by Australia with a share of 28% and South Africa with 17% (Figure 20). *WEO 2011* projects that India's dependence on imported coal will increase to 30% or 280 Mt (178 Mtce) of coal demand in 2020 and to 34% or 460 Mt (294 Mtce) by 2035. Increasing import dependence is generally due to rising coal demand and stagnating domestic production. More specifically, the expansion of supercritical power plants requiring higher quality of coal will lead to greater imports. Industrial coal demand, especially for coking coal, will represent 38% of projected growth.

Figure 20 • Coal imports in India



* Estimate.

Sources: IEA database; UN comtrade, 2012.

Increasing coal imports has led Indian coal companies to invest in overseas coal assets. The Indian government established co-operative relations for coal sector investments with countries including the United States, Indonesia and South Africa. CIL was allocated two blocks in Mozambique in 2009, which are the only overseas reserves held by CIL and currently at exploration stage (MOC, 2011a). CIL also received the approval to invest up to USD 2 billion in equity acquisition of unlisted coal companies abroad (ET, 2011a). India's private Adani Enterprise acquired a 100 percent interest in the Galilee Coal Tenement in Queensland, Australia, in 2011, now known as Carmichael Coal Project, which is expected to export 60 Mt per year by 2020 (UPI, 2011). However, most of these projects are still at the early stage and how much physical coal would be actually shipped back to India to ease the supply shortage is unclear.

Beneficiation (washing)

Indian coal is typically of poor quality, with an average heating value of about 4 500 kcal/kg, compared to over 6 000 kcal/kg for most internationally traded coals, and high moisture during the monsoon season. It has a high ash content, typically 30% to 50%, but is low in sulphur and very little is suitable for iron and steel making (IEA, 2007).

Due to this characteristic of Indian coal, beneficiation or washing is typically necessary to reduce ash contents and make coal more suitable for consumers. The washing of coal provides more consistent quality and increases energy efficiency of conventional pulverised coal combustion

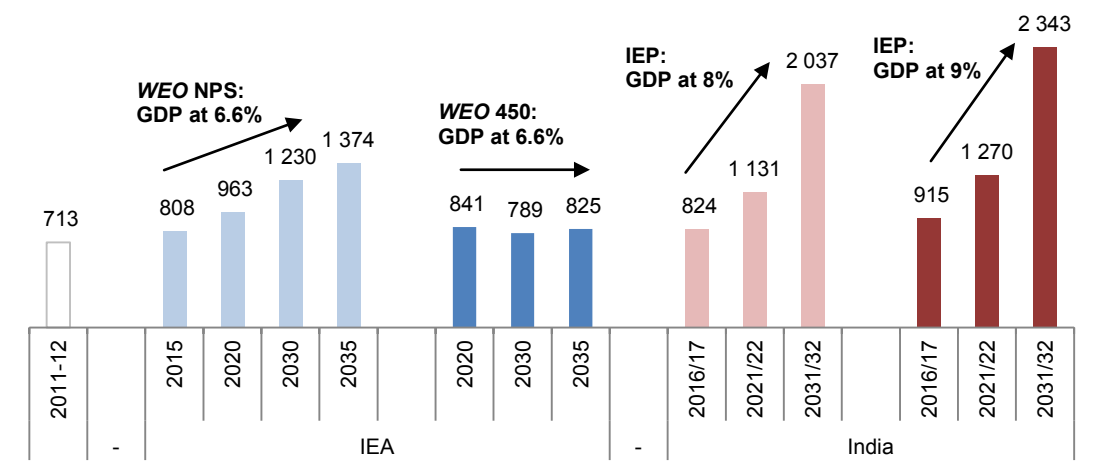
boilers by 10% (PC, 2007). Furthermore, washing coal is known to reduce the potential damage to power plant equipment and improve the plant availability factor (Chikkatur, 2009). Despite its benefits, not all coal is actually washed in India. CEA reported a loss of 7.7 TWh or 35% of the coal-based generation in FY 2010/11 due to the poor quality/wet coal (CEA, 2011). The 11th Five-Year Plan estimated about 243 Mt per year needs to be washed by the end of FY 2011/12. However, India's beneficiation capacity remained at 135.18 Mt and an additional capacity of 190 Mt was urgently needed (PC, 2010). The 12th Five-Year Plan estimates that coal washing capacity would remain at 175 Mt by the end of 12th Plan (MOC, 2011b).

Demand

India will become the second largest coal consumer around 2025 surpassing the United States, with primary coal demand more than tripling from 280 Mtoe in 2009 to 618 Mtoe in 2035, according to *WEO 2011* NPS. This enormous coal demand will predominantly come from the power sector, representing over 60% of coal demand growth between 2009 and 2035 under the NPS.

Box 6 • Projections for coal demand: *WEO 2011* versus IEP (Mt)

Based on WEO 2011 projections, in 2035 coal demand will reach approximately 1 374 Mt (618 Mtoe) under the NPS and 825 Mt (365 Mtoe) under the 450 Scenario, assuming the economy grows at a CAGR of 6.6%. India's IEP projects that in FY 2031/32 India's coal demand would increase dramatically to 2 037 Mt (835 Mtoe) at GDO growth rate of 8% and 2 343 Mt (947 Mtoe) at GDP growth rate of 9%. This large discrepancy is primarily explained by the different assumption for India's economic growth as well as for the average calorific value of Indian coal. For instance, India's Planning Commission assumes that Indian coal on average contains 4 100 kcal/kg, hence a greater volume of coal is required. In contrast, IEA assumes that Indian coal typically has 4 500 kcal/kg (IEA, 2007). Depending on the quality of coal, especially in light of increasing import of higher quality of coal, absolute volume of India's coal demand can vary.



Note: *WEO 2011* projection figures in Mtoe and Mtce were converted to Mt, assuming calorific value of 4 500 kcal/kg for Indian coal.

Sources: IEA, 2011a; PC, 2006.

Consumption

The power sector consumed over 73% of India's coal in 2009, which increased notably from a share of 61% in 1991 (IEA database). The second largest consumer was the steel and iron industry, representing about 9% in 1991 and 6% in 2009. The cement industry was the third largest coal consumer, using 6% of coal in 1991 but only 2% in 2009. This trend can be explained

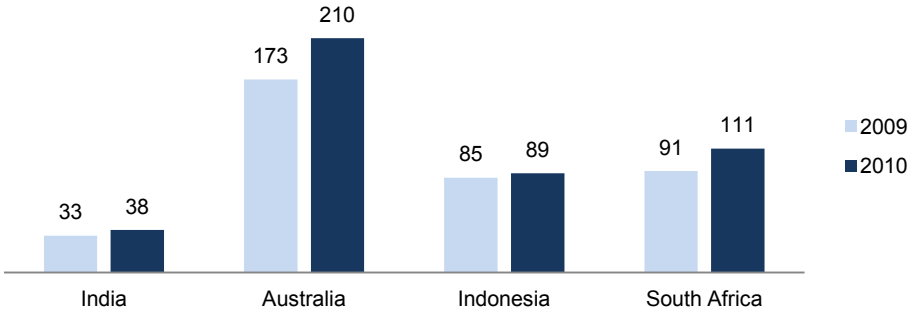
by the substantial demand increase for coal in the expanding power sector, as well as through substitution with other forms of energy, namely electricity, within the industry sector.

Pricing

India's coal prices were officially completely deregulated in 2000, allowing coal producers to set their own coal prices based on an escalation formula under a cost plus approach. In the absence of an independent regulator and meaningful competitors, however, the monopolistic status of CIL granted enormous pricing power to the company at the expense of consumers' interest (PC, 2006). In practice, the adjustment of coal prices is made only in consultation with MOC (PC, 2012b).

Until recently, Indian coal has been priced based on useful heat value (UHV) measures, under which coal was categorised and priced into seven grades (A, B, C, D, E, F & G) in accordance with its calorific value. It has the merit of simple and easy pricing, but also limitations. Its rather wide grade range provided little incentive to coal producers to improve coal quality, since coal grade could remain the same even after beneficiation (Chikkatur, 2009). Furthermore, as UHV is not an internationally used measure, it caused difficulty in aligning the price and quality of Indian coal with imported coal.

Figure 21 • Comparison of prices of Indian and imported coal by origin (USD/tonne)



Note: average prices were calculated by dividing the total value (or net sales) by the total import (or off-take) volume and adjusted to 6 000 kcal/kg. Also note that Australian coal is mostly coking coal.

Sources: CIL, 2011; UN comtrade, 2012.

Box 7 • Coal trading in India

Currently, there is only one stream through which India's domestic coal is traded without institutional pre-arrangements. CIL sells 10% of its produced coal through e-auction. Originally, e-auctioning of coal started in 2005, but discontinued in 2006 when the Supreme Court decided that it was a misuse of CIL's monopoly status to seek the highest price rather than fulfilling its constitutional goals (FE, 2007b). The NCDP 2007 reintroduced the e-auctioning with rationales for transparency of the price setting process and availability to all consumers with minimum demand of 50 tonnes regardless of coal/non-core categorisation. It was reported that e-auctioned coal has been sold at premium of 80% on average vis-à-vis prices paid by power sector. Despite strong opposition from the MOP in the context of CIL's failure to deliver its coal supply commitments and its appeal to PMO to divert e-auctioning quota to power sector, MOC decided to continue with e-auction in 2012 in expectation of an increase of coal production (FE, 2012e).

At the beginning of 2012, CIL announced a shift from UHV to the international practice, gross calorific value (GCV) (TGOI, 2012), which was recommended in the IEP. Under the GCV, heat value is computed based on the empirical data of ash and moisture content and its 17 pricing

bands are narrower than in the UHV. It is expected to encourage efficient use and allocation as well as to promote beneficiation of coal (PC, 2010). However, because of strong resistances from major coal consumers – particularly, the power sector – concerned about price hikes due to GCV measures, CIL was forced to temporarily suspend the new mechanism (IE, 2012a; Hindu, 2012a).

The greatest challenge posed by India's pricing system is the price disparity with international coal prices (Figure 21). Indian coal was priced at a discount to imported thermal coal and because of large price differentials, Indian consumers are highly reluctant to take imported coal. The Indian government is currently considering the pooling of prices of domestic and imported coal to resolve this issue (PC, 2012b), but difficulty exists due to the quality differences of coal by origin.

Issues

Stagnating domestic production

During the 11th Five-Year Plan, India's coal demand increased at CAGR of 8.5%. However, CIL's domestic production has increased at a CAGR 4.6% during this period (MOC, 2011b). The cause for slow production growth is two-fold. First, as pointed out by MOC and CIL, the rigid and time-consuming procedure to obtain environmental and land permission from MOEF and state governments incurred considerable delays on coal mining projects. For instance, CIL reported that 24 out of 44 of its currently delayed projects were due to land acquisition (CIL, 2011). Second, CIL's production was stalled by its own low productivity due to frequent strikes and strong unionisation. This view was expressed by then-Environment Minister during the go/no-go area disputes in 2011, saying that "the government should question why production targets cannot be met from the considerable areas already owned by CIL" (Hindu, 2011).

The production shortage would continue to be a serious issue for the power sector. Recently, CIL was pressured to agree on the FSAs with power companies for those plants to be commissioned by March 2015. This would make CIL's total coal commitment amount to 555.56 Mt, nearly 250 Mt increase from the standing FSAs (MOC, 2012a). The uncertainty over whether CIL can deliver the committed volume is one problem. Another concern is that any additional coal requirement for new power plants would be unlikely met through FSAs with CIL, hence finding alternative sources is unavoidable.

However, the shortage of fuel supply will most likely last through the short term. The 12th Five-Year Plan already estimates the shortfall of coal supply for the power sector in FY 2016/17 at 238 Mt, even after coal supply from CIL (415 Mt) and captive blocks (100 Mt) is delivered as expected (MOP, 2012a). The power sector would need to import at least 159 Mt, which is not financially or technically feasible due to the reasons stated below.

Import dependence

The direct outcome of sluggish domestic coal production is the considerable increase of imported coal. India's coal imports have more than doubled over the last five years, which is noteworthy in a country where the public perception is that coal is abundant. Growing coal import dependence creates several major complications. First is that coal imports are not easy due to limited supporting infrastructure, as mentioned earlier. Second, different characteristics of coal typically allow Indian power plants to blend imported coal with domestic coal only up to 10% to 15% (CEA, 2012f). As such, the Indian government requires new power plants to be able to take up a greater portion of imported coal. Furthermore, the price disparity between Indian domestic and international coal posit a considerable difficulty for both CIL and consumers. Finally, the recent movement of coal exporting countries, including Indonesia, towards banning the exports of lower

quality coal (ET, 2012j) indicates that India's growing coal imports expose the country more to external political risks and raises questions about its energy security.

For CIL, its obligation to fulfil its commitment by importing more expensive coal under the FSA will most likely undermine its margins, as CIL need to lower it to offset the high prices of imported coal. Equally for coal consumers, using imported coal is costly and most likely reduces their profits. Already some UMPP operators are anxious about the financial viability of their projects running on imported coal, for escalated fuel costs cannot be passed through to tariff under the PPA (Chapter 4).

Infrastructure

India requires a well-integrated infrastructure for its coal supply chain, which includes railroads, importing ports and washeries. Delayed construction of railways by Indian Railways, a government monopoly, to connect mines, dispatch centres and end-use destinations, has already created a considerable bottleneck in coal supply in recent years.

The supporting infrastructure – India's domestic manufacturing capacity of mining equipment and machinery – is a cause of concern as well. Currently, two PSUs, BHEL and BEML (Bharat Earth Movers Limited) are the major suppliers to CIL. The limited supply capacity and poor quality of equipment of Indian suppliers can hinder mining productivity. For instance, it was reported that BEML can only supply dumpers of 100-tonne capacity against the 240-tonne size needed by CIL (BS, 2011b). To meet the growing need for mining equipment, potentially for underground mining, CIL and BEML formed a consortium with another power PSU and acquired Mining and Allied Machinery Corporation (MAMC) in 2010, a PSU that was set up to manufacture underground mining equipment and that had been shut down two decades ago. MAMC is expected to resume operations in 2012 (TI, 2012).

Investment

The coal sector is the only energy sector remaining de facto closed to private investment. Two PSUs, CIL and SCCL, practically have a monopoly on coal production. The only segment open to private participation is captive production. FDI is allowed only in captive-mining related business: 100% FDI is allowed in captive mining for power projects and coal processing plants selling washed coal to raw coal producers; FDI up to 74% is allowed for other captive consumption. But private producers are barred from selling processed coal in the open market.

The most problematic aspect in the coal sector is this lack of private investment. Once CIL and SCCL fail to achieve production targets, there is no reliable alternative source to make up the losses other than imports. This has resulted in enormous constraints to both the coal and power sector. Allowing private participation in captive mining does not bring much technical improvement, as those companies are not specialised in coal mining, and hence have limited expertise in coal production. They also have few financial incentives to augment their coal production without access to an open market. The participation of private coal mining companies with technical expertise and experience would be essential to boost the volume of investment and production, especially for mining in underground and geologically challenging areas.

The additional advantage of private participation would be spill-over of more transparent and efficient management by private/foreign companies. 10% of divested government stakes in CIL could have been offered to strategic partners who could bring useful business knowledge to CIL and created a stepping stone for better business management within CIL. However, through the IPO, shares were taken by a number of individual investors instead. Furthermore, its recent dispute with the largest minority shareholder (with a 2% share) revealed a wide gap in perception

between private investors and the Indian government, as the Coal Minister said that "India is a socialist country, with a large proportion of poor people, and so pricing decisions by state-run companies can't be set to secure only profits" (FE, 2012b).

Therefore, the most urgent issue in India's coal sector is to end the monopoly of CIL. It is increasingly evident that CIL alone cannot increase coal production adequately to meet the current and future demand. To open the coal sector to the private sector, the enactment of the Coal Mines (Amendment) Bill 2000 is the first step. The liberalisation of the coal sector would help make it more modern and competitive. Furthermore, the Indian government must implement consistent and clear policies to assure fair competition between public and private, and national and foreign companies. Only then will India's coal sector be able to increase its production substantially and deliver adequate energy to meet the growing demand of the population.

