Emerging Markets Forum

New Global Energy Scene: Implications for Emerging Market Economies

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I. Overview

Energy demand has historically been strongly linked to GDP – the higher the GDP the more demand for energy. Modern transportation deeply depends on petroleum. In addition, because of the host of conveniences electricity provides right across a modern economy, it is not surprising that in historical data and in most projections, electricity grows faster than any other energy form in final consumption. Emerging Market Countries (EMCs) have even higher needs for energy to foster the required growth. Development results in greater production and economic activity, both requiring increased energy consumption, even when development is accompanied by efforts to moderate energy intensity by improving the energy efficiency of the economy.

This paper provides historical data and outlines a possible future scenario for the year 2030, concentrating on the developments in the global energy markets and the implications for EMCs. In the paper, we will separate our analysis in two periods: before 2003 (historic background) and after 2003 (new oil prices and perspectives for 2030). The also paper includes a brief discussion of sector analysis in the following groups: (1) Petroleum; (2) Natural Gas; (3) Coal; and (4) Electricity (and its main components: hydropower, nuclear, geothermal, solar, wind, wood and waste). The paper concludes with the implications for EMCs, and suggests points for discussions at the forthcoming Emerging Markets Forum.

The paper will show that, despite the efforts for conservation of energy, the overall demand will continue to grow and the dependence on fossil fuels, particularly on petroleum, will remain for the foreseeable future. The most important conclusions are:

- World primary energy demand will continue to rise, driven by overall economic growth
- Countries have reduced their energy intensity in the recent past. It is expected that this trend will continue resulting in projected energy annual growth significantly lower than projected GDP growth.
- The recent sharp increase of petroleum prices could reduce both the future economic growth and energy requirements
- Growth of energy consumption in non-OECD countries will be three times the growth in OECD countries in 2003-2030.
- Emerging Market Countries, especially in Asia, will account for the largest share of the growth in world energy demand
- By 2030 energy consumption in non-OECD countries should be 40 percent higher than in OECD countries
- Fossil fuels (oil, natural gas and coal) will continue to dominate energy supplies, meeting 80 percent or more of demand growth
- Oil is expected to continue to be the most important source of primary energy, followed by natural gas and coal.
- The transportation sector will continue to drive oil consumption since no large scale alternative to oil is foreseen in the near future.

- Oil prices have moved to a different level that may last for some years.
- The growth in natural gas consumption will be largely destined to power generation
- Liquid Natural Gas (LNG) is expected to have an important role in gas market
- Higher gas prices in turn may stimulate a resurgence in growth in coal and nuclear for power generation
- Electricity consumption is expected to double in 2003-2030, but should triple in non-OECD countries.
- Renewable primary sources of energy are expected to receive more attention, but will continue to represent a small share of the total energy supply
- The world will need US$17 trillion for investments in energy during 2003-2030, of which about half in non-OECD countries.
- Security of supply of oil and of natural gas is a major issue that would need to be addressed by most countries
- Nuclear power development in non-OECD countries needs to find a way for assurance against military use without restricting development of local capacity of those countries.

II. Background (1990 -- 2003)

1. Between 1990 and 2003, the world's total consumption of primary energy -- petroleum, natural gas, coal, and electric power (hydro, nuclear, geothermal, solar, wind, wood and waste)--increased at an average annual rate of 1.5 percent. World consumption increased twenty one percent, from 347 quadrillion BTU in 1990 to 420 quadrillion BTU in 2003.

2. In 2003, petroleum (crude oil and natural gas plant liquids) continued to be the world's most important primary energy source, accounting for 38.1 percent of world primary energy production. Between 1990 and 2003, consumption of petroleum increased by 20.2 percent.[1] In 2003, the ten biggest consumers of oil were: U.S.A, China, Japan, Russia, Germany, India, Canada, South Korea, Brazil, and France. On the production side, the Middle East continued to be the biggest source of supply (mainly Saudi Arabia, Iran, Iraq, United Arab Emirates, Kuwait and Qatar), followed by Russia, and Africa (mainly Nigeria, Algeria, and Angola). In Latin America, Venezuela and Mexico continued to be the biggest producers. Other main players in the production side are: the U.S.A., Norway, the U.K., and Canada. In the period 1990-2003 petroleum prices fluctuated in a narrow range and were considered relatively stable.

3. Coal ranked second as a primary energy source in 2003, accounting for 24.0 percent of world primary energy production. However, between 1990 and 2003, consumption of coal increased only 3.2 percent.[2] The low growth in the use of coal was due to the increased use of natural gas, especially in power generation as a result of environmental concerns and greater availability of natural gas, but mainly due to the increasing use of combined cycle thermal plants which can have much greater thermal efficiency than single cycle steam plants.

[1] from 66.6 to 80.1 million barrels per day, representing an annual growth of 1.4 percent
[2] from 5,269 to 5,440 short tons, representing an annual growth of only 0.2 percent

4. Dry natural gas ranked third as a primary energy source, accounting for 23.6 percent of world primary energy production in 2003. Between 1990 and 2003, consumption of dry natural gas increased by 30 percent.[3] The ten biggest consumers were: the U.S.A., Russia, Germany, the U.K., Canada, Iran, Ukraine, Japan, Saudi Arabia, and Italy. Russia is by far the biggest producer and the biggest exporter. During the period in question, Canada, Norway and Algeria were also important producers. For gas transportation at very long distances or maritime transportation the gas needs to be liquefied (Liquid Natural Gas -- LNG), which could make commerce of gas more flexible. In fact, during this period occurred a great expansion of the commerce of LNG with Japan, South Korea, Spain, France, the U.S.A., and Taiwan being the biggest importers and Indonesia, Malaysia, Algeria, Qatar, Australia and Brunei the biggest exporters. However, the high investment required for liquefying and transporting the gas has been a barrier for the creation of a LNG free market. Dry natural gas prices do not follow a market pattern as oil does – transportation is the big limitation.

