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## SECTION 2

# ASIA'S CLEAN ENERGY CHALLENGE

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## SECTION 2

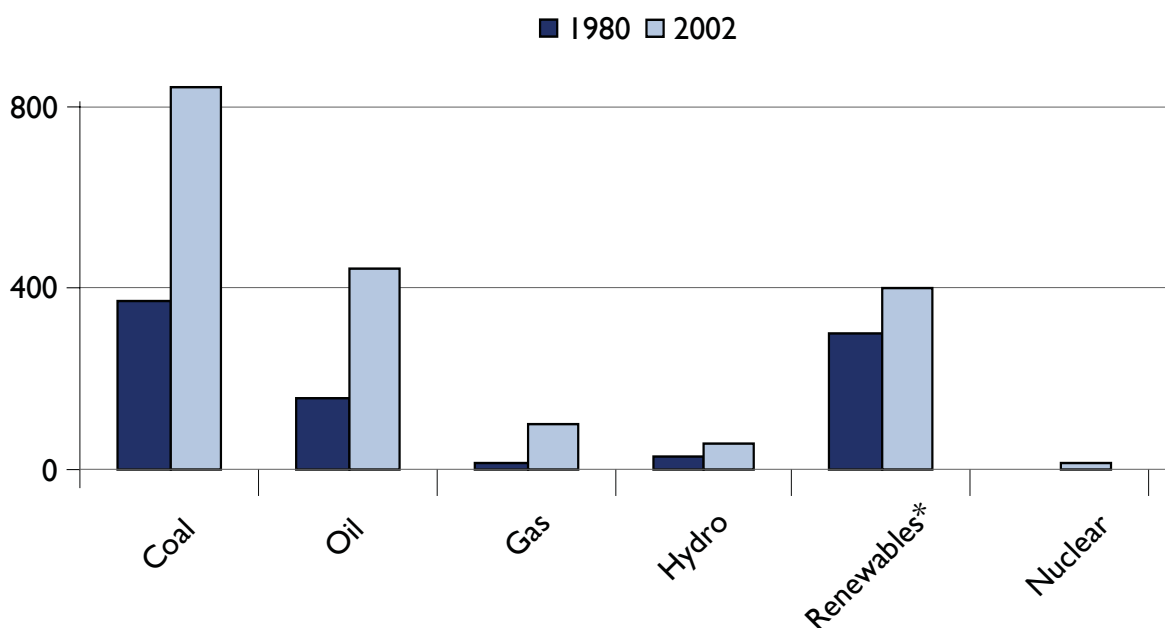
# ASIA'S CLEAN ENERGY CHALLENGE

This section provides an overview of Asia's clean energy challenges. Divided into three main parts, it begins by examining *current energy demand trends* in developing Asia from 1980 to the present, highlighting the increased reliance on fossil fuels in the power, transport, residential, commercial, industrial, and manufacturing sectors.<sup>1</sup> It then reviews *projections* of future fossil fuel use and energy demand for these sectors, and explores potential environmental, social, and energy security impacts. Finally, it reviews current and projected *investment trends* in conventional and clean energy options to evaluate the scale and scope of planned investments and the prospects for clean energy in the region.

## 2.1 CURRENT TRENDS IN ENERGY RESOURCE AVAILABILITY AND USE

Between 1980 and 2002, developing Asia's primary energy demand more than doubled (Figure 2).<sup>2</sup> During the same period, coal and oil use more than doubled in the focus countries examined in this report.<sup>3</sup>

**FIGURE 2. HISTORICAL TRENDS IN PRIMARY ENERGY DEMAND BY FUEL TYPE IN THE SIX FOCUS COUNTRIES**



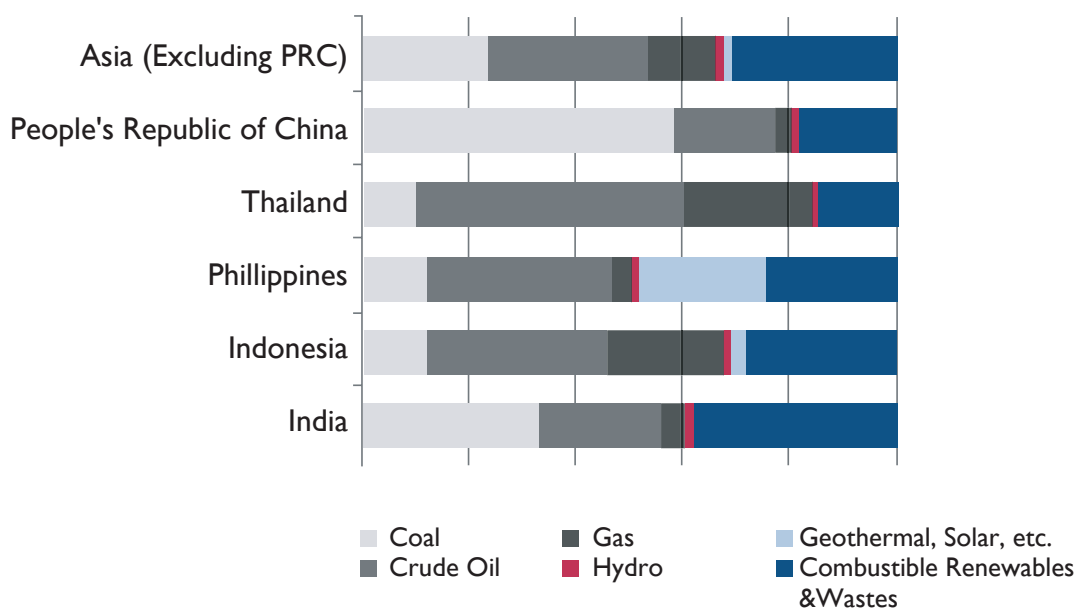
Source: BP Statistical Review, 2006; TERI, 2006; APERC, 2006. \* Renewables consist predominantly of biomass.

