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Energy implications of faster growth in India with different economic compositions

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India's economic development is likely to have a considerable impact on future international energy markets because of the country's large population and potential for growth. The current Indian government is also reviewing a set of economic and social programs, including financial reforms and expansions in providing electricity service, which could have a profound impact on both future economic growth and energy demand within the country. This article presents the results of sensitivity cases to examine how different types of future economic growth in India may affect energy markets.

Three high economic growth side cases are examined in this report—Export-led, Investment-led, and Consumption-led. In the Export-led case, Indian economic growth relies heavily on the expansion of exports—as was the case in South Korea. In the Investment-led case, a combination of investment and export growth is the primary driver of economic expansion—as was the case in China over the past decades. In the Consumption-led case, Indian economic growth is primarily the result of an increase in personal consumption expenditures.[1] Despite the differences in how the economy expands, real Indian gross domestic product (GDP) is projected to grow by an average of about 7.1% per year over the period of 2015–2040 across all of the three side cases, which is about 1.1 percentage points per year higher than the rate in the *International Energy Outlook 2018* (IEO2018) Reference case.[2]

The results demonstrate how different energy consumption patterns can result with identical levels of economic growth but different patterns of economic development. Although each of the side cases is associated with the same level of economic growth, the Export-led case results in the largest increase in Indian energy use, with 33% more energy consumed in 2040 than in the IEO2018 Reference case. This side case also leads to nominal gross output from the energy-intensive manufacturing sector that is about 50% larger in 2040.[3] Further, the industrial sector remains the largest energy-consuming end-use sector through 2040 across all side cases considered in IEO2018.

The results also indicate that the transportation, residential, and commercial sectors in India combined account for nearly 31% of the increase in delivered energy consumption in the Consumption-led case compared with the IEO2018 Reference case in 2040. In comparison, these sectors account for only 28% of the change between the IEO2018 Reference case and the Investment-led case, and 26% of the change between the IEO2018 Reference case and the Export-led case. These results are not presented in as much depth as those for the industrial sector, because more data analysis and model development are needed to better understand future energy consumption in the other three energy end-use sectors.

Background

India has a sizeable economy and a large, growing population. Its economy is currently the third largest of any nation (as measured in terms of 2010 purchasing power parity dollars), surpassed by only China and the United States (Figure 1). India also consumed more energy than any other nation except China,

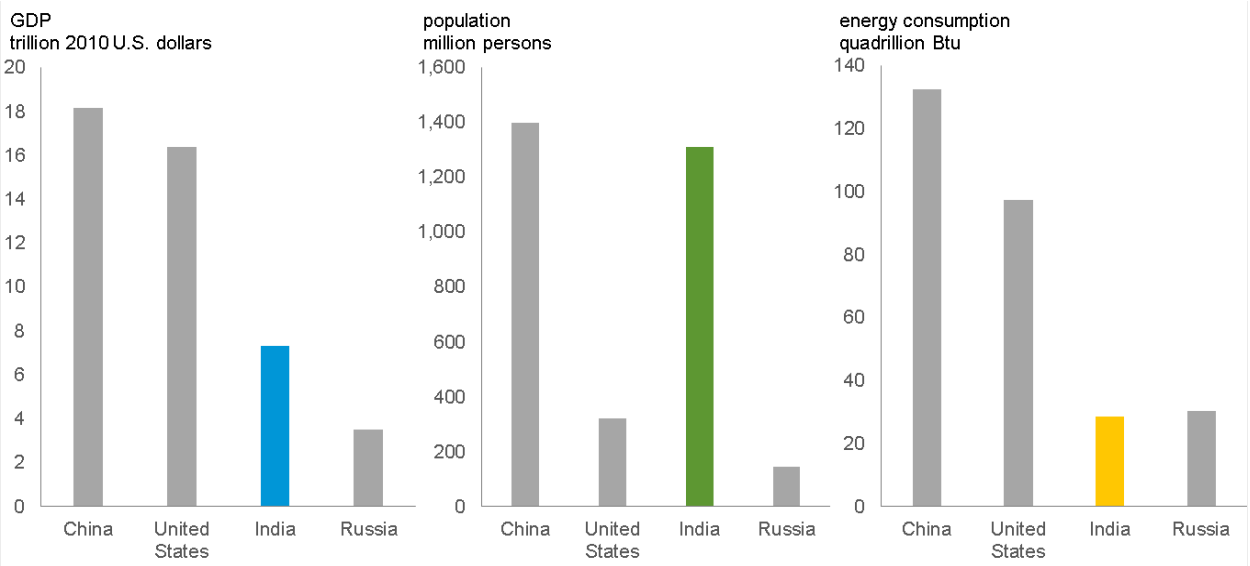
[1] The economic concepts used are based on expenditures that sum to total GDP as defined in the United Nation's (UN) *System of National Accounts* (SNA). Consumption is annual personal consumption expenditures; investment is annual spending on gross private domestic investment; and exports are the annual value of exported goods and services.

