

Chapter 6

India Country Report

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CHAPTER 6

INDIA COUNTRY REPORT¹

LU ZHENG² AND SAPTARSHI DAS³

1. Background

India is located in South Asia and has a land area of three million square kilometres. India has the second largest population in the world – it was around 869 million in 1990 and grew at an average annual rate of 1.6 percent to reach 1.24 billion in 2012. India's gross domestic product (GDP) increased at an average annual rate of 6.5 percent from US\$ 352 billion in 1990 to US\$ 1.395 trillion (2005 constant price) in 2012, which meant it ranked as the 10th largest economy globally. The services sector and the industry sector are the largest contributors to India's GDP.

1.1. Energy Situation

India's total primary energy consumption increased by 4.2 percent per year, from around 317 Mtoe in 1990 to 788 Mtoe in 2012. In 2012, coal, mainly consumed for power generation and by industry, accounted for the largest share of primary energy, at 44.9 percent. 'Others',⁴ most of which is the non-commercial biomass used by the residential sector, had the second largest share at 23.4 percent, followed by oil at 22.5 percent. The remaining shares were natural gas (6.2 percent), hydro (1.4 percent), and nuclear (1.1 percent). Compared with 1990, the share of non-commercial biomass energy decreased marginally, but the share of fossil energy including coal, oil, and natural gas increased. Amongst the major energy sources, the fastest growing were natural gas and nuclear energy – natural gas grew at an average annual rate of 7.2 percent and nuclear by 7.9 percent per year. Coal, oil, and hydro consumption increased, but at slower annual average rates, of 5.8 percent, 5.0 percent, and 2.6 percent, respectively.

India generated 1,128 TWh of electricity in 2012. Average annual growth in electricity generation between 1990 and 2012 was 6.3 percent, almost as high as the growth in GDP. The shares of generation by fuel type in 2011 were: coal, 71.1 percent; hydro, 11.2 percent; natural gas, 8.3 percent; nuclear, 2.9 percent; oil, 2.0 percent; and others (wind, solar PV, and other renewable energy sources), 4.5 percent.

India's final energy demand grew by 3.3 percent per year, from 250 Mtoe in 1990 to 512 Mtoe in 2012. Between 1990 and 2012, the industry sector grew by 4.1 percent per year, the transport sector by 5.9 percent per year, and the residential and commercial

¹ Based on Model run and broad assumptions by the Institute of Energy Economics, Japan (IEEJ).

² Energy Data and Modelling Center (EDMC), The Institute of Energy Economics, Japan (IEEJ).

³ Modelling and Scenario Building Area (MSB), The Energy and Resources Institute, India (TERI).

⁴ Others constitute non-commercial biomass, wind, solar, solid and liquid biomass, and other renewable energy sources as well as electricity imports or exports.

(others) sectors by 2.2 percent per year. Non-energy use⁵ saw fast growth of 4.6 percent a year.

In terms of commercial energy consumption, the share of oil was the highest, at 20.1 percent of total final energy demand in 1990, and 29 percent in 2012. The share of coal increased from 16.8 percent in 1990 to 17.3 percent in 2012, that of electricity from 7.4 percent to 14.6 percent, and that of natural gas from 2.3 percent to 5.1 percent. The share of other energy, most of which is the non-commercial biomass, dropped from 53.0 percent in 1990 to 34 percent in 2012.

2. Modelling Assumptions

India's GDP is assumed to grow at an average annual rate of 6.6 percent from 2012 to 2035, and its population is assumed to increase by an average 0.9 percent per year.