Current trends indicate that developing Asia's reliance on fossil fuels is rising sharply and outpacing the modest increases in use of renewable energy resources. In 2002, more than 75 percent of the total final energy consumption in the focus countries was derived from fossil fuels. Coal and oil accounted for 69

1. The agricultural sector was not included in the analysis.
2. While more than half of the world's population lives in Asia, individuals in Asia currently consume 33 percent less energy than the global average.
3. Since 2002, the growth rates have been higher. 2002 was the latest year with consistent data for all six focus countries.

percent of this energy mix (45 and 24 percent respectively); together, natural gas, hydropower, biomass (renewables) and nuclear power contributed the remaining 31 percent. Country energy mixes vary greatly: coal is the dominant source of energy in China (60 percent, 2005 est.) and India (over 30 percent), while oil figures more prominently as a source of energy in Thailand, Indonesia, and the Philippines (IEA, 2006). Throughout the entire region biomass continues to supply a significant portion of the primary energy mix, mostly in the form of traditional fuels used by rural households and the urban poor (Figure 3).

**FIGURE 3. PRIMARY ENERGY MIX IN SELECTED ASIAN COUNTRIES (2005)<sup>4</sup>**



Source: ADB, 2006b.

Electricity demand has increased largely as a result of urbanization and increased manufacturing activity. Between 1980 and 2002, electricity use in the six focus countries increased nearly five-fold (APEREC, 2006; TERI, 2006). As reflected in Table 2, the heaviest reliance has been on coal and oil for electricity generation, although hydropower plays a significant role.

**TABLE 2. ELECTRICITY GENERATION BY SOURCE IN THE FOCUS COUNTRIES IN 2002 (TWh)**

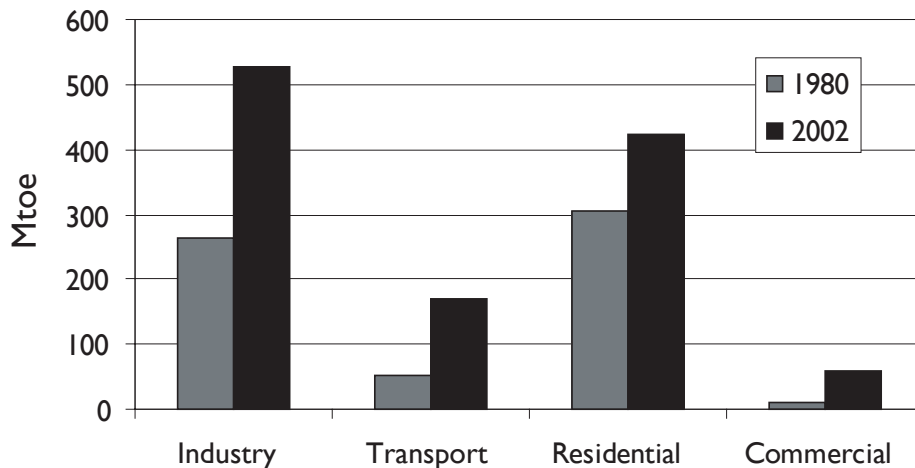
Source	China	India	Indonesia	Philippines	Thailand	Vietnam
Coal	1,056	418	30	21	18	5
Oil	49	30	16	2	2	4
Gas	5	66	34	9	82	8
Hydro	275	64	10	6	8	18
Renewables	4	2	5	13	1	
Nuclear	27	18				

Source: APERC, 2006; TERI, 2006; WDI, 2006.

4. Data were not available for Vietnam.

Final energy demand is indicative of the large growth rates throughout the region as well. In the four major energy sectors for which consistent data are available, final energy demand in the focus countries has grown 88 percent from 1980 to 2002 (Figure 4).

