

Chapter 6

India Country Report

September 2016

This chapter should be cited as

Zheng, L. (2016), 'India Country Report' in Kimura, S. and P. Han (eds.) in *Energy Outlook and Energy Saving Potential in East Asia 2016*. ERIA Research Project Report 2015-5, Jakarta: ERIA, pp.127-136.

India Country Report¹

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1. Background

India is located in South Asia and has a land area of 2,973 thousand square kilometres. It has the second largest population in the world. In 1990 it had around 869 million people, and this rose to 1,252 million in 2013, at an average annual growth rate of 1.6 percent. India's gross domestic product (GDP) increased at an average annual rate of 6.5 percent from US\$350 billion in 1990 to US\$1,490 billion (2005 constant prices) in 2013, ranking it as the third largest economy in the Asia region. The services and the industry sectors are the largest contributors to India's GDP.

1.1. Energy Situation

India's primary energy supply increased by 4.1 percent per year, from around 307 Mtoe in 1990 to 775 Mtoe in 2013. In 2013, coal represented the largest share of primary energy at 44.0 percent. Coal is mainly consumed for power generation and by industry. 'Others,'² most of which is the non-commercial biomass used by the residential sector, had the second largest share at 24.8 percent, followed by oil at 22.7 percent in 2013. The remaining shares were natural gas (5.7 percent), hydro (1.6 percent), and nuclear (1.2 percent). Compared with 1990, the share of

¹ Based on Model run and broad assumptions by IEEJ.

² Others constitute non-commercial biomass, wind, solar, solid, and liquid biomass and other renewable energy sources as well as electricity imports or exports.

non-commercial biomass energy decreased, whereas the share of fossil energy including coal, oil, and natural gas increased. Among the major energy sources, the fastest growing were natural gas and nuclear energy. Natural gas grew at an average annual rate of 6.4 percent and nuclear grew by 7.8 percent per year. Coal, oil, and hydro consumption increased, but at slower annual average rates of 5.8 percent, 4.7 percent, and 3.0 percent, respectively.

India generated 1,193 TWh of electricity in 2013. The average annual growth in electricity generation between 1990 and 2013 was 6.3 percent, almost as high as the growth in GDP. The shares of generation by fuel in 2013 were: coal 72.8 percent, hydro 11.9 percent, natural gas 5.5 percent, nuclear 2.9 percent, oil 1.9 percent, and 'others' (wind, solar PV, and other renewable energy sources) 5.0 percent.

India's final energy consumption grew by 3.4 percent per year from 243 Mtoe in 1990 to 528 Mtoe in 2013. Between 1990 and 2013, the industry sector grew by 4.4 percent per year, the transport sector by 5.7 percent per year, and the residential and commercial ('others') sectors by 2.3 percent per year. Non-energy use³ saw fast growth, increasing by 4.5 percent a year.

Among commercial fossil energy, oil was the most consumed product with a share of 20.6 percent of total final energy consumption in 1990, and 28.4 percent in 2013. The share of coal increased from 16.0 percent in 1990 to 19.6 percent in 2013. The share of electricity increased from 7.6 percent in 1990 to 14.5 percent in 2013. Similarly, the share of natural gas increased from 2.3 percent in 1990 to 5.0 percent in 2013. The share of other energy, most of which is non-commercial biomass, fell from 53.5 percent in 1990 to 32.5 percent in 2013.

³ Non-energy use refers to consumption of energy products for non-energy purposes such as feedstock in the petrochemical industry for the production of ethylene and lubricants in the transportation and industrial sector, etc.

2. Modelling Assumptions

India's GDP is assumed to grow at an average annual rate of 6.5 percent from 2013 to 2040, and the population is forecast to increase by 0.9 percent a year.

Concerning future electricity supply, the share of coal in electricity generation will continue to be the largest one. Nuclear power plants and 'others,' especially wind and solar, are projected to increase to 2040, but the shares of oil and hydro are expected to fall.

Implementation of energy efficiency programmes in power generation and energy end-use sectors are expected to allow India to attain its energy saving goals. Improvements in highly energy-intensive industries and in inefficient small plants are some of the measures to ensure energy savings in the industrial sector. In the residential and commercial sectors, significant savings can be induced through efficient end-use technologies and energy management systems. In the transport sector, improved vehicle fuel economy and more effective traffic management are important measures to achieve efficiency improvements.