5. Electric Power generation, from hydro, nuclear, and other (geothermal, solar, wind, and wood and waste) ranked fourth, fifth, and sixth, respectively, as primary energy sources in 2003, accounting for 6.5, 6.4, and 0.9 percent, respectively, of world primary energy production. Between 1990 and 2003, total consumption of electricity increased by 40 percent.[4] Nuclear electric power generation increased 21.2 percent, from 1.9 trillion kilowatt-hours to 2.5 trillion kilowatt-hours.

6. In 2003, the contribution of each primary source of energy for the production of electricity varied in the different regions of the world. Overall, 65.7 percent of the electricity was generated from conventional thermal power plants using fossil fuel (coal, oil or natural gas), 16.5 percent was generated from hydro-plants, 15.9 from nuclear power plants and only 1.9 percent from geothermal, solar, wind, wood and waste. The only exception to this predominance of generation from fossil fuels was in South America where hydro-plants represented 67 percent of the power generated, particularly because of Brazil.

III. Future Perspectives (2003 -- 2030)

7. During the last three years (2004 – 2006) the energy outlook has been shaken by the substantial and continuous increase in the oil prices. Past experience has shown that to counteract to higher prices of energy, governments start efforts for conservation of energy. However, results take time and, in many cases, after some accommodation, country economies adjust and growth has usually required additional consumption of energy. Without an unexpected technological revolution in the near future, it is very difficult to forecast a drastic variation of sources of energy between now and 2003– fossil fuels (oil, natural gas and coal) are expected to continue to be the predominant actors.

8. We will base our discussions on a possible scenario of evolution to the year 2030. For that, we will consider the projections made by three different agencies: (a) Energy Information Administration (EIA of the US Department of Energy); (b) World Energy Council (WEC); and (c) European Commission – Directorate-General for Energy and Transport. The three agencies have issued publications with world energy

[3] from 73.4 to 95.5 trillion cubic feet, representing an annual growth of 2.0 percent
[4] from 10,543 to 14,781 billion kilowatt-hours, representing an annual growth of 2.6 percent

prospects for 2030[5]. Although the final level of consumption is not the same in the three projections, the qualitative analysis reaches the same conclusions. EIA forecasts that between 2003 and 2030 world consumption of energy will increase at an annual growth of 2.0 percent (see Table 1). WEC forecast is lower, with an annual growth of 1.6 percent. And the EU forecasts an annual growth of 1.8 percent. These forecasts include the continuation of efforts to improve energy efficiency and reduction of energy intensity resulting in annual growth of energy requirements smaller than economic growth[6].

9. The above forecasts were made when petroleum prices were below the peak levels reached in mid 2006, although having already had the price increases in 2004-05. This current oil price levels, if sustained, are likely influence the future projections with lower demand[7].

10. Fossil fuels will continue to dominate energy supplies, meeting about 80 percent (or even more) of projected increase in primary energy demand. The higher growth of energy demand will occur in non-OECD countries. In 2003 total energy consumption in non-OECD countries represented 44.7 percent of the total world consumption and it is estimated that in 2030 this would represent 57.2 percent. The three fossil fuels (oil, natural gas and coal) show the same tendency of higher growth rates in non-OECD countries. Despite the efforts for higher energy efficiency, this dominance of fossil fuels will result in an increase in carbon dioxide emissions.

11. Oil is expected to continue to be the most important source of energy, growing from 80 million barrels per day of consumption in 2003 to about 118 million in 2030. This high dependency on oil is explained by the consumption in the transportation sector, where substitution for other types of energy will require new technology and implementation of new systems for production and distribution of energy which take time. Industrial use is another high component in oil consumption, although the recent price increase of oil may provide incentives for moving to natural gas or even coal. These higher prices of oil and the high efficiency in power generation using combined cycle are increasing (and will continue to increase) the use of natural gas. Consequently, it is foreseen that by 2030, natural gas would become the second most important source of energy, displacing coal.

12. Higher prices for oil will inevitably reflect in higher prices for natural gas, which in turn would make coal more competitive. Therefore, it is foreseen that, despite concerns about the environment, coal's share of total energy use will not fall and may even increase with the possibility of reaching 27 percent in 2030, compared to 24 percent in 2003. The largest increases in coal use worldwide are expected in China and India, where coal supplies are plentiful but which are already major oil importers.

13. Electricity consumption is expected to double between 2003 and 2030, with an annual increase of 2.7 percent. This strong projected growth is basically due to non-

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[5] (a) International Energy Outlook – 2006 – Energy Information Administration; US Department of Energy
(b) World Energy Propects for 2030; World Energy Book 2005 – World Energy Council
(c) European Energy and Transport -- Trends to 2030; European Commission – Directorate-General for Energy and Transport

[6] The basic forecast shown in the tables attached to this paper considered in 2003-2030, GDP growth of 2.6% for OECD countries and 5.0% for Non-OECD countries with a global growth of 3.8%.

[7] As a consequence of a small GDP growth of 3.1 percent in 2003-2030 instead of 3.8 percent used in the reference forecast, energy consumption would, in 2030, be 50 percent higher than the occurred in 2003 compared with 71.5 percent increase in the reference forecast.

OECD countries. With economic growth and rising living standards, Latin America, Africa and Asia will represent important sources for increase in electricity consumption. Africa has the lowest level of accessibility to electricity and Asia, being a region so big and so diverse, has the largest population and the fastest growing energy demand in the world – with China and India leading the way. In these three continents, increasing access to electricity and increasing availability of electricity will be big challenges, which will result in high increase of consumption.