**FIGURE 4: GROWTH IN FINAL ENERGY DEMAND BY SECTOR IN THE FOCUS COUNTRIES**



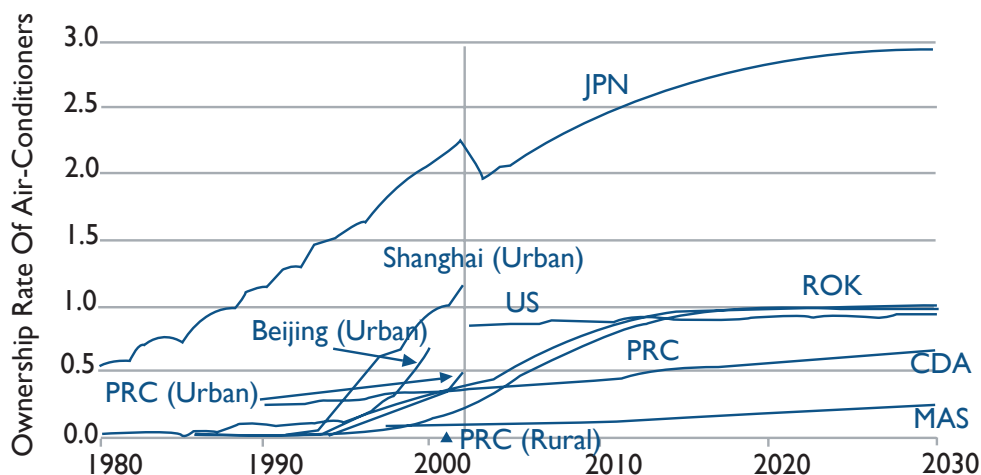
Source: APERC (2006); TERI (2006).

The transport sector in the focus countries accounts for an average of 15 percent of final energy demand (roughly tripling between 1980 and 2002), primarily due to increased personal mobility and shipment of goods. During the past 30 years, the number of vehicles has increased nine-fold in ASEAN countries, 11-fold in India, and 16-fold in China. Driven mostly by transport, demand for oil in developing Asian countries accounted for 46 percent of the global increase in oil demand between 2000 and 2005; nearly 30 percent of this increase was from China alone (IEA, 2006).

During the past decade, the energy consumption of developing Asia's residential and commercial sectors has grown in parallel with increasing incomes and populations. Combined, these sectors constituted 41 percent of final energy demand in the focus countries in 2002. The increased energy consumption, mainly of electricity, has gone towards meeting requirements for air conditioning, space and water heating, lighting, and operating home appliances such as televisions and washing machines. The wider use of air conditioners and refrigerators is the most significant factor contributing to increased demand for electricity in the residential sector.

Compared with developed economies, purchases of new air conditioners and refrigerators in the region are rising sharply, and this trend can be expected to continue until market saturation slows growth (Figure 5). For example, in China, refrigerator ownership per 100 rural households jumped from 0.1 to 17.8 between 1980 and 2004; similarly, ownership of air conditioners went from 0 to 69 per 100 urban households in the same time period (Stanford, 2006).

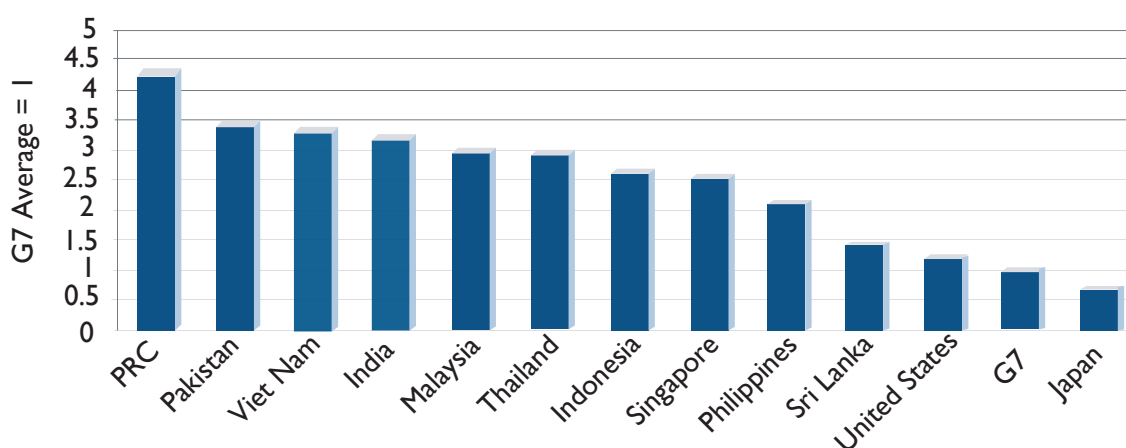
**FIGURE 5. AVERAGE NUMBER OF AIR CONDITIONERS PER HOUSEHOLD IN SELECTED ASIAN COUNTRIES (1980-2030)**



Source: APERC, 2006. Note: Canada (CDA); Japan (JPN); Malaysia (MAS); People's Republic of China (PRC); Republic of Korea (ROK); United States (US).

Since much of developing Asia's economic activity is centered within industrial and manufacturing sectors that use largely inefficient technologies, energy intensities in Asia have remained high relative to western economies. The industrial sector represents about 45 percent of final energy demand on average in the focus countries, reflecting a high share of manufacturing. From 1980 to 2005, most countries in developing Asia experienced increases in energy intensities. China, which started with a relatively high energy intensity, managed to achieve significant reductions in its energy intensities through a combination of energy efficiency improvements and structural changes (Zhang, 2003). Nevertheless, energy intensities in developing Asia remain 1.5 to 4 times higher than intensities in G7 nations (ADB, 2006) and dramatic opportunities for improvement are available (Figure 6).

**FIGURE 6. VARIATION IN AGGREGATE ENERGY INTENSITY ACROSS ASIAN COUNTRIES (2005)<sup>5</sup>**



Source: ADB (2006).

5. G7 Average = 1. Some of the differences shown in the chart are due to differences in the structure of the economy (i.e. developing Asian economies are more manufacturing-intensive). However, comparisons within industrial sub-sectors indicate significant inefficiencies in Asian industries compared to industries in North America, Europe, and Japan.