[2] The IEO2018 Reference case referred to in this document updates the IEO2017 Reference case with macroeconomic information, but no modeling changes were made to other end-use sectors.

[3] Energy-intensive industries include food, pulp and paper, basic chemicals, refining, iron and steel, nonferrous metals, and nonmetallic minerals.

the United States, and Russia in 2015, and is expected to have more people than any other single country by 2040.

Figure 1: Gross domestic product, population, and energy consumption in four countries, 2015



Sources: U.S. Energy Information Administration, World Energy Projection System Plus (2018)

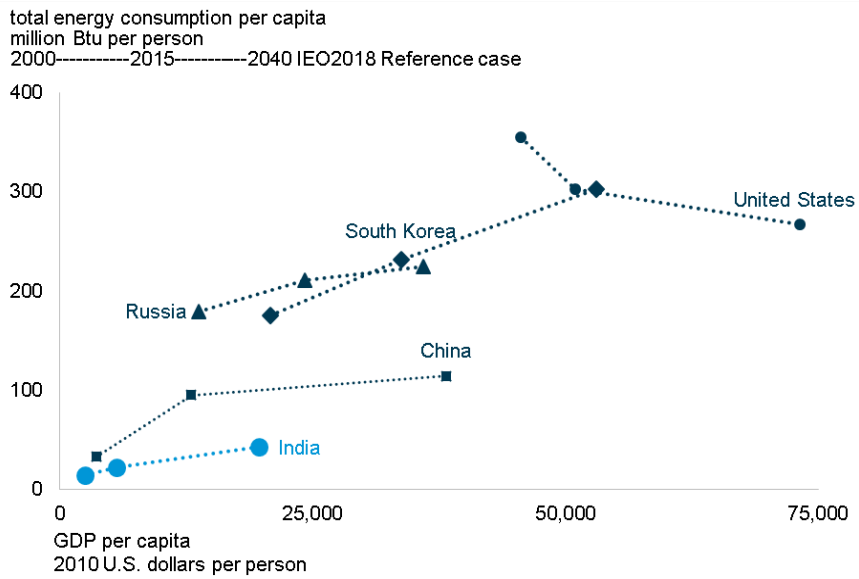
Although economic activity in India has increased over the past several decades, the economies in many nearby countries have experienced stronger economic growth—for example, the economies of Hong Kong, Singapore, South Korea, and Taiwan grew more rapidly from the 1960s through the mid-1990s. From the 1970s through the 2000s, China's economy also experienced unprecedented, often double-digit annual growth in GDP that typically surpassed growth in India.

Figure 2 shows how India's economy has also not kept pace with per capita GDP growth experienced in other countries such as China. In 2000, Indian per capita GDP was about 30% lower than that of China ($2,525 per person in India compared with $3,616 per person in China). By 2015, Indian per capita GDP was slightly lower than $5,600, the level of GDP per capita that China exceeded by 2006.