14. Worldwide consumption of electricity generated from nuclear power is expected to increase moderately, with annual growth of 1.0 percent[8] -- non-OECD countries having an annual growth of 3.5 percent and OECD countries only 0.3 percent annually. However, the current high levels of oil prices may increase further the use of nuclear power. On the other hand, the growth of nuclear power in non-OECD countries has faced recent opposition due to concerns of possible military use.

15. Hydroelectricity and other renewable sources are expected to grow; however, their participation in the total energy consumption is expected to continue to represent a small share. Much of the growth in hydroelectricity will come from non-OECD countries like Brazil, China, Laos and India.

16. It is very difficult to estimate the precise amount of resources required to fund the investments for such an increase in energy supply. WEC estimates that about US$ 17 trillion (in 2004 dollars) would be required between 2004 and 2030, about half in non-OECD countries. Financing, especially for the non-OECD countries portion, would be a big challenge.

IV. Sector Analysis

Petroleum

17. As mentioned, it is expected that oil will continue to be the most important source of primary energy in the period 2003 – 2030 (see Table 2). The oil consumption in OECD countries is estimated to grow 23 percent -- 0.8 percent annually. However, in non-OECD countries the growth would be substantial -- nearly doubling the consumption occurred in 2003, an annual growth of 2.3 percent.

18. About half of the projected increase in oil demand is for use in the transportation sector, where there are very few competitive alternatives to petroleum. Several new technologies using alternative liquids are being developed (like ethanol and biodiesel); however, they will require time for maturation and dissemination. The industrial sector, especially for chemical and petrochemical, will continue to rely on petroleum and its share accounts for 39 percent of the projected increase in consumption.

19. Since the biggest consumption of oil is in the transportation sector, the development of alternative liquid fuels for transportation is of great importance. The possible use of biofuels in addition to reducing adverse environmental effects, could improve energy security (for being local and from diverse sources of supply) and economic development by creating opportunities in agriculture. There are several research projects in biofuels. However, two biofuels have proven commercial use in several countries -- ethanol and biodiesel.

[8] from 2,523 billion kilowatt-hours in 2003 to 3,299 billion kilowatt-hours in 2030

20. Ethanol is the most common biofuel, accounting for more than 90 percent of the total usage. It is currently produced by fermentation of sugars from grain or sugar crops. Ethanol is used in Brazil for vehicles running 100 percent on ethanol and in flexi-fuel vehicles that can run on gasoline or ethanol or any mixture of both (ethanol-gasoline). Brazil started its Ethanol program in the 1980s and has today the whole infrastructure from production to distribution of ethanol in the whole country. As a result, the use of sugarcane products represents 13.5 percent of the total energy consumption in Brazil. Ethanol is also used in low-concentration blends (of 5 – 10%) with gasoline in the U.S.A. and in parts of Europe – Japan is also considering the use of ethanol blending in the gasoline.

21. Biodiesel refers to a diesel-equivalent, processed fuel derived from biological sources. Though derived from biological sources, it's a processed fuel that can be readily used in vehicles with diesel-engines, which distinguishes biodiesel from the straight vegetable oils (SVO) or waste vegetable oils (WVO) used as fuels in some modified diesel vehicles. Biodiesel can be distributed using today's infrastructure and its use and production is increasing rapidly. Fuel stations are beginning to make biodiesel available to consumers, and a growing number of transportation fleets use it as an additive in their fuel. Biodiesel can be used alone or mixed with petroleum diesel. The most common is to mix 20 percent of biodiesel to petroleum diesel. Several countries are using biodiesel: Australia, Brazil, Belgium, Canada, Czech Republic, Germany, India, Malaysia, Spain, Taiwan, Thailand, the U.K. and the U.S.A. And others are planning to use it in the near future: Costa Rica, Estonia, Finland, Israel, Norway and Singapore.

22. In regional terms, the fastest growth in oil consumption is projected for Asia, with a high growth of 3 percent/year, under the leadership of China and India. In 2030, Asia is projected to become the major consuming region in the world. Africa with 2.2 percent/year and Central and South America with 1.8 percent/year also contribute to this high increase. As can be seen in Table 2, OECD countries that, in 2003, consumed 55 percent more than non-OECD countries will, in 2030, have approximately the same total consumption as non-OECD countries.

23. After the year 2000, the development of oil production has been mainly in non-OECD countries. For the future, the share of OECD countries production is projected to decline. Very few OECD countries dominate the production of petroleum and other countries will continue to have import dependence from those few producing countries. Table 3 provides the level of petroleum production in the year 2004 and the proven reserves of all producers. The total level of reserves shows that until 2030 no shortage of oil is foreseen, however large investments in production will need to continue. Today proven reserves of oil and of natural gas are concentrated in very few areas. Countries in the Middle-East plus Russia and Venezuela alone concentrate around 70 percent of world oil reserves. This raises concerns about security of supply.

24. Oil prices have been in the news for the last twelve months. Prices have reached record highs. In recent months, crude spot prices have hovered between US$70-74 a barrel. This has generated serious concerns over the level of future oil prices. Table 4 shows the price of imported oil in the U.S.A. from 1968 to 2005. An analysis of these prices shows two interesting conclusions: (i) actual prices, although nominally very high, are in real terms at about the same level of prices in 1980-81, and (ii) after the peak at beginning of the 1980s market prices were relatively stable

until 2002.[9] Some argue that this stability resulted from overinvestment in production after the price increases resulting from the 1979 oil shock and the reaction from consuming countries improving energy efficiency and reduction of consumption, which generated spare output capacity. Since 2002, however, energy markets have exhibited some unnerving behavior resulting in the sharp price escalation of the last three years. The times of spare capacity have gone and their comeback is by no means certain. This raises concerns in consumer countries of increases in price levels and price volatility.

25. There is no consensus about the level of future price of oil. However, different actors agree that future prices will be at least double of the stable prices of 1980s and 1990s. EIA considers three scenarios with oil prices per barrel of US$34, US$57 and US$96 in 2030. The WEC considers that in 2030 prices will be in the order of US$65 to US$86 per barrel, while the World Bank[10] considers that the world is going through a volatile period and prices may settle down at US$57/barrel by 2008.

