GLOBAL ENERGY TRENDS

HIGHLIGHTS

- Global primary energy demand in the Reference Scenario is projected to increase by 53% between 2004 and 2030 – an average annual rate of 1.6%. Over 70% of this increase comes from developing countries. The power-generation sector contributes close to one-half of the global increase. Demand grows by one-quarter in the period to 2015 alone.
- Globally, fossil fuels remain the dominant source of energy, accounting for 83% of the overall increase in energy demand between 2004 and 2030. As a result, their share of world demand edges up, from 80% to 81%. In contrast to *WEO-2005*, coal sees the biggest increase in demand in absolute terms, its percentage share in global demand – like that of gas – increasing slightly. The share of oil drops. Non-hydro renewables grow quickest, but from a small base.
- The world's remaining economically exploitable energy resources are adequate to meet the projected increases in demand through to 2030. With sufficient investment in production and transportation capacity, international energy trade would grow steadily over the *Outlook* period to accommodate the increasing mismatch between the location of demand and that of production. Energy exports from non-OECD to OECD regions rise by 47%. Oil remains the most heavily traded fuel in 2030, but gas trade grows most rapidly.
- Cumulative investment in energy-supply infrastructure amounts to just over $20 trillion (in year-2005 dollars) over 2005-2030 – significantly more than in *WEO-2005* because of higher unit costs. The power sector requires more than $11 trillion, equal to 56% of total energy investment needs (two-thirds if investment in the supply chain to meet the fuel needs of power stations is included). Capital expenditure amounts to $4.3 trillion in the oil sector and $3.9 trillion in the gas sector. Roughly half of all the energy investment needed worldwide is in developing countries, where demand and production are projected to increase fastest.
- Global energy-related carbon-dioxide emissions increase slightly faster than primary energy use, because the fuel mix becomes more carbon-intensive. The power sector contributes around half the increase in emissions from 2004 to 2030. Coal remains the leading contributor to global emissions over the *Outlook* period. China accounts for 39% of the increase between 2004 and 2030, overtaking the United States as the world's biggest emitter before 2010.

Demand

Primary Energy Mix

Global primary energy demand[1] in the Reference Scenario is projected to increase by 1.6% per year between 2004 and 2030, reaching 17.1 billion tonnes of oil equivalent (Table 2.1). The increase in demand amounts to almost 6 billion toe, or 53% of current demand. The average projected rate of growth is, nevertheless, slower than that over the period 1980-2004, when demand grew by 1.8% per year. The pace of demand growth slackens progressively over the projection period: in the period 2004-2015, it grows by 2.1%. By 2015, total global energy demand is one-quarter higher than in 2004. The rate of growth drops to 1.3% in 2015-2030.

Table 2.1: **World Primary Energy Demand in the Reference Scenario**
(Mtoe)

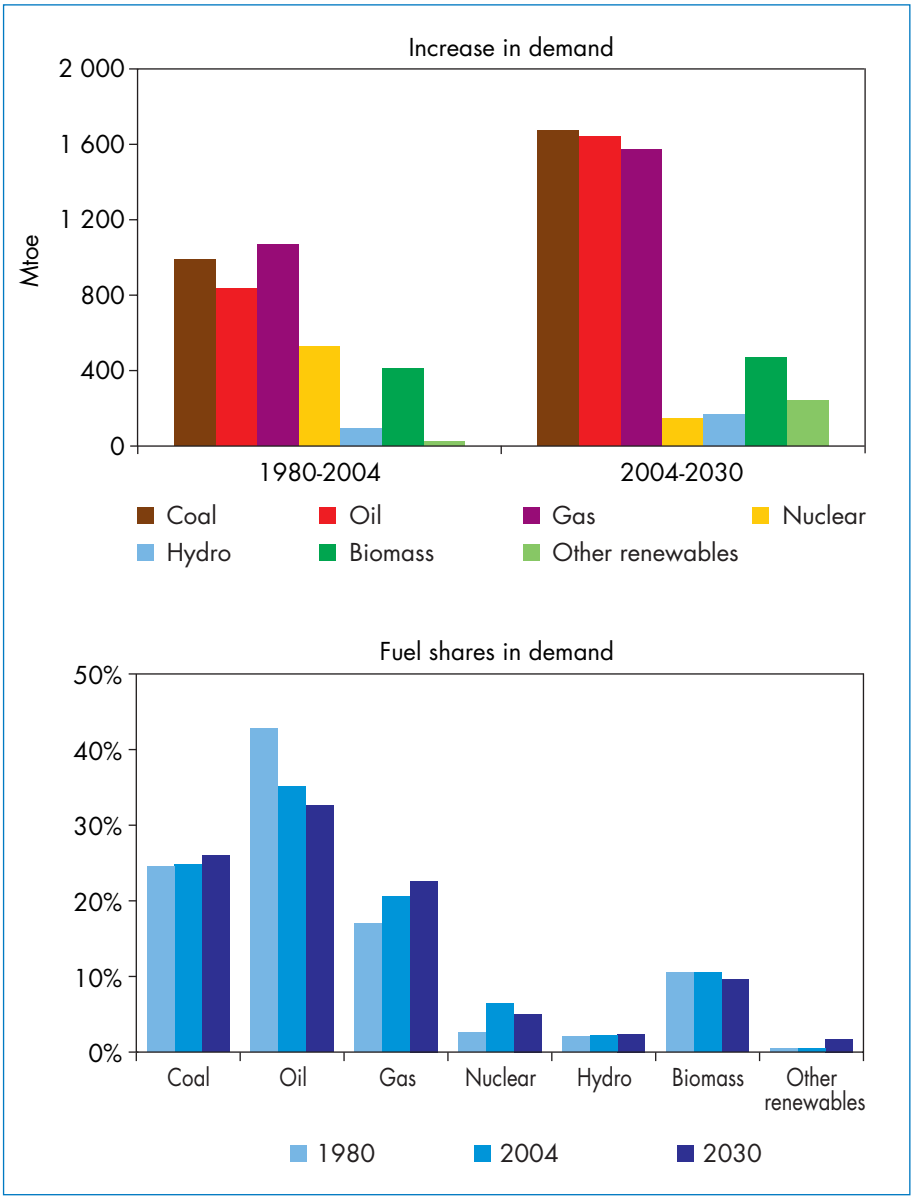
	1980	2004	2010	2015	2030	2004 - 2030*
Coal	1 785	2 773	3 354	3 666	4 441	1.8%
Oil	3 107	3 940	4 366	4 750	5 575	1.3%
Gas	1 237	2 302	2 686	3 017	3 869	2.0%
Nuclear	186	714	775	810	861	0.7%
Hydro	148	242	280	317	408	2.0%
Biomass and waste	765	1 176	1 283	1 375	1 645	1.3%
Other renewables	33	57	99	136	296	6.6%
Total	**7 261**	**11 204**	**12 842**	**14 071**	**17 095**	**1.6%**

* Average annual growth rate.