Chinese per capita energy consumption in 2015 was also almost 4.4 times higher than India's in that year. The differences between per capita energy consumption in India and in the United States, Russia, or South Korea are even larger. Although these differences are partly attributed to India's extremely large population relative to the other comparison countries, infrastructure and institutional constraints may have slowed the growth in India's per capita energy consumption.

Looking forward, many forecasters believe that India will be one of the fastest-growing economies in the world over the next several decades. However, substantial uncertainty about the pace and the path of this growth still exists. Economic growth also does not always translate directly into increases in per capita energy demand.

Figure 2. Energy consumption relative to GDP on a per capita basis in 2000, 2015, and 2040 across major economies



Sources: U.S. Energy Information Administration, International Energy Statistics database (as of April 2018), World Energy Projection System Plus (2018)

In the IEO2018 Reference case, India is already projected to achieve the fastest economic growth of any region in the world between 2015 and 2040. Yet per capita GDP only reaches $19,677 by 2040—about half the level in China ($38,218 per person) and Russia ($35,929 per person) in 2040 despite some notable demographic and economic challenges faced by those nations over the projection period. Both China and Russia also maintain much higher levels of per capita energy use than India over the projection.

However, these results are affected by the economic development pattern of the IEO2018 Reference case. The pattern of economic development influences sectoral energy consumption shares, per capita energy consumption, and energy efficiency. Patterns of economic growth are explicitly addressed in the side cases.

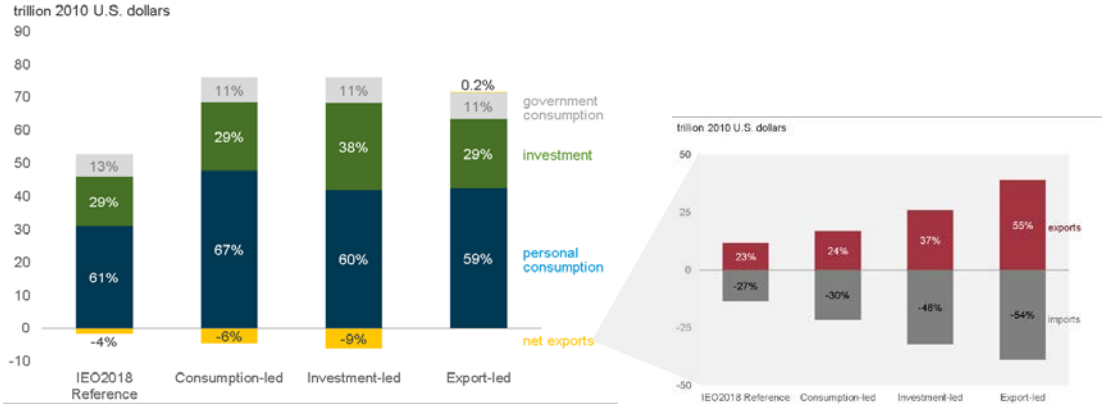
Results

To consider how different patterns of economic growth in India may affect Indian and world energy markets, the results for three different high economic growth cases are presented. India's economy grows about 7.1% per year on average through 2040 instead of the IEO2018 Reference case average of 6.0%. The results are placed in the context of expenditure shares, which are the ratios of the individual expenditure components of GDP (personal consumption expenditures, gross fixed private investment, government expenditures, and net exports) to total GDP.

Figure 3 shows the expenditures on each component of GDP in 2040 for each high economic growth case and for the IEO2018 Reference case, as summarized below:

- **Export-led case** – The expenditure share of exports in 2040 is 55%, compared with 23% in the IEO2018 Reference case. This export-driven case is patterned after the South Korean experience of the 1960s–1990s.
- **Investment-led case** – The expenditure share of investment rises to 38% by 2040, compared with 29% in the IEO2018 Reference case. The export share also increases to 37%. This investment and trade-driven case is patterned after China's growth path over the past 40 years.
- **Consumption-led case** – The consumption share of expenditures reaches 67% in 2040, rising higher than the 61% exhibited in the IEO2018 Reference case. This case does not reflect any particular country's historical development, but reflects U.S. levels of consumption relative to GDP.