Natural Gas

26. Natural gas will become the second most important source of primary energy, displacing coal, despite its higher prices compared with coal. Environmental concerns and much higher efficiency in combined cycle for power generation, create the biggest incentives for greater use of natural gas. It is estimated that by the year 2030, consumption of natural gas will be nearly the double of the occurred in 2003 (see Table 5 for details).

27. Industry and the electric power sector are the biggest consumers of natural gas around the world, but especially in OECD countries. In 2003, 44 percent of natural gas produced aimed at industrial use and 31 percent was used in power generation. OECD countries are mature consumers of natural gas with well established infrastructure of pipelines or importation facilities for importing LNG. Non-OECD countries (with Russia as the only exception) are in its infancy with respect to natural gas use. However, it is expected that this picture will change dramatically by 2030. Natural gas demand in non-OECD countries accounts for about 70 percent of the incremental world consumption in 2003-2030.

28. Regionally, the natural gas consumption will grow in very different ways. The U.S.A. is expected to have a modest growth rate of about 1.1 percent mainly due to the expected high prices of gas in the region and its dependence on imported gas with growing prices tendency (for the use of LNG). In Europe the use of natural gas for power generation (representing about 60 percent of incremental consumption) is expected to grow at an annual rate of 2.0 percent. On the other hand, in non-OECD countries, growth of consumption of natural gas is expected to be significant, nearly tripling in 2003—2030.

29. Non-OECD Asia is the area with highest growth due to China and India. In both countries, natural gas has today a small participation in the energy matrix,

[9] In the period prior to the 1973 shock, prices were stable at a level of US$12 (in 2005 dollars). After 1973, prices again stabilized at a level of US$38 (in 2005 dollars), up to the new shock in 1979 when they raised to US$70 in 1980-81. After 1981, prices started to decline from US$55 (in 1982-83) and US$45 (in 1984-85) to stabilize in the range between US$25 (in 1986-92) and even further to US$20 (in 1993-99); and starting to climb again to US$27 (in 2000-03); reaching US$37 (in 2004) and US$49 (in 2005).

[10] Global Development Finance, 2006 – The development potential of surging capital flows.

representing 3 and 7 percent of energy consumption, respectively. However, both countries are implementing strong infrastructure for natural gas transportation (pipelines) and for importation of LNG. Both have limited natural gas reserves and should rely on imports to meet about 40 percent of their demands. Both are pursuing importation through gas pipelines but are also implementing installations for importing LNG.

30. In the Middle East, oil-exporting countries are expanding domestic natural gas use to free-up more oil for export. Others (like Egypt) having more natural gas and less petroleum, are expanding domestic natural gas consumption as a substitute for oil. Additionally, with higher prices of oil (and gas), several countries are developing LNG installations and it is expected that this region becomes the fastest growing source of supply of LNG. In Africa it is expected that natural gas will be the fastest growing primary source of energy, particularly for use in industry and power generation.

31. In South-America, natural gas (especially in the southern cone) has the prospective of fast growth. Bolivia, Brazil, Argentina and Chile are already interconnected by a network of pipelines. Other pipelines to connect the existing network to Peru and Ecuador and even to Venezuela and Colombia are under consideration. However, the economics and the political aspects of some of those projects may create impediments to their implementation.

32. Similar to petroleum, only a few countries have vast reserves of natural gas (see Table 3). Nearly 60 percent of the world's natural gas reserves are in Iran, Qatar and Russia. Russia is today the biggest exporter to Europe (provider of today's two-thirds of Europe's imports). Worldwide reserves are estimated sufficient for 67 years on the basis of actual production. However, due to the uneven geographical distribution of the reserves, transportation becomes a limitation for greater economic use. The higher prices of gas have, however, made LNG to start growing and becoming a possible alternative for the transportation barrier.

33. LNG is expected to become an increasingly important source of supply to meet world's demand for natural gas. Today only a few countries export and import LNG. In 2002 the market has included: (1) as importers: Japan; South Korea; Spain; France; U.S.A.; Taiwan; Italy; Turkey; Belgium; Greece; and Portugal; and (2) as exporters: Indonesia; Algeria; Malaysia; Qatar; Australia; Brunei; Oman; Nigeria; Abu Dhabi; Trinidad and Tobago; U.S.A.; and Libya. Since then, Egypt has become an exporter and today ranks seventh. In the next 10 years, however, the U.S.A. and some countries in Europe will have to rely much more on imported gas. Because of the projected reduction of dry gas imports from Canada (currently the source of 90 percent of US gas imports), the U.S.A. should vastly increase imports of LNG, which would become the biggest source of imported gas after 2010. With domestic production declining in most OECD countries in Europe, more than half of the demand in 2015 and almost two-thirds of the demand in 2030 will be imported. Due to the crisis between Russia and Ukraine in January 2006 and resultant concerns about security of supplies from Russia, European countries are considering aggressively expanding LNG importing capacity to diversify their sources of gas supplies.

34. Unlike petroleum, there is not an international market for natural gas. The big differences are on transportation and storage – gas is much more difficult (and expensive) to transport and to store. The entrance of LNG in the scene brings the hope of changing this picture; however, until now this has not been sufficient to create a real free market (as flexible as the oil market) due to the uncertainties faced by

exporters in view of the high investments in transportation. The high investment needed in the transportation of dry gas (pipelines) and for liquefaction and shipping of LNG, makes the gas sales contracts of long-term type and in general with volume obligations to buyer (take or pay). This long-term contract scheme tends to remain as the dominant relationship, despite the big pressures from buyers for more flexible short-term volume obligations. The large capital of the business and the risks involved restricts this business only to a few entrepreneurs in the world. New installations of bigger trains for gas liquefaction and bigger tankers may reduce the transportation costs.