Fossil fuels are projected to remain the dominant sources of primary energy globally. They account for close to 83% of the overall increase in energy demand between 2004 and 2030. Their share of world demand edges up from 80% in 2004 to 81% in 2030. Coal sees the biggest increase in demand in volume terms in 2004-2030, closely followed by oil (Figure 2.1). In *WEO-2005*, oil and gas

1. World total primary energy demand, which is equivalent to total primary energy supply, includes international marine bunkers, which are excluded from the regional totals. Primary energy refers to energy in its initial form, after production or importation. Some energy is transformed, mainly in refineries, power stations and heat plants. Final consumption refers to consumption in end-use sectors, net of losses in transformation and distribution. In all regions, total primary and final demand includes traditional biomass and waste such as fuel wood, charcoal, dung and crop residues, some of which are not traded commercially.

Figure 2.1: **World Primary Energy Demand by Fuel in the Reference Scenario**



were projected to grow the most. Oil nonetheless remains the single largest fuel in the primary fuel mix in 2030, though its share drops, from 35% now to 33%. Coal remains the second-largest fuel, with its share increasing one percentage point to 26%. Gas demand grows faster than coal, but – in contrast to *WEO-2005* – does not overtake it before 2030. The growth in demand for gas has

been revised down and that for coal up, mainly owing to relatively higher gas prices. In the Reference Scenario, the share of nuclear power is expected to fall (albeit less rapidly than in *WEO-2005*), on the assumption that few new reactors are built and that several existing ones are retired between now and 2030. Hydropower's share of primary energy use rises slightly. The share of traditional biomass falls, as developing countries increasingly switch to using modern commercial energy. Other renewable energy technologies, including wind, solar, geothermal, wave and tidal energy, see the fastest increase in demand, but their share of total energy use still reaches only 1.7% in 2030 – up from 0.5% today.

Global primary energy intensity, measured as energy use per unit of gross domestic product, falls on average by 1.7% per year over 2004-2030. The decline is most rapid in the non-OECD regions, mainly because they profit from the greater scope for improving energy efficiency and because their economies become less reliant on energy-intensive heavy manufacturing industries as the services sector grows faster. The transition economies see the sharpest fall in intensity, which almost halves between 2004 and 2030, as new technologies are introduced, wasteful practices are dealt with and consumption subsidies are reduced (see Chapter 11). Yet they remain far more energy-intensive than either developing or OECD countries in 2030. The shift to services is much more advanced in the OECD, so there is less scope for reducing energy intensity.

Regional Trends

Over 70% of the increase in world primary energy demand between 2004 and 2030 comes from the developing countries (Figure 2.2). OECD countries account for almost one-quarter and the transition economies for the remaining 6%. As a result, the OECD's share of world demand drops, from just under half in 2004 to 40% in 2030, while that of the developing countries jumps, from 40% to 50%. The share of China alone rises from 15% to 20%, though this projection is particularly uncertain (Box 2.1). The transition economies' share falls from 10% to 8%. The increase in the share of the developing regions in world energy demand results from their more rapid economic and population growth. Industrialisation and urbanisation boost demand for modern commercial fuels.

The developing regions account for 23 mb/d, or 71%, of the 33 mb/d increase in oil demand between 2005 and 2030, with demand growing most rapidly in volume terms in the developing Asian countries. Oil demand increases less quickly in the OECD regions and the transition economies. In volume terms, gas demand expands most in the Middle East. Coal demand grows most in developing Asia, where there are large, low-cost resources. Coal

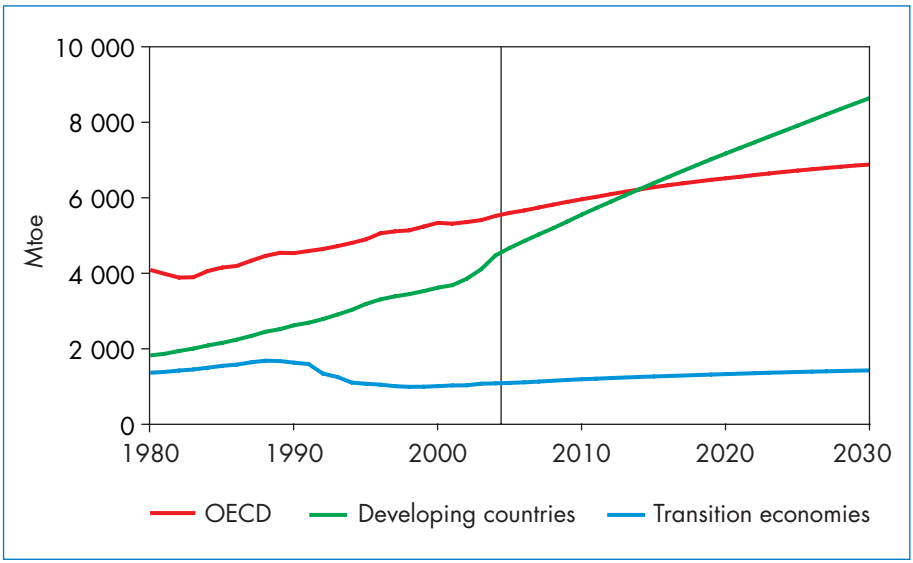
Box 2.1: Uncertainty Surrounding China's Energy Trends