3. Outlook Results

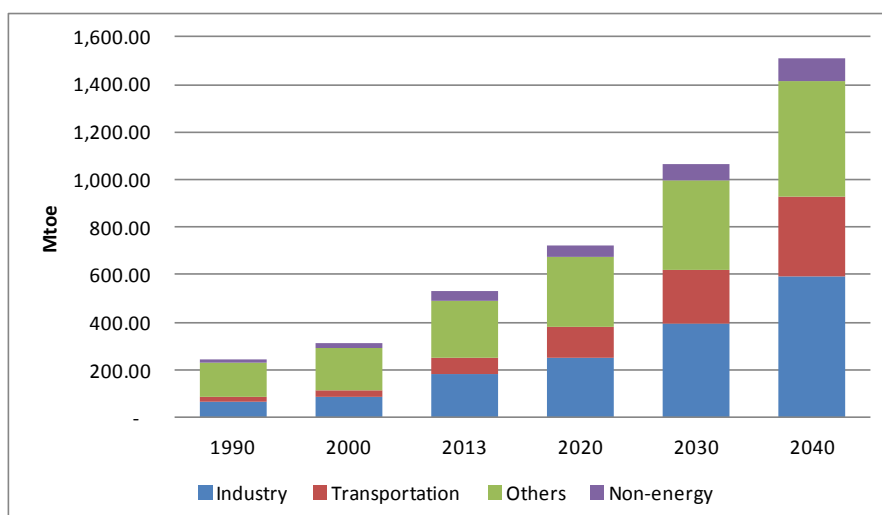
3.1. Business-as-Usual (BAU) Scenario

3.1.1. Final energy consumption

Under BAU, with assumed strong economic growth and a growing population, India's final energy consumption is projected to increase at an average rate of 4.0 percent per year from 528 Mtoe in 2013 to 1,508 Mtoe in 2040 (Figure 6-1). The strongest growth is projected to occur in the transport sector, increasing by 5.7 percent a year between 2013 and 2040. Strong growth is also expected in the industry sector (4.5 percent a year) and non-energy consumption (3.7 percent a year). Due to the large share of non-commercial energy in the final energy consumption, the growth rate of the 'others' sector that includes the residential and commercial sectors, is projected to be modest at 2.7 percent per year. However, in the residential and commercial sectors, the consumption of commercial energy, especially electricity, will increase rapidly.

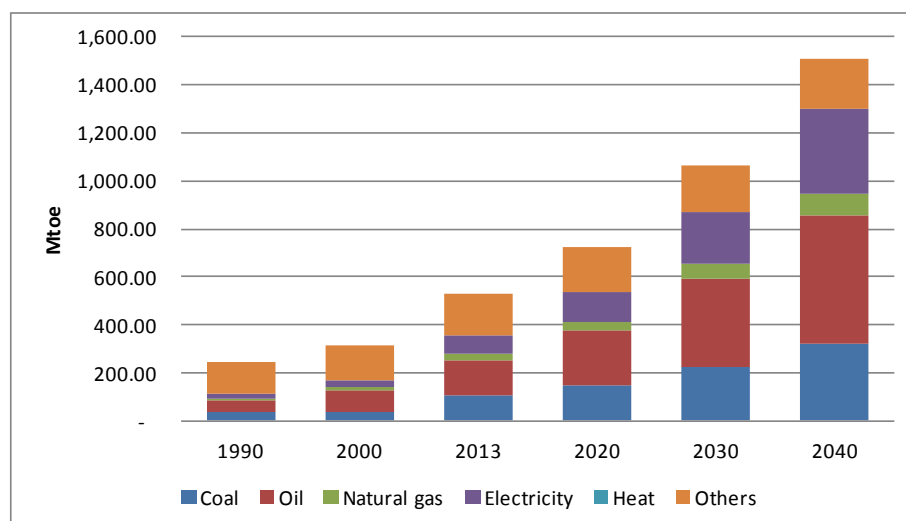
The share of 'others,' which is the largest at 45.1 percent in 2013, will drop to 32.2 percent in 2040. The share of industry will increase to 39.3 percent in 2040 from 33.9 percent in 2013 and the share of transport will be 22.1 percent in 2040, up from 14.2 percent in 2013.