35. As a result of the lack of an international market for natural gas, prices are defined regionally, basically depending on the production cost of gas at the source plus the costs of transportation compared to the opportunity cost of competing fuels. Long-term contracts have price adjustment clauses that traditionally have been related to oil price variations. Different from pipelines, which have their costs more sensitive to length than to volume, LNG transportation is very sensitive to volume. A recent study published by Oxford Institute for Energy Studies[11], included an example of capital expenditures for a hypothetical LNG project, estimating the cost of transportation as US$3.39 per million BTU.

36. New technology is being developed and applied to convert natural gas to liquids in gas to liquids technology (gas-to-liquid or GTL). It is technically feasible to synthesize almost any hydrocarbon[12] from any other; and in the past five decades several processes have been developed to synthesize liquid hydrocarbons from natural gas creating liquid fuel equivalent to those produced from petroleum. These can be moved in existing pipelines or products tankers and even blended with existing crude oil or product streams. Further, no special contractual arrangements are required for their sale with many suitable domestic and foreign markets. The projects are scalable, allowing design optimization and application to smaller gas deposits. The key influences on their competitiveness are the cost of capital, operating costs of the plant, feedstock costs, scale and ability to achieve high utilization rates in production. As a generalization however, GTL has not been competitive against conventional oil production unless the gas has a low opportunity value and is not readily transported, however, the new levels of petroleum prices may change this scenario. Only South Africa and Malaysia have commercial GTL operations but new projects are under consideration (in Algeria, Australia, Egypt, Iran Nigeria and Qatar).

Coal

37. Although losing ground to natural gas, coal will continue to be a very important source of primary energy. In 2003, coal represented 24 percent of the world energy consumption, basically used for power generation (67 percent) and for industrial uses (27 percent). In 2030, coal is expected to represent 27 percent of total energy consumption, mainly because of increased consumption in the US, China and India (see Table 6). Europe faced a reduction of use of coal during the 1990s and future consumption is expected to remain relatively flat. Japan, after an increase in the 1990s is expected to have a flat consumption profile until 2030. The U.S.A., however, shows a very different scenario. From 2003 to 2030, the USA consumption should grow 63 percent, basically for use in power plants due to the increase of price of natural gas.

[11] James T. Jensen --The Development of a Global LNG Market -- Oxford Institute for Energy Studies
[12] China is also pursuing the development of Coal-to-liquids (CTL) technology.

38. In non-OECD countries, the highest growth in coal consumption has occurred (1990 – 2003) and it is projected to occur (2003 – 2030) in Asia, particularly in China and India.[13]. Nearly half of the coal used in China in 2003 was for the industrial sector (mainly steel and pig iron). In the future, both industrial use and power generation coal consumption are expected to triple. In India, in 2003, the power sector consumed around 70 percent of the total coal demand, and for the future, it is expected that almost 70 percent of the growth in coal consumption continues to be for power generation. In Africa, South Africa (for its power sector) is the only significant consumer and will continue so. In South America, Brazil accounts for around 70 percent of the consumption – basically for industrial use, especially in the steel industry; and the projections are for an increase of 56 percent in the projection period for expansion of the industry.

39. Coal reserves are widely distributed around the world and, consequently, most countries consume domestic coal and only about 13 percent of total coal consumed in 2003 was imported. Even so, four countries have the largest reserves: U.S.A. (27 percent of total reserves); Russia (17 percent); China (13 percent) and India (10 percent). The larger exporters were: Australia, Indonesia, China, South Africa, Colombia, and the U.S.A.

Electricity

40. From 1990 to 2003 electricity consumption worldwide increased by 40 percent,[14] having an increase of 30 percent in OECD countries and an impressive 56 percent increase in non-OECD countries (see Table 7). For the future, the tendency is expected to be the same, and in 2030 non-OECD countries should have a market bigger than that in OECD countries. It is estimated that OECD countries will grow at 1.5 percent annually and non-OECD countries at 3.9 percent annually. Another important difference between these two groups is the profile of consumption. While in OECD countries the actual and future consumption is about 60 percent for household and commerce use, in non-OECD countries this represents about 30 percent of the electricity consumption. However, from 2003 to 2030, it is estimated that residential consumption multiplies by 4 in non-OECD countries, representing a great increase in access to electricity.

41. On the supply side it will be necessary to implement 2,740 gigawatts (at an average annual rate of 2.0 percent) to satisfy the demand. The primary source for those generating units will depend on the resources of each country (see Table 8). Coal is today the largest primary source of energy used in power generation (about 40 percent of total generation). For the future, this should not change. China and the U.S.A. should add 546 and 154 gigawatts, respectively – the countries with biggest investment in coal based power plants. Oil based power plants should not increase in the future. In fact it is expected that the participation of oil fired plants reduces from 10 percent of total generation in 2003 to 7 percent in 2030. Only China and the Middle-East are considering new installations using oil.

42. Natural gas is the primary source for increase in power generation. In a global basis, the participation of natural gas for power generation is expected to increase from 19 percent in 2003 to 22 percent in 2030. In Europe the participation of natural gas is expected to double between 2003 and 2030. In the U.S.A., although natural gas has had an increasing participation in the share of primary source for power

[13] These countries grew at annual rates of 2.4 and 4.1 percent respectively between 1990 and 2003, and are projected to grow at 4.2 and 2.7 percent, respectively, between 2003 and 2030

[14] an annual growth of 2.6 percent

generation in the last ten years, it should stop rising and begin a decline reaching in 2030 the same participation (15 percent) of 2003. In non-OECD countries it is expected an increase in the use of natural gas in power generation, with greater relevance in China, India, Russia and the Middle-East.