China is a major source of uncertainty for our global energy projections. The country is already a key player in the global energy market, and its role is expected to grow significantly over the projection period. In the Reference Scenario, the country accounts for 20% of the world primary energy demand in 2030 – up from 15% today. Its share of global coal demand rises from 36% today to 46% in 2030 (on an energy-content basis). Small changes in the outlook for China would, therefore, have a significant impact on the global energy picture. For example, a one-percentage point higher average annual rate of growth in China's demand would raise world primary energy demand by nearly 1 000 Mtoe, or 6%, and oil demand by 4.4 million barrels per day, or 4%, in 2030. Several factors could change energy prospects in China:

- **Long-term macroeconomic prospects:** China's economy has grown by about 10% per year on average for the past two decades, the fastest rate of any major country. The government's 11th five-year plan aims to moderate growth to 7.5% per year between 2005 and 2010 to prevent the economy from over-heating. But the preliminary estimate for its growth rate in the first half of 2006 is nearly 11%. In the longer term, growth is nonetheless expected to slow as the economy matures and population growth declines, but how quickly this occurs is very uncertain.
- **The link between energy demand and GDP growth:** Energy demand has not grown in a stable ratio to GDP in the past. For example, primary coal demand grew steadily between 1971 and 1996, but fell between 1997 and 2001 – despite continuing rapid economic growth. Demand started to grow again in 2002, surging in 2003 and 2004 by around 20% per year. Demand for other fuels has also soared relative to GDP in the past few years (see Chapter 11). Several factors, such as a surge in vehicle ownership, periodic government measures to limit energy use, the Asian financial crisis and statistical problems help to explain these erratic trends in demand.
- **The impact of structural reforms in the energy sector:** End-use energy prices, which have been under the government's control, are expected to be more liberalised in future. How quickly this occurs will have a significant impact on energy markets. In the coal industry, the government has encouraged the closure and consolidation of inefficient small mines. By the end of 2005, more than 2000 small mines had been closed. Restructuring of the coal industry and the pace of demand growth will determine whether China remains a net coal exporter.

World Energy Outlook 2007 will be devoted to an extensive analysis of energy developments in China, as well as India, and their implications for global energy markets.

Figure 2.2: **World Primary Energy Demand by Region in the Reference Scenario**



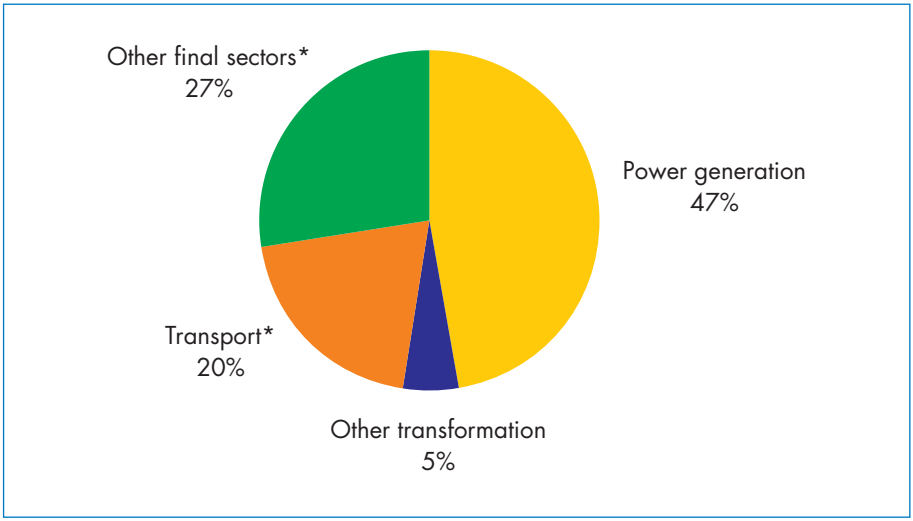
continues to dominate the fuel mix in India and China. By 2030, they account together for 57% of world coal demand, up from 43% in 2004. On the policy assumptions of the Reference Scenario, nuclear power declines in Europe, but increases in all other regions. The biggest increases in nuclear power production occur in Russia, Japan, Korea and developing Asian countries. Overall, nuclear power's share of world primary energy drops from 6% in 2004 to 5% in 2030.

Sectoral Trends

The power-generation sector accounts for 47% of the increase in global energy demand over the projection period (Figure 2.3). Its share of primary demand increases from 37% in 2004 to 41% in 2030. Demand for electricity-related services, the main determinant of how much fuel is needed to generate power, is closely linked to incomes. Nonetheless, continued improvements in the thermal efficiency of power stations mean that the rate of growth in power-sector energy demand is somewhat lower than that of final electricity demand. The transport sector (excluding electricity used in rail transportation) accounts for about another fifth of the increase in global demand.

World energy consumption in end-use sectors as a whole – industry, transport, residential, services (including agriculture) and non-energy uses – increases by 1.6% per year over 2004-2030, the same rate as primary demand. Among all major end-use energy sources, electricity is projected to grow most rapidly, by

Figure 2.3: **Incremental World Primary Energy Demand by Sector in the Reference Scenario, 2004-2030**



* Excluding electricity and heat.