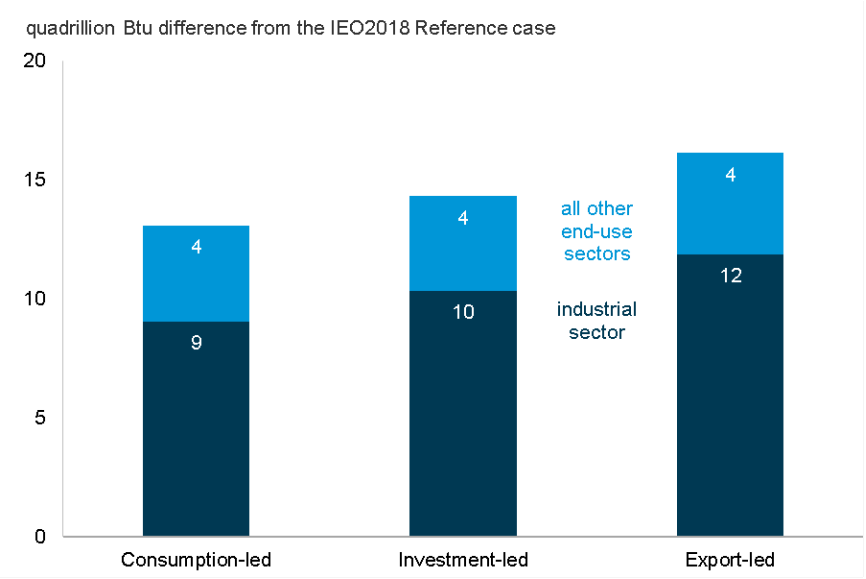
Figure 3. Expenditures on each component of GDP in 2040 for IEO2018 Reference case and India High Growth cases



Source: U.S. Energy Information Administration, World Energy Projection System Plus (2018)

In absolute terms, the conditions presented in the side cases result in substantial energy consumption increases when compared with the IEO2018 Reference case (Figure 4). The largest increase occurs in the Export-led case, where energy consumption in 2040 is about 33% higher (slightly more than 16 quadrillion Btu). The smallest increase is in the Consumption-led case, where energy consumption is about 26% higher than in the IEO2018 Reference case in 2040.

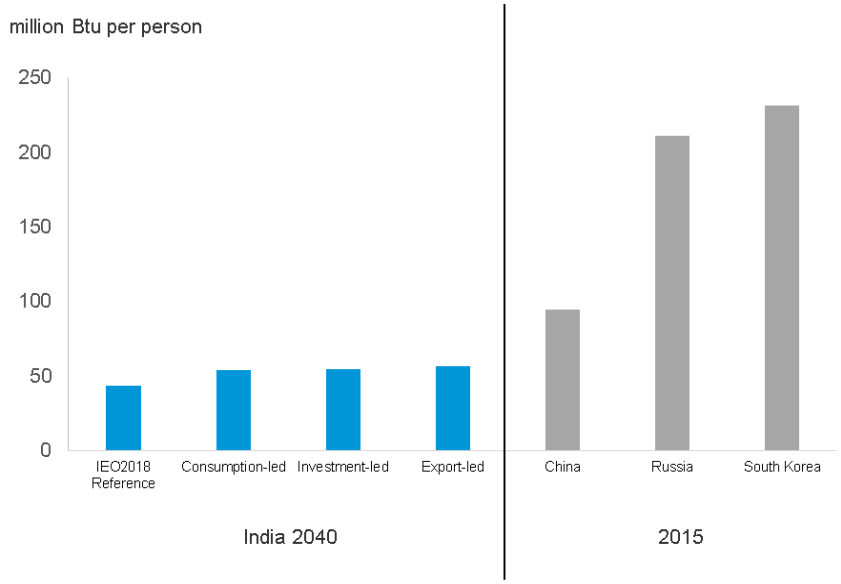
Figure 4. Increase in Indian energy consumption in three India High Growth cases compared to IEO2018 Reference case in 2040