43. Nuclear plants are expected to grow from 361 gigawatts in 2003 to 438 gigawatts in 2030, or 1.0 percent annually. In OECD countries, it is expected that new installations will only be sufficient to replace retired installations, resulting in only 0.3 percent of annual growth. However, in non-OECD countries, the growth projected is of 3.5 percent annually, of which China and India would each grow approximately 7.5 percent annually. Nuclear plants, however, continue to face opposition from environmental groups, particularly about security and disposal of used fuel. More recently, nuclear plants have also been facing strong political opposition, due to fears of military use.

44. Hydro-plants represented only 16.5 percent of the electricity generated in 2003. OECD countries have already developed all of their possible hydro sites. For the future, the remaining potential for large projects is in Asia (China, Laos and Vietnam), in Africa (Congo River) and in Brazil. However, even after the development of all those projects, the share of hydro-power in the total generation should not increase. Other renewables continue to have minimum participation as primary source of energy (1.9 percent in 2003). Wind is the most used source (especially in Germany, the Netherlands, Denmark and Spain), but its cost is still high compared to traditional sources of energy.

Conservation of Energy

45. Conservation of energy can be achieved without harming economic growth or the environment through more efficient use of energy. The world has made efforts to increase efficiency in using energy. However, much more can be done yet, especially in the transportation sector by the use of smaller and more efficient vehicles and better use of public transportation.

46. Figure 9 shows, for the period 1980-2030, the actual and forecast variation of energy intensity (in thousands of BTU of consumption of energy per 2,000 US$ of GDP), which is a measure of the efficiency in the use of energy. This figure shows that in OECD countries the energy intensity in 2000 was 30 percent lower than in 1980 and in 2030 will be 50 percent of 1980. In non-OECD countries in Asia, Africa and Latin-America the energy intensity in 1980 was 30 percent lower than in OECD countries but it has also been reducing and is expected to continue below OECD countries levels until 2030. However, non-OECD countries in the former Soviet Union had in 1980 high energy intensity (50 percent higher than in OECD countries) which continued to grow, increasing 13 percent in 2000. The forecast is that these countries will improve their energy efficiency reaching 2030 a reduction of 50 percent of the 1980 levels, but yet 60 percent higher than the other non-OECD countries.

47. Improving energy intensity is particularly challenging for most emerging economies, but also most important. Most fast growing EMCs, like China and India, which are driving growth in global energy demand are also at a stage of development when energy intensity of an economy normally increases with a rise in living standards and change in structure of production. Such countries are short of capital and technology needed to significantly improve energy efficiency. Yet, these are also the countries that need to do most to temper energy demand. The benefits to them also

clear in three critical areas: reducing their energy import bills; improving their energy security and reducing environmental degradation.

V. Looking Forward -- Implications for EMCs and Points for Discussions

48. Based on the prior analysis we suggest the following points for discussions at the EMF meeting in Jakarta, in view of their future implications for EMCs.

A. Oil Price and Sustainability of Development Growth:

The scenario looking forward is based on expected growth, particularly in EMCs. The projections for the future were based on oil prices expected to be stable at about 50-60 US$/barrel. Future oil prices generate a big uncertainty due to the possible effects of sustained higher prices of oil for EMCs and for OECD economies, especially the U.S.A. EMC economies would be affected by price volatility and also by a new level of higher prices. However, not all EMC would be affected in the same way.

The EMCs with significant net energy export capacity would benefit from this new level of prices, but, they would face the challenge of following prudent fiscal and financial policies to avoid wasteful expenditures and to use the current surpluses for the benefit of future generations. Unlike recently, it appeared that most oil exporting countries are taken advantage of the initial balance of payment surpluses to improve the national balance sheets (e.g. pay off international and national debts, and balance their fiscal budgets), refrained from raising domestic expenditures to unsustainable levels, and invest their new international reserves in a prudent manner in long-term investments. There are, however, some signs more recently that some countries have started to deposit their surpluses in international banks, as in the 1970s, who are in turn may be investing these funds in riskier instruments.

Those EMCs importing fuels would, on the other hand, have to find ways to pay for expensive imported energy and raise domestic energy prices. Many countries have seen hard earned balance of payments turn into large deficits. Energy security has become a major concern. And large importers like China and India are often competing with each other to secure long term supplies, in turn bidding up the prices of energy assets. The energy deficit countries need to find the best way to grow with less energy requirements, through conservation of energy, and selection of growth in sectors of low energy intensity and, in some cases, having to bear higher initial investment for greater energy efficiency.

Therefore the following questions related to this topic are proposed:

- *At which new level are the energy prices most likely to stabalise?*
- *What effect would this new price level have on the future economic growth and comparative advantage of EMCs, and how these higher prices could affect trade between EMCs and OECD countries?*
- *Which could be the best strategy for EMCs to cope with this new level of prices (For fuel importing and for fuel exporting EMCs)?*
- *Can EMCs improve even more their energy efficiency without impairing their growth? How?*

B. Security of Supply:

The two fuels expected to lead consumption (oil and natural gas) have been facing several uncertainties for a secure supply. Future oil and natural gas resources are concentrated in few countries, especially in the Middle-East and in Russia. The political and war risk in the Middle-East and the recent use of natural resources as political instrument in the Russia-Ukraine crisis over natural gas create big uncertainty in security of supply. Fuel importing EMCs must consider long-term policies to promote diversification of their energy supplies as a way to reduce their vulnerability to disruptions of supply. Such diversification should cover different types of energy and different geographical sources of supply. Another issue for consideration would be the creation of strategic stocks of fuel to face either price volatility or lack of security of supply. Fuel exporting EMCs should aim at being seen as reliable energy suppliers, trying to reduce the security risks to the supply to their long-term commercial partners, particularly in the natural gas sector.