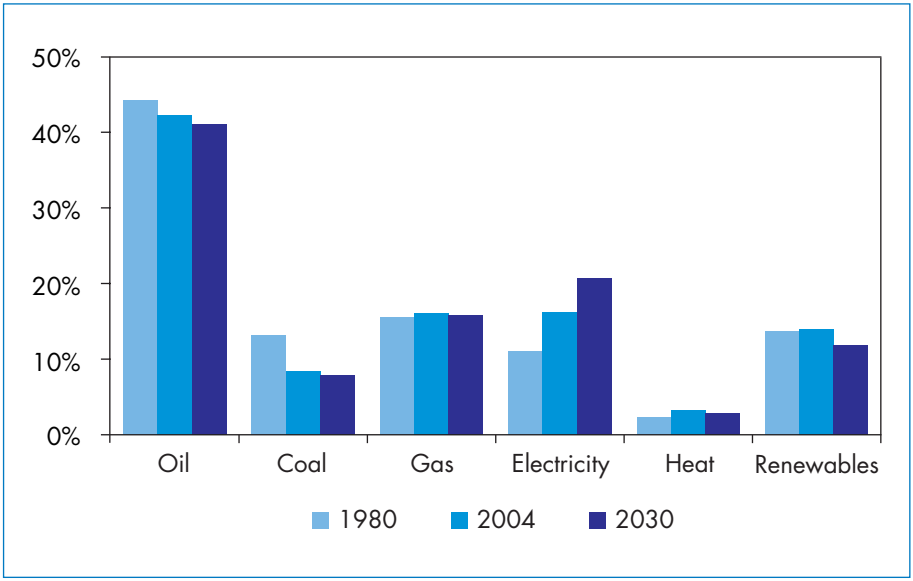
2.6% per year, nearly doubling between 2004 and 2030. As a result, electricity's share of total final consumption grows from 16% to 21% (Figure 2.4). In 1980, it was only 11%. Electricity use grows most rapidly in developing countries, as the number of people with access to electricity and incomes rises steadily. By 2030, the share of electricity in final energy use in developing countries almost reaches that of OECD countries. Yet per-capita consumption remains much lower, mainly because incomes are far smaller – even though the gap between OECD and developing country incomes narrows significantly over the projection period. In 2030, per-capita consumption reaches 26.9 kWh per day in OECD countries but only 6.2 kWh in non-OECD countries. The share of traditional biomass in final consumption declines, as developing-country households switch to modern fuels for cooking and heating (see Chapter 15). The share of other renewables increases, but is still less than 1% in 2030. The shares of all other fuels hardly change over 2004-2030.

Energy Production and Trade

Resources and Production Prospects

Sufficient resources exist worldwide to permit the world's energy industry to expand capacity in order to meet the projected increases in demand through to 2030 for each form of energy described above. The world's remaining economically exploitable fossil-fuel, hydroelectric and uranium resources are

Figure 2.4: **Fuel Shares in World Final Energy Demand in the Reference Scenario**



adequate. At issue is whether these resources will actually be developed quickly enough and at what cost. The Reference Scenario is predicated on the assumption that the stated prices will be high enough to stimulate sufficient investment in new supply infrastructure to enable all the projected demand to be met. Notwithstanding this assumption, it is far from certain whether energy companies will be willing or able to invest in developing those resources and in bringing them to market, and how much it will cost. A number of factors may impede required investments from being made in a particular sector or region. These include a worsening of the investment climate, changes in government attitudes to foreign investment and capacity expansions, the adoption of more stringent environmental regulations and less favourable licensing and fiscal conditions.[2]

Proven reserves of natural gas and coal are much larger than the cumulative amounts of both fuels that will be consumed over the projection period. Today, proven reserves are equal to 64 years of current consumption of gas and 164 years of coal. And substantial new reserves will undoubtedly be added between

2. The impact of a deferral of investment in the upstream oil industry is assessed in Chapter 3. A detailed assessment of current trends in oil and gas investment is provided in Chapter 12. The impact of new government policies to bolster energy security and curb energy-related greenhouse-gas emissions is assessed in the Alternative Policy Scenario, described in detail in Part B (Chapters 7-10).

now and 2030. Proven reserves of crude oil and natural gas liquids are much smaller in relation to current consumption, covering barely 42 years. Although that is enough to meet all the oil consumed in the Reference Scenario through to 2030, more oil would need to be found were conventional production not to peak before then. Even if it were to do so, non-conventional sources of oil – including oil sands and gas- and coal-to-liquids plants – could meet any shortfall in conventional oil supply if the necessary investment is forthcoming. There is no lack of uranium for projected nuclear power production in the Reference Scenario for the next several decades at least. There is also significant remaining potential for expanding hydropower and energy from biomass and other renewable sources.

The Middle East and North Africa, which have massive hydrocarbon resources (IEA, 2005a), are expected to meet much of the growth in world oil and gas demand over 2004-2030. Latin America (especially Venezuela and Brazil), Africa and the transition economies also increase production of both oil and gas. Conventional oil production declines in most other regions, including OECD North America and Europe. Production of natural gas, resources of which are more widely dispersed than oil, increases in every region other than Europe. Although there are abundant coal reserves in most regions, increases in coal production are likely to be concentrated in China, India, the United States, Australia, South Africa, Indonesia, and Colombia, where extraction, processing and transportation costs are lowest. The production prospects for each fuel are discussed in more detail in later chapters.

Inter-Regional Trade

International energy trade is expected to grow steadily over the *Outlook* period to accommodate the increasing mismatch between the location of demand and that of production. In the Reference Scenario, the OECD accounts for 23% of the total increase in world primary energy demand, but only 5% of the growth in output. As a result, exports from non-OECD regions to OECD regions expand by 47%. Total OECD imports, including trade between OECD regions, will also increase by 47% between 2004 and 2030 (Table 2.2). By 2030, 43% of all the primary energy consumed in the OECD is imported. The transition economies and the developing countries in aggregate become bigger net exporters. Trade between major non-OECD regions also increases sharply. The Middle East sees the biggest increase in energy exports, while imports grow most in developing Asia.

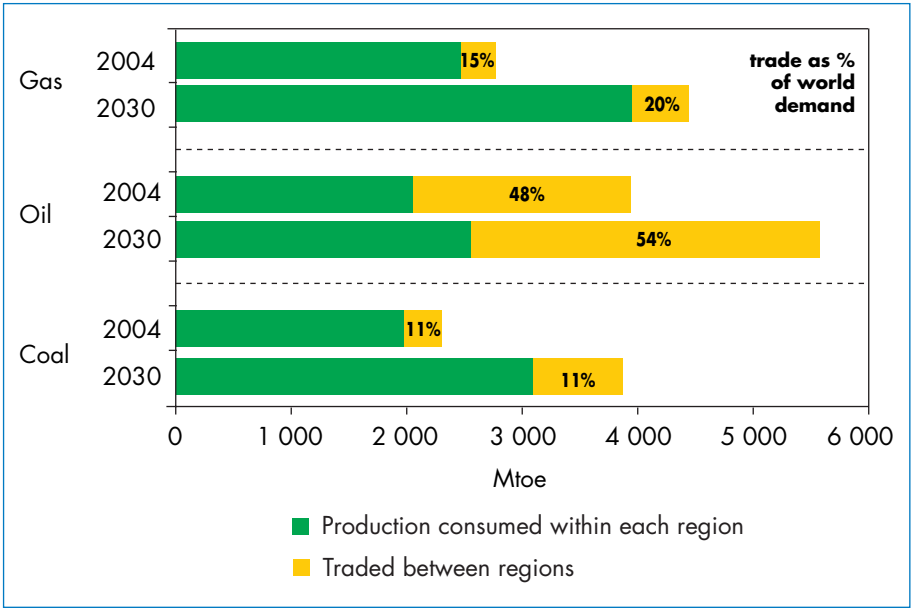
Almost all of the projected increase in inter-regional energy trade is in the form of conventional oil, gas and coal, but biofuels make a growing contribution. Trade in electricity remains minimal. Oil remains the most traded fuel in both percentage and volume terms (Figure 2.5). By 2030, 54% of all the oil