Key message • Coal is the primary energy source in India; reform is critical for development of the sector:

- **stagnating domestic production and inadequate infrastructure for coal have caused serious bottlenecks in India's energy supply;**
- **the near monopoly of two public enterprises has blocked the needed increase of coal production, causing a serious fuel shortage in the power sector; and**
- **private companies that are currently allowed only in captive production should be able to engage in commercial mining, and bring technical improvements and more efficient management to the coal sector.**

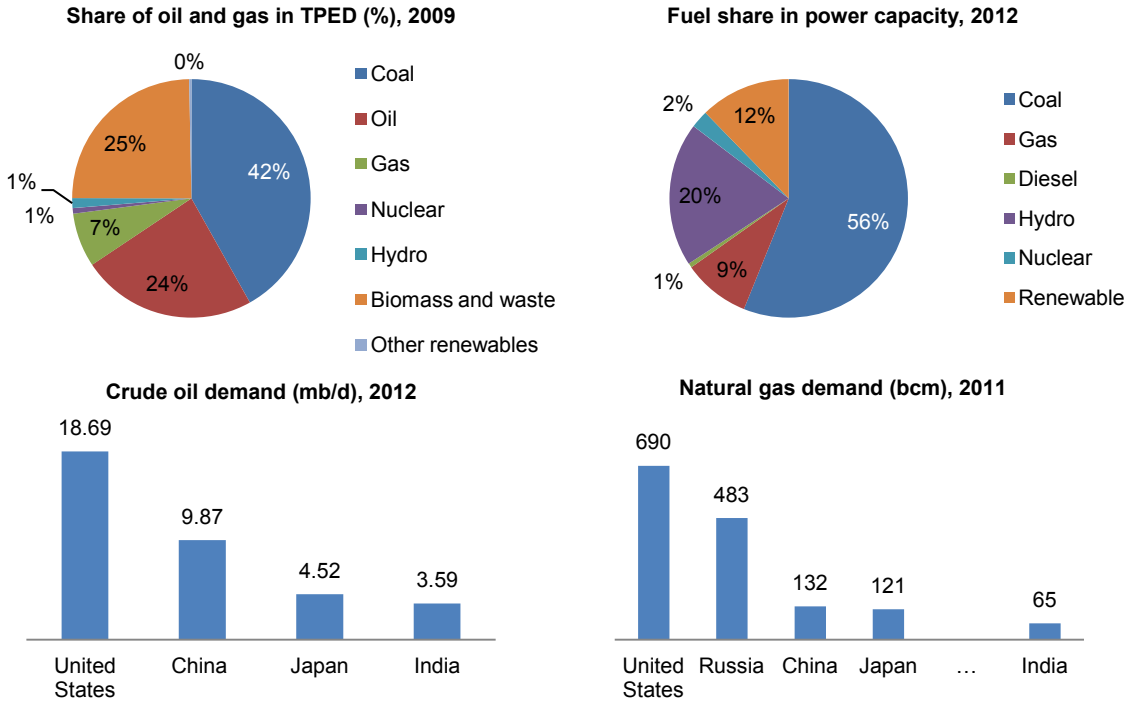
6. Oil and gas sector

Bolstered by rapid economic growth, India's demand for oil and gas has been increasing significantly over the last two decades. In 2012, India is the world's fourth largest oil consumer and is also the fourth largest importer (IEA, 2012a). Oil accounted for 24% of India's TPED in 2009. India's gas demand was 65 bcm in 2011 and accounted for only 7% of India's energy mix (Figure 22). India's domestic hydrocarbon reserves are relatively small resulting in increasing dependence on imports and concerns over energy security.

Since the liberalisation of the upstream sector and subsequent reforms in the downstream, the oil and gas sector is comparably more open and competitive than other energy sectors in India. It is open to 100% FDI and a number of private and foreign private companies are actively operating. However, persisting issues remain unresolved, including a distorted pricing mechanism, under-utilisation of domestic resources, and lack of investment from major international oil companies (IOCs).

This chapter first introduces the policy and regulatory framework and key players in both oil and gas sector, and then discusses important aspects and issues of the oil and gas sector separately.

Figure 22 • Snapshot of India's oil and gas sector



Sources: IEA, 2011a; IEA, 2012a; IEA, 2012b.

Policy framework

Key policies

After independence, India focused on regaining control over its oil and gas sector which had been dominated by companies in the West. "It was recognized that majority ownership and effective control of critical industries like petroleum should always rest in Indian hands and the need for developing an independent and self-reliant petroleum industry was felt" (PC, 2006). Under the Industrial Policy Resolution in 1956, the Oil and Natural Gas Commission and Indian Oil Corporation

were created for the upstream and downstream sectors respectively. The Indian government nationalised the hydrocarbon sector during the 1970s, reaching completion in 1981. Upstream blocks for exploration were then allocated to oil PSUs on a nomination basis and private companies could later participate too, but only through a joint venture with PSUs. However, slow exploration and development of hydrocarbon reserves led to a re-liberalisation of the sector in the 1990s.

New Exploration Licensing Policy (NELP)

The NELP, effectuated in 1999, is a cornerstone of India's upstream policy. Its aim was to accelerate exploration and development of hydrocarbon resources in India against the backdrop of increasing domestic demand (MOPNG, 1999). The NELP awards exploration blocks through international competitive bidding and allows 100% foreign and private participation. The PSUs had to begin competing on equal footing with private and foreign companies, while earlier allocation of upstream projects to PSUs was controlled through administrative orders from the Indian government, under the NELP, with the Production Sharing Contract (PSC) as the managing instrument. A total of eight bidding rounds of NELP have been implemented since the first in 1999, with mixed outcomes. Through these eight rounds, a total of 326 blocks have been offered and, 236 awarded. A total of 107 discoveries were made, of which 31 were declared commercial and six have started production (MOPNG, 2012a). The 9th round of NELP is underway at the moment and is expected to be concluded soon. Under the NELP, India's unexplored sedimentary areas decreased from 50% in FY 1995/96 to 12% in FY 2010/11 (DGH, 2011). However, participation of major IOCs in NELP biddings still remains low.

India Hydrocarbon Vision (IHV) 2025

Introduced in 2001, IHV 2025 laid out the long-term vision for the oil and gas sector with objectives of enhancing energy security and promoting a free market and competition within the sector (PIB, 2012). In the medium- and long-term strategies contained in the IHV 2025, some salient features stand out, notably increasing operational flexibility and autonomy of PSUs, developing the sector to a globally competitive level, and better utilisation of domestic hydrocarbon resources. The IHV 2025 confirmed the importance of foreign investment, but also emphasised the critical role of Indian PSUs.

Key players

Ministry of Petroleum and Natural Gas (MOPNG)

The MOPNG oversees the entire oil and gas sector, ranging from E&P, refining, supply distribution to marketing and pricing, and initiates and implements the five-year plans for the oil and gas sector. It oversees import, export and conservation of petroleum products and natural gas. The MOPNG regulates the allocation of gas under the Gas Utilisation Policy and pricing of gas produced by its PSUs through administrative orders, while gas from JVs and from NELP fields are governed through Production Sharing Contracts (PSCs). The MOPNG supervises eight statutory bodies and 14 PSUs (IEA, 2010a). It also has responsibility for development and implementation of pricing policy and for supervising the marketing of biofuels (IEA, 2007).

- **The Directorate General for Hydrocarbons (DGH)** was established in 1993 and acts as the upstream regulator. Its original role was to provide technical advice to MOPNG on upstream sector development. Since 2000, DGH generally represents the Indian government at the Management Committee meetings for the PSCs. In 2006, DGH was empowered to monitor the country's E&P activities and Coal Bed Methane projects and to obtain all data from all lessees/licensees to monitor the government revenues from upstream projects (PIB, 2007d).

- **The Petroleum Planning and Analysis Cell (PPAC)** was created in 2002 to enhance the institutional capacity of oil and gas-related data management and analysis. It administers the subsidies on kerosene and domestic LPG and analyses trends in the oil and gas market, including prices and import/export (PPAC, 2012).
- **The Oil and Natural Gas Corporation (ONGC)** was renamed and incorporated from the Oil and Natural Gas Commission in 1961 to develop India's upstream sector. It is also the parent company of ONGC Videsh (OVL), its overseas investment arm, and of Mangalore Refinery and Petrochemicals Corporation Limited (MRPL), a single integrated refinery and petrochemical plant in Mangalore (IEA, 2010c).
- The **Oil India Limited (OIL)** was incorporated in 1959 and is one of the oldest upstream companies in India, focusing on the north-east regions of India and Rajasthan. It produced about 3.6 million metric tonne (MMT) of crude oil and condensate in FY 2010/11 (OIL, 2011).
- **Oil Marketing Companies (OMCs)** in the petroleum products retail business in India include: Indian Oil Corporation Limited (IOCL), Bharat Petroleum Corporation Limited (BPCL), and Hindustan Petroleum Corporation Limited (HPCL), which are all vertically-integrated companies. IOCL is the largest company in India in terms of revenue (Fortune, 2011) and also owns Chennai Petroleum Corporation Limited (CPCL) as a subsidiary, operating two small refineries in Tamil Nadu (IEA, 2010c). Currently, these three OMCs have a near monopoly on the petroleum products retail business in India.
- **The Gas Authority of India Limited (GAIL)** was created in 1984 to construct, operate and maintain India's largest cross-country gas pipeline (Hazira-Vijaypur-Jagdishpur pipeline). It has a market share of three-fourths of the natural gas transmitted through pipelines. Its business has now expanded to E&P, LPG production and city gas distribution (GAIL, 2011).

Petroleum and Natural Gas Regulator Board (PNGRB)

The PNGRB was created in 2006 as a downstream regulator. The members of the board are nominated by the government and although it operates independently from the MOPNG, it receives directions from the ministry. The PNGRB regulates the refining, processing, storage, transportation, distribution, marketing and sales of both petroleum products and natural gas. It also regulates transportation access and rates, and access to distribution or city networks. However, it has no price setting power, which weakens its authority to regulate the downstream sector (ET, 2012f).

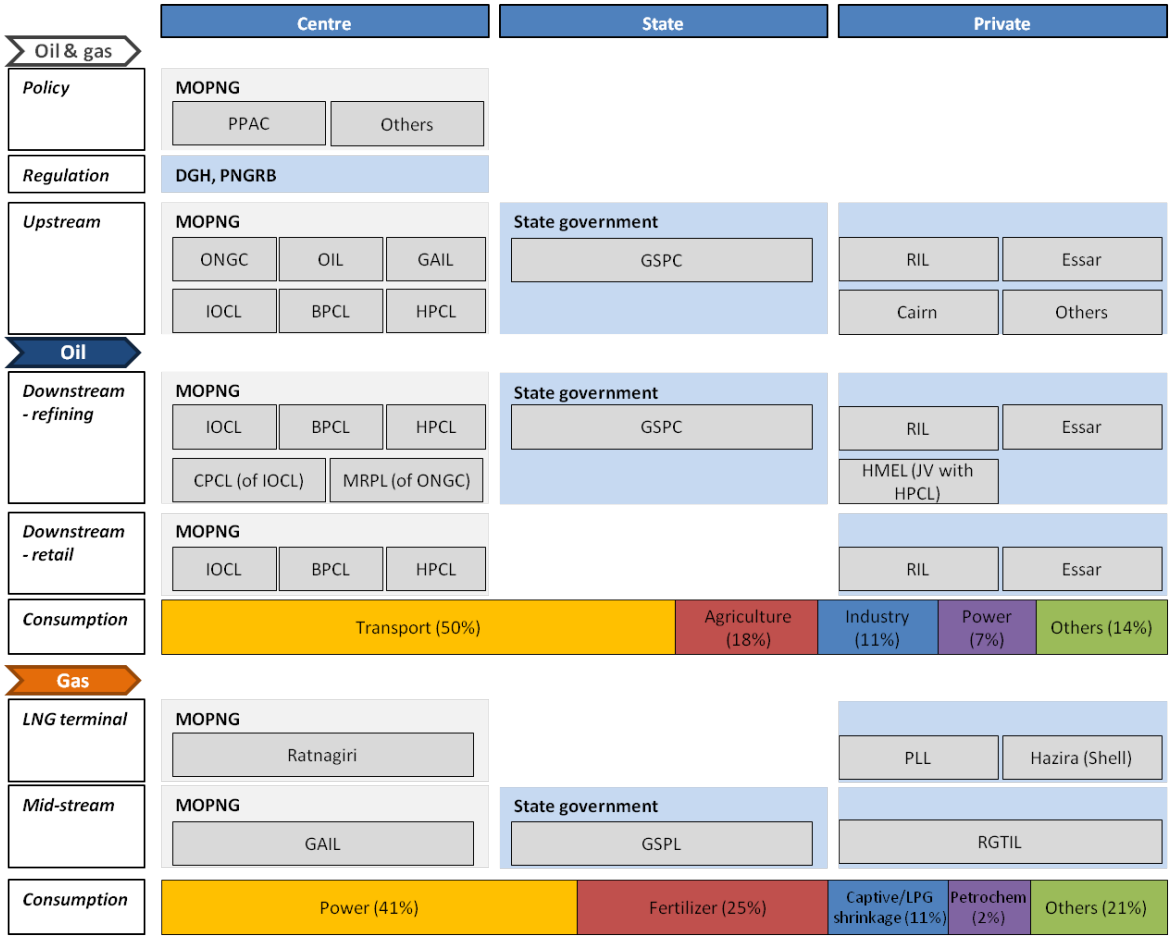
State governments

The Indian Constitution gives the central government exclusive rights to regulate and develop oil and gas resources both onshore and offshore. However, states levy taxes on sales of petroleum products, and earn royalties and dividends from upstream projects within their states. Gujarat is a significant player in the oil and gas sector; Gujarat State Petroleum Corporation (GSPC) was created in 1979 as a petrochemical company, but when the hydrocarbon sector was liberalised, it acquired some blocks and moved into the upstream business (GSPC, 2012). It is now a vertically-integrated entity with business in gas transmission through Gujarat State Petronet Limited.

Private companies

Petronet LNG Limited (PLL) was formed to import LNG and build re-gasification plants in 1998 as a JV by oil PSUs, namely GAIL, ONGC, IOCL and BPCL, each of them owning 12.5% of share. However, PLL is considered to be a private entity, as the remaining 50% share is held by private shareholders, including a Gaz de France (today GDF Suez) subsidiary (10%) and the Asian Development Bank (5.2%) (PLL, 2012).

Figure 23 • Key players in the oil and gas sector



Sources: MOPNG, 2012e; IEA database; GSPC, 2012.

Of the few private companies that operate in India's oil and gas sector, most of them are Indian conglomerates. **Cairn India** is one of the first private companies that capitalised on India's upstream sector in 1990s. With its major reserves in Rajasthan, it produced 149 103 barrels per day (b/d) or about 20% of India's domestic crude in FY 2010/11 (Cairn, 2011). Cairn India sold a controlling stake to UK-based Vedanta, a newcomer to the oil and gas business, in December 2011. **Reliance Industries (RIL)**, has emerged as a prominent player in both upstream and the refining sector since the discovery of considerable gas reserves in the Krishna-Godavari (KG) basin in 2002 and the completion of its Jamnagar refinery in Gujarat in 2008. RIL also owns **Reliance Gas Transportation Infrastructure (RGTIL)**, which operates the 1 396 km-long East-West Gas Pipeline from Andhra Pradesh to Gujarat. **Essar Oil** is another key player in both upstream and downstream, and is the second largest private refiner; it recently completed the expansion of Vadinar refinery in Gujarat. **Mittal Energy Limited** entered the refining sector through a JV with HPCL, called HMEL, starting operation of the Bathinda refinery in Punjab in 2012 (HMEL, 2012).

In terms of major IOC participation, **British Petroleum (BP)** acquired 30% of RIL's share in the KG-D6 gas field for USD 7.2 billion in 2011. **Royal Dutch Shell** has been active in the LNG business in India, owning the Hariza LNG terminal that was commissioned in 2005 (Hazira, 2012). However, the overall interest of major IOCs in the Indian upstream oil and gas sector remains low.

Oil sector

Supply

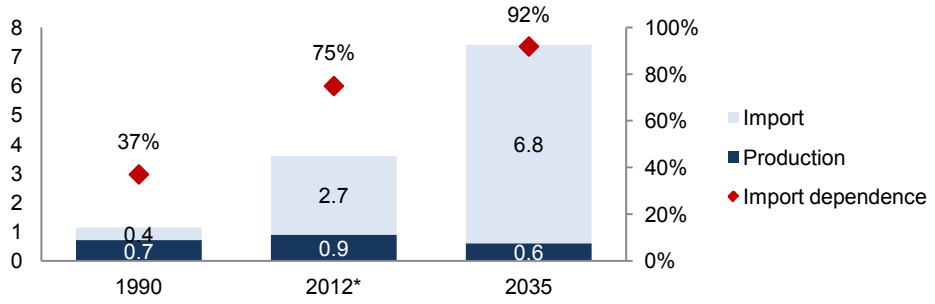
As of 2010, India had 0.8 billion tonnes of petroleum reserves, which accounts for approximately 0.3% of world reserves (BP, 2012). One recent discovery was made in Rajasthan by Cairn India in 2009. India's oil reserves are mostly located in the western part of India. Western offshore represents 46% of oil reserves, while Gujarat has 19% and Rajasthan 6%, while Assam, located in the north-eastern part of the country, has about 19% of oil reserves (CSO, 2011). Offshore production accounts for about 53% of India's crude production in FY 2011/12 (MOPNG, 2012b). India's relatively small resource endowment and its offshore location require greater upstream technical expertise to fully exploit its potential.

India's domestic crude production has stagnated, growing very slightly from 0.7 mb/d in 1990 to 0.89 mb/d in 2011 at a CAGR of 1% (IEA database; IEA, 2012a). This is attributable to declining production from mature oil wells, mostly ONGC fields in Mumbai High offshore, and insufficient production from new fields to offset the shortfall. ONGC produced 62% of domestic crude, compared to OIL with 10% and private/JV companies with 28% in FY 2011/12 (MOPNG, 2012b). The doubling of the share of the private/JV companies sector in domestic production is notable, which was 14% in FY 2006/07. The 12th Five-Year Plan projects that India's domestic crude production would be 0.82 mb/d in FY 2016/17, with ONGC and OIL maintaining similar production shares (MPONG, 2012a).

Import

To meet fast growing demand, India's crude oil imports are increasing strongly. In 1990, India imported only 37% of its oil demand. However, oil imports were expected to reach 2.7 mb/d or 75% of demand in 2012, and 6.8 mb/d or 92% in 2035 under the *WEO 2011* NPS (Figure 24). Increasing reliance on imported crude has been a serious concern to Indian policy makers, both in terms of increasing energy insecurity and financial burden because of exposure to the fluctuation of international oil prices and exchange rate. Its largest crude supplier is Saudi Arabia (18%), followed by Iran (11%), Nigeria (11%) and Kuwait (9%), in terms of imported volume in 2010 (UN comtrade, 2012).

Figure 24 • India's oil supply, 1990-2035 (mb/d)



* Estimate.