Figure 6-1. Final Energy Consumption by Sector



Mtoe = million tons of oil equivalent.
Source: Author's calculations.

Figure 6-2. Final Energy Consumption by Energy



Mtoe = million tons of oil equivalent.
Source: Author's calculations.

In the final energy consumption by source, electricity will see the fastest growth, increasing by 5.8 percent per year over the period 2013–2040 (Figure 6-2). Oil

demand will increase at the second highest rate of 4.8 percent per year, followed by natural gas (4.7 percent a year), and coal (4.3 percent a year).

3.1.2. Primary energy supply

Under BAU, India's primary energy supply will increase at an average annual rate of 4.1 percent to 2,281 Mtoe in 2040 from 775 Mtoe in 2013. Coal consumption, driven by the demand of power generation, will grow by 4.5 percent per year and reach 1,129 Mtoe in 2040, from 341 Mtoe in 2013, maintaining the largest share at 49.5 percent in 2040 (44.0 percent in 2013). Due to rapid motorisation, oil will increase to 567 Mtoe and is forecast to have the second largest share at 24.8 percent in 2040. The average annual growth rate for oil demand during 2013–2040 is estimated at 4.4 percent. Natural gas consumption is expected to increase by 5.1 percent per year between 2013 and 2040. Its share will be 7.5 percent in 2040, 1.8 percentage points up from 5.7 percent in 2013. Figure 6-3 shows the projected primary energy supply in India from 1990 to 2040 under the BAU.

Nuclear energy is expected to grow the fastest at an average annual rate of 8.5 percent, with its share increasing from 1.2 percent in 2013 to 3.5 percent in 2040. Within 'others,' solar and wind will increase significantly, but due to the slow growth of non-commercial biomass, which has the largest portion overall, 'others' is projected to increase by an average 1.7 percent a year through to 2040. Its share will drop to 13.2 percent from 24.8 percent in 2013.

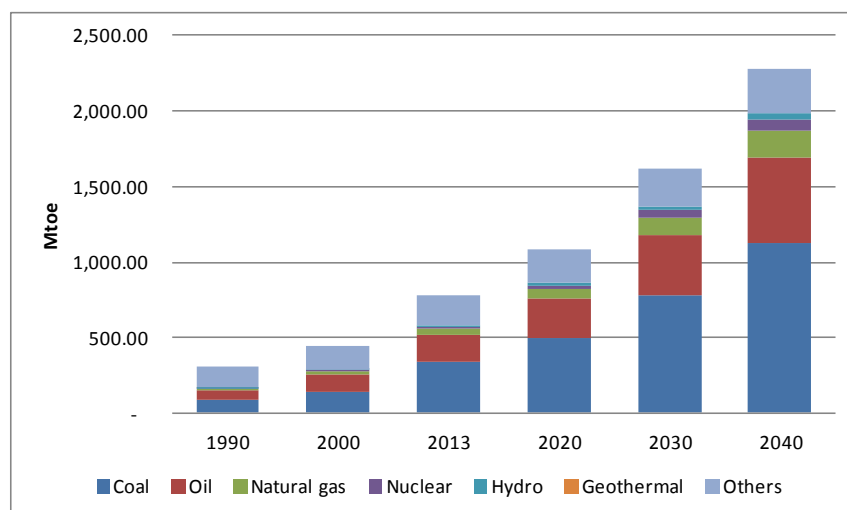
3.1.3. Power generation

In 2013, power generation in India was 1,193 TWh. Under BAU, India's power generation will increase at an annual average rate of 5.5 percent per year to 5,077 TWh in 2040. Coal will continue to dominate India's power generation mix, but its share will drop from 72.8 percent in 2013 to 66.5 percent in 2040.