Source: U.S. Energy Information Administration, World Energy Projection System Plus (2018)

India's per capita energy consumption across all cases in 2040 is still much lower than per capita energy consumption was in other large countries in 2015 (Figure 5). One reason for this result is that India is the beneficiary of technological progress—particularly in terms of energy-intensive processes and equipment. As India adopts more energy-efficient practices and equipment, it will not require the same energy that China needed in the 2000s to increase industrial output. Another reason that Indian per capita energy use does not increase to levels of other nations is related to how India's industry composition is projected to grow.

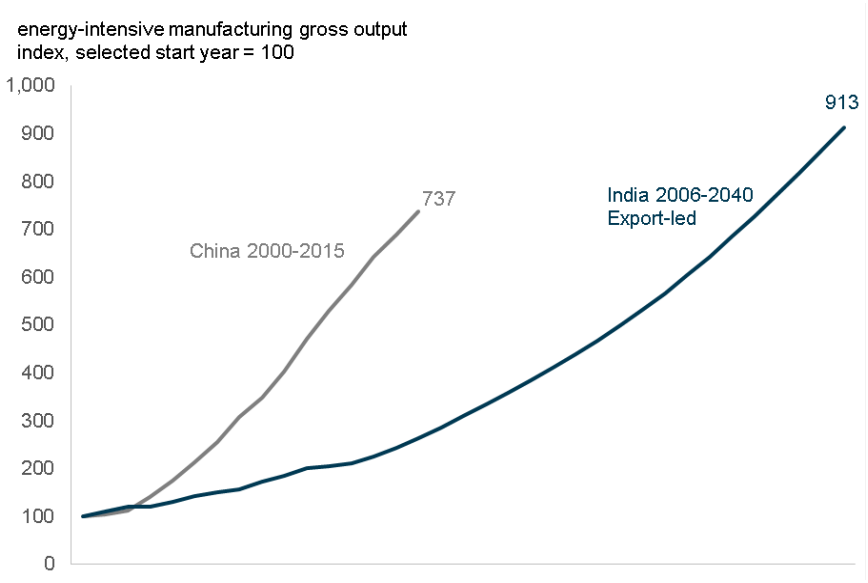
Figure 5. Energy consumption per person in 2040 for India and 2015 for other select countries



Source: U.S. Energy Information Administration, World Energy Projection System Plus (2018)

To illustrate this last point, Figure 6 shows that historical Chinese energy-intensive manufacturing output grew more rapidly than the projections for India.[4] Only near the end of the projection period in the Export-led case does India's energy-intensive output exceed that of China in 2015. Some of this divergence is related to specific characteristics of India, which include policies, people, economic structure, and resources. For example, the Indian economy currently produces more services than manufactured goods, and this characteristic persists throughout the projection period in the IEO2018 Reference case. Delivering economic services, which are products that cannot be stored and are consumed at the place and time of their purchase, is generally less energy intensive than producing manufactured goods.