Sources: IEA, 2011a; IEA, 2012a; IEA database.

Overseas upstream investment

To mitigate risks from growing import dependence, India has encouraged oil PSUs to acquire overseas upstream assets. The IEP viewed equity oil investment as a risk management tool to mitigate oil supply risk and the market volatility of oil prices hurting the national economy. However, as the IEP recognised, the actual impact of equity oil to deter supply risk in case of geopolitical crisis or natural disaster is rather limited, while it could contribute to hedge the cost of oil imports (Dadwal, 2012).

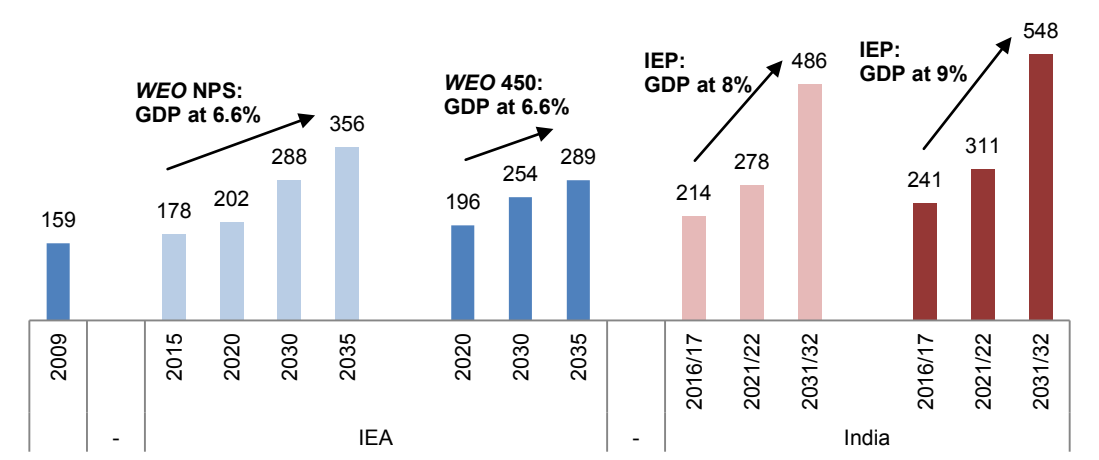
The most active player of overseas upstream investment, OVL, had a cumulative investment of USD 14.35 billion at the end of 2011, with 30 projects in 15 countries around the world (Halder, 2012). OVL is the only company that has overseas oil production. Its largest assets are GNOP block in Sudan, which contributes 27% of India's total equity oil production, and Sakhalin I in Russia, which contributes 22%. The combined equity oil production in FY 2010/11 was 6.75 MMT or 10% of India's domestic production (MPONG, 2012a). Other PSUs including BPCL, OIL and HPCL and private companies also increasingly engaged in acquiring upstream assets abroad. However, they face intense international competition for resource acquisition.

Demand

WEO 2011 projects that with a demand of 7.4 mb/d, India would be the third-largest crude oil consumer by 2035 after China and the United States. Its rapid demand growth of a CAGR of 3.4% from 2010 to 2035 would be one of the highest in the world, driven primarily by the transport sector. India has a very low passenger car ownership rate of 12 per 1 000 people in 2009, compared to 34 in China, 439 in the United States and 125 in the world (WDI, 2012). According to the *WEO 2011,* India would reach close to 100 per 1 000 people in 2035 under the NPS, but would still only be half of the world average.

Box 8 • Projections for crude oil demand: *WEO 2011* versus IEP (Mtoe)

WEO 2011 projects that India's oil demand would reach 356 Mtoe under the NPS, at a CAGR of 3.1%, and 289 Mtoe under the 450 Scenario, at a CAGR of 2.3% from 2009 to 2035. India's Integrated Energy Policy presents a different prospect. With the assumption of an annual average GDP growth rate of 8% to 9%, India's primary commercial oil demand would grow much faster to 486 Mtoe and 548 Mtoe in FY 2031/32 respectively at CAGR of 5.5%.



Sources: IEA, 2011a; PC, 2006.

Consumption

As shown in Figure 23, the transport sector is the largest consumer of oil in India, representing 50% of total demand, followed by agriculture (18%) and industry sector (11%). In terms of product consumption, diesel is the largest with 44% share in FY 2011/12. LPG and gasoline each represent a 10% share, while naphtha has an 8% share (PPAC, 2012).

Refining

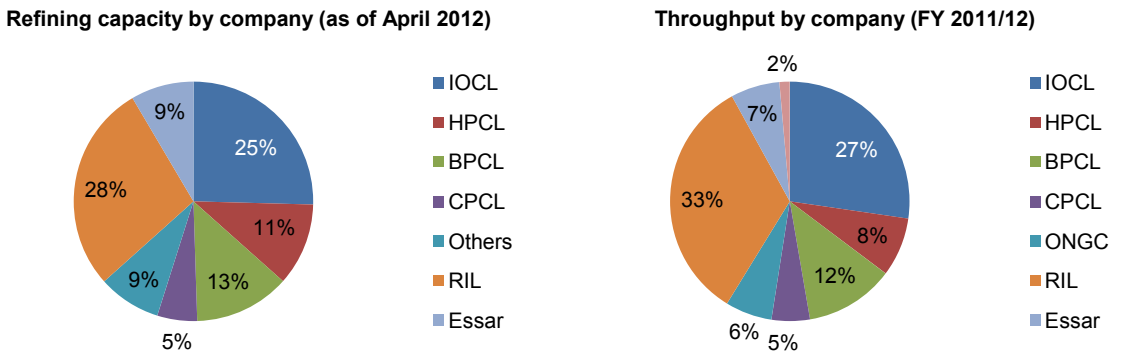
As of April 2012, India's refining capacity was approximately 4.2 mb/d or 213 million metric tonne per annum (MMTPA), making it the third largest in Asia after China and Japan (PPAC, 2012).

India's refining sector underwent a significant transformation from a net product importer to a major regional exporter in one decade. India was a net importer of oil products until 2001, relying on imported products for almost 20 to 25% of total oil demand in 1990s. During this time, India's import bill for petroleum products was nearly USD 3 to USD 4 billion per year. The 9th Five-Year Plan (FYP 1997-2002) encouraged private investment in the refining industry. With the commissioning of export oriented refineries of RIL and Essar Oil in Jamnagar, India turned into a net exporter of petroleum products in 2001. The 11th Five-Year Plan aimed to promote India as a regional refining export hub, targeting 4.9 mb/d of refining capacity by 2012. The 12th Five-Year Plan aims to increase refining capacity to 6.2 mb/d or 310 million metric tonne per annum (MMTPA) by 2017 (IEA, 2011e). Against the backdrop of growing domestic demand, export-oriented refineries were converted to domestic refineries in 2009, which helped to ease a domestic shortage of petroleum products. Some products, namely kerosene and LPG, are still imported.

It should be noted that the refining industry plays an increasingly important role in the Indian economy. Its total export value reached nearly USD 40 billion in FY 2010/11, representing 16% of India's total exports (DOC EIDB, 2012). This is a remarkable growth from a mere USD 39 million or 0.1% of total exports from FY 1999/2000. India's top exporting markets are geographically diverse, and include the United Arab Emirates (UAE) (14%), Singapore (13%), Netherlands (9%), France (6%) and Japan (5%) in terms of export value in 2010 (UN comtrade, 2012).

The private sector has played a critical role in the emergence of India's refining sector. In FY 2009/10, 90% of India's refined product exports came from RIL and Essar. Furthermore, improvement and modernisation of the business structure and management in the refining industry were driven by private companies. RIL's second refinery was commissioned in record time of 36 months and its expansion made RIL's total refining capacity of 1.24 mb/d, the world's single largest refining capacity and also one of the most complex plants (RIL, 2012). RIL and Essar Oil produced 40% of India's throughput in FY 2011/12 (Figure 25).

Figure 25 • Refining industry in India



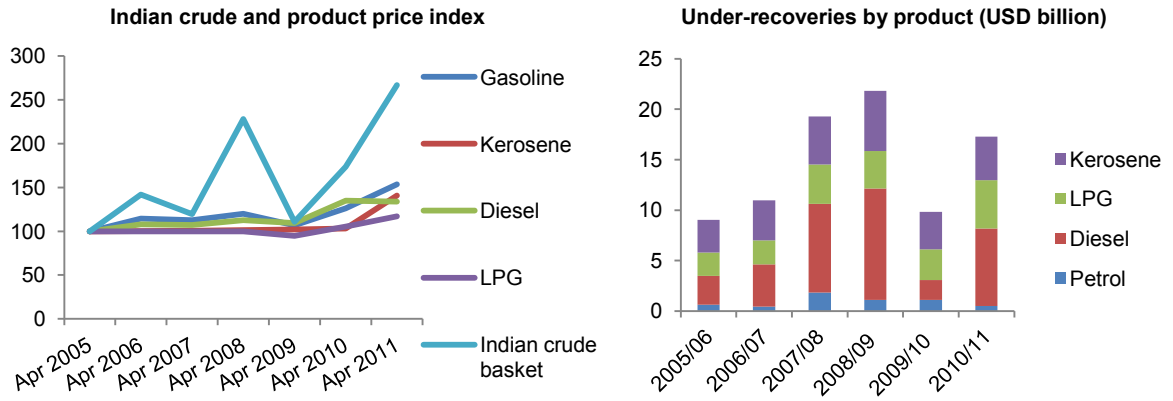
Source: PPAC, 2012.

Under-recoveries

Pricing of India's petroleum products was decided by the government under the Administered Pricing Mechanism (APM) until it was dismantled in April 2002. The APM was based on a cost of operating capital plus formula (IEA, 2009). Under the post-APM regime, OMCs were allowed to set the price of all fuels, while two strategically important products for the poor, kerosene and LPG, remained regulated. However, two major transportation fuels, gasoline (called "petrol" in India) and diesel, were still regulated by the government, although there was no official subsidy provided for these fuels. The Indian government announced the deregulation of gasoline prices and the phased deregulation of diesel prices in 2010, but as of 2012, diesel prices were still regulated and gasoline price changes take place only in consultation with MOPNG.

As a result, the actual selling price (retail price minus taxes and dealer's commission) of those four "sensitive products" is lower than ex-pump price that OMCs pay to refineries based on import/ trade parity. The difference between the two prices is called "under-recoveries" (PPAC, 2012). As India imports nearly 80% of its crude demand, increasing international prices result in escalation of under-recoveries to OMCs. The largest component of under-recovery is diesel, representing USD 8 billion or almost 44% of the total amount in FY 2010/11. Recently, OMCs announced a gasoline price increase of a record high INR 7.5/litre (ET, 2012g), but this was shortly after reduced by INR 2/litre (Reuters, 2012). Although the rise would help to alleviate the mounting losses to OMCs, the actual impact on total under-recovery would be insignificant, given the small share of gasoline in total consumption and the deteriorating INR/USD exchange rate. Hence, continued financial support from the government for OMCs will be required to maintain their financial viability.

Figure 26 • Under-recoveries of OMCs



Note: local currency was adjusted by exchange rate of corresponding years.
Source: PPAC, 2012.

What is noteworthy is that the actual retail prices for Indian consumers are not low even by international comparison, and are even higher than in Canada and the United States (Bloomberg, 2012a). This is due to the high taxation on petroleum products levied by both central and state government, comprising 37% of retail price, in the case of gasoline, and 16% for diesel in 2012 in Delhi (IOCL, 2012a). Although under-recoveries generally adversely affect the fiscal health of the government, the actual issue would be the vertical fiscal imbalance between central and state governments (IEA, 2010c). For the central government, tax revenues from sales of all petroleum products alone (excluding other revenues from the upstream sector) usually outweigh the payouts for under-recoveries on the four sensitive products, with the exception of FY 2008/09. However, the central governments fiscal burden, that includes the oil bonds to compensate OMCs, increases in tandem with international oil prices. Contrarily, the state governments share no burden for under-recoveries in spite of their considerable revenue from the oil sector.

Issues

Import dependence

India spent about USD 92 billion on importing crude oil in FY 2010/11, which was a record amount and represented about 25% of its total import bill. That year, India recorded nearly USD 118 billion trade deficit (DOC EIDB, 2012). The challenges from India's import dependence will increase at least in the short term: first, India's demand is still growing, hence further import increase is inevitable: second, India is a price taker in the global oil market, so any international price hike will have a direct impact on India's current account and: finally, as seen recently, a depreciation of Indian currency will also push up the import bill.

The Indian government is well aware of risks associated with growing import dependence. The NELP contributed to better explore its hydrocarbon potentials, but it did not lead to a meaningful increase of domestic production. India needs the participation of E&P companies with advanced technical expertise and know-how, particularly for offshore E&P and improvement of Enhanced Oil Recovery (EOR) in existing fields. Equity oil acquisition could hedge the market risks to a certain extent, but its effect would be minor, given its current share of 10% of domestic production, just 2% of India's total demand. Thus, India is increasingly focusing on mitigating its growing oil consumption through demand-side management, such as vehicle fuel efficiency and biofuels.

Pricing

The current pricing system posits problems to all stakeholders in the sector. For the government, even if total tax revenue earned on petroleum products outweighs the compensation for OMCs, maintaining the current system is very costly. The complexity of the system entails considerable administrative costs and resources for monitoring the scale of under-recoveries, transferring funds among PSUs and arranging the issuance of oil bonds by the Finance Ministry.

Consumers already pay a relatively high price for at least gasoline, especially given India's low per-capita income level, due to heavy taxation. And the current subsidy system fails to effectively reach those who are in need, while untargeted subsidies benefit mostly middle and upper income classes. Furthermore, the system results in rampant adulteration of fuel, which creates artificially greater demand for subsidised fuels (PC, 2012b). The current pricing structure does not send the right signal to incentivise consumers for efficient use of fuels.

Oil PSUs, both in the upstream and retail sectors, are also worse off. Upstream players such as ONGC, OIL and GAIL have been asked by the government to shoulder the financial burden of OMCs. To do so, upstream PSUs sell their crude and products at discount to OMCs, equivalent to INR 158 billion (USD 3.5 billion) to IOCL and INR 69 billion (USD 1.5 billion) to BPCL in FY 2010/11 (IOCL, 2012b; BPCL, 2011). For OMCs, financial compensation from the government has become indispensable to keep its balance sheet afloat. For instance, IOCL's profit (before tax) of INR 90 billion in FY 2010/11 would actually become a deficit of INR 135 billion, if the government revenue grant of INR 226 billion for under-recoveries is deducted from the income (IOCL, 2012b). This financial sacrifice of oil PSUs to support the government subsidy regime is made at the expense of minority shareholders, since all these companies are traded on a stock exchange. Furthermore, the delayed compensation from government harms the cash flow of OMCs and undermines its investment capability and management autonomy.

Ultimately, the current system provides no incentive for private companies to re-enter the retail market in India. Two-thirds of India's retail stations were closed in 2008 as private companies were not compensated for selling their products below cost, unlike their government-owned competitors. *WEO 2011* estimated that India would need a total investment of USD 203 billion for its oil industry from 2011 to 2035. Private investment will be critical to materialise this projection. It can only come when the full implementation of price deregulation in the downstream sector is completed.

Key message • India's oil demand is growing fast, bolstered by its economic growth:

- **with increasing dependence on imported oil, India needs to enhance energy security by optimal utilisation of its resource potentials and strategic investment in overseas assets; and**
- **current pricing mechanisms result in huge financial and administrative burdens on government and state oil companies and most of all, discourages private investment.**

Gas sector

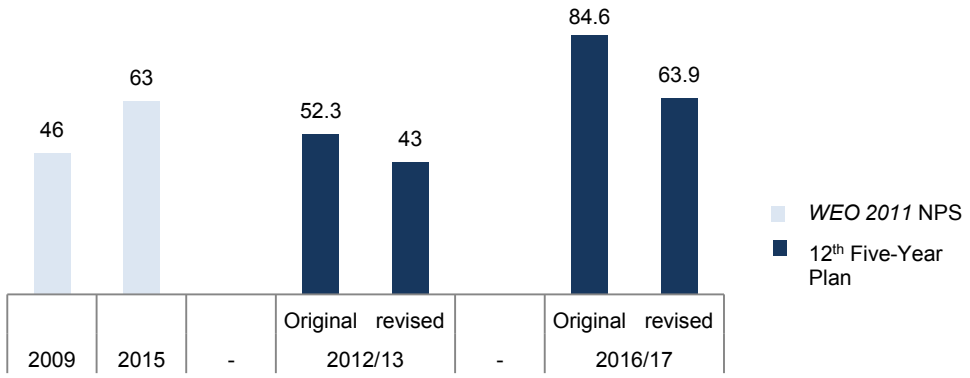
Supply

Domestic production

India's share of proved global natural gas reserves stood at 0.6%, or 42.4 trillion cubic feet (tcf)[14], at the end of 2011. Proved reserves increased from 25 tcf to 29 tcf between 1991 and 2001 but grew by 50% between 2002 and 2011 (BP, 2012). This increase is in large part the result of exploration success in fields offered under India's NELP.

Massive gas discoveries in 2002 in the D-6 field in the KG basin off India's east coast raised high expectations. Estimated originally at recoverable reserves of over 6 tcf, the field KG-D6 equates to 40 times the size of India's largest producing gas field, the off-shore Bombay High (Rediff, 2002; EVW, 2003). About 80% of India's gas production comes from off-shore fields, mainly from the west coast. On-shore production is dominated by four states. Assam in the north-east, Gujarat in the west, Tamil Nadu and Andhra Pradesh in the south east jointly account for close to 90% of production (MOPNG, 2012b).