## 2.2 FUTURE ENERGY DEMAND GROWTH

If current trends continue, developing Asia's energy consumption will more than double over the next 30 years. Energy demand in the region is expected to exceed 5,000 Mtoe by 2030, accounting for 30 percent of worldwide energy demand (APERC, 2006; TERI, 2006).<sup>6</sup> Currently, much of this projected demand for energy will be met with fossil fuels (Table 3). The trend is clear: in the region, coal use is expected to grow nearly four-fold by 2030 (IEA, 2006) and will be central to future energy plans because of its availability and price stability.

**TABLE 3. TRENDS IN FOSSIL FUEL CONSUMPTION IN THE FOCUS COUNTRIES (1980-2030) (UNITS = Mtoe)**

	1980	2002	2010	2020	2030
<b>Coal</b>	369	819	1,438	2,027	3,124
<b>Oil</b>	161	447	685	1,069	1,649
<b>Gas</b>	18	125	217	398	557

Source: APERC, 2006; TERI, 2006. Note: Data was not complete for some countries in 1980.

Notwithstanding the current increased rate of growth in the renewables sector, only modest increases in supply are projected unless greater growth rates are realized in the future (Table 4). China is expected to lead the region in renewable energy supply by 2020 (IEA, 2002b).

**TABLE 4. INCREASE IN RENEWABLE ENERGY CONSUMPTION IN ASIA (1997-2030) (UNITS = Mtoe)**

	1997	2030
<b>China</b>	17	56
<b>East Asia</b>	15	49
<b>South Asia</b>	9	20

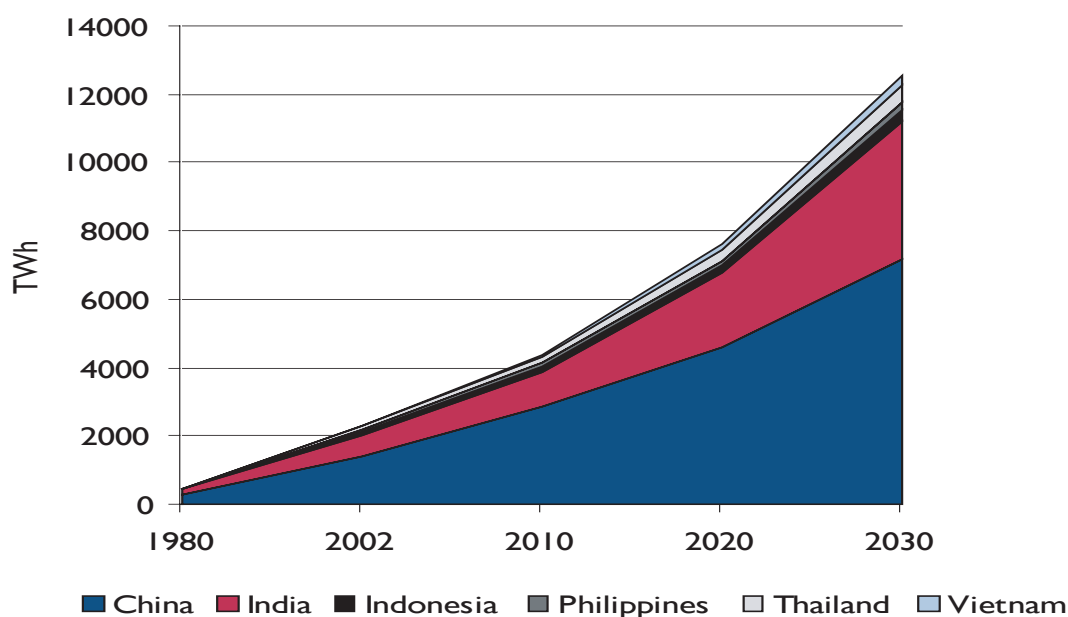
Source: IEA, 2002.

As illustrated in Figure 7, electricity generation is expected to grow more than five-fold in the focus countries from 2002 to 2030 (APERC, 2006; TERI, 2006).<sup>7</sup> Within the region, Southeast Asia is predicted to have the highest electricity demand growth rate in the world at 6.1 percent annually until 2020; China's electricity demand is projected to expand at 5.6 percent annually until 2020 (Fujitomi, 2004).<sup>8</sup>

6. China, in particular, is a significant source of uncertainty in future energy projections for the region. Its economy has grown an average of 10 percent per year for the past two decades, and continued growth will have a major impact on the world energy scenario. China's economic growth is expected to slow as the Chinese Government implements its Eleventh Five-Year Plan, which aims to moderate growth to 7.5 percent per year from 2005-2010. Despite this moderation, the IEA (2006) predicts that China's share of global energy demand will rise from 15 percent now to 20 percent by 2030.

7. Overall electricity generation in the six focus countries is projected to grow 2,600 percent from 1980 to 2030.

8. In comparison, North America's electricity growth rate is predicted by APEC to be 1.9 percent annually until 2020.

**FIGURE 7. TOTAL ELECTRICITY GENERATION 1980-2030**

Source: APERC, 2006; TERI, 2006.