Concerning future electricity supply, the share of coal in electricity generation will continue to be the largest. The shares of nuclear power and others, especially wind and solar, are projected to increase to 2035, whereas 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 planned measures to achieve 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

Total Final Energy Consumption

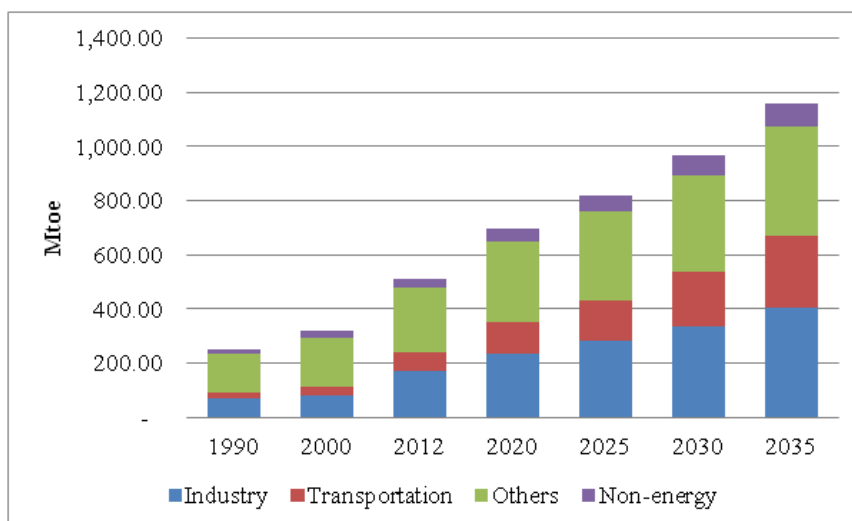
Under the BAU scenario, with assumed strong economic growth and a rising population, India's final energy demand is projected to increase at an average rate of 3.6 percent per year from 512 Mtoe in 2012 to 1156 Mtoe in 2035 (Figure 6-1). The strongest growth is expected to occur in the transport sector, increasing at 5.8 percent a year between 2012 and 2035. Strong growth is also expected in the industry sector (3.9 percent a year) and non-energy consumption (3.7 percent a year). Due to the large share of non-commercial energy in final energy demand, the growth rate of the 'others' sector that includes the residential and commercial sectors, is projected to be modest, at 2.4 percent per year. But the consumption of commercial energy, especially electricity, will increase

⁵ Non-energy use refers to consumption of energy products for non-energy purposes, such as feedstock for the petrochemical industry for the production of ethylene and lubricants in the transportation and industrial sector.

rapidly in the residential and commercial sectors.

The share of 'others', which is the largest at 45.8 percent in 2012, will drop to 34.9 percent in 2035, that of industry will increase from 32.8 percent in 2012 to 34.8 percent in 2035, and that of transport from 14.4 percent to 23.2 percent.

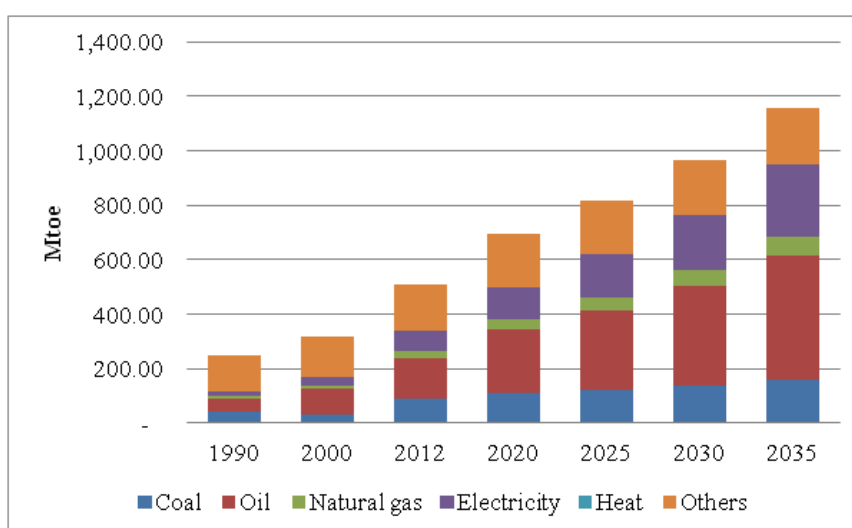
Figure 6-1. Final Energy Demand by Sector



Source: Author's calculation.

In final energy demand by source, electricity is expected to see the fastest growth, increasing by 5.6 percent per year from 2012 to 2035 (Figure 6-2). Oil demand will increase at the second highest rate, of 5.0 percent per year, followed by natural gas (4.5 percent), and coal (2.5 percent).