Hydro's share in India's power generation mix will decline from 11.9 percent in 2013 to 8.0 percent in 2040, and oil's share will decline from 1.9 percent in 2013

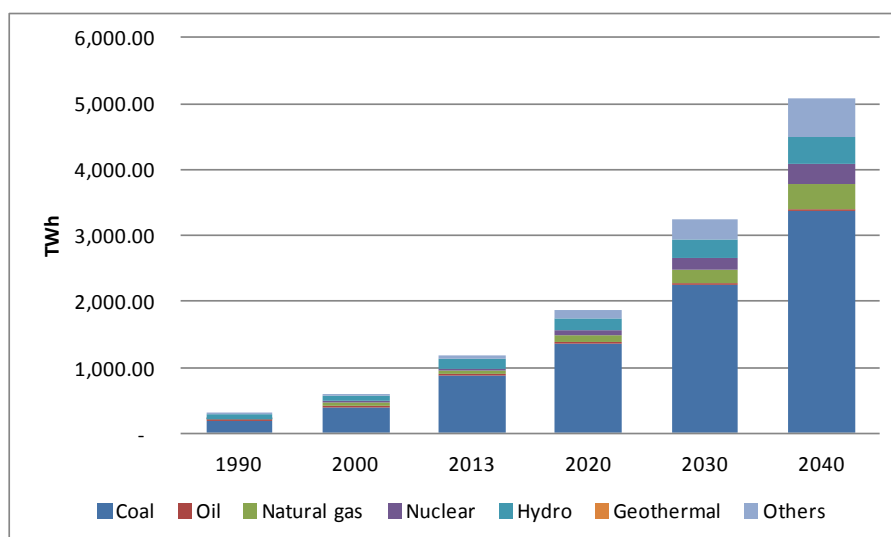
to 0.5 percent in 2040. In contrast, the share of nuclear power will increase from 2.9 percent to 6.1 percent, and new energy including wind and solar power will increase from 5.0 percent to 11.4 percent.

Figure 6-3. Primary Energy Supply by Source



Mtoe = million tons of oil equivalent.
Source: Author's calculations.

Figure 6-4. Power Generation, BAU



BAU = Business-as-Usual scenario; TWh = terawatt-hour.
Source: Author's calculations.

The share of natural gas will be 7.5 percent in 2040, and the annual average growth rate during 2013–2040 will be 6.8 percent. Figure 6-4 shows the projected power generation in India from 1990 to 2040 under the BAU.

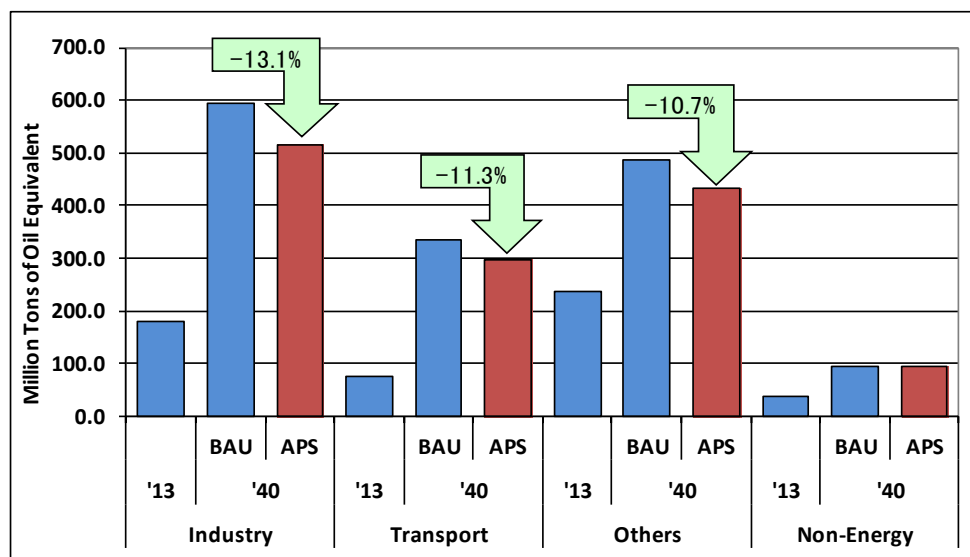
3.2. Energy Saving and Carbon Dioxide (CO₂) Reduction Potential

3.2.1. Final energy consumption

Under the Alternative Policy Scenario (APS), final energy consumption is projected to increase at a slower rate of 3.5 percent per year from 528 Mtoe in 2013 to 1,341 Mtoe in 2040. This is 167 Mtoe or 11.1 percent lower than under BAU. The slower growth in demand is expected to occur across all end-use sectors, reflecting improvements in end-use technologies and the introduction of energy management systems (Figure 6-5).