Among the various sectors, transport is expected to be one of the fastest growing at 4.6 percent a year. This growth will be driven primarily by increased urbanization and rising per capita incomes, both of which increase demand for personal motorized transport. Road and rail freight transport is expected to grow 4.1 percent per year until 2030, and the transport sector is expected to increase its share of Asia's overall primary consumption from 38 to 40 percent during the same period (Leather, 2006). The expansion of the transport sector will have far-reaching impacts on the consumption of gasoline and diesel, which is expected to double in the ASEAN region and triple in India by 2020 (Leather, 2006). The projected average annual growth rate in the number of personal vehicles is 1.7 percent for developing Asia, with higher rates for India and China. Estimates for transport energy use in these countries show a three-fold increase over the next 20 years; in China alone, there will be 140 million more vehicles on the road by 2020 (ADB, 2006b).

China will continue to lead in residential and commercial energy demand growth with a projected growth rate of 6 percent annually in household appliances.<sup>9</sup> As incomes rise, demand for cooking, lighting, space heating, air conditioning, refrigeration, and electrical appliances grows. Between 2002 and 2030, commercial energy demand in the region is projected to grow 2.5 percent annually while residential energy demand will grow 1.6 percent per year (APERC, 2006).

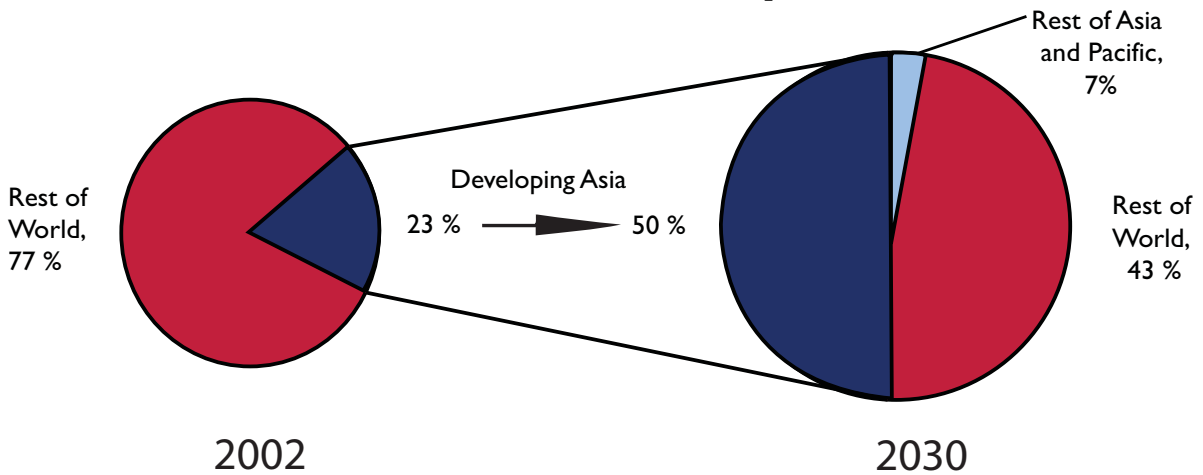
Industrial energy demand is expected to double by 2030, primarily driven by China's and India's high economic growth, thus highlighting the need for technology transfer and energy efficiency measures to reduce industrial energy intensities. Over the outlook period, Vietnam and China are projected to have the fastest annual growth in the industrial sector's added value (7.1 and 6.6 percent per year, respectively), partly due to high domestic demand growth and the influx of foreign investment (APERC, 2006).

9. Figure 5 illustrates China's projected growth in air conditioners.

### 2.3 TRENDS IN ENVIRONMENTAL IMPACTS AND SECURITY

Asia's energy use is placing a severe strain on the local environment and increasingly contributing to global climate change, with its growing emissions of criteria air pollutants and GHGs. This situation will be exacerbated as the contribution of Asia's developing economies to global CO<sub>2</sub> emissions rises from its current level of 23 percent to nearly 50 percent by 2030 (Figure 8).

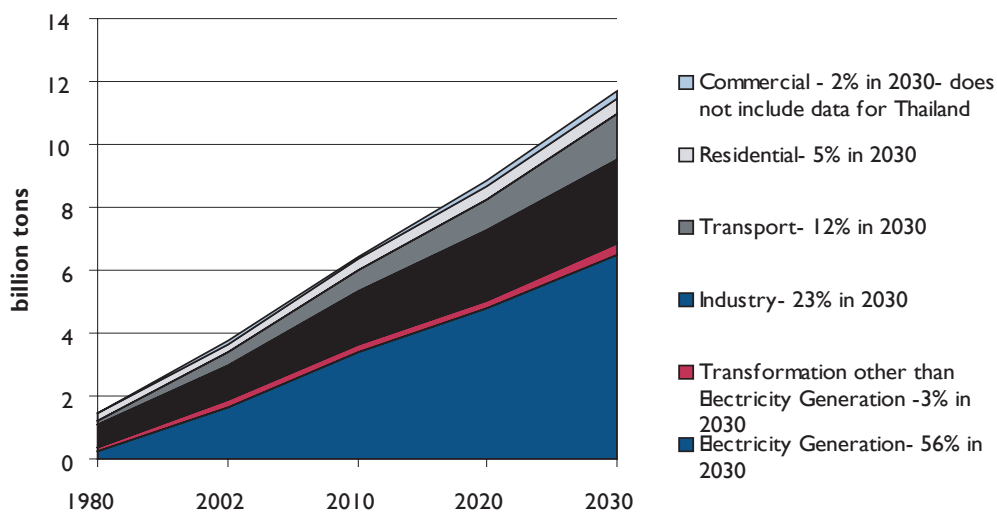
**FIGURE 8. CURRENT AND PREDICTED (IN 2030) CONTRIBUTION OF DEVELOPING ASIAN ECONOMIES TO GLOBAL CO<sub>2</sub> LEVELS**



Source: IEA, 2006.