Table 2.2: **Net Energy Imports by Major Region** (Mtoe)

	2004	2015	2030
OECD	**1 657**	**2 123**	**2 444**
Coal	113	117	98
Oil	1 272	1 569	1 712
Gas	272	436	634
Transition economies	**–492**	**–641**	**–745**
Coal	–27	–39	–46
Oil	–345	–476	–541
Gas	–120	–126	–158
Developing countries	**–1 228**	**–1 549**	**–1 776**
Coal	–70	–71	–45
Oil	–1 007	–1 168	–1 256
Gas	–152	–310	–476

Note: Trade in other forms of energy is negligible. Negative figures are net exports. Total imports do not always equal total exports because of processing gains, international marine bunkers and statistical discrepancies.

Figure 2.5: **Share of Inter-Regional Trade in World Primary Demand by Fossil Fuel in the Reference Scenario**



Note: Takes account of all trade between *WEO* regions.

consumed in the world is traded between the *WEO* regions, up from 48% in 2004. The volume of oil traded grows by 60%. The Middle East accounts for the bulk of the increase in oil exports, with most of this oil going to developing countries, especially in Asia. The transition economies, Africa and Latin America also export more oil. OECD oil-import dependence, taking account of trade between OECD regions, rises from 56% now to 65% in 2030, as a result of dwindling indigenous production and rising consumption. Intra-regional trade, which is not captured by our projections, is also likely to expand.

Inter-regional natural gas trade expands quickly too, though the bulk of the gas consumed around the world is still produced within each consuming region in 2030. Most of the *additional* gas traded between now and 2030 is in the form of liquefied natural gas. An unprecedented boom in LNG developments is under way. LNG trade increased by almost one-third between 2000 and 2005, and it is expected to double by 2010, as projects that are currently under construction or that are at an advanced stage of planning come on stream. More liquefaction capacity is expected to be added through to 2030. Although a number of major long-distance pipelines are also likely to be completed, the share of piped gas in total inter-regional trade is expected to drop from 77% today to about 50% in 2030. The largest volume increases in gas imports occur in Europe and North America. Several developing countries – including China and India – emerge as major gas importers over the projection period. The Middle East, Africa and the transition economies meet most of the increase in demand for gas imports.

Inter-regional hard-coal trade increases in volume terms over 2004-2030, but the share of coal trade in total world coal supply is flat. Most of the increase in traded coal goes to OECD Europe, already the largest importing region, where demand is projected to rise and coal mining to continue to decline through to 2030. Steam coal accounts for a growing share of world hard-coal trade, driven mainly by power-sector needs.

Investment in Energy Infrastructure

The Reference Scenario projections in this *Outlook* call for cumulative investment in energy-supply infrastructure of just over $20 trillion (in year-2005 dollars) over 2005-2030. This projection is around $3 trillion higher than in *WEO-2005*. The increase is explained by recent sharp increases in unit capital costs, especially in the oil and gas industry. Projected capital spending includes that needed to expand supply capacity to meet rising demand and to replace existing and future supply facilities that will be retired during the projection period. Just over half of the investment will go simply to maintain the current level of supply capacity: much of the world's current production

capacity for oil, gas, coal and electricity will need to be replaced by 2030. In addition, some of the new production capacity brought on stream in the early years of the projection period will itself need to be replaced before 2030. Many power plants, electricity and gas transmission and distribution facilities, and oil refineries will also need to be replaced or refurbished. Box 2.2 describes the methodology used to project energy investment.

Box 2.2: Methodology for Projecting Energy Investment

The projections of investment in both the Reference and Alternative Policy Scenarios for the period 2005-2030 are derived from the projections of energy supply. The calculation of the amount of investment corresponding to projected supply for each fuel and each region involved the following steps:

- New-build capacity needs for production, transportation and (where appropriate) transformation were calculated on the basis of projected supply trends, estimated rates of retirement of the existing supply infrastructure and natural decline rates for oil and gas production.
- Unit capital cost estimates were compiled for each component in the supply chain. These costs were then adjusted for each year of the projection period using projected rates of change based on a detailed analysis of the potential for technology-driven cost reductions and on country-specific factors.
- Incremental capacity needs were multiplied by unit costs to yield the amount of investment needed.

All the results are presented in year-2005 dollars. The projections take account of projects that have already been decided and expenditures that have already been incurred. Capital spending is attributed to the year in which the plant in question becomes operational. In other words, no attempt has been made to estimate the lead times for each category of project. This is because of the difficulties in estimating lead times and how they might evolve in the future. Investment is defined as capital expenditure only. It does not include spending that is usually classified as operation and maintenance.

The power sector requires more than $11 trillion of investment, 56% of that for the energy sector as a whole (Table 2.3). That share rises to two-thirds if investment in the supply chain to meet the fuel needs of power stations is included. More than half of the investment in the electricity industry is in transmission and distribution networks, with the rest going to power generation. Capital expenditure in the oil industry amounts to $4.3 trillion, or just over one-fifth of total energy investment. More than three-quarters of total

oil investment is in upstream projects. Gas investment is $3.9 trillion, or 19%. The upstream absorbs 56% of total gas investment (Figure 2.6).[3] Coal investment is about $560 billion, or 3% of total energy investment. Producing, transporting and delivering coal to power stations and end users is much less capital-intensive than oil or gas, but operating and maintenance costs are higher per unit of output on an energy-content basis.