Figure 27 • Estimated domestic gas production (bcm)



Sources: IEA, 2011a; MPONG, 2012a.

Production from India's maturing gas fields is largely stagnating. KG-D6 production was expected to compensate for those fields and while production started according to plan in 2009, it has since dropped significantly due to technical problems as stated by the field operator. In March 2012, production was at 34 mcm/d, instead of the projected 80 mcm/d, which would have equalled 46% of the total domestic supply. Of the total 128 mcm/d produced in March 2012, ONGC contributed 53%, OIL 6%, and private producers 41%, and the share of KG-D6 accounted for 26%. Consequently, cumulative domestic supply projections for the 12th Five-Year Plan were revised downward by 27% from 342 bcm to 249 bcm over the entire period as shown in Figure 27 (MOPNG, 2012c).

Imports

Imports accounted for 28% of total Indian gas supply in FY 2011/12 (MOPNG, 2012b). The share of imports is expected to increase to almost 70% by 2017, the end of the 12th Five-Year Plan, in light of falling domestic supply. However, actual usage of LNG re-gasification capacity will depend not only on providing necessary transport infrastructure, but also on international LNG price development.

India imports LNG through two terminals located off its western coast. The PLL Dahej terminal has a nameplate capacity of 10 million tonnes per annum (mtpa) and 7.5 mtpa of the LNG sourced

[14] Measurement used in accordance with Indian government sources.

under a long-term supply contract from RasGas in Qatar. The Dahej terminal will be expanded to 12.5 mtpa by 2013 and to 15 mtpa by 2016. India's second operational LNG terminal is a 3.6 mtpa facility owned by Shell in Hazira, which will be expanded to 5 mtpa by 2014 and to 7 mtpa by 2017. Hazira uses short-term sales contracts and sources LNG on demand. Two more LNG facilities on the west coast are nearing completion. PLL's second terminal in Kochi with a capacity of 5 mtpa will become operational in 2012 and has secured 1.44 mtpa of long-term supplies from Australia's Gorgon field. The Ratnagiri facility has a capacity of 1.2 mtpa and is expected to be commissioned in late 2012. Capacity might be expanded to 5 mtpa by 2014 (MOPNG, 2012a).

Several more companies are contemplating to set up LNG plants. GAIL, in association with the Andhra Pradesh Gas Distribution Corporation and GDF Suez, announced plans in April 2012 for a Floating Storage and Regasification Unit (FSRU) off India's east coast. The FSRU is targeted for commissioning by 2014 and is expected to have a capacity of 3.5 mtpa (PIB, 2012c).

The Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline, first initiated in 1995, has made substantial progress with the signing of a Gas Sales and Purchase Agreement (GSPA) in May 2012. Under the GSPA, landed cost at the Pakistan-Indian border is said to be around USD 13/million British thermal units (MBtu) (FE, 2012g). The 1 800 km long pipeline would be designed to carry up to 33 bcm/y, of which India's share is 14 bcm/y. The construction cost was estimated at USD 7.6 billion in 2008. TAPI will be constructed and operated by a special purpose consortium company that is yet to be selected. The pipeline is expected to become operational in 2018 (ADB, 2012).

Unconventional gas

Unconventional gas is unlikely to play a major role in India's gas supply in the medium term. Four rounds of bidding for Coal Bed Methane (CBM) exploration blocks have been held and 33 blocks have been awarded. However, only five blocks are currently producing a total of approximately 0.23 mcm/d (MOPNG, 2012a).

Box 9 • KG-D6 gas discovery and its implication for NELP

The discovery of a considerable reserve in KG-D6 block by RIL in 2002 – the largest discovery of that year – was hailed as a success story under the NELP. Over ten years since then, however, RIL's KG-D6 has encountered a number of setbacks, which encapsulate key underlying issues in India's gas sector.

First, there was the so-called "Ambani brothers' dispute." In 2005, Reliance Industries (RIL, owned by Mukeshi Ambani) and Reliance Natural Resources Limited (RNRL, owned by Anil Ambani) agreed that RIL would supply gas from KG-D6 to RNRL at a price of USD 2.34/MBtu. However, when RIL and the government agreed to a price of USD 4.2/MBtu for KG-D6 gas in 2007, RIL subsequently refused to sell gas to RNRL at the previously agreed price. This led to a law suit between the two companies and in June 2009, the Bombay High Court decided that RIL should honour its supply agreement to RNRL. The central government then intervened and argued that the government has a final say over its natural resources, including pricing and quantity of gas supply. Eventually, the Supreme Court ruled in favour of RIL and the central government in May 2010. A key implication for investors was the central government's continued control over gas pricing under NELP, leading to wariness about the sanctity of PSCs for upstream projects. The rigid pricing for domestic gas, much lower than imported LNG prices, continues to be at the centre of issues in India's gas sector (IEA, 2010a).

In 2011, India's supreme auditor, Controller and Auditor General (CAG), released a report criticising RIL for inflating its capital expenditure for KG-D6 by almost four-fold without "reasonableness of cost incurred", which would lower the government profit under the PSC. The RIL counter-argued that the cost increase was well justified. However, while the dispute is ongoing, one of the issues emerging is the question as to whether DGH carried out its role as the upstream regulator effectively in assessing and monitoring PSCs and protecting the government interest (ET, 2011b).

Similarly, RIL and the government are arguing about delayed investment approvals for the KG-D6 gas block for the new fiscal year. Through considerable investments in satellite fields of D-6, RIL and its partners hope to re-boost the declining production. The government's decision is still outstanding and this delay has the potential to further reduce production from the block (FE, 2012i). Ongoing discussion about gas pricing for NELP gas, exemplified by RIL KG-D6 production, underlines the uncertainties investors face in India's upstream gas sector. Concern remains over whether such discord could drive away potential investors and eventually jeopardise the future success of the NELP regime (Bloomberg, 2012b).

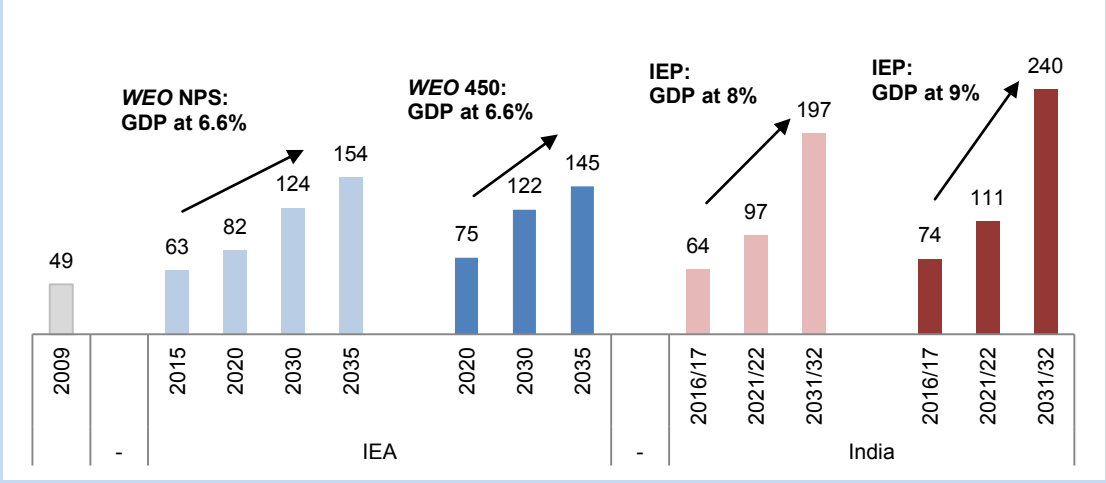
India is said to have substantial shale gas resources in the order of 250 tcf, but has made limited efforts to explore this potential. Issuance of a shale gas policy is not expected before late 2012. To allow for the existing reserve potential to materialise, important legal, structural and environmental challenges will have to be overcome. A National Gas Hydrate Programme was launched by the government over a decade ago and the initial phase of the programme has confirmed the existence of gas hydrates. But technical challenges associated with hydrate exploration imply that commercial production is unlikely to commence soon.

Demand

India's gas demand is expected to triple to 180 bcm by 2035 at a CAGR of 4.5% and this growth will be primarily driven by the power sector (IEA, 2011a). The share of gas in total TPED is expected to increase from 7% in 2009 to 11% in 2011. Gas demand is highly price sensitive, especially for power and fertilizer. Only about 30% of projected demand is expected from sectors with low price elasticity.

Box 10 • Projections for natural gas demand: *WEO 2011* versus IEP (Mtoe)

Based on *WEO 2011* projections, natural gas demand would reach 154 Mtoe (186 bcm) under the NPS and 145 Mtoe (175 bcm) under the 450 Scenario, at a CAGR of 4.5% in 2009 and 4.3% in 2035. India's Integrated Energy Policy suggests that in FY 2031/32 India's gas demand would increase to 197 Mtoe (238 bcm) at a CAGR of 7.2% and based on a GDP growth rate of 8% and 240 Mtoe (289 bcm) at a CAGR of 8% and based on a GDP growth rate of 9%. This projection is also based on the assumption that gas will account for 16% of power generation, while it was about 9% in 2012.



Sources: IEA, 2011a; PC, 2006.

Consumption

The two largest consumers of domestic natural gas in India account for almost 80% of total consumption: the power sector with a share of 53%, followed by the fertilizer industry with 26%. Captive use and LPG represent the third-largest consumer industry with a share of about 9% (Figure 23). However, for total Indian gas supplies, including R-LNG, the share of the power sector drops to 41% and the fertilizer sector to 24% as R-LNG is mostly consumed by price robust sectors like industry (MOPNG, 2012d).

Transmission infrastructure

India's gas transmission infrastructure is mainly concentrated in the northern and western parts of the country reflecting historical gas production and consumption centres. The entire network comprises around 13 000 km. Approximately 15 000 km of additional pipelines are to be put into operation during the 12th Five-Year Plan.

GAIL is the quasi-monopoly operator of cross-national pipelines with a network of almost 8 500 km. The sector was opened to private investment in 2006, and the newly created Reliance Gas Transportation Infrastructure Limited (RGTIL) built the East-West pipeline of about 1 500 km to supply gas from its KG operations to customers. The remaining 3 000 km comprise mainly regional pipelines owned primarily by Gujarat State Petronet Limited (GSPL) (MOPNG,2012a).

Pricing

India's natural gas prices are regulated and set at different levels for gas originating from different producers. Gas from fields allocated to PSUs by the government is sold under prices set by the government under the APM. Joint venture (JV) gas producers are paid based on formula pegged loosely to international prices as per their PSCs but de facto the government maintains close oversight of price adjustments. JV gas prices cover a wide band; they range from USD 3.5/MBtu to 5.65/MBtu (MOPNG, 2010). Gas from NELP fields was supposed to be sold at market-base prices set through a so-called price discovery process. Following the first gas price discovery process, the price for NELP gas was fixed at USD 4.2/MBtu in 2009 based on an oil indexed price formula and will be revised in 2014. The APM gas price was increased to match the NELP price in the same year.

However, re-gasified LNG is priced based on different supply contracts, long- and short-term supplies as well as spot prices. Short-term supplies and spot cargos carry substantially higher prices than domestically produced gas and long-term supply contracts for LNG.

Issues

Declining domestic production

In addition to a substantial reduction of output from KG-D6, the question of overall reserves in KG-D6 is now being posed. The majority owner of D6, RIL, announced in May 2012 that it had cut proven gas reserve estimates by about 7 percent to 3.67 tcf (Rediff, 2012). Shortly after minority partner Niko stated that the field contains about 80% less reserves than estimated (Zeenews, 2012). Niko reduced its estimates for proved and probable reserves to 1.93 tcf down from 9.65 tcf thereby indirectly confirming an earlier reduction of proved reserves of KG-D6 to 1.4 tcf in BP's 2011 annual report.

The second reduction of KG basin reserve estimates took place in 2006; ONGC claimed to have found between 20 and 22 tcf in KG-DWN-98/2 and shortly thereafter GSPC claimed similar reserve levels in its KG-OSN-2001/3 field. One year later DGH revised the estimates downward to 2.09 tcf

for ONGC and 1.8 tcf for GSPC (ET, 2007). These revisions not only question how reserves are certified in the first place, but they also question the real potential of domestic gas production.

The uncertain medium-term future of Indian domestic gas production has cascading effects on the overall role of gas in the country's energy sector. The first impacts have already been felt in the power sector where the PLF of gas-fired plants averaged only 54% in March 2012 due to unavailability of gas (CEA, 2012h), India is, therefore, contemplating the import of more LNG, but this again raises the question of affordability.

Affordability

The two largest gas consumers, power and fertilizer, are highly price-sensitive as they operate in tightly regulated output markets and fuel is not a pass-through cost. Thus, it is unlikely that they can substitute domestically produced gas with LNG in light of the substantially higher costs, at least in the short term.

However, for other potential customers – industry, captive power production, refining and petro-chemicals – affordability is considered high, although no alternative cost benchmark has yet been established. One possible benchmark could be alternative fuel prices based on calorific value, as unmet gas demand is currently substituted with liquid fuels.

Gas utilisation policy

The central government's Gas Utilisation Policy, in practice, negates the right of the NELP producers to sell gas on purely commercial basis. Instead gas is allocated by the government. Priority is given to the fertilizer, LPG and power sector. One of the side-effects of the Gas Utilisation Policy is that the latent gas demand in India is difficult to discover as industrial consumers and IPPs rank at the bottom of the priority list. Furthermore, the policy limits further upstream investments as the high cost of off-shore exploration cannot be recovered from the priority sectors that are highly price sensitive.

Infrastructure

India is still far away from having a fully integrated national gas grid. Especially, the Southern and Eastern parts of the country suffer from a lack of connectivity. A fully developed grid would allow gas-fired power generation, especially high efficient CHP (Combined Heat and Power) units and industrial use to spread throughout the country and provide anchor load for other users like city-gas and CNG. Particular attention should be paid to last-mile connectivity as many potential and solvent gas consumers are unable to access the gas due to lack of regional infrastructure. However, the absence of clear and effective third-party access conditions both to distribution and transmission grid needs to be resolved urgently to encourage much needed investment.

Key message • Gas has the potential to play an important role in meeting India's energy demand, but important prerequisites need to be put in place to fulfil this potential:

- **gas pricing has to be made attractive to ensure timely and sufficient investment in domestic exploration and production, and LNG re-gasification facilities; and**
- **priority should be given to a fully-integrated national gas grid that assures effective third-party access.**

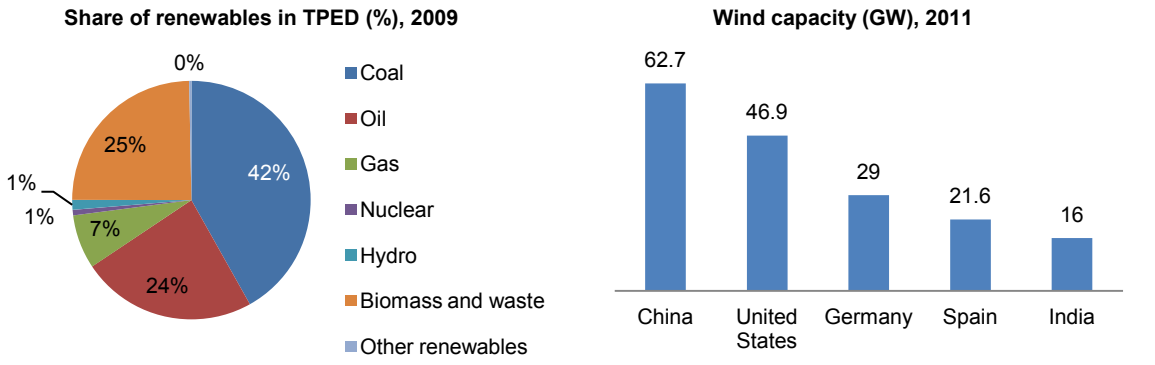
7. Renewable sector

Renewable energy is becoming an increasingly important part of India's energy mix. With vast potentials, renewable energy is no longer seen as an alternate energy source to conventional energy, but as a critical element in pursuit of key policy objectives (MNRE, 2011a). It enhances India's energy security by diversifying its energy mix and reducing import dependence on fossil fuels. Solar power, especially, is seen as having the potential for India possibly to attain "energy independence in the long run" (PC, 2006). In providing energy access to India's people, renewable energy is expected to "supplement conventional power generation and meet basic energy needs, especially in the rural and remote areas" (PC, 2007). Mitigating climate change is also one of the reasons India seeks to promote renewable energy, but not the primary force behind it.

The share of renewables in India's energy mix, combining biomass, hydro and other renewables, was approximately 26% in 2009, of which biomass accounted for the largest share.[15] India had the fifth-largest capacity for wind energy in the world in 2011 and in 2010 India launched an ambitious plan to significantly augment its capacity of solar power. Although installed solar capacity remains quite small, it has promising potential for growth. Private investment has been the key driver behind the growth of renewables in India.

This chapter provides an overview of India's renewable sector, its key players and prospects. In addition, it focuses on the close link between renewable energy and the issue of energy access.

Figure 28 • Snapshot of India's renewable sector



Sources: IEA, 2011; GWEC, 2011.