In 2040, under APS relative to BAU, there is an estimated saving of 78 Mtoe (13.1 percent) in the industry sector, 38 Mtoe (11.3 percent) in the transport sector, and 52 Mtoe (10.7 percent) in the 'others' sector.

Figure 6-5. Final Energy Consumption by Sector, BAU and APS



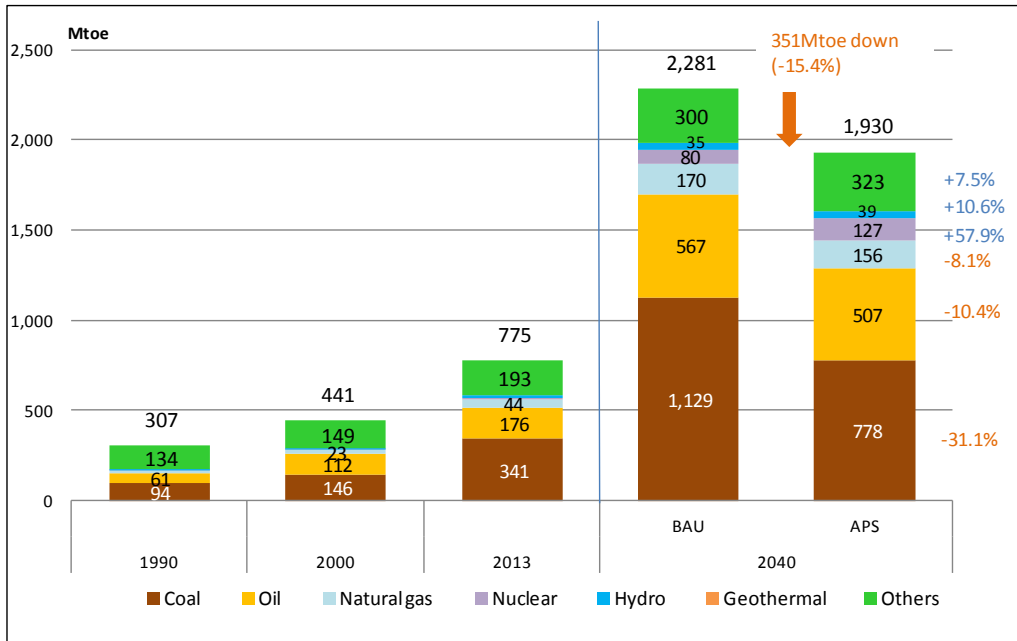
BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario.
Source: Author's calculations.

3.2.2. Primary Energy Supply

Under APS, relative to BAU, India's primary energy supply is projected to increase at a slower rate of 3.4 percent per year to 1,930 Mtoe in 2040. The difference

between primary energy supply under the BAU versus the APS in 2040 is 351 Mtoe or 15.4 percent (Figure 6-6).

Figure 6-6. Total Primary Energy Supply, BAU and APS



BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario; Mtoe = million tons of oil equivalent.

Source: Author’s calculations.

In the APS, nuclear will be the fastest growing energy source, increasing at 10.3 percent per year, to reach 127 Mtoe in 2040, 57.9 percent higher than the BAU. Hydro and ‘others’ will grow at 4.4 percent and 1.9 percent per year, increasing to 39 Mtoe and 323 Mtoe, respectively, which represents an increase of 10.6 percent and 7.5 percent, respectively.