Figure 6-2. Final Energy Demand by Source



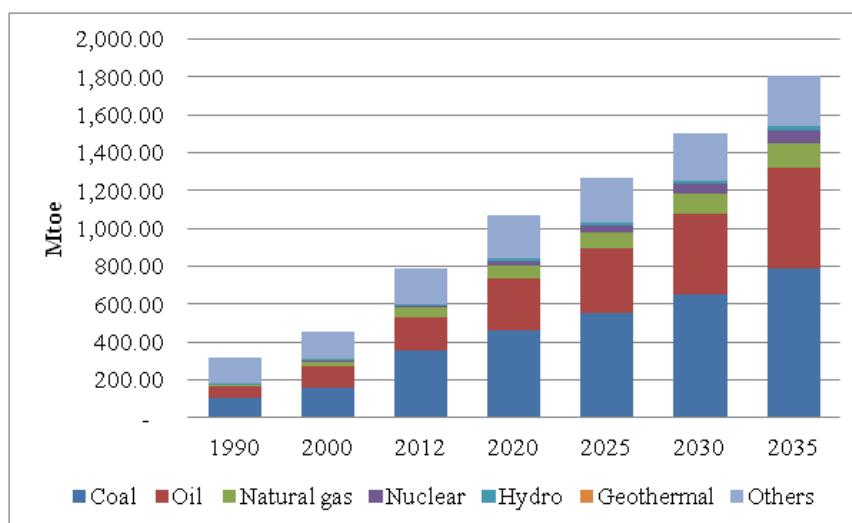
Source: Author's calculation.

Primary Energy Demand

Under the Business-as-Usual (BAU) scenario, India's primary energy demand will increase at an average annual rate of 3.7 percent to 1,805 Mtoe in 2035 from 788 Mtoe in 2012. Coal demand, driven by the demand of power generation, is projected to grow at 3.5 percent per year and reach 787 Mtoe in 2035, from 354 Mtoe in 2012, maintaining the largest share at 43.6 percent in 2035 (44.9 percent in 2012). Due to rapid motorisation, oil is expected to increase to 529 Mtoe and would have the second largest share at 29.3 percent in 2035. The average annual growth rate for oil demand from 2012 to 2035 is assumed to be 4.9 percent. Natural gas consumption is expected to increase by 4.5 percent per year between 2012 and 2035 and its share will be 7.4 percent in 2035 (6.2 percent in 2012). Figure 6-3 shows projected primary energy demand in India from 1990 to 2035 under the BAU scenario.

Nuclear energy is expected to grow fastest, at an average annual rate of 9.2 percent, with its share increasing from 1.1 percent in 2012 to 3.6 percent in 2035. Of the 'others', solar and wind will increase significantly, but due to the slow growth of non-commercial biomass which has the largest portion, 'others' as a whole is projected to increase by only 1.6 percent per year through to 2035, with its share dropping to 14.9 percent from 23.9 percent in 2012.

Figure 6-3. Primary Energy Demand by Source



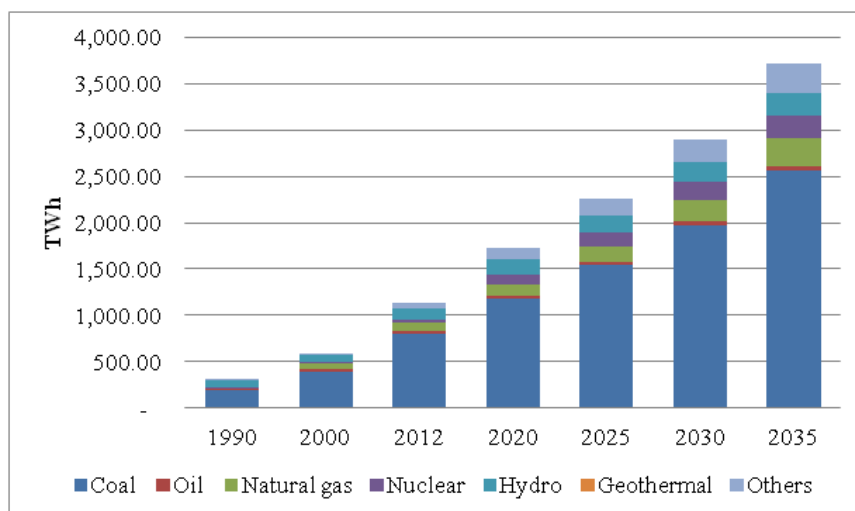
Source: Author's calculation.