Policy framework

Key policies

Electricity Act 2003

The Electricity Act 2003 provided the first comprehensive framework for the development of renewable power in India at the national level. It included essential elements of a preferential tariff for renewable-based electricity and a mandatory renewable purchase obligation (RPO) for power utility companies, especially at the state level (MNRE, 2011b). This led to the introduction of the Renewable Energy Certificate (REC) scheme in 2010 to enable state electricity distribution companies to fulfil their RPO by trading the RECs. Other national power policies that were mandated by the 2003 Act also had important features for renewables. The **National Electricity Policy 2005**

[15] This chapter only discusses renewable energy falling under the responsibility of Ministry of New and Renewable Energy, which excludes large hydro over 25 MW, which belongs to India's Power Ministry.

stipulated the progressive increase of RPO and mandated a competitive bidding process for their purchase by power distribution companies. The **National Tariff Policy 2006** required SERCs to fix the minimum percentage of state RPO and to set a preferential rate for renewable power in their states (Sharma, NK, 2012) (Chapter 4).

Jawaharlal Nehru National Solar Mission (JNNSM) 2010

The JNNSM was launched in 2010 as one of eight missions under the National Action Plan on Climate Change. It has three implementation phases:

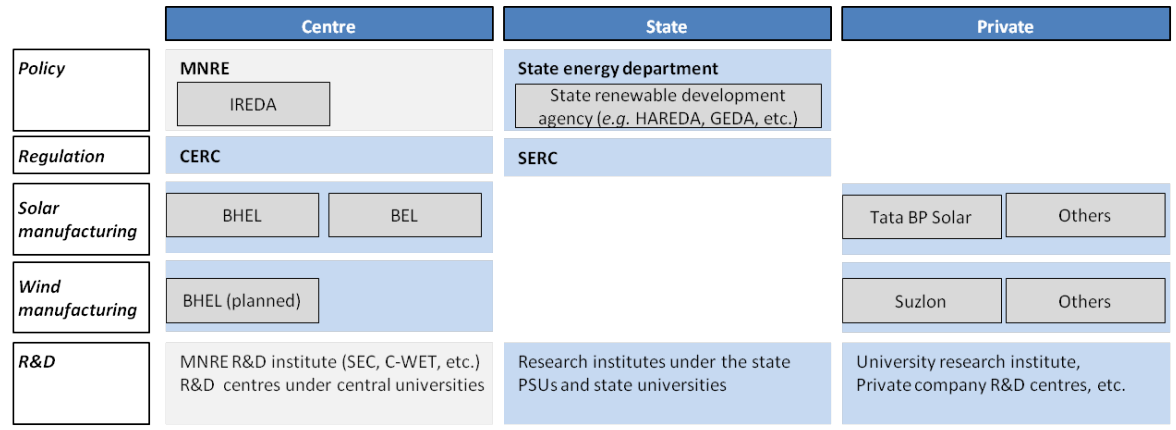
- **Phase 1:** 1.1 GW of grid-connected PV and 0.2 GW of off-grid PV by 2013.
- **Phase 2:** 4 GW of grid-connected PV and 1 GW of off-grid PV by 2017.
- **Phase 3:** 20 GW of grid-connected PV and 2 GW of off-grid PV by 2022.

To accelerate the growth of solar capacity, the JNNSM included a Solar Purchase Obligation (SPO) as part of the RPO and financial incentives, including capital subsidies and custom duty exemptions for "specific capital equipment, critical materials and components" (MNRE, 2009). It anticipates that solar power would achieve grid-parity by 2022 and coal thermal power parity by 2030. In this spirit, the amended **National Tariff Policy 2011** included 0.25% of SPO by 2013 and up to 3% by 2022 (MNRE, 2012a). The JNNSM has an ambitious goal to transform India into a global leader in solar manufacturing with a target of a 4 GW to 5 GW equivalent of installed capacity by 2020 (MNRE, 2009).

Key players

India has shown keen interest in renewable energy and was the country that established the world's first ministry dedicated to it. The Commission for Additional Sources of Energy (CASE) was created in 1981, which became the full-fledged Ministry of Non Conventional Energy in 1992, renamed the Ministry of New and Renewable Energy in 2006.

Figure 29 • Key players in the renewable sector



Sources: MNRE, 2012b; BHEL, 2012.

Ministry of New and Renewable Energy (MNRE)

The MNRE is the leading ministry for all matters relating to new and renewable energy including planning national policies and promoting development and deployment of new and renewable energy. It also undertakes initiatives harnessing renewable power and renewable energy in rural areas for lighting, cooking and motive power to, *i.e.* engines and vehicles. There are a number of R&D institutes under the MNRE, including the Solar Energy Centre (SEC) and the Centre for Wind Energy Technology (C-WET) which validates sites for wind projects (MNRE, 2012b). The MNRE also co-ordinates with state nodal agencies.

Indian Renewable Energy Development Agency (IREDA)

Under the administrative control of MNRE, IREDA was established in 1987 as a Non-Banking Financial Institution to provide financial assistance for renewable energy and energy conservation projects. IREDA selects projects for financial assistance and implements government incentive programmes including the Grid Based Incentive (GBI).

Regulatory commissions (CERC and SERCs)

As per the CERC Regulation, "Terms and Conditions for Tariff Determination for Renewable Energy Sources" of 2009, the CERC has the authority to set the generic tariff for renewable-based electricity from the following categories: wind, small hydro, biomass, solar PV, and thermal and non-fossil fuel-based co-generation (CERC, 2010).[16] This tariff serves as a benchmark for specific renewable power projects. At the state level, SERCs have rights to decide on state RPOs and renewable tariffs, in consideration of the CERC guideline (Chapter 4).

NTPC Vidyut Vyapar Nigam (NVVN)

The NVVN is a wholly-owned subsidiary of NTPC and a nodal agency for sale and purchase of grid-connected solar power under Phase 1 of JNNSM. It signs a power purchase agreement (PPA) with solar project developers up to a cumulative capacity of 1 000 MW for all projects, based on the tariffs fixed by the CERC. Then NVVN bundles the purchased solar power with coal-generated electricity from unallocated quota of NTPC to lower the overall cost. NVVN sells the bundled power to power utilities at the regulated tariff plus facilitation charges (NVVN, 2010).

State governments

The role of renewable energy varies among states. Generally, state governments approve all projects within their states including land acquisition and especially, water allocation for solar thermal projects. The state energy agencies run their own renewable programmes. Some states, including Gujarat and Karnataka, have their own independent solar policies and generation-based tariffs that are applicable upon signing a PPA with the state DISCOMs (CSTEP, 2010). Some states offer incentives to increase investment; for example, Maharashtra provides a single window clearance process for land acquisition (Sharma, A, 2012).

Private companies

There are a large and growing number of private renewable companies in India and some are already globally established. Their core competencies, in terms of manufacturing capacity, technological advancement and operational experience, will play a key role in developing India's renewable sector into world-class level. One of the major players in wind industry is Suzlon Energy. As a vertically integrated wind power company, it had the world's fifth largest wind turbine manufacturing capacity at the end of 2011 (Suzlon, 2012). India's wind manufacturing capacity is about 3.5 GW to 4 GW per year (MNRE, 2012a). Tata BP Solar is the largest solar company in India, created as a JV between Tata Power and BP Solar in 1989. It is a vertically integrated solar company, ranging from cell manufacturing, module assembly to balance of system (Tata BP, 2012). Central PSUs, such as BHEL and BEL, have also shown greater interest in the renewable manufacturing market (BS, 2011d).

Various international institutions also actively engage in India's renewable sector. In 2010, the International Finance Corporation (IFC) invested USD 10 million in India's independent solar power producer, Azure Power Private Ltd, which developed India's first utility-scale solar power

[16] In 2012, biogas based power project was added to the category.

plant of 2 MW (IFC, 2012). This was IFC's first solar project under its clean technology investment programme. India represents about 20% of the registered Clean Development Mechanism (CDM) projects and the Indian CDM projects increasingly invest in renewables.

Supply

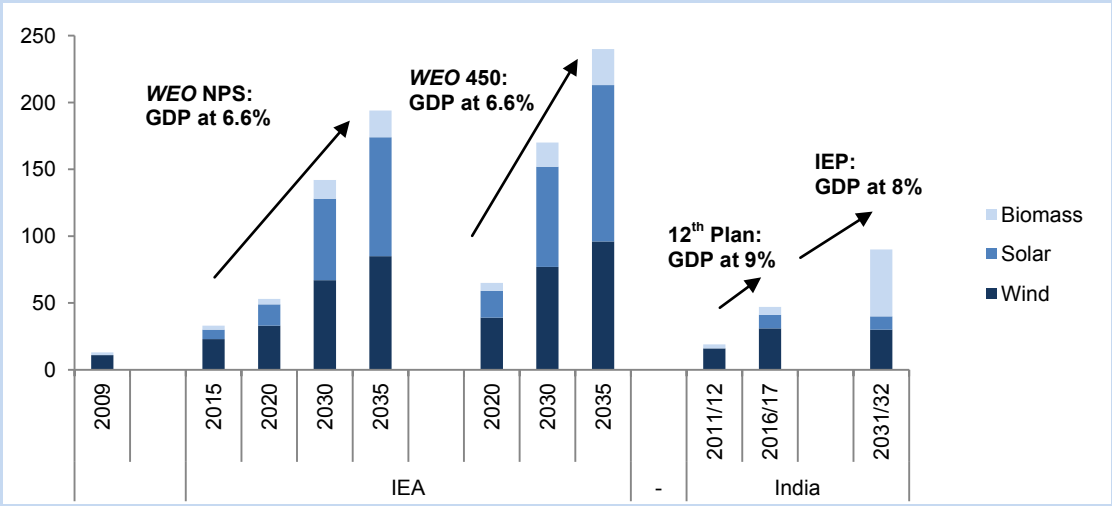
According to MNRE, India's total renewable potential for power generation (excluding solar) is estimated at 90 GW up to 2032 (PIB, 2012). Wind has the largest potential at 49 GW and Karnataka, Gujarat and Andhra Pradesh, in particular, are rich in wind resources. In the case of solar, India has excellent solar resources with an average 300 sunny days per year and yearly irradiation of 200 W/m^2 (IEA, 2011c). Currently western Rajasthan has the greatest irradiance and the north-eastern regions have the least (Sharma, NK, 2012).

Power generation

The installed capacity of renewable power generation was 23 GW in January 2012, which is equivalent to nearly 12% of total power capacity (MNRE, 2012a; CEA, 2012a). Wind comprises the largest capacity with 16 GW or 70% of total renewable capacity, followed by small hydro at 14% and bagasse co-generation at 9%. Solar PV with 481 MW capacity represented only 2% of total renewable installation. One notable aspect of renewable power in India is the high proportion of private ownership. At the end of 11th Five-Year Plan, private share of renewable power was 86%, compared to 14% of state. The central government, however, does not own any renewable power capacity (CEA, 2012a).

Box 11 • Projections for required renewable generation capacity: *WEO 2011* versus the 12th Five-Year Plan versus IEP (GW)

WEO 2011 projects that India's renewable power capacity will increase substantially from 2009 to 2035 under both the NPS and 450 Scenarios. The NPS suggests that India's renewable power capacity will reach 194 GW in 2035 at a CAGR of 11% from 2009 to 2035. Under the 450 Scenario, the total renewable capacity would be 241 GW in 2035 at a CAGR of 12%. In contrast, India's 12th Five-Year Plan targets a renewable capacity of 52 GW by FY 2016/17. The IEP presented a renewable scenario, assuming that all options for power generation were pushed to their limits. Since the IEP projections were prepared in 2006, they now appear rather conservative, especially in comparison with IEA scenarios and India's own. The IEP target of creating solar capacity of 10 GW for FY 2031/32 would be met by FY 2016/17 if the 12th Five-Year Plan achieves its target. The IEP puts more emphasis on biomass power generation than the IEA.



Note: solar capacity in *WEO 2011* refers to PV and CSP. Other renewables such as geothermal energy were not included here.
Sources: IEA, 2011a; PC, 2006.

The 11th Five-Year Plan targeted additional renewable capacity of 14.5 GW, of which 10.5 GW was for wind, 1.4 GW for small hydro and 2.1 GW for bio power. The target for solar was only 50 MW. All renewable power, especially wind, failed to achieve the targets, with the exception of solar, which added 478 MW. The causes for the shortfall were regulatory issues including delayed introduction of GBI and a slow clearance process for land acquisition and irrigation for wind and hydro projects (PC, 2010). However, solar capacity increased considerably, bolstered by JNNSM. In May 2012, MNRE announced that the installed solar capacity reached 979 MW, implying that the target for Phase 1 would be likely met as planned by 2013 (PIB, 2012e).

The 12th Five-Year Plan (FYP 2012-17) envisages an ambitious capacity expansion of renewable power of nearly 30 GW. Wind will add 15 GW, solar 10 GW, small hydro 2.1 GW and bio power 2.7GW (PIB, 2012f). This expansion requires a high annual growth for renewables at a CAGR of 18%. Particularly, solar power needs to grow at a CAGR of 85%, or nearly 1.9 GW new additions per year. If these capacity targets are met, the share of renewables could increase to 16% of total installed capacity by the end of 12th Plan.

Regional distribution

India's regional distribution of installed renewable power capacity underlines different degrees of progress among states. Wind is concentrated in a handful states, namely Tamil Nadu (41% of total wind capacity), Gujarat (17%), Maharashtra (16%), Karnataka (12%) and Rajasthan (11%) (MNRE, 2012a). Tamil Nadu's large wind capacity is derived from the state government's early efforts to promote wind energy in the 1990s as well as the strong presence of wind turbine manufacturers/suppliers situated in the state (Jagadeesh, 2000). For grid-connected solar, Gujarat (50%) and Rajasthan (33%) represent almost 83% of India's total capacity (MNRE, 2012a). The uneven regional distribution of renewable capacity is attributable to both different resource potentials and policy initiatives among states. However, the disparity of renewable capacity among states could hamper the development of state RPO as states with low renewable capacity would likely less pursue setting an obligatory purchase quota for renewable electricity. This could eventually hinder the emergence of an all-India REC market.

Energy access

As stated earlier, *WEO 2011* notes that 289 million or 25% of the Indian population had no access to electricity in 2009. *WEO 2011* NPS estimates that this would decrease to 154 million or 10% of the population in 2030. There were also 836 million people, or 72% of the population, without access to clean cooking stoves and/or facilities in 2009. This share would decrease to 63% of the population or 778 million in 2030. These rates are among the highest in the world. India ranked 34th out of 64 developing countries in the IEA Energy Development Index (IEA 2012c). Even some countries with a lower per-capita income than India, for example Yemen and Vietnam, ranked higher than India; this reflects a key challenge for India's energy sector. Energy demand for a considerable share of the population remains unsatisfied and will stay this way for a long time.

The majority of the population in energy poverty reside in rural areas, which highlights the imbalance of socio-economic development between rural and urban areas. The recent India National Sample Survey (NSS 66th) indicates that the absolute monthly expenditure for fuel and lighting for an urban resident was much higher than that of their rural counterpart in FY 2009/10. Urban fuel spending accounted for a lower share of total expenditure at 6.94%, compared to the rural resident at 8.03%; hence, the energy bill places a heavier economic burden on rural residents. The opportunity cost means less financial resource is available for human capital development. For instance, the average share of education in total expenditure in rural areas is 3.59% vis-à-vis 8.09% in urban areas (MOSPI, 2011).

Rural electrification

Rural electrification has been considered key to accelerating economic growth, employment, elimination of poverty and human development (MOP, 2012a). The Electricity Act 2003 mandated the formulation of a national rural electrification policy and India's major rural electrification programme, RGGVY, started in 2005. Under this scheme, a capital subsidy of 90% of the total project cost for rural electrification is covered and the remaining 10% of the cost is provided by REC as a loan. For BPL households, the total cost for connection is covered. The unit of electrification under RGGVY is measured by individual villages; if 10% of the village population has access to electricity, the programme uses this threshold percentage as a marker for designating the village as "electrified." Yet, electrification does not imply a steady, minimum level of electricity supply (Chapter 4).

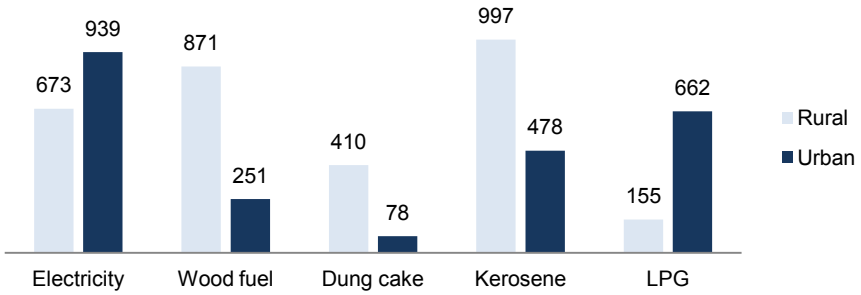
According to the Ministry of Power, as of July 2011, 572 344 out of a total 593 732 villages in India were electrified, implying that 96% of the country's villages have access to electricity (MOP, 2012a). Out of the remaining un-electrified villages, 10 000 villages are located in remote areas and are to be electrified through schemes promoted by MNRE.

The JNNSM also has a strong focus on providing solar energy in rural areas. As solar power can be stand-alone and close to the residents in remote areas, off and mini-grid solar power is an economical option that does not necessitate grid-connection. As such, some argue that JNNSM should have focused more on off-grid solar PV capacity expansion, which currently targets to reach 2 GW by 2022. Instead, JNNSM is largely promoting large, utility-scale, grid-connected PV capacity (CSTEP, 2010). In addition to the JNNSM scheme, MNRE promotes power generation programmes based on other renewable sources, including small hydro, biomass and bagasse cogeneration.

Access to other modern energy

The rural population in India relies heavily on traditional biomass for their daily activities due to a lack of access to modern energy and low affordability in rural areas (Figure 30). However, the consumption of traditional biomass for cooking, heating and lighting causes serious health, environmental and safety problems, especially for women and children who often prepare meals and bear the burden of collecting traditional fuels (PC, 2006). Thus, providing modern, clean energy would bring a considerable improvement of quality of life for rural residents.