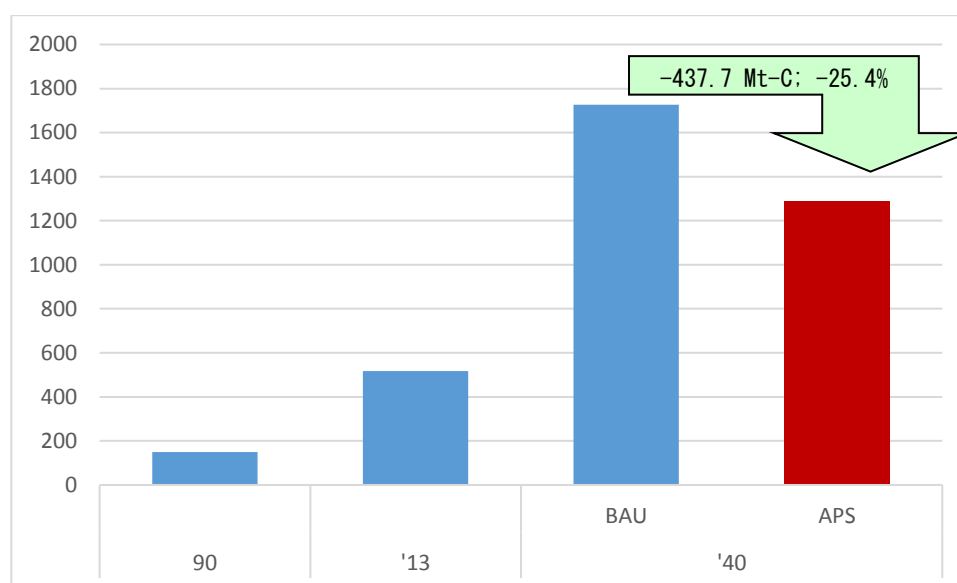
Natural gas, oil, and coal will grow at slower annual rates of 4.8 percent, 4.0 percent, and 3.1 percent, respectively, increasing to 156 Mtoe, 507 Mtoe, and 778 Mtoe in 2040, respectively. These are 8.1 percent, 10.4 percent, and 31.1 percent lower, respectively, than in BAU.

3.2.3. CO₂ Emissions

Under BAU, CO₂ emissions from energy consumption will increase by 4.6 percent per year from 517 Mt-C in 2013 to 1,727 Mt-C in 2040.

In the APS, the annual increase in CO₂ emissions from 2013 to 2040 will be slower than in the BAU at 3.4 percent. CO₂ emissions in 2040 will be 1,289 Mt-C, 25.3 percent lower than in the BAU. Reduced demand for coal in final demand and in power generation and oil in the transport sector contribute most to the expected reduction in CO₂ emissions. Figure 6-7 shows the CO₂ emission in 2040 under the BAU versus the APS in this energy outlook.

Figure 6-7. CO₂ Emissions from Energy Consumption, BAU and APS



BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario; Mtoe = million tons of oil equivalent.

Source: Author's calculations.

4. Implications

- Energy security and access to energy are key challenges for India. Enhanced domestic production of energy is necessary to address these challenges.
- Hydrocarbons, particularly coal and oil, will continue to dominate the energy

mix in both the BAU and the APS. Use of domestic coal for supply security, as well as more efficient coal technologies such as integrated gasification combined cycle, ultra-supercritical, etc., would be necessary. In the long and medium terms, research and development (R&D) on cleaner energy development will play a key role.

- Natural gas can play an important role in energy supply and environment issues. To capitalise on the increasing global natural gas production, it is necessary to enhance the infrastructure for importation, domestic transportation, and utilisation.
- India's government announced ambitious targets for renewable energy, but the cost and infrastructure will be the bottleneck. Developing the domestic manufacturing capacity can play an important role.
- Energy efficiency and demand side management are important. New power plants, new factories, new buildings, new appliances, and new cars, should be more efficient. The Minimum Energy Performance Standard and mandatory energy labels should be expanded to more equipment.
- There are huge potential savings in the power sector. Advanced technologies for power generation should be used as much as possible.
- Industry will account for 42 percent of the incremental energy use to 2040; energy efficiency programmes should be focused on this sector. Broadening the scope of the Perform, Achieve, Trade scheme will be important in achieving this.
- Growth of energy consumption in the transport sector should be curtailed.
- Losses in electricity distribution should be minimised by using better technologies.
- Rationalising energy prices across fuels and sectors is necessary.