Power Generation

In 2012, power generation in India was 1,128 TWh. Under the BAU scenario, India's power generation will increase at an annual rate of 5.3 percent per year to 3,721 TWh in 2035. Coal will continue to dominate India's power generation mix, maintaining its share at above 65 percent. Hydro's share in India's power generation mix will decline from 11.2 percent in 2012 to 6.5 percent in 2035, and oil's share will decline from 2 percent in 2012 to 1.3 percent in 2035. In contrast, the share of nuclear power will increase from 2.9 percent to 6.7 percent, and new energy including wind and solar power will increase from

4.5 percent to 8.7 percent. The share of natural gas-fired generation will decrease until 2020, but increase when the barriers to supply and utilisation of natural gas are cleared. The share of natural gas will be 8 percent in 2035, and the average growth rate from 2012 to 2035 is expected to be 5.1 percent per year. Figure 6-4 shows the projected power generation in India from 1990 to 2035 under the BAU scenario.

Figure 6-4. Power Generation, BAU



BAU = Business-as-Usual.

Source: Author's calculation.

3.2. Energy Saving and CO₂ Reduction Potential

3.2.1 Final Energy Demand

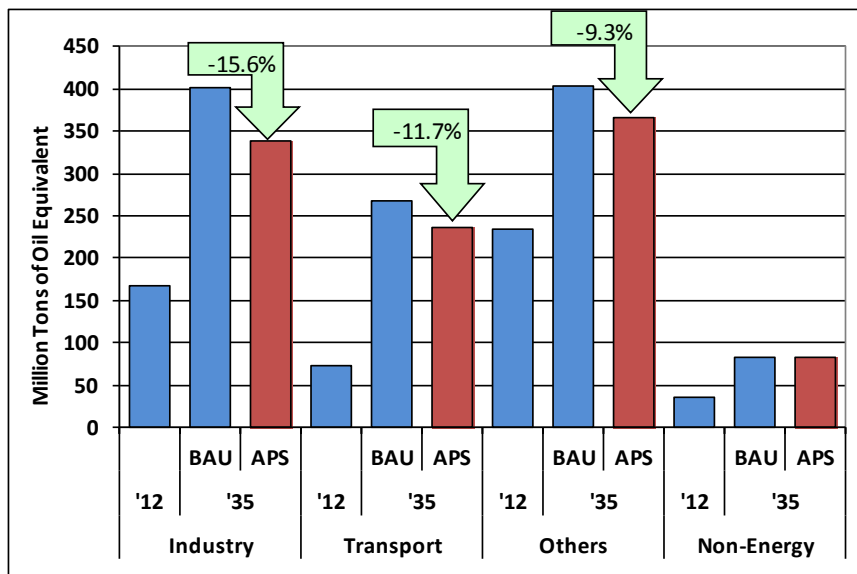
Under the Alternative Policy Scenario (APS), final energy demand is projected to increase at a slower rate, of 3.1 percent per year from 512 Mtoe in 2012 to 1,025 Mtoe in 2035. This is 132 Mtoe or 11.4 percent lower than under the BAU scenario. The slower growth in demand is expected to occur across all end-use sectors, reflecting improvements in end-use technologies and the introduction of energy management systems (Figure 6-5).

In 2035, under the APS relative to the BAU scenario, there is an estimated saving of 62.9 Mtoe (15.6 percent) in the industry sector, 31.4 Mtoe (11.7 percent) in the transport sector, and 37.5 Mtoe (9.3 percent) in the 'others' sector.