On this issue, the following points are proposed:

- *How to reduce the risks to security of supplies? How to reduce the risk of political use of natural energy resources?*
- *Which level of strategic stocks should fuel importing EMCs consider? And which policies should fuel exporting EMCs pursue to improve their image on the issue of security of supply?*
- *Diversification of sources of energy for better security of supply may result in higher costs of energy. Which level of diversification should be pursued and up to which premium cost?*
- *Should EMCs pursue a more intense nuclear option?*

C. Local Investments in EMCs:

It is estimated that around US$9 trillion will be required for investments in energy until 2030 in non-OECD countries. On one side, transportation is responsible for the greatest consumption of oil. On the other side, a great part of these investments will be for power. For the first, reduction of consumption and diversification of types of energy would require investments in the creation of a whole chain of supply of substitutes. For the second, it is recognized that expanding electricity supply is vital for development. Even with electrification rates rising over the period, the total number of people still without access to electricity will be very high (around 1.4 billion).

The following questions are suggested:

- *How to attract the required funding for the needed investments? Which policies governments should pursue? What should be the strategies of the private sector*
- *How to increase domestic energy prices to provide incentives for energy conservation and for new investments in production?*
- *Which incentives should be created (or actions be taken) to increase the use of substitutes to petroleum in the transportation sector? Are bio-fuels (like ethanol and bio-diesel) a solution?*

D. Environmental Impact:

Energy consumption accounts for 80 percent of global Green House Gases (GHG) emissions, with carbon dioxide as the most important component. In 2003 world carbon dioxide emissions were estimated at 25 billion metric tons of which around 52 percent from OECD countries. However, the future

projections are that by 2030, non-OECD countries may represent 60 percent of total world emissions of 43 billion metric tons. This would represent an annual increase of 2.1 percent of GHG emissions. Although world carbon dioxide intensity has improved (decreased) substantially, falling from 629metric tons/million US dollars of GDP in 1990 to 493 metric tons/million of US dollars of GDP in 2003 and is expected to continue improving, the total emissions would nearly double between 2003 and 2030, which is unsustainable. EMCs will be under great pressure to grow without increasing emissions substantially.

The following questions are suggested:

- *Which strategy should EMCs use for making the Kioto agreement a reality?*
- *Which constraints and higher investment costs should EMCs expect for growing with lower energy intensity?*
- *How to achieve increased access to energy (particularly electricity) with increased energy efficiency (less intensity)?*
- *Is energy conservation compatible with economic growth -- how to achieve both?*

Emerging Markets Forum
September 2006

Table 1: World Total Energy Consumption

(Quadrillion BTU)

Country	Actual			Projected[15]	
	1990	2003	Annual Growth	2030	Annual Growth
OECD Countries					
OECD North America	100.8	118.3	1.2%	166.2	1.3%
USA	84.6	98.1	1.1%	133.9	1.2%
Other	16.1	20.2	1.8%	32.4	1.8%
OECD Europe	69.9	78.9	0.9%	94.5	0.7%
OECD Asia	26.7	37.1	2.6%	48.0	1.0%
Japan	18.4	22.4	1.5%	24.3	0.3%
Other	8.2	14.6	4.5%	23.7	1.8%
TOTAL OECD	197.4	234.3	1.3%	308.8	1.0%
Non-OECD Countries					
Europe & Eurasia	67.2	48.5	-2.5%	79.0	1.8%
Russia	39.0	29.1	-2.2%	44.8	1.6%
Other	28.3	19.4	-2.9%	34.1	2.1%
Asia	47.5	83.1	4.4%	223.6	3.7%
China	27.0	45.5	4.1%	139.1	4.2%
India	8.0	14.0	4.4%	32.5	3.2%
Other	12.5	23.6	5.0%	52.0	3.0%
Middle-East	11.3	19.6	4.3%	37.7	2.5%
Africa	9.5	13.3	2.6%	26.8	2.6%
Central & South America	14.5	21.9	3.2%	45.7	2.8%
Brazil	5.8	8.8	3.3%	17.2	2.5%
Other	8.8	13.1	3.1%	28.5	2.9%
Total Non-OECD	150.0	186.4	1.7%	412.8	3.0%
TOTAL WORLD	347.3	420.7	1.5%	721.6	2.0%

[15] Source of projection: EIA – International Energy Outlook -- 2006

Table 2: World Petroleum Consumption

(Million Barrels per Day)

Country	Actual			Projected[16]	
	1990	2003	Annual Growth	2030	Annual Growth
OECD Countries					
OECD North America	20.5	24.3	1.3%	33.4	1.2%
USA	17.0	20.1	1.3%	27.6	1.2%
Other	3.5	4.2	1.4%	5.8	1.2%
OECD Europe	13.7	15.5	1.0%	16.3	0.2%
OECD Asia	7.1	8.8	1.7%	10.1	0.5%
Japan	5.2	5.6	0.6%	5.4	-0.1%
Other	1.9	3.2	4.1%	4.7	1.4%
TOTAL OECD	41.3	48.5	1.2%	59.7	0.8%
Non-OECD Countries					
Europe & Eurasia	9.3	4.9	-4.8%	7.1	1.4%
Russia	5.4	2.7	-5.2%	3.4	0.9%
Other	3.9	2.2	-4.3%	3.8	2.0%
Asia	6.6	13.5	5.7%	29.8	3.0%
China	2.3	5.6	7.1%	15.0	3.7%
India	1.2	2.3	5.1%	4.5	2.5%
Other	3.1	5.6	4.7%	10.3	2.3%
Middle-East	3.5	5.3	3.2%	7.8	1.4%
Africa	2.1	2.7	2.0%	4.9	2.2%
Central & South America	3.8	5.3	2.6%	8.5	1.8%
Brazil	1.5	2.1	2.6%	3.3	1.7%
Other	2.3	3.2	2.6%	5.2	1.8%
Total Non-OECD	25.3	31.6	1.7%	58.2	2.3%
TOTAL WORLD	66.6	80.1	1.4%	118.0	1.4%