Figure 9 shows that from 1980 to 2002, CO<sub>2</sub> emissions rose 2.5-fold in five of the six focus countries,<sup>10</sup> and from 2002 to 2030 they are expected to increase by another three-fold. **Electricity generation** in these countries is expected to make the greatest contribution to CO<sub>2</sub> emissions (APERC, 2006). The IEA predicts that China will be responsible for 39 percent of global GHG emissions increases from 2004-2030 (IEA, 2006). It now appears that China's emissions of GHGs will exceed those of the United States by 2009, a full decade earlier than previously projected (IEA, 2006).

**FIGURE 9. CO<sub>2</sub> EMISSIONS BY SECTOR IN SELECTED COUNTRIES (1980-2030)**

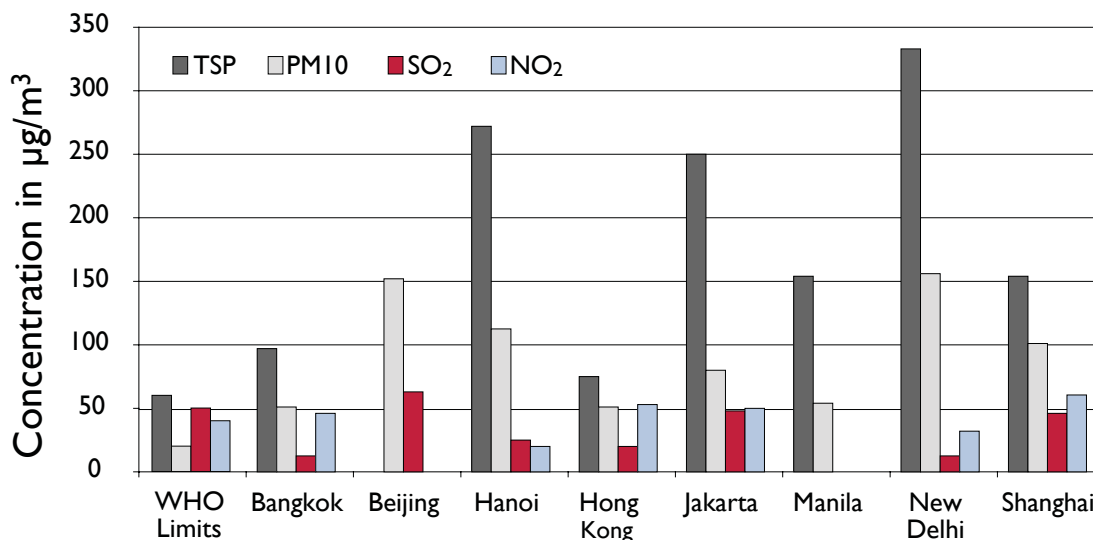


Source: APERC, 2006.

10. Compatible data for India were not available across the time frame, and hence India is not included in this graph. India's 2004 national communications to the UNFCCC contains 1994 data. It is expected that more recent data will become available within the next year.

Combustion of fossil fuels for power and transportation is also causing significant deterioration in **local air quality** in many of Asia's largest cities, several of which have particulate pollutant levels that are three to four times the acceptable levels set by the World Health Organization (**Figure 10**). Poor outdoor air quality in many Asian cities has been linked to severe health impacts. Extreme levels of urban air pollution leads to about 800,000 deaths per year in the world, and 65 percent of these deaths occur in the Asia Pacific region (UNEP, 2006).

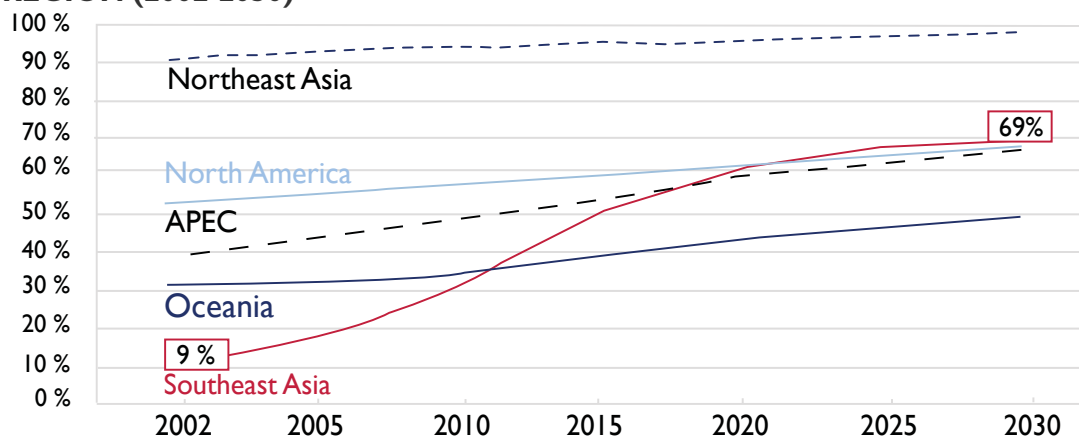
**FIGURE 10. CRITERIA POLLUTANT LEVELS IN ASIAN MEGACITIES**



Source: Clean Air Asia, 2006. TSP = Total suspended particulates.