Figure 30 • Fuel consumption in rural and urban India (per 1 000 people)



Source: MOSPI (2011).

The MNRE implements various programmes including solar water heating systems, solar lanterns, solar steam cooking systems and biomass gasifiers to replace conventional fuels. The National Biomass Cookstoves Initiatives (NBCI) is also one of the major policy programmes of the MNRE, which aims to make biomass consumption more efficient and cost effective, as users are usually in the poorer section of the community (MNRE, 2012a). The rural population of India is heavily

dependent on subsidised kerosene and consumes nearly twice (0.51 litre per month) as much as urban residents (0.29 litres per month) (MOSPI, 2011). The replacement of subsidised kerosene with renewable energy would bring financial benefits to the government.

Issues

Infrastructure

To support growing renewable energy, the expansion of transmission infrastructure, for both intra and inter-state, is required. However, heavily indebted state power utilities will face considerable challenges finding funds to invest in their transmission network (FE, 2012f).

Similar to other energy projects, land acquisition has been identified as a major barrier for renewable projects across India. The lead time to acquire land can range from 6 to 12 months to more than a year depending on the case (World Bank, 2010). The World Bank proposed a single window clearance for all approvals. In the case of grid-connected projects, the proximity to transmission and distribution networks is important. As more renewable projects are executed, the competition for suitable land is becoming tougher and also drives up capital costs.

Coupled with land issues, water is crucial as well. For solar PV projects, especially large-scale projects that are increasingly situated in the desert, dust is a serious problem which can reduce the energy output by up to 30% within a few weeks of installation (Sharma, NK, 2012). As such, water is necessary to clean the solar panels, and its availability close to the project site is essential for optimal operation of solar installation. The MNRE recognised the need for a regulatory process to obtain land acquisition permits and a quota for the required quantity of water from state government. It suggested regular interaction with state government and regulatory authorities, but the actual effect on accelerating the process remains to be seen (MNRE, 2011a).

Domestic content

As previously mentioned, one of the key objectives of JNNSM was to promote India as a leading global solar manufacturer. The JNNSM requires that to be selected for the JNNSM scheme during FY 2011/12 all solar PV projects should use 100% of the cells and modules manufactured in India, and 30% of local content ensured in all plants/installations for a solar thermal project (MNRE, 2010). For a thin film project, local content is not mandatory.

Concern over this requirement is twofold. Some project developers believe that domestic content obligation should not be introduced, at least for Phase 1, to ensure that high quality equipment at competitive rates will be installed and commissioned successfully to achieve the target of 1.1 GW by 2013 (World Bank, 2010). They argue that India does not yet have sufficient knowledge or expertise in operationalising large size solar power plants, and there should be a sufficient learning period to obtain the necessary experience. Others argue that domestic content could slow down the actual expansion of India's solar capacity due to the supply bottleneck (E&Y, 2010).

Second, there is a trade-related issue. Recently, American solar companies contested India's local content provisions, claiming they were in violation of the WTO rules. The MNRE responded that it is not a WTO violation, as the JNNSM scheme is essentially procurement by the government through a designated entity, NVVN, and India is not a signatory to the Government Procurement Agreement under the WTO (Hindu, 2012b; ET, 2012h).

The domestic content requirement is probably derived from India's tradition of import substitution strategy. However, it should be carefully assessed to ensure that domestic content requirement does not hinder the growth of solar capacity and that it leads to the building of

domestic manufacturing capacity in a meaningful way. To be globally competitive, considerable investment in R&D programmes, as well as human resource development is necessary in addition to local content requirements. The experience of India's wind industry, which acquired global competency without a domestic content obligation, can offer useful lessons.

Investment

Policy efforts by the Indian government to encourage investment in the renewable sector should be recognised. Various incentives are provided including accelerated depreciation, concessional custom duty, excise duty exemption and income tax exemption. For IPPs, GBI of INR 0.5/kWh (with a ceiling of INR 62 000/MW) and preferential tariffs are provided, while GBI and accelerated depreciation are mutually exclusive (MNRE, 2012a). However, some issues relating to pricing and PPAs should be addressed with a view to their possible implications for investment. The competitive bidding process for renewable power intends to motivate developers to be more innovative and efficient. While generic tariffs were set by CERC in FY 2010/11 at INR 17.91/kWh for solar PV and INR 15.31/kWh for solar thermal, the actual average tariffs for solar projects bid in 2010 were INR 12.20/kWh and INR 8.78/kWh in 2011 (MNRE, 2012a). Due to falling bidding prices, CERC set generic tariffs for FY 2012/13 at INR 10.39/kWh for solar PV and INR 12.46/kWh for solar thermal projects (CERC, 2012). Although falling prices could be attributed to technological innovation and capital cost reduction, it remains to be seen whether such tariffs are realistic and if developed projects would be viable upon the completion of installation. Cases in Gujarat indicate that project developers who won the bidding in 2009 are now having difficulties fulfilling their PPAs with power distribution companies within the given deadline (PVI, 2011; BS, 2011e). Some suggest that more thorough criteria for technical experience and financial capacity should have been required for project bidders for at least Phase 1, rather than emphasising the lowest tariffs (World Bank, 2010).

There is little doubt that India's renewable sector is ready to thrive, with strong support from the government and active private sector participation. Renewable energy would play a critical role to solve some of India's energy problems and to improve the quality of people's lives. Ambitious policy targets would help build investors' confidence in the future of India's renewable sector. However, effective implementation requires timely regulatory clearance and available human and manufacturing resources. Moreover, an adequate and meticulous learning process should be in place so that India can internalise the necessary experience and expertise. As one Indian solar entrepreneur put, "let's walk before we can run" (WSJ, 2009).

Key message • Renewable energy is becoming an essential part of India's energy mix, and is essential to enhance energy security and provide universal energy access to the population, as well as to mitigate climate change:

- **supported by strong government initiatives, renewable energy, mainly wind and solar, will grow considerably in the near future;**
- **a considerable proportion of the Indian population lacks access to clean and modern energy, implying that a significant increase of energy demand is still on the way. Effective renewable energy policies, specifically targeting rural areas, can help ensure that demand is met in a sustainable way; and**
- **investment barriers, including administrative processes and inadequate supporting infrastructure, should be removed and a clearer strategy is needed, both to increase India's renewable capacity and to build a competitive renewable industry.**

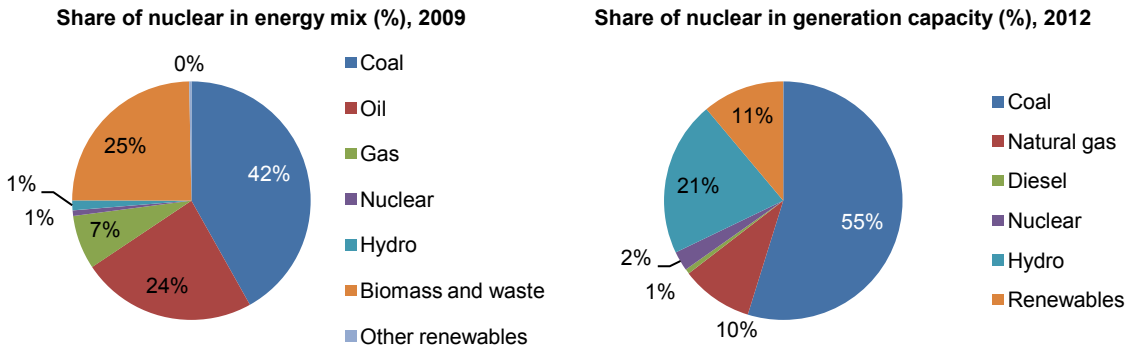
8. Nuclear sector

India has had a long commitment to nuclear energy since the establishment of the Atomic Energy Commission in 1948 and the Department of Atomic Energy in 1954. India was one of the few countries to achieve the complete fuel cycle – from uranium exploration, mining, fuel fabrication and electricity generation, to reprocessing and waste management – by the 1970s. (Sethna, 1979). The country's nuclear industry is viewed with strong pride and considered an instrument to achieve "energy independence," "fossil fuel free future" or "self-sufficiency" (Kalam, 2011; Sethna, 1979).

However, India's nuclear power capacity remains small despite continuous commitment and advances in indigenous technology. India's current nuclear generation capacity is 4.8 GW and ranks 13th in the world, which account for only 1.2% of global nuclear capacity (WNA, 2012). The share of nuclear was 1% in India's total energy mix in 2009 and 2% in electricity generation capacity in 2012 (Figure 31). This is the result of India's long isolation from the global nuclear energy regime and its emphasis on a thorium-based nuclear development programme.

Nuclear energy could play a critical role in addressing India's energy challenges, meeting massive energy demand potentials, mitigating carbon emissions and enhancing energy security through the reduction of dependence on foreign energy sources. This is why India remains devoted to nuclear power even after the Fukushima-Daiichi accident in 2011 (PMO, 2012). This chapter discusses India's policy framework for the nuclear sector, provides an overview of nuclear capacity and prospects and key issues.

Figure 31 • Snapshot of India's nuclear sector



Sources: IEA, 2011a; CEA, 2012a.

Policy framework

Key policies

Atomic Energy Act 1962

This act empowers the central government with the exclusive authority for all nuclear-related activities, including controlling its uranium and thorium resources, developing atomic energy industry, setting tariffs for electricity generated from nuclear plants and waste disposal (DAE, 1962).

Three-Stage Nuclear Power Programme

India's three-stage nuclear programme was approved by parliament in 1958 and developed by Dr. Homi Bhabha, the first Chairman of the Atomic Energy Commission, who is widely known as

the father of India's nuclear programme (Suryanarayan, 2010). The three-stage strategy aimed to utilise India's vast thorium reserves, an approach that is still valid today (NPCIL, 2008):

- **First stage:** Pressurised Heavy Water Reactors (PHWRs), fuelled by natural uranium.
- **Second stage:** Fast Breeder Reactors (FBRs) backed by reprocessing plants and plutonium-based fuel fabrication plants, fuelled by mixed oxide of Uranium-238 and Plutonium-239. With sufficient inventory of plutonium, thorium can be converted to fissile isotope U-233.
- **Third stage:** Thorium generated U-233 cycle using Advanced Heavy Water Reactor (AHWR), which generates a large amount of energy.

India has so far reached the commercial maturity of the first stage and is moving into the second stage (NPCIL, 2008). The country's first-of-its-kind 500 MWe prototype Fast Breeder Reactor (PFBR), which was scheduled for completion in 2011, is under construction at Kalpakkam, Tamil Nadu and expected to start operation by early 2013 (Raj, 2009; DAE, 2012a; ET, 2012c). Nuclear capacity is envisioned to reach 20 GW by 2020. India also aims to develop a thorium-based demonstration plant and a full prototype before 2050.

US-India Civil Nuclear Agreement 2008

Until recently, India has isolated itself from the global nuclear industry and technology. The origin of this isolation goes back to when India conducted its first nuclear weapon test in 1974 and another underground test in 1998. India has remained outside of the Non-Proliferation Treaty (NPT), viewing the NPT regime as infringement to its sovereignty.[17] This conviction has resulted in enormous repercussions, both geopolitical and economic, including the exclusion of the Indian nuclear industry from Nuclear Suppliers Group (NSG), a global regime banning supply of nuclear fuel, technology and equipments to non-signatories of the NPT. Without access to mainstream nuclear materials and technologies, and due to its thorium-based nuclear programme, India's nuclear industry has experienced rather limited development as a result.

The India-US nuclear deal in 2005 was a breakthrough in India's nuclear programme. The joint statement between President George W. Bush and Prime Minister Manmohan Singh was agreed in 2005, but this deal soon stirred domestic and international criticism, especially in the context of the United States' anti-proliferation policy. In 2008, the NSG granted a waiver to India, allowing it access to civilian nuclear technology and nuclear fuel from other countries, thus ending India's long isolation from the international nuclear market. Subsequently that year, the US-India Civil Nuclear Agreement 2008 (called "123 Agreement" in India) was ratified in the United States. A number of bilateral cooperation agreements between India and other countries have since followed, including France (2006), Russia (2010) and the United Kingdom (2010) (DAE, 2012c).

The Civil Liability for Nuclear Damage Act 2010

As part of the agreement between the United States and India in 2008, the United States asked India to enact a civilian liability law to clearly define the scope of civil liability in case of a nuclear incident. This measure was proposed to protect private nuclear companies, especially those from the United States, that engage in India's nuclear sector as an outcome of the agreement. The act defined the compensation burden on the operator and the liability of the central government for nuclear damage (TGOI, 2010). However, the Civil Liability Act was criticised because it holds the nuclear suppliers liable for a nuclear accident, which is a "sharp deviation" from the international practice that only

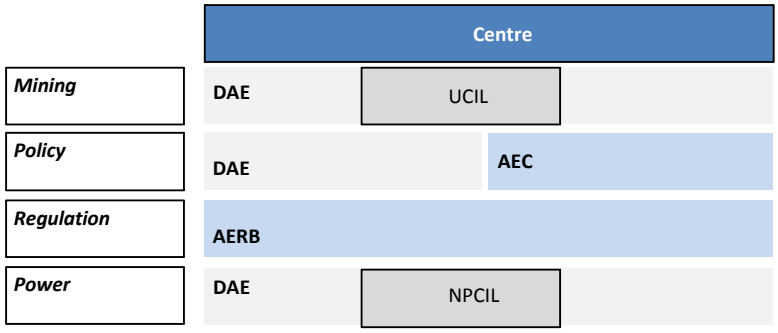
[17] This position was reiterated in Prime Minister's speech in 2009. "It is of no question that India joins the NPT as a non-nuclear-weapon state" (PMO, 2009). Here, a nuclear-weapon State (NWS) is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967 (UN, 2010). NPT prohibits a non-NWS from receiving whatsoever of nuclear weapons or manufacturing or acquiring nuclear weapons or other nuclear explosive devices.

nuclear operator takes responsibility in case of an accident (CFR, 2010). For instance, the act allows the operator the right of recourse against nuclear suppliers if the incident was caused by "supply of equipment or material with patent or latent defects or sub-standard services" (Hindu, 2010).

Key players

As per the Indian Constitution, the central government has the sole responsibility for nuclear energy and mineral resources necessary for its production. However, similar to other sectors, state governments have the authority over land use within their jurisdiction, which affects the development of nuclear energy to a certain degree.

Figure 32 • Key players in the nuclear sector



Source: DAE, 2012c.

Department of Atomic Energy (DAE)

Under the direct charge of the prime minister, the DAE is headed by a secretary and is exclusively in charge of all activities relating to nuclear energy in India. DAE supervises four PSUs, including the **National Power Corporation of India Ltd (NPCIL),** India's only nuclear power generation company; the **Bharatiya Nabhikiya Vidyut Nigam Ltd (BHAVINI)** in charge of developing FBR's under the 2nd Phase of India's nuclear programme; and, the **Uranium Corporation of India Ltd (UCIL)** for uranium mining and procession.

Two key players oversee DAE's activities: the **Atomic Energy Commission (AEC),** which was established in 1948 and empowered with full executive and financial powers in 2010. Its main responsibilities are to formulate the policy of DAE and to prepare the DAE's budget (DAE, 2010). The secretary of the DAE is at the same time an ex-officio Chairman of the AEC. The other full-time members of the AEC are appointed on the recommendation of the Chairman and approved by the prime minister. The other player, the **Atomic Energy Regulatory Board (AERB),** is an independent regulatory body and is responsible for the licensing and regulation of all activities related to nuclear energy.

Supply

India has limited uranium reserves of 80 000 tonnes or 1.5% of the world's recoverable reserves; the resources are of low grade, however, and located in remote, insecure areas in the eastern states (Surendra, 2008). Based on India's current uranium demand of 937 tU, the uranium R/P ratio would be about 85 years (WNA, 2012). However, India is known to have the world's fourth largest thorium resource, which however, requires a complex process to convert it to fissile material (WNA, 2012).

Installed capacity and targets

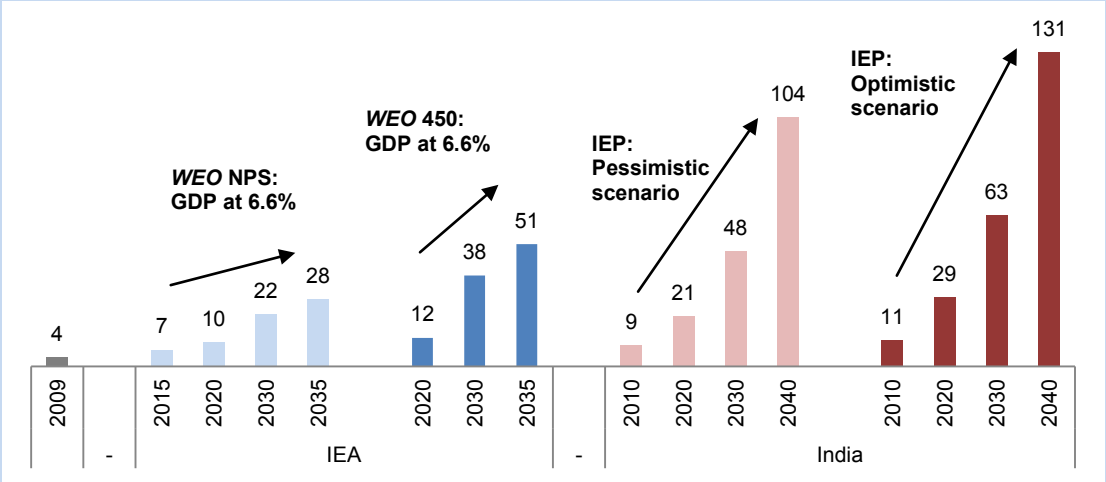
The earliest nuclear power plants were purposely constructed along the western, northern and southern coasts of India, as these regions are far from coal mines and coal transportation was

difficult at the time (Sethna, 1979). India has 20 nuclear reactors that operate with a total of 4.8 GW capacity (CEA, 2012a). An additional 4.8 GW capacity is under construction, including two reactors in Tamil Nadu, two in Gujarat and the remainder in Rajasthan (DAE, 2012a). In terms of generated electricity, nuclear represented 4% of total generation in FY 2011/12 (CEA, 2012g).