3.2.2 Primary Energy Demand

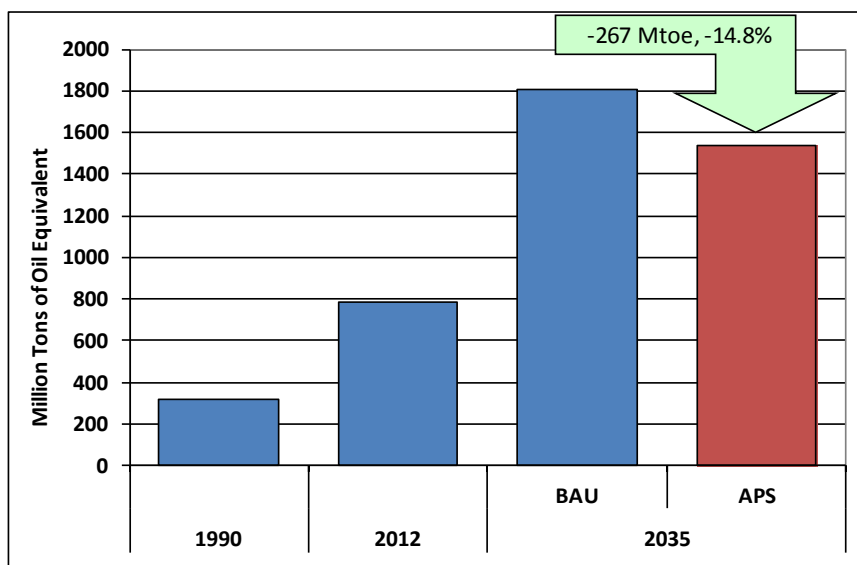
Under the APS relative to the BAU scenario, India's primary energy demand is projected to increase at a slower rate, of 3 percent per year to 1,539 Mtoe in 2035. The difference between primary energy demand under the BAU scenario versus the APS in 2035 is 266.8 Mtoe or 14.8 percent (Figure 6-6).

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



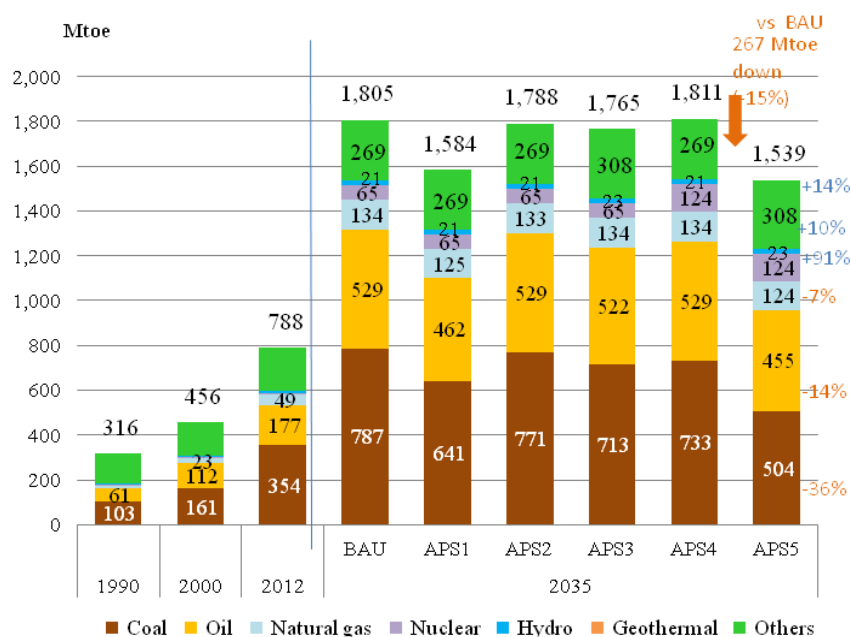
BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

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



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

In the APS, nuclear will be the fastest growing energy source, increasing at 12.3 percent per year, to reach 124.4 Mtoe in 2035, 91 percent higher than under the BAU scenario. Hydro and 'others' will grow at 3.3 percent and 2.2 percent per year, increasing to 22.9 Mtoe and 307.84 Mtoe, or 10 percent and 14 percent higher than the BAU scenario, respectively (Figure 6-7).