Although Asia has significant fossil fuel reserves,<sup>11</sup> **energy security** is a growing concern for governments in the region, especially in the oil sector. As domestic oil supplies trail demand, increases in oil prices in recent years have more than doubled energy import bills. Malaysia and Indonesia, which have traditionally been oil exporting countries, are now net importers of oil. Between 2002 and 2025, the oil import dependency of Southeast Asian nations will increase from 10 percent to nearly 70 percent (**Figure 11**). The vast majority of this oil is expected to be sourced from the Middle East (Saha, 2006) making the region vulnerable to embargos and supply shocks.<sup>12</sup>

**FIGURE 11. TRENDS IN OIL IMPORT DEPENDENCY IN THE ASIA-PACIFIC REGION (2002-2030)**



Source: APERC, 2006. Note: The percentages in the figure only refer to line (green color) representing the ASEAN region.

11. In 2005, the Asia-Pacific region accounted for almost 25 percent of global oil reserves, 55 percent of global gas reserves, and 54 percent of coal reserves, with sizeable renewable resources. China and India held 23 percent of world's coal reserves in 2005 (IEA, 2006).  
 12. In response, China has been targeting African oil exporters, and currently one-third of China's oil imports come from Africa.

## 2.4 INVESTMENT TRENDS

Meeting increased energy demand in the future will require large capacity additions and significant investments. During the next 25 years, the IEA (2006) estimates that investments of more than US\$6.2 trillion will be needed to build and maintain the energy supply infrastructure to satisfy projected demand in developing Asian economies (Table 5).

**TABLE 5. CUMULATIVE REQUIRED INVESTMENTS IN ENERGY SUPPLY INFRASTRUCTURE: 2005-2030 (US\$ BILLION)**

	Coal	Oil	Gas	Power	Total
<b>Total for Developing Asia (incl. India and China)</b>	298	662	457	4,847	6,264
<b>India<sup>13</sup></b>	38	48	55	967	1,108
<b>China</b>	238	351	124	3,007	3,720

Source: IEA, 2006.

As power generation is the fastest growing energy sector, a large proportion of these projected investments will be made in electricity generation infrastructure. Between 2005 and 2030, the IEA (2006) forecasts that 1,824 GW of electricity capacity will be added in developing Asia at an investment cost of US\$4.8 trillion (Table 6).

**TABLE 6. TRENDS IN ELECTRICITY CAPACITY ADDITIONS (2005-2030)**  
**Investment in electricity sector (US\$ billion)**

	Capacity Additions (GW)	Generation (US\$ billion)	Transmission (US\$ billion)	Distribution (US\$ billion)	Total (US\$ billion)
<b>Total for Developing Asia<sup>14</sup></b>	1,824	1,965	908	1,974	4,847
<b>China</b>	1,089	1,170	579	1,258	3,007
<b>Indonesia</b>	84	83	33	71	187
<b>India<sup>15</sup></b>	330	408	176	383	967

Source: IEA, 2006.

Investments in coal, oil, and gas from 2005 to 2030 in developing Asia are projected to reach US\$1.4 trillion, or roughly US\$56.7 billion annually. It is estimated that developing Asia's share of the investment will equal 43 percent of total world investment. Within the region, China is expected to attract 62 percent of this investment and India about 20 percent.

The global renewable energy sector has seen a sharp rise in investments in recent years, signaling an increased emphasis on displacing conventional energy with clean technologies (Worldwatch, 2005). Of the various clean technologies, wind and solar generation have each been growing at around 30 percent per year. Lower costs have been a positive outcome of these capacity additions in the renewable energy industry. Nevertheless, global investments in the conventional power sector are expected to remain well above investments in the renewable energy sector. In 2004, US\$150 billion was invested globally in

13. IEA projections for capacity investments are generally lower than Indian government projections; therefore, India's investment requirements are likely to be higher than what is shown.