The 11th Five-Year Plan targeted an additional 3.38 GW of nuclear capacity, of which only 0.88 GW was achieved. This is due to delayed construction of nuclear plants because of public protest and also safety audits undertaken after the Fukushima accident (BS, 2011c). The 12th Five-Year Plan envisages increasing nuclear capacity by 2.8 GW (MOP, 2012a).

Box 12 • Projections for required nuclear generation capacity: *WEO 2011* versus IEP (GW)

WEO 2011 projects that nuclear power capacity will grow substantially from 4 GW in 2009 to 28 GW under the NPS and to 51 GW under the 450 Scenario in 2035, implying a CAGR of 7.6 % under the NPS and 10.2% under the 450 Scenario. However, nuclear share in total installed capacity in 2035 will still remain small at 4% under the NPS and 7% under the 450 Scenario under which nuclear energy has a potential to play a greater role in reducing carbon emissions. While the IEA scenarios project a considerable increase of nuclear capacity, they appear conservative in comparison to the Indian scenarios. In the IEP Pessimistic scenario, India's nuclear capacity will grow to 104 GW in 2040. Under the Optimistic scenario nuclear capacity is estimated to even reach 131 GW in 2040, based on the IEP assumption that all conditions for technological achievements, uranium exploration and production, and equipment and fuel imports are met. Given that the capacity was 4.8 GW in March 2012, much lower than even the IEP Pessimistic scenario with 9 GW for 2010, the longer-term prospect for nuclear in India's energy mix is uncertain at this point in time.



Sources: IEA, 2011a; PC, 2006.

Plant Load Factors (PLF)

It is noteworthy that Indian nuclear plants have suffered from low PLF due to a shortage of fuel supply. PLF was as low as 40% to 50% in FY 2006/07, before India agreed on the nuclear deal with the United States (BS, 2010). The import situation eased after the NSG waiver in 2008, and average PLF improved to 65% in FY 2010/11 and to 76% in FY 2011/12 (CEA, 2012g). However, considering that nuclear generation is generally for base load, this is still a relatively low level. More interestingly, nuclear plants running on imported fuel had nearly 95% of PLF, much higher than the 67% PLF of plants operating on domestic fuel (DAE, 2012a). This is attributable to delays in some projects for uranium mining and also to a labour-management dispute of UCIL, India's only uranium mining entity (TOI, 2012b). India will need to improve the reliability of uranium supply, especially domestic, to fully utilise its existing nuclear power capacity.

Issues

Technological challenge

Currently, India remains "the only country currently developing the potential of thorium fuel cycles" (IEA, 2010b). Against the backdrop of the Fukushima-Daiichi accident, India argued that thorium-based nuclear generation is safer than uranium-based, with "a passive cooling system that operates naturally if the reactor shuts down"(Guardian, 2011). This commitment might bring more international attention to thorium-based technology. However, thorium fuel cycles have not yet been fully demonstrated at large scale and several important technical challenges remain, particularly in the reprocessing of thorium fuel (IEA, 2010b). After nearly half a century of commitment to a thorium-based nuclear programme, India is now entering into the second stage of operating the fast-breeder reactor. The feasibility of its vision of deploying prototype thorium plants by 2050, assuming no technical barriers in the way, remains challenged. As such, India should carefully assess what different roles thorium- and uranium-based nuclear energy can play in resolving short and long-term energy supply.

Anti-nuclear public sentiment

The Fukushima-Daiichi accident resulted in growing concern over the safety of nuclear plants in India (BBC, 2011). The construction of a nuclear plant in Kudankulam, Tamil Nadu, brought the issue directly into the public domain in 2012. The plant consists of two reactor units, each with 1 GW capacity, which could help ease power shortages in the region (DAE, 2012b). However, final completion was delayed owing to public protests; residents, relying on fisheries within the vicinity, feared that the nuclear plant would damage the surrounding ecosystem and their fishing activities, and endanger the local community (ET, 2012d). The central government offered a considerable compensation package of reportedly INR 5 billion (≈ USD 90 million) to local areas for infrastructure development (ET, 2012e). Public fear is not limited to nuclear plants, but also includes concerns about India's uranium mines. In 2011, the discovery of a uranium reserve in Maghalaya, located in north-east region, led to fierce opposition from the local community on the grounds that "it would degrade the environment, cause health hazards besides open up flood gates for influx of outsiders into the predominantly tribal state" (TOI, 2011a).

The public opposition to nuclear power will most likely continue and site selection and construction will become even more lengthy and costly. Therefore, for nuclear sector development, the government must ensure transparent and thorough safety measures and effective public communication.

Key message • Nuclear energy could enhance India's energy situation greatly; however, its thorium-based strategy requires a significant technological breakthrough:

- **despite policy commitments and an ambitious vision, nuclear's share in India's energy mix remains small;**
- **in the short term, India needs to improve fuel supply for existing plants in order to raise plant load factors;**
- **India also needs to place more emphasis on timely and well developed communication to gain public support for nuclear energy, especially from communities in close proximity to plants and mines; and**
- **with slower-than-expected development and deployment of thorium technology, the role and time frame of India's thorium-based strategy should be revisited in terms of long-term energy security and sustainable development.**

9. Challenges

India has experienced impressive economic growth since its reforms in 1991. Since that time, the country has witnessed a considerable reduction in poverty and vast improvements in the standard of living. India now has an economy with a dynamic private sector and a burgeoning middle class, however, faces growing challenges to maintain its economic growth. In the first quarter of 2012, the Indian economy grew by 5.3%, the lowest in almost a decade. With surging trade and budget deficits, and a depreciating currency, widespread concern exists over whether India could see the return of a "1991-like crisis"(FT, 2012). To revive the vibrancy of its economy, a well-functioning and financially-sound energy sector is critical to allow India to sustain further economic growth and reduce negative impacts on its public finance. This will require an accelerated transition to an energy sector based on market economy.

The previous chapters show two major trends appearing in India's overall energy sector: first, a serious energy shortage across different fuel sectors, ranging from coal, gas, and oil to uranium. The deficiency of these fuels is resulting in a considerable shortage of electricity, which hampers economic and social development. Second, there is an increasing need to import more energy as a result of the country's stagnating domestic production. Crude oil used to be the main energy import, but India now needs to import greater volumes of coal and gas as well. However, due to considerable disparity between domestic and international prices for these fuels, actual imports might not take place, or will take place to a lesser degree then the actual fuel shortage might require. Moreover, increasing fuel imports will have negative implications on India's financial condition.

To effectively address these two trends, India needs a functioning energy market, in other words, a system where national energy demand can be met by timely and adequate investment in a sustainable way and business entities operating in the energy market are commercially viable. Six major challenges are identified in this paper, which need to be resolved to create a functioning energy market: **players, pricing, investment, implementation, policy and political will.** These challenges should be addressed urgently by Indian policy makers, as the deteriorating energy situation can seriously weaken the country's prospects for a robust national economy and improved daily life of its citizens.

Players

The capability of individual players to carry out their business objectives is as important as the overall business structure that shapes and limits the scope of their operations. This was well expressed by prominent Indian energy expert, Professor Rajendra Pachauri, "building blocks of the energy sector, namely the enterprises producing electricity, petroleum products or other forms of energy have to be upgraded to healthy and vibrant business entities" (Pachauri, 2005). A number of core competencies need to be improved for India's energy players.

Financial capacity

This is the most important capacity required for players to fulfil their primary business objective – delivering energy profitably to consumers. However, many of India's energy players suffer from financial weakness, with limited financial resources and restricted investment ability. There are two categories of companies in this regard.

First, there are companies that are in debt due to the institutional compulsions overriding their business interests. One example is the state electricity distribution companies that are obliged to sell electricity to certain customers at prices lower than generation costs without being sufficiently compensated through direct transfers from state governments.

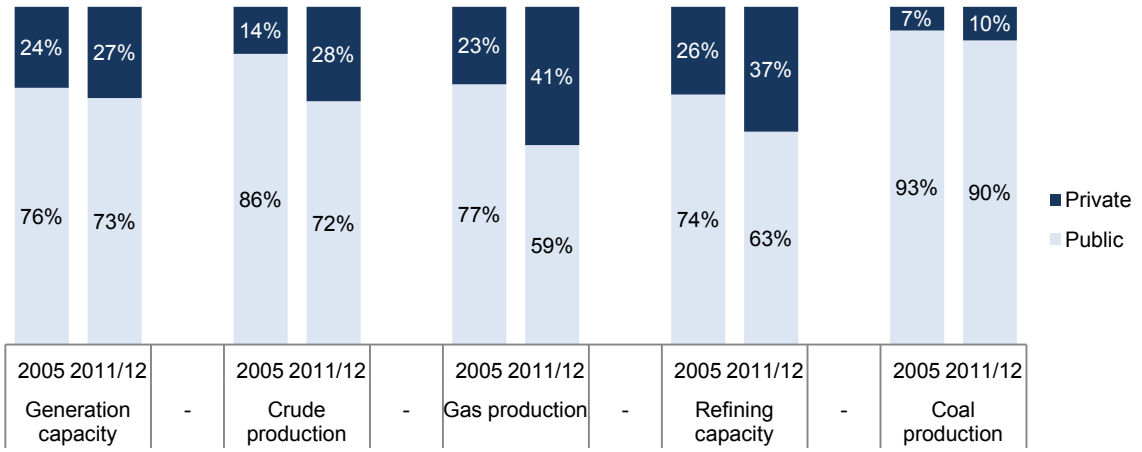
At the same time, financial weakness is derived from systemic failure to enforce legitimate revenue collection. Many state utilities lose a significant portion of their revenue due to this reason (Chapter 4). The deteriorating financial status of state DISCOMS has been one of the grave concerns for power producers and fuel importers as it calls into question whether they will actually receive payments for their electricity. Another example are oil marketing companies (OMCs), who sell certain petroleum products at government regulated prices, at which they cannot recover their costs. Although OMCs generate profits on their balance sheet, without discounted crude purchases from government-owned upstream companies and government grants and oil bonds, their business appears to make losses (Chapter 6).

The second case is when business entities are profitable but underperforming. The upstream companies in the oil and coal sectors are a case in point. ONGC, OIL and CIL all sell their products at a much lower price compared to international prices in order to keep the end-use prices low. In the short term, sacrificing these companies' potential profits can make sense to curb inflationary effects and provide affordable energy to the Indian people. But in the longer term, the lack of sufficient investment by these companies due to insufficient financial resources could jeopardise the reliable energy supply to the nation.

Management autonomy

India's energy sector is dominated by public sector companies or PSUs (owned by the central and state government). Based on a similar overview on ownership made in the *WEO 2007*, some parts of the energy sector have made very little progress in attracting private investment since 2007 (Figure 33).

Figure 33 • Private participation in India's energy sector, 2005 and FY 2011/12



Sources: for 2005 data, IEA, 2007 and for FY 2011/12 data, previous chapters of this report.

As PSUs are owned and supervised by the government, they have rather limited autonomy over management and investment decisions. The split goal between political priority and commercial interest often creates confusion in the roles and focuses of PSUs. For instance, gasoline prices were officially deregulated in 2010, but in reality, OMCs cannot revise the price without government consultation. Furthermore, there have been cases in which PSUs failed to deliver timely investment decisions, while waiting for government approval. One of the problematic areas is overseas upstream investment for oil and gas resources. ONGC/OVL needs a government approval for investment decisions above a certain threshold which is not always received in a

timely manner. The threshold of INR 3 billion (≈ USD 55 million)[18] is small compared to the size of a typical deal in the global upstream sector (TOI, 2011c). More operational autonomy should be allowed to enable Indian oil PSUs to compete with their international rivals.

Finally, no management mechanism exists to penalise companies for underperforming or breaching business contracts, including the fuel supply agreement. Nor are sufficient incentive measures in place. To build operational accountability and autonomy within the company, a more strategic human resource management mechanism – including an internal promotion and reward structure – should be adopted in public enterprises. A proper separation of ownership and management can enhance the corporate autonomy that is required to make investment decisions based on commercial assessment at an opportune moment.

Other expertise

Technical and managerial expertise of Indian energy companies needs to improve. Obtaining the latest technology for upstream investments in coal, oil and gas to boost domestic production should be the top priority. Additionally, more focus should be given to the level of operation and management. Providing continuous training and other human capital development programmes to employees could enhance the internal knowledge base of the company, which is essential to adapt to a fast changing technological and business environment and to successfully implement and manage projects. This is particularly relevant in the renewable sector, which is fast expanding and in need of skilled personnel.

Pricing

Pricing is the key to ensure the commercial viability of business entities and to attract investment into each fuel sector. The importance of pricing was recognised by the deputy chairman of the Planning Commission: "The energy challenge in the Twelfth Plan is how to deal with a situation in which global energy prices will be high and the cost of alternative energy sources will also be high. Our ability to grow rapidly in this environment depends critically on our ability to transmit the high energy prices to energy users in the economy, rather than keep the prices artificially low" (Ahluwalia, 2011).

Commercial viability

Proper pricing that ensures long-term business viability should be in place. As described earlier, some parts of the energy sector in India keep end-user prices too low: for instance, power tariffs for agricultural consumers and subsidised cooking and transport fuels. The problem is that these subsidies are untargeted and ineffective in terms of benefiting the poor, while the overall price level is not sufficient for companies to recover costs. The price should be set at the level where business stays viable and generates adequate financial resources for investment, and at the same time, subsidies should be directly channelled to those who are in need. The pricing mechanism needs to be rationalised holistically, as the current mechanism has the balloon effect of shifting distortion from one sector to another along the entire energy value chain. Furthermore, a proper enforcement mechanism for revenue collection is undoubtedly crucial, as shown in the power sector where institutional failure to deter any illegitimate power usage and to actually collect the payments from consumers results in near-insolvency of state utilities (Chapter 4).

[18] It was reported that the government is considering giving ONGC Videsh powers to decide investments of up to INR 30 billion. However, it has not been officially announced.

Rigid tariff setting mechanism

Theoretically, energy prices should be supervised and adjusted in a timely manner and adequately by independent regulators to reflect changing costs. However, in India, regulators including CERC and SERCs operate in a very rigid way due to political considerations. This jeopardises the operational profitability of companies. The UMPP Mundra project is one good example of how the financial viability of the investment, as well as the credibility of regulators as an independent actor was put into question due to the inability to pass on the unexpected increase of imported fuel under the PPA regime approved by CERC (Chapter 4). Tata Power, the operator of the Mundra project, is reportedly running the plant on lower quality coal and plans to appeal to the government for a tariff revision (FE, 2012h).

In the petroleum and gas sector, where there is no independent regulator and prices are set by government, price changes appear to be even more rigid. Despite a considerable increase of the international crude price, India's retail prices for these four products have been adjusted very marginally by the government, escalating the revenue losses to OMCs (Chapter 6). When it comes to those officially deregulated sectors including gasoline and coal, prices are also de facto determined by the government through its ownership of oil and coal PSUs.

The ability to pass on the fluctuating fuel costs in a timely manner to the power tariffs is particularly important to ensure investment in upstream coal and gas sector as well as in LNG import infrastructure. Considering that India is a price taker in the international energy market, a flexible pricing mechanism is also essential to increase the acceptability of greater imports of these fuels. Furthermore, the inflexible pricing mechanism has led to distortion of fuel choices by consumers. For instance, subsidised fuel like kerosene and diesel result in artificially high consumption and impede the investment in cleaner energy that is more costly.

No signalling function

Due to a pricing mechanism that is disconnected from the global market conditions, it is difficult to use pricing as a policy instrument for demand-side management. The artificially low prices provide little incentives for more efficient energy use, especially in circumstances where high international prices should result in the reduction of domestic consumption. Furthermore, since some energy prices are set in an ad hoc manner by political decision, they provide little certainty or clear direction for future investment. For instance, gas pricing under the NELP regime was set by the government in 2009, and is only to be revised in 2014 (Chapter 6). It would be highly challenging for potential investors to make a decision in the gas sector without proper knowledge of pricing vis-à-vis increasing project costs.

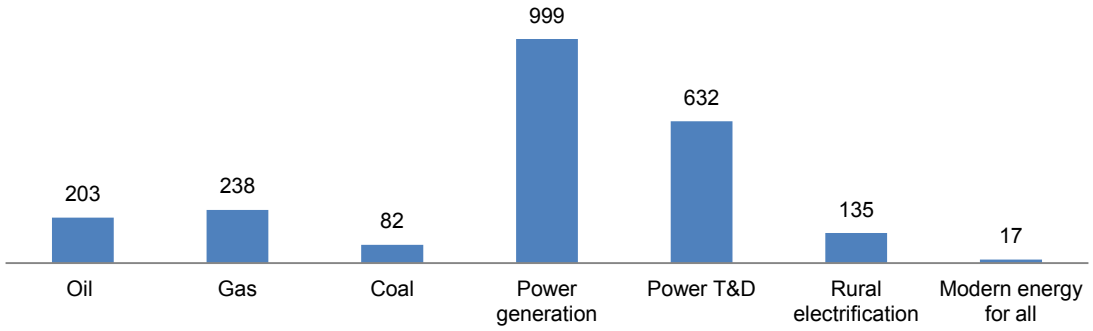
Investment

Private investment in India has steadily increased since the liberalisations of the power, oil and gas sectors. However, despite some of the positive changes that private investment brought to India's energy sector, this achievement is a half success. Most of the major international companies are still reluctant to invest in India's energy sector. Moreover, the coal sector that urgently needs private participation stays closed. Prospects for private investment in India are flagging. In terms of the general investment environment, the doing business index (DBI) by the World Bank ranked India at 132nd out of 183 countries in the world (World Bank, 2012). The areas in which India performed particularly poorly were "Dealing with construction permit" (ranking at 181st) and "Enforcing contract" (ranking at 182nd), both of which are critical for infrastructure and energy investment.