More than half of all the energy investment needed worldwide is in developing countries, where demand and production increase most quickly. China alone needs to invest about $3.7 trillion – 18% of the world total. Russia and other transition economies account for 9% of total world investment and the OECD for the remaining 37%.

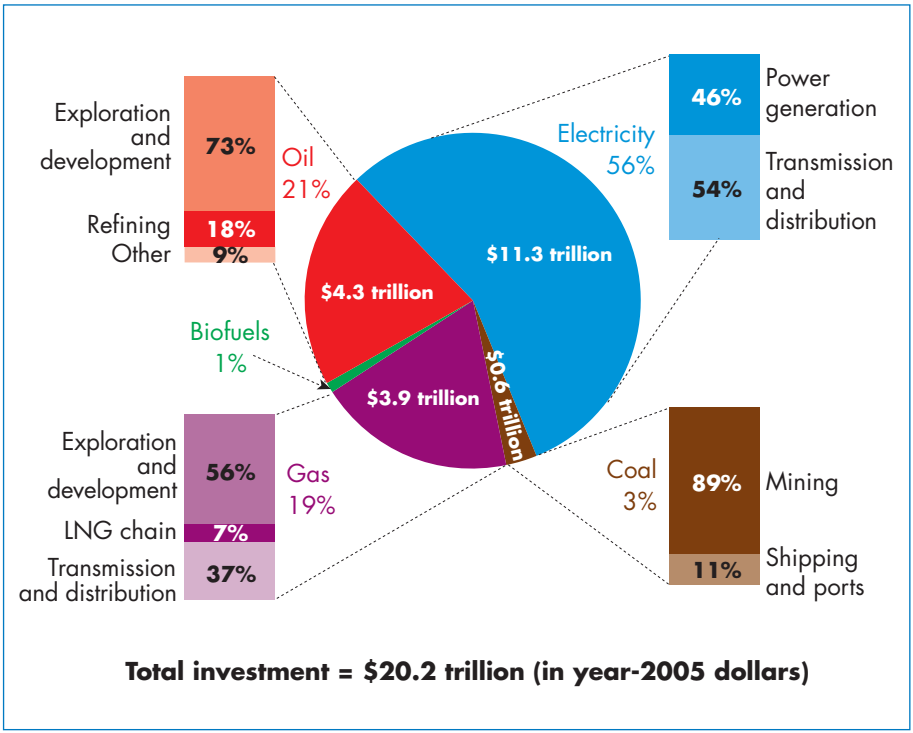
Table 2.3: **Cumulative Investment in Energy-Supply Infrastructure in the Reference Scenario, 2005-2030**
($ billion in year-2005 dollars)

	Coal	Oil	Gas	Power	Total
OECD	**156**	**1 149**	**1 744**	**4 240**	**7 289**
North America	80	856	1 189	1 979	4 104
Europe	34	246	417	1 680	2 376
Pacific	42	47	139	582	809
Transition economies	**33**	**639**	**589**	**590**	**1 850**
Russia	15	478	440	263	1 195
Developing countries	**330**	**2 223**	**1 516**	**6 446**	**10 515**
Developing Asia	298	662	457	4 847	6 264
China	*238*	*351*	*124*	*3 007*	*3 720*
India	*38*	*48*	*55*	*967*	*1 108*
Indonesia	*13*	*49*	*86*	*187*	*335*
Middle East	1	698	381	396	1 476
Africa	20	485	413	484	1 402
Latin America	12	378	265	719	1 374
Brazil	*1*	*138*	*48*	*252*	*439*
Inter-regional transport	45	256	76	–	376
World	**563**	**4 266**	**3 925**	**11 276**	**20 192**

Note: World total includes $161 billion of investment in biofuels.

3. See Chapter 12 for a detailed discussion of the near-term prospects for oil and gas investment.

Figure 2.6: **Cumulative Investment in Energy Infrastructure in the Reference Scenario by Fuel and Activity, 2005-2030**
(in year-2005 dollars)



Energy-Related CO_2 Emissions

Global energy-related carbon-dioxide (CO_2) emissions increase by 1.7 % per year over 2004-2030 in the Reference Scenario. They reach 40.4 billion tonnes in 2030, an increase of 14.3 billion tonnes, or 55%, over the 2004 level (Table 2.4). By 2010, emissions are 48% higher than in 1990. However, the aggregate increase is much smaller for Annex I countries with commitments to limit emissions under the Kyoto Protocol (Box 2.3). Power generation is projected to contribute a little less than half the increase in global emissions from 2004 to 2030. Transport contributes one-fifth, with other uses accounting for the rest. By 2030, the power sector accounts for 44% of total emissions, up from 41% today. Continuing improvements in the thermal efficiency of power stations are largely outweighed by the strong growth in demand for electricity. Transport remains the second-largest sector for emissions worldwide, with its share of total emissions stable at around 20% throughout the projection period.

Box 2.3: Will Signatories to the Kyoto Protocol Respect their Greenhouse-Gas Emission-Limitation Commitments?

The energy-related CO_2 emissions projected in the Reference Scenario give an indication of how likely it is that those countries that have agreed to limit their emissions, known as Annex I countries, under the Kyoto Protocol will meet their commitments. The Kyoto Protocol, which came into effect on 16 February 2005, sets binding targets for developed countries to reduce greenhouse-gas emissions by an average of 5.2% below 1990 levels by 2008-2012. The Protocol covers six types of emissions and the contribution of sinks (vegetation that absorbs carbon dioxide). Although our projections reflect only energy-related CO_2 emissions, these account for the bulk of greenhouse-gas emissions.

Our analysis suggests that, if total greenhouse-gas emissions rise at the same rate as energy-related emissions, Annex I countries in aggregate would not be able to meet the overall emissions-reduction target on current trends. In 2010, the total emissions of Annex I OECD countries are projected to be 29% above the target. Excluding the United States and Australia, which have not ratified the Protocol, the gap would be 19%. The emissions of Annex I transition economies are projected to be 22% *below* target. This would not be enough to make up all of the gap in all Annex I OECD countries, even if the United States and Australia are not included. Even if Annex I countries were to adopt a new set of policies and measures, they would be unlikely to significantly affect emission trends before 2010 – a key message that emerges from the Alternative Policy Scenario (see Part B). The recent surge in emissions makes it even less likely that the targets will be met: global emissions rose at a much faster rate in the four years to 2004 than they did in the 1990s (Figure 2.7).