14. Developing Asia is an overarching category that includes China, India, and Indonesia.

15. TERI in India estimates that electricity capacity additions will be nearly double IEA projections

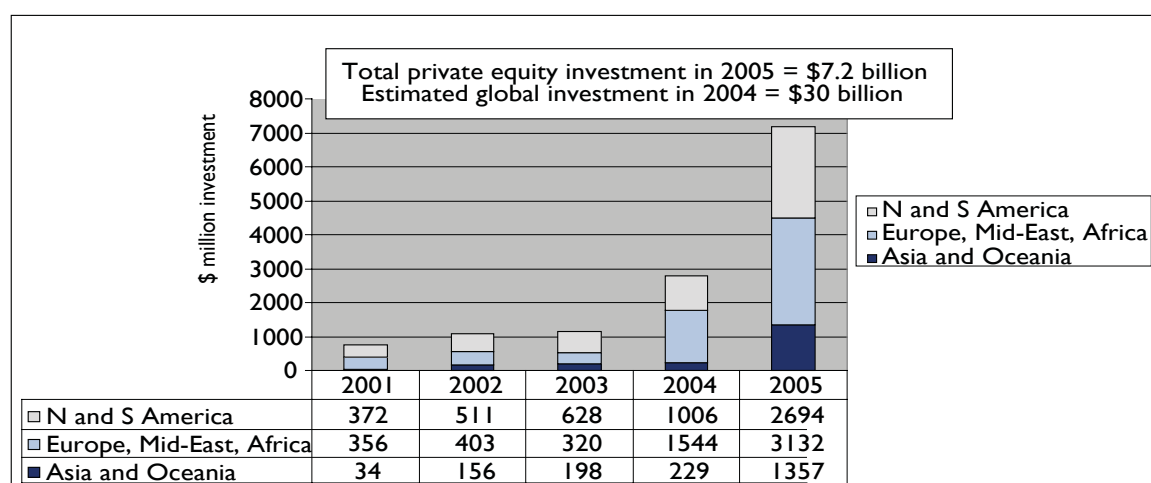
conventional technology while US\$30 billion was invested in renewables (Worldwatch, 2005). Looking to the future, if investments in renewable energy sources were to satisfy 4 percent of current energy consumption in the region, the renewable energy market could reach US\$10 billion annually in the Asia-Pacific region within 10 years (ADB, 2006).<sup>16</sup>

In addition to supply-side investments, many developing Asian countries have set energy efficiency targets and determined corresponding energy efficiency investment requirements. According to the ADB: China expects US\$6.5 billion will be needed for change in industrial structure and an additional US\$21 billion in peak load shifting; India will require US\$3.16 billion for energy efficiency in the industrial and commercial sectors; the Philippines will require US\$2.81 billion for energy efficiency and conservation programs; and Thailand conservatively projects a minimum of US\$698 million will be needed for the industrial and commercial sectors, with upwards of US\$1.52 billion required in an alternate scenario (ADB, 2006).<sup>17</sup>

Clean energy investments in Asia come from a diverse set of public and private sources due to technology standardization and growing acceptance by the financial community. As Figure 12 shows, private equity investments in clean energy (not including energy efficiency) have increased dramatically over the last half decade, from US\$760 million in 2001 to more than US\$7 billion in 2005 (New Energy Finance, 2006).

Current investments in renewable energy range from BOOT or BOT<sup>18</sup> projects valued at hundreds of millions of dollars, to household-scale initiatives supported through microfinance schemes. Renewable energy companies are also attracting venture capital. In this case, the attraction is due in part to future global market projections, some of which show solar PV and wind industries each growing to US\$40-50 billion per year during the period 2010-2014 (Worldwatch, 2005).

**FIGURE 12. PRIVATE EQUITY INVESTMENT IN CLEAN ENERGY BY REGION (2001-2006)**



Source: New Energy Finance, 2006.

In many countries the majority of energy investments come from budgetary spending routed through government energy agencies. In addition, several multilateral agencies (ADB, World Bank, etc.) are

16. This assumes an average investment payback period of eight years.

17. Comparable numbers for energy efficiency investments needed for Vietnam were not available from the ADB.

18. BOOT stands for build, own, operate, and transfer. BOT stands for build, operate, and transfer.

providing funds for energy development. Financing by public banking institutions has also played an important role in stimulating private investments and industry activity in clean energy in general. The World Bank, International Finance Corporation (IFC), and the Asian Development Bank (ADB) have clean energy projects in their lending portfolios. However, as is the case with overall energy sector investments, these institutions have mostly favored conventional fossil energy investments over clean energy investments. The World Resource Institute estimates that more than 80 percent of the World Bank's investments in the energy sector between 2000 and 2005 did not consider climate change implications (Sohn, 2005).<sup>19</sup> In an effort to address this, the G-8 Summit at Gleneagles created the Investment Framework in Clean Energy. This framework aims to promote clean energy development through public-private partnerships and increased lending across the portfolios of multilateral lending institutions.

## 2.5 CONCLUSIONS

The future picture of the Asian energy sector is one of considerable demand increasing across all countries through 2030, most of it met with fossil fuels. Oil is the dominant fuel within the ASEAN region while coal is the dominant fuel in India and China. However, in response to the relatively stable price and supply advantages offered by coal over oil and gas, ASEAN nations are also emphasizing coal in their energy sector expansion plans. In this business-as-usual scenario, the projected constraints on future fossil fuel supplies and significant climate and health risks resulting from fossil fuel use call into question the viability of such an unrestrained expansion of fossil fuels.

Over the next 25 years, developing Asia will need to invest an estimated US\$6 trillion to build and maintain the energy supply infrastructure in order to satisfy its growing energy demands, and the majority of these investments are expected to flow towards fossil-based power generation (IEA, 2006). While recent trends suggest that clean energy options and energy efficiency investments are gaining ground, the vast majority of investments continue to be directed towards conventional technologies and systems. Energy infrastructure is long-lived (25-50 years); therefore, it is critical that Asia does not become locked into inefficient and polluting energy technology that is dependent on imported fuels. To change the current course and realize the benefits of clean energy, Asia's energy sector stakeholders will need a blend of enabling policies, incentives, and financial resources.

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19. Out of the more than US\$ 2 billion spent by the World Bank on energy projects in 2003, about 90 percent did not address climate change. In 2004, the percentage was 72 percent.