Investment needs

India needs considerable investment to build a reliable and adequate energy supply chain. This is especially necessary to provide modern energy to the large proportion of the Indian population whose energy demand is currently unmet (chapters 4 and 7). *WEO 2011* estimates that India would need a total investment of USD 2 306 billion on overall energy supply infrastructure from 2011 to 2035, or an average USD 92 billion per year (Figure 34). This is a substantial amount, considering that India's government budget for total capital expenditure is estimated for INR 3 735 billion or around USD 68 billion for FY 2012/13 (IMF, 2012). Ensuring this scale of investment for the next two decades will be a challenge for India, making private investment in particular crucial.

Figure 34 • Required energy investment, 2011-35 (USD billion)



Note: for "Rural electrification" and "Modern energy", investment figure is for 2010-30.
Source: IEA, 2011a.

What's more, investment in supporting infrastructure for energy is also indispensable; this includes transportation and import facilities, especially for gas and coal, and manufacturing base for equipment and components. Investment in this area should be aligned with the expected expansion of energy capacity from the planning stage.

Sustainable development

As in the rest of the world, investment in advanced and clean technology is required to set India's energy future on a sustainable path. India is facing rising environmental problems. With falling gas production and faltering nuclear capacity, India's power generation is increasingly dependent on coal-based capacity, which is less efficient and more carbon-intensive compared to other fuels. Also the widespread consumption of biomass results in environmental deterioration including deforestation and air pollution, which could be alleviated by providing access to and encouraging consumption of more efficient and modern energy. Energy infrastructure usually has a very long life-cycle. Thus, it is critical for India to now invest in state-of-the-art, low-carbon technology for its energy sector; otherwise, India's energy sector could be locked into a coal-dependent and higher than necessary carbon-intensive path. Power and other energy tariffs should be rationalised to promote sustainable investment.

Implementation

India has demonstrated an ability to quickly address pressing issues, and devise policies and set targets. However, for actual policy implementation, India lacks a clear strategy and action plans. "There has been little indication of how policies should be prioritised, no plan for funding them,

and often a gap between policymaking and implementation" (Madan, 2006). What's more, government initiatives often end up being announced and not followed up. For instance, India announced the creation of a sovereign oil fund to support overseas upstream investment in 2010, but no visible progress has been made to date.

Bureaucracy

A slow and lengthy process to obtain land acquisition permits, environment clearance, and other statutory clearances has been identified as the major barrier for implementing energy and infrastructure projects. Clearly, those statutory clearances are necessary to protect the environment and land rights, but they need to be streamlined by removing red tape to assure the in-time completion of projects. Many key energy and infrastructure projects have not progressed beyond this stage due to the lagging administrative process. Furthermore, excessive red tape is a serious operational and financial risk that discourages prospective investment. Eventually, this would constrain India's ability to supply energy in coming years.

Inter-ministerial coordination

For effective implementation, horizontal coordination among different ministries needs to be improved, especially taking the absence of single unified energy ministry into consideration. At the top level, there is already an inter-ministry coordination mechanism in place; however, working-level coordination can be improved throughout the entire policymaking and implementation process. And this coordination should be done in a regular and institutionalised manner, rather than on a sporadic and personal basis.

Furthermore, institutional mechanism to reconcile different interests and views of various ministries are crucial. Often, ministries disagree over a particular issue, which takes long to resolve; for instance, it took nearly three years for the MOP and MOC to reach an agreement, albeit still negotiating, on the coal supply contract for power plants. At the same time, the MOC and MOP find themselves frequently in disagreement with the MOEF over the environment clearance process. To settle the gas pricing issue for NELP supplies, the MOP and MOPNG went through a tedious grid-lock until a decision was made by the High Court (Chapter 6). Finally, inter-ministerial coordination should be approached in terms of broader national interests, which are often overlooked in pursuit of individual objectives by each ministry.

Inter-governmental coordination

In India's federalist political system, vertical coordination between the central government and state governments is crucial to implement policies. The central government makes plans and provides funding, but most of the time, it is the state governments that actually execute the plans and implement the projects. For instance, although the Electricity Act 2003 mandated state regulatory commissions to introduce RPOs, some states have yet to do so. Recently, MNRE called for the Expression of Interest for reviewing state Solar RPO and RECs (MNRE, 2011c), which would be highly valuable to assess status quo of state renewable policy implementation. But there would be very limited scope for MNRE to enforce the implementation of these initiatives at state level.

Inter-governmental coordination is also important to alleviate the growing imbalance among states in terms of energy infrastructure and investment. The regional concentration of energy capacity in a few states risks perpetuating the uneven economic development across the nation. The central government needs to closely work with state governments to address this issue and ensure that an investment-friendly environment can be created in those less developed states.

Policy

A well-designed policy and a clear vision are critical to guide and direct the overall energy sector and future investments, especially in India as most of the key players are public enterprises and energy access is not yet universal. However, the complexity of institutional arrangements with multiple energy ministries often obstructs coherent and integrated energy policy making.

Truly integrated energy policy

India's Integrated Energy Policy 2008 was an important step towards formulation of a comprehensive and coherent national energy policy. However, compiling all energy plans and targets in one policy document itself is not sufficient to assure integration of energy policymaking and implementation. In the case of the five-year plans, sub-groups consisting of multi-ministry experts are set up to provide inputs to the Plan. However, often their contributions are not fully incorporated into the final policy document, and their reports on the different energy sub-sectors can have inconsistent data and targets from one another. Based on the Working Group reports, Planning Commission produces one five-year plan document with their recommendations included. However, these recommendations sometimes remained unimplemented. The final five-year plan should be more closely linked to the actual implementation strategy of each ministry. Especially to deal with key challenges including pricing and investment, it is critical that related ministries maintain the "integrated" policy through multi-ministerial coordination.

Furthermore, India's long-term energy vision should be taken into account when these policies and plans are devised. India has produced various long-term energy visions, yet they are often overlooked in the five-year plan cycle. The visions towards a low carbon, green growth economy, expressed in IEP and the country's National Action Plan on Climate Change should be embraced in policies, not only by the MNRE but other fossil fuel ministries including MOC and MOPNG, as well. In short, a truly integrated energy policy needs to reflect India's long-term vision in its short-term energy policies.

Consistency of policy

There have been cases where internally inconsistent, even contradicting, policies have been adopted by energy ministries. They usually occurred when the government attempted to achieve multiple policy objectives with one policy instrument. The JNNSM is one example; while aiming to increase India's installed solar capacity substantially, JNNSM also aims to establish India as a global solar manufacturing hub. To do so, it stipulated a mandatory domestic content for solar PV and thermal project, reflecting India's earlier industrial policy of import substitution.

Nurturing a domestic solar industry is a legitimate goal for the Indian government; however, how this is currently pursued could potentially hamper the building of India's solar capacity (Chapter 7). Providing sufficient assistance to domestic manufacturers through separate industry and education policy could have been considered. Thus, domestic and imported equipment manufactures could compete with one another on an equal basis and solar capacity growth would not be restrained by a domestic manufacturing bottleneck and higher domestic equipment prices. For a relatively new industry like renewables, and particularly in consideration of the fluid global market conditions and high risks, expertise and know-how of established manufacturers should be valued.

Political will

To successfully cope with the five challenges discussed earlier, political will is a prerequisite. Meeting these challenges and transforming India's energy sector into a functioning market

requires continued and united political leadership from policy makers. India's current political culture, which is based on fragmented political interest and multi-party coalition government, makes this rather difficult (Chapter 3). However, the energy sector is too important to be compromised by political interest and rent-seeking behaviour. Bipartisan consensus on energy policy should be sought in the national interest.

Delayed reforms

There are a number of important energy sector reforms that are still pending due to political impasse. One is the Coal Mines (Amendment) Bill of 2000, which allows private companies to engage in commercial coal mining on par with CIL (Chapter 5). This bill is a critical initiative that would potentially bring greater investment into the stagnating coal sector, but no visible legislative progress has been made since 2000. Another needed energy reform is the actual deregulation of petroleum products. The Indian government announced the deregulation of petroleum prices in 2002 just to backtrack a few years later when international prices increased strongly. Gasoline prices were again officially de-regulated in 2010, however, de facto they are still determined by government. Diesel, kerosene and LPG prices remain regulated until today (Chapter 6). Petroleum price reform should take place as soon as possible to demonstrate the government's will towards open and competitive energy market in India.

Consistent message

The government too needs to maintain consistency in its public messages. There have been examples where policy initiatives were changed or postponed after announcement due to public resistance and political opposition. For instance, in January 2012, coal pricing mechanism was shifted from useful heat value to gross calorific value. Strong criticism from major coal consumers led to temporary postponement of implementing GCV (Chapter 5). The most recent case was the price increase of petroleum products in May 2012. A price hike of over 11% brought public strikes and OMCs decided to roll back the price increase by 3% (Chapter 6). Such changes in policy decisions undercut the credibility and predictability of government policy and eventually investment.

Public communication

Public communication is an important, strategic component of the implementation of new energy policies. Given rising public awareness on environmental and health issues, and a growing, increasingly conscientious, Indian middle class, public communication strategies can play a critical role in disseminating knowledge and generating public consent. The development of a new energy infrastructure entails sizable land requirements that can have an environmental impact on the local community; this is particularly the case for nuclear plants, as well as coal and uranium mines. Public communication is also important for necessary, but unpopular, policy decisions including fuel price increases, which can have a direct impact on the daily lives of Indian citizens. It is, therefore, crucial to effectively and continuously communicate with the Indian public on the intention and importance of such policy moves, especially against the backdrop of India's increasing imports from the global energy market.

At the same time, policy makers and politicians should be cautious about the potential consequences of their populist messages. Rhetorical statements, such as "free electricity" and "fossil fuel free future", not only raise unrealistic expectations about India's energy situation, but undermine the workability of necessary energy sector reform. Policy makers, through effective public communication, should convey the right messages to the Indian people.

Conclusion

A serious energy shortage and growing pressure on imports have been seen in the Indian energy sector. In the middle of 2012, India's power shortage led to massive rolling power cuts across the nation. Industries and businesses shut down and public protests followed, demanding better power supply. That the current power crisis is not a temporary hiccup in the power system, but rather a symptom of the entire energy sector reaching the tipping point, is worrying. After a decade of unfinished liberalisation of the energy sector, India is now standing at the crossroads with a need for the next phase of energy sector reform. Strong political leadership is vital to address energy challenges.

Public perception should be shifted to accept that energy is not an entitlement, but a commodity. Energy supply cannot be taken for granted, and it requires sufficient resources to be delivered to consumers. India's policy objective of inclusive development and affordable energy should be maintained, but business viability cannot be sacrificed in the process. This perception is the foundation of a functioning energy market and the sustainable, green growth economy that India pursues.

India is undoubtedly and irrevocably integrated into the global energy market. It relies on significant amounts of energy from foreign sources and, as such, India is a price taker, not a price setter. India can reduce its vulnerability to energy price fluctuation through a flexible and competent energy market, but it cannot isolate itself from price volatility. At the same time, to expand its energy supply capacity to meet the rapidly growing energy demand of its people, India needs more investment. A significant portion of the required investment must come from foreign investors, for whom it competes with other countries. This implies the necessity of integrating India's energy institutions and policies with global practices.

Finally, energy challenges should come before political interests. As the father of India's nuclear energy, Dr. Bhabha, once put, "no power is as expensive as no power." A reliable and adequate supply of modern and clean energy is the prerequisite for India's continued economic development. Nothing would be more costly than the disruption of the national economy, which has so much potential to prosper, as well as the disruption of daily activities of the Indian citizens, who are ready to participate in another economic miracle.

Annex: India's five regional grids

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Acronyms, abbreviations and units of measure

Acronyms and abbreviations

AEC	Atomic Energy Commission
AERB	Atomic Energy Regulatory Board
APM	Administered Pricing Mechanism
ARDRP	Accelerated Power Development and Reform Programme
AT&C	Aggregated Transmission and Commercial
BEE	Bureau of Energy Efficiency
BEL	Bharat Electronics Limited
BHAVINI	Bharatiya Nabhikiya Vidyut Nigam Limited
BHEL	Bharat Heavy Electricals Limited
BPCL	Bharat Petroleum Corporation Limited
BPL	below poverty line
CAG	Controller and Auditor General
CAGR	compound annual growth rate
CBM	coal bed methane
CDM	Clean Development Mechanism
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CHP	combined heat and power
CIL	Coal India Limited
CO_2	carbon dioxide
CPP	captive power plant
CTU	Central Transmission Utility
DAE	Department of Atomic Energy
DGH	Directorate General for Hydrocarbons
DISCOM	distribution company
E&P	exploration and production
EGOM	Empowered Group of Ministers
EOR	enhanced oil recovery
ETP	Energy Technology Perspectives
FDI	foreign direct investment
FSA	fuel supply agreement
FY	fiscal year
GAIL	Gas Authority of India Limited
GCV	gross calorific value
GSPA	Gas Sales and Purchase Agreement
HPCL	Hindustan Petroleum Corporation Limited
IEP	Integrated Energy Policy
IHV	India Hydrocarbon Vision
INR	Indian rupee
IOC	international oil company
IOCL	Indian Oil Corporation Limited
IPP	independent power producer
IREDA	India Renewable Energy Development Agency
LOA	Letter of Assurance
JNNSM	Jawaharlal Nehru National Solar Mission
JV	joint venture

KG	Krishna Godavari
LNG	liquefied natural gas
MNRE	Ministry of New and Renewable Energy
MOC	Ministry of Coal
MOEF	Ministry of Environment and Forest
MOP	Ministry of Power
MOPNG	Ministry of Petroleum and Natural Gas
MTA	mid-term appraisal
NAPCC	National Action Plan on Climate Change
NCDP	New Coal Distribution Policy
NEEPCO	North Eastern Electric Power Corporation
NELP	New Exploration Licensing Policy
NHPC	National Hydroelectric Power Corporation
NLC	Neyveli Lignite Corporation
NMEEE	National Mission for Enhanced Energy Efficiency
NPCIL	Nuclear Power Corporation of India Limited
NPS	New Policies Scenario
NPT	Non-Proliferation Treaty
NSG	Nuclear Suppliers Group
NTPC	National Thermal Power Corporation
NVVN	NTPC Vidyut Vyapar Nigam
OECD	Organisation of Economic Corporation and Development
OIL	Oil India Limited
ONGC	Oil and Natural Gas Corporation
OMC	Oil Marketing Company
OVL	ONGC Videsh Limited
PFC	Power Finance Corporation
PLF	plant load factor
PLL	Petronet LNG Limited
PNGRB	Petroleum and Natural Gas Regulator Board
POSOCO	Power System Operation Corporation
PPA	Power Purchase Agreement
PPAC	Petroleum Planning and Analysis Cell
PPP	purchasing power parity
PSC	Production Sharing Contract
PSU	Public Sector Undertaking
REC	Rural Electrification Corporation
RECs	Renewable Energy Certificates
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana (Rural electrification programme)
RGTIL	Reliance Gas Transportation Infrastructure Limited
RIL	Reliance Industries Limited
RPO	Renewable Purchase Obligation
SCCL	Singareni Collieries Company Limited
SDA	State Designated Agency
SEB	State Electricity Board
SERC	State Electricity Regulatory Commission
STU	State Transmission Utility
TPED	total primary energy demand
UCIL	Uranium Corporation of India Limited
UHV	useful heat value

UMPP	Ultra Mega Power Project
USD	United States dollar
WEO	World Energy Outlook
WTO	World Trade Organization

Units of measure

b/d	barrels per day
bcm	billion cubic meters
Bt	billion tonnes
GW	gigawatt (1 Watt x 10^9)
GWh	gigawatt-hour
kcal	kilocalorie (1 calorie x 10^3)
kW	kilowatt (1 Watt x 10^3)
kWh	kilowatt-hour
mb/d	million barrels per day
mcm	million cubic meter
MMTPA	million metric tonne per annum
Mt	million tonnes
Mtce	million tonnes of coal equivalent
Mtoe	million tonnes of oil equivalent
MW	megawatt (1 Watt x 10^6)
tcf	trillion cubic feet
TWh	terawatt-hour

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Printed in France by IEA, September 2012
Cover design: IEA. Photo credits: © Brand X, Photodisc and Corbis

Understanding Energy Challenges in India

Policies, Players and issues

A combination of rapidly increasing energy demand and fuel imports plus growing concern about economic and environmental consequences is generating growing calls for effective and thorough energy governance in India.

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The publication explores in detail the policies, players and issues of the country's power, coal, oil and gas, renewables and nuclear sectors. It also highlights the key challenges India faces, challenges that must be resolved for the evolution of the fast-growing country's energy sector towards a sustainable energy future and eventually critical for the prospects of the Indian and global economies.