Figure 6-7. Primary Energy Demand by Source, BAU and APS

BAU = Business-as-Usual; APS = Alternative Policy Scenario.

Source: Author's calculation.

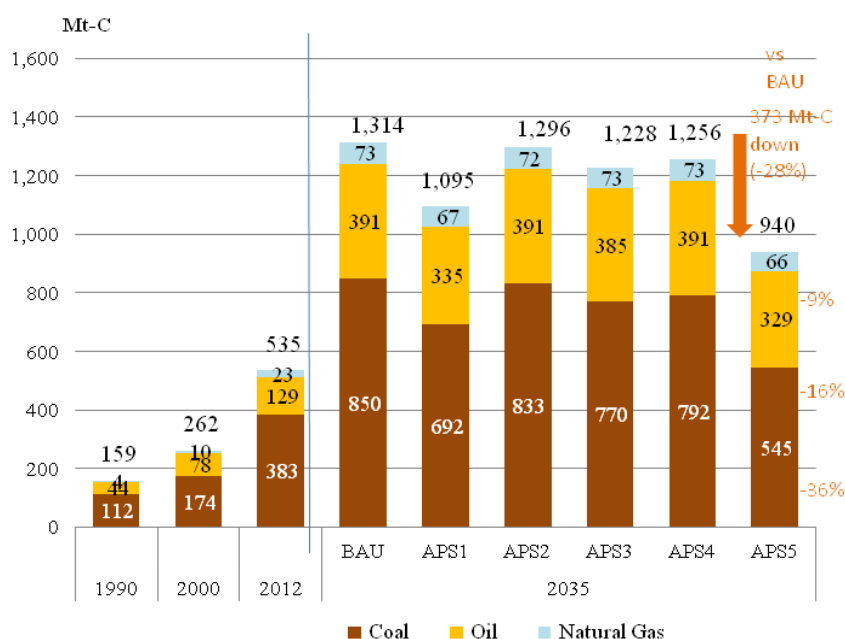
Natural gas, oil, and coal will grow at slower annual rates of 4.1 percent, 4.2 percent, and 1.5 percent, respectively, increasing to 124 Mtoe, 455 Mtoe, and 504 Mtoe, respectively, in 2035, meaning they will be 7.7 percent, 14.0 percent, and 35.9 percent lower, respectively, than under the BAU scenario.

3.3. CO₂ Emissions from Energy Consumption

Under the BAU scenario, CO₂ emissions from energy consumption will increase by 4.0 percent per year, from 535 Mt-C in 2012 to 1314 Mt-C in 2035. The projected growth in emissions is less than the projected growth in primary energy consumption, reflecting the expected increase in the use of less carbon intensive energy sources in India.

In the APS, the annual increase in CO₂ emissions from 2012 to 2035 will be 2.5 percent slower than under the BAU scenario – CO₂ emissions in 2035 will be 940 Mt-C, 28.4 percent lower than under the BAU scenario. Lower demand for coal in final demand and in power generation and for oil in the transport sector contribute most to the expected reduction in CO₂ emissions. Figure 6-8 shows the CO₂ emission in 2035 under the various scenarios analysed in this energy outlook.

Figure 6-8. CO₂ Emissions from Energy Combustion, BAU and APS



BAU = Business-as-Usual; APS = Alternative Policy Scenario.

Source: Author's calculation.

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 scenario and in the APS. Use of domestic coal for secure supply as well as more efficient coal technologies such as integrated gasification combined-cycle (IGCC), ultra-supercritical (USC), etc. would be necessary. In the long term and medium term, 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 fully utilise the increasing global natural gas production, it is necessary to enhance the infrastructure for importation, domestic transportation, and utilisation.
- Energy efficiency and demand side management are important.
 - Industry will account for 39 percent of the incremental energy use to 2035; energy efficiency programmes should be focused on this sector. Broadening the scope of the PAT (Perform, Achieve, Trade) scheme will be an important way of achieving this.
 - There are huge potential savings in the power sector. Advanced technologies for power generation should be used as much as possible.
 - 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.