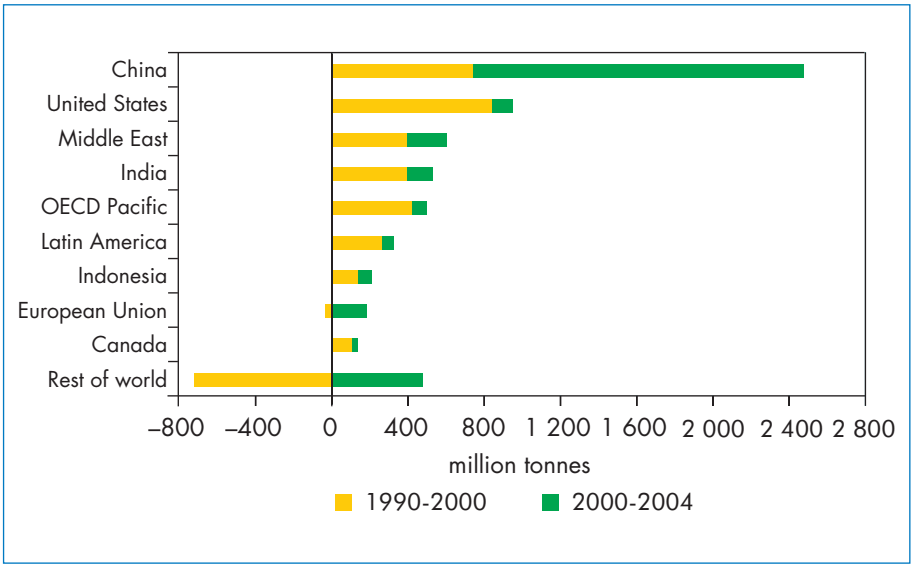
The Kyoto Protocol was always intended to be a first step. There is little that governments can do today that will have any significant effect on emissions before 2010. The challenge now is to forge an international framework that engages all major emitting countries in an effective long-term effort to mitigate greenhouse-gas emissions (IEA, 2005b). In May 2005, parties to the UN Framework Convention on Climate Change convened a seminar of government experts to discuss possible future efforts, but explicitly did not open negotiations on new commitments. In July 2005, at the Gleneagles Summit, G8 leaders pledged to introduce innovative measures to achieve substantial reductions in greenhouse-gas emissions as part of an agreed long-term plan. This pledge was reaffirmed at the 2006 St Petersburg Summit.

Table 2.4: **World Energy-Related CO_2 Emissions by Sector in the Reference Scenario** (million tonnes)

	1990	2004	2010	2015	2030	2004-2030*
Power generation	6 955	10 587	12 818	14 209	17 680	2.0%
Industry	4 474	4 742	5 679	6 213	7 255	1.6%
Transport	3 885	5 289	5 900	6 543	8 246	1.7%
Residential and services**	3 353	3 297	3 573	3 815	4 298	1.0%
Other***	1 796	2 165	2 396	2 552	2 942	1.2%
Total	**20 463**	**26 079**	**30 367**	**33 333**	**40 420**	**1.7%**

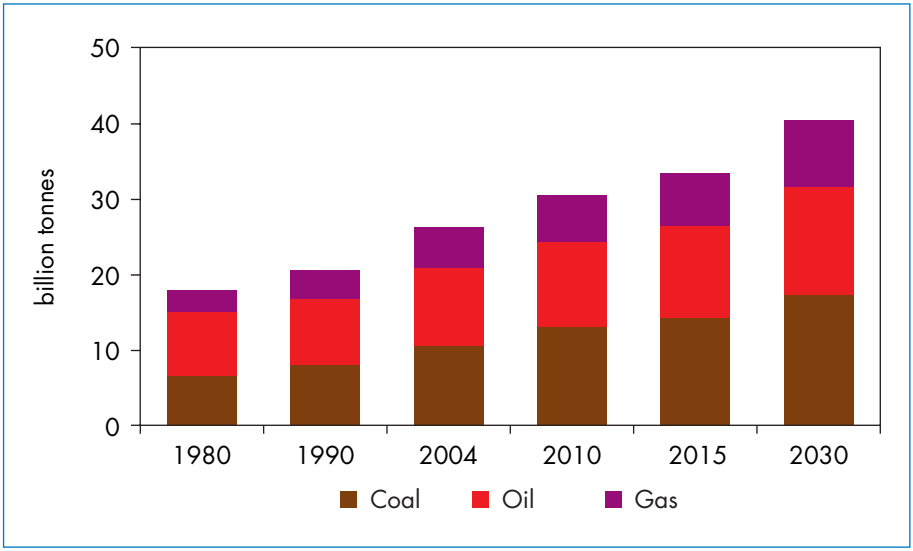
*Average annual growth rate. **Includes agriculture and public sector. ***Includes international marine bunkers, other transformation and non-energy use.

Figure 2.7: **Increase in Energy-Related CO_2 Emissions by Region**



Coal recently overtook oil as the leading contributor to global energy-related CO_2 emissions and, in the Reference Scenario, consolidates this position through to 2030 (Figure 2.8). Coal's share of emissions increases slightly, from 41% today to 43%. The share of natural gas also increases, from 20% to 22%, while that of oil falls, from 39% to 35%. Gas-related emissions increase most rapidly, by two-thirds between 2004 and 2030.