Figure 6. Index of Indian and Chinese energy intensive manufacturing output (China, 2000=100 and India, 2006=100)



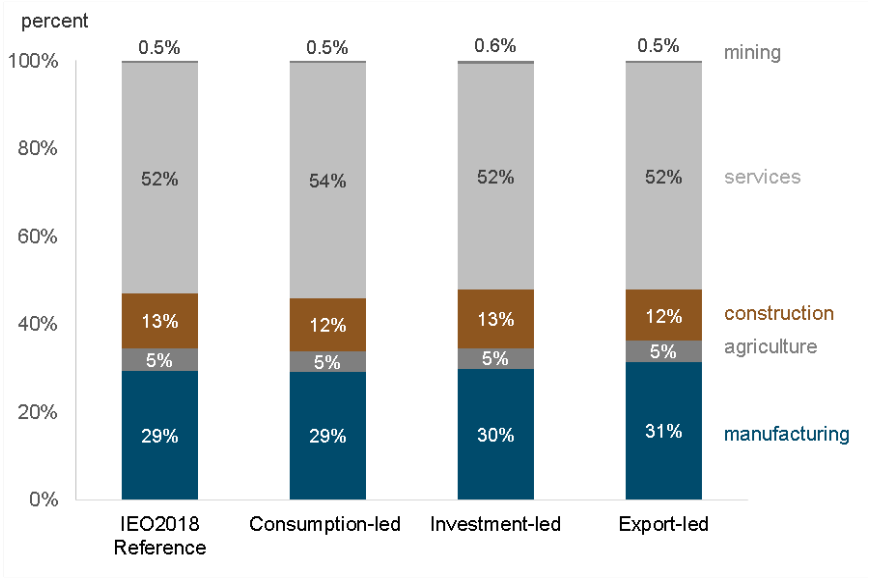
Source: U.S. Energy Information Administration, World Energy Projection System Plus (2018)

The delivery of economic services accounts for about 50% of Indian output in 2040 across all cases, which implies that changing the expenditure shares of GDP has a limited effect on the production structure of the Indian economy (Figure 7). As a result, for India to reach levels of per capita energy consumption similar to those in other large countries, the country must either undergo major changes in its production structure or see a large increase in energy consumption outside of the industrial sector.

However, the industrial sector is directly affected by the composition of GDP, and the industrial results are more sensitive to the assumptions of each case. For example, the Export-led case, where exports are assumed to account for a larger share of GDP, sees a shift in the output of industries toward more energy-intensive manufacturing, such as bulk chemicals, which are highly trade sensitive.

[4] Each series is set to equal 100 in the year when GDP per capita in each country was about $3,500 (2000 for China and 2006 for India).

Figure 7. Gross output share of each major sector in 2040 for IEO2018 Reference case and India High Growth cases



Source: U.S. Energy Information Administration, World Energy Projection System Plus (2018)

Other types of industrial activities, such as construction, are more sensitive to investment, as shown in the industry composition in the Investment-led case, which is the only side case where the construction sector output share does not decrease compared with the IEO2018 Reference case. The services share is highest under the Consumption-led case, and this case is the only side case where the services sector share of the economy grows relative to the IEO2018 Reference case. Figure 4 shows that differences between the side cases are much smaller than those relative to the IEO2018 Reference case—about 3.0 quadrillion Btu between the highest and lowest levels of energy consumption in 2040—Export-led and Consumption-led, respectively. Most of this difference is accounted for by the industrial sector (2.8 quadrillion Btu), with the transportation, residential, and commercial sectors collectively accounting for slightly less than 0.2 quadrillion Btu in 2040.

Distinguishing between the expenditure shares of GDP (Figure 3) and the production structure of the economy (Figure 7) also helps to explain why energy consumption differences between side cases are relatively small. In the Export-led case, which has the largest change in energy consumption of any case in 2040 compared with the IEO2018 Reference case, the share of exports more than doubles relative to the baseline. Although manufacturing is about 2 percentage points larger as a share of the economy in the Export-led case, this sector still only accounts for about 31% of Indian output in 2040, while the services share remains higher than 50%.

In the Investment-led case, where energy consumption is about 1.8 quadrillion Btu less than in the Export-led case at the end of the projection period, services are still 52% of output in 2040. This case has higher construction output and lower manufacturing output than the Export-led case, and the result is slightly less energy consumption than in the Export-led case. The Consumption-led case has the highest share of services, but manufacturing still accounts for 29% of total output in 2040.