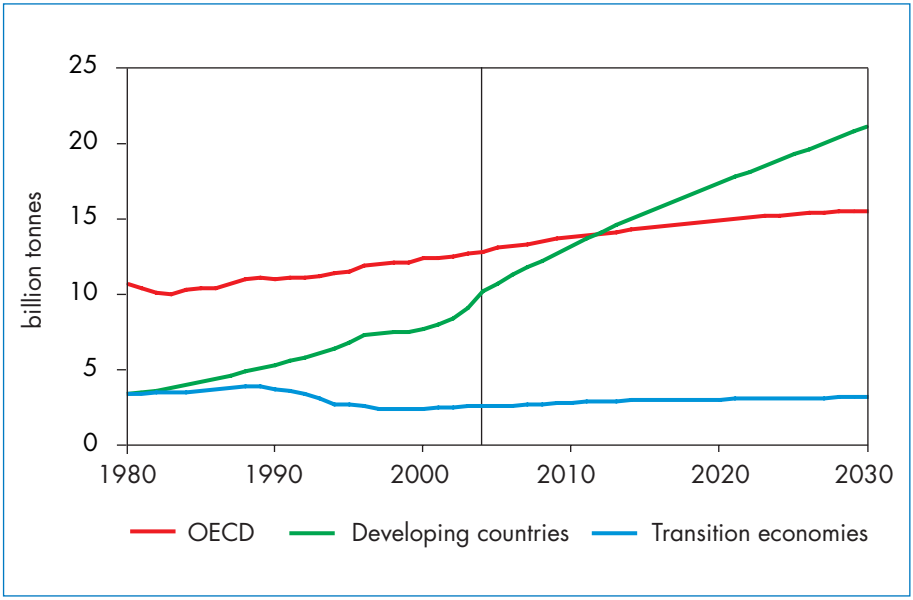
Figure 2.8: **World Energy-Related CO_2 Emissions by Fuel in the Reference Scenario**



Developing countries account for over three-quarters of the increase in global CO_2 emissions between 2004 and 2030. They overtake the OECD as the biggest emitter by around 2012 (Figure 2.9). The share of developing countries in world emissions rises from 39% at present to 52% by 2030. This increase is faster than that of their share in energy demand, because their incremental energy use is more carbon-intensive than that of the OECD and transition economies. In general, they use more coal and less gas. China alone is responsible for 39% of the rise in global emissions. China's emissions more than double between 2004 and 2030, driven by strong economic growth and heavy reliance on coal in industry and power generation. China overtakes the United States as the world's biggest emitter before 2010. Other Asian countries, notably India, also contribute heavily to the increase in global emissions.

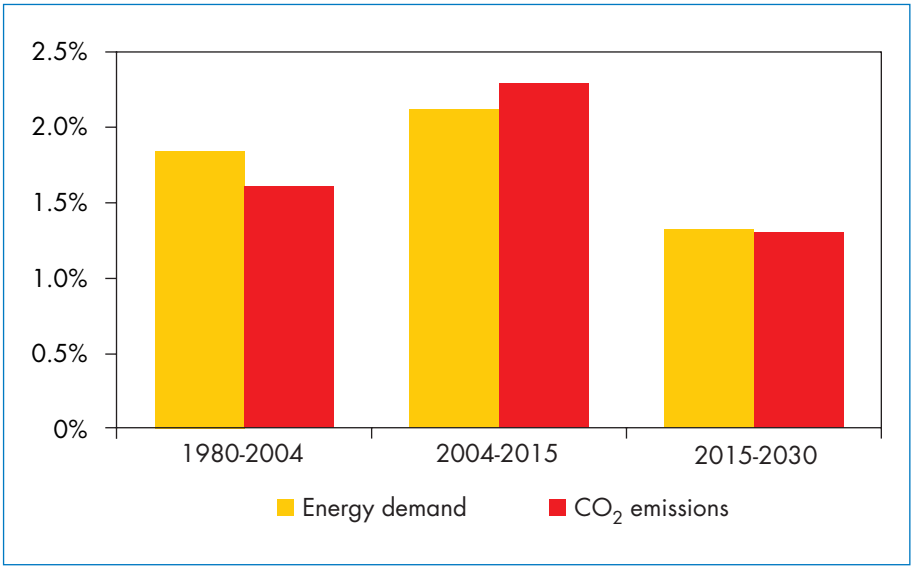
Over the past two-and-a-half decades, energy-related CO_2 emissions worldwide grew less rapidly than primary energy demand, largely because of the rising shares of gas, which is less carbon-intensive than coal and oil, and of nuclear power in the energy mix. Carbon emissions grew by 1.6% per year, while energy demand grew by 1.8%. In the Reference Scenario, the trend is reversed over the projection period, as the rate of growth in emissions, at 1.7% per year, is faster than the 1.6% rate of demand growth (Figure 2.10). This is because the average carbon content of primary energy consumption increases from 2.33 tonnes of CO_2 per toe of energy to 2.36 tonnes

Figure 2.9: **Energy-Related CO_2 Emissions by Region in the Reference Scenario**



Note: Excludes emissions from international marine bunkers.

Figure 2.10: **Average Annual Growth in World Energy-Related CO_2 Emissions and Primary Energy Demand in the Reference Scenario**



(Table 2.5). Per-capita emissions also rise, mainly because rising incomes push up per capita energy consumption. They grow most rapidly in the developing countries. Yet the OECD still has by far the highest per-capita emissions and developing countries the lowest in 2030. Developing countries have lower per-capita incomes and energy consumption, and rely more heavily on biomass and waste, which are assumed to produce no emissions on a net basis.[4] By contrast, the carbon intensity of the global economy, measured by emissions per unit of GDP, is projected to decline steadily in all regions in line with the fall in primary energy intensity.

Table 2.5: **World Energy-Related CO_2 Emission Indicators by Region in the Reference Scenario** (tonnes of CO_2)

	OECD			Non-OECD			World		
	2004	2015	2030	2004	2015	2030	2004	2015	2030
Per capita	11.02	11.69	11.98	2.45	3.09	3.55	4.11	4.65	4.97
Per unit of GDP*	0.39	0.33	0.27	0.49	0.39	0.30	0.44	0.37	0.29
Per toe of primary energy	2.33	2.30	2.26	2.30	2.41	2.42	2.33	2.37	2.36

* Thousand dollars in year-2005 dollars and PPP terms.

4. For the purposes of this analysis, all biomass is assumed to be replaced eventually. As a result, the carbon emitted when biomass fuels are burned is cancelled out by the carbon absorbed by the replacement biomass as it grows.

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