[16] Source of projection: EIA – International Energy Outlook -- 2006

Table 3: Petroleum and Natural Gas Reserves

	Petroleum		Natural Gas	
Region/Country	**Production Thousands Barrel/day 2004**	**Proven[17] Reserves Billion Barrels** (2006 estimate)	**Production Trillion Cubic Feet**	**Proven[18] Reserves Trillion Cu Ft** (2006 estimate)
Canada	3,135.2	178.792	6.483	56.577
Mexico	3,847.6	12.882	1.464	15.985
United States	8,700.2	21.371	18.757	192.513
North America	**15,683.0**	**213.046**	**26.704**	**265.075**
Argentina	822.7	2.320	1.585	18.866
Bolivia	61.4	0.441	0.355	24.000
Brazil	1,837.7	11.243	0.341	11.515
Colombia	542.9	1.542	0.218	4.040
Cuba	66.6	0.750	0.013	2.500
Ecuador	528.3	4.630	0.006	0.345
Peru	93.6	0.930	0.030	8.723
Trinidad and Tobago	165.3	0.990	0.992	25.880
Venezuela	2,854.8	79.729	0.961	151.395
Other	46.5	0.790	0.039	3.465
Central & South America	**7,019.8**	**103.364**	**4.540**	**250.729**
Denmark	391.4	1.328	0.333	2.786
France	77.7	0.158	0.049	0.378
Germany	167.4	0.367	0.726	9.076
Italy	145.1	0.622	0.458	8.000
Netherlands	95.8	0.106	3.036	62.000
Norway	3,196.6	7.705	2.948	84.260
Romania	130.9	0.956	0.417	3.550
United Kingdom	2,074.8	4.029	3.389	18.750
Other Countries	295.1	1.109	0.533	11.945
Europe	**6,574.8**	**16.380**	**11.890**	**200.745**
Azerbaijan	316.8	7.000	0.177	30.000
Kazakhstan	1,223.4	9.000	0.724	65.000
Russia	9,273.7	60.000	22.386	1,680.000
Turkmenistan	213.7	0.546	2.068	71.000
Ukraine	85.1	0.395	0.678	39.600
Uzbekistan	142.0	0.594	2.114	66.200
Other Countries	57.3	0.297	0.010	0.800
Eurasia	**11,312.1**	**77.832**	**28.157**	**1,952.600**

[17] Penn Well Corporation, Oil & Gas Journal, Vol. 103, No. 47 (December 19, 2005). Oil includes crude oil and condensate.

[18] Penn Well Corporation, Oil & Gas Journal, Vol. 103, No. 47 (December 19, 2005). Oil includes crude oil and condensate

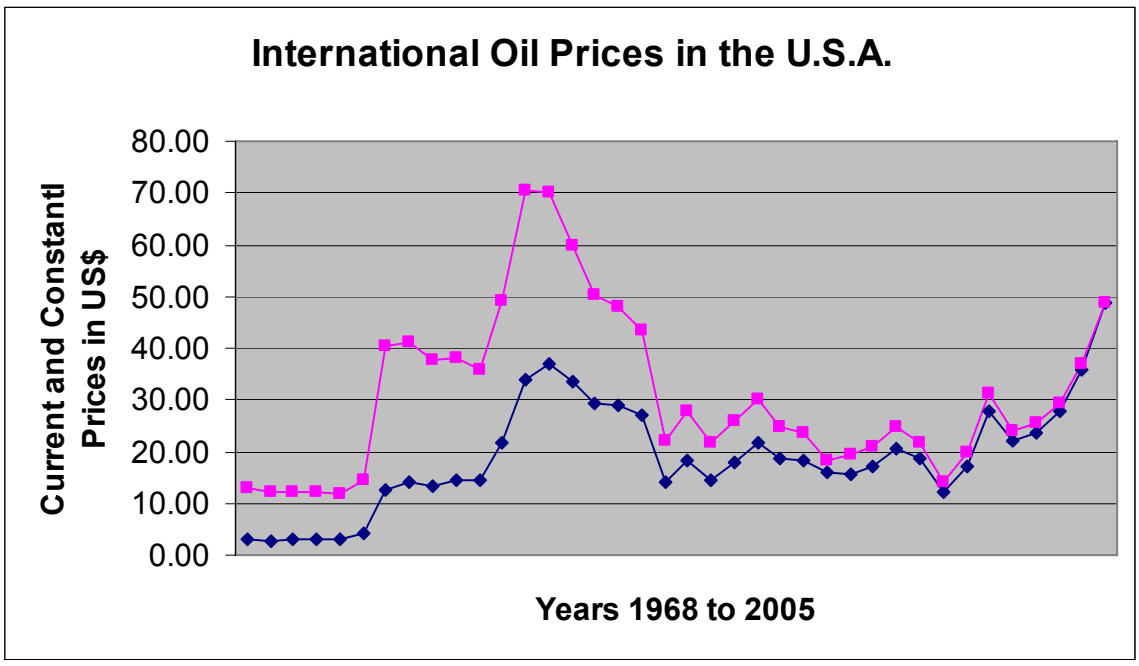
Table 3: Petroleum and Natural Gas Reserves (cont)

	Petroleum		Natural Gas	
Region/Country	**Production Thousands Barrel/day 2004**	**Proven Reserves Billion Barrels** (2006 estimate)	**Production Trillion Cubic Feet 2004**	**Proven Reserves Trillion Cu Ft** (2006 estimate)
Bahrain	50.0	0.125	0.344	3.250
Iran	4,101.7	132.460	2.963	971.150
Iraq	2,023.7	115.000	0.062	111.950
Kuwait	2,514.3	104.000	0.343	56.015
Oman	754.2	5.506	0.607	29.280
Qatar	1,043.5	15.207	1.383	910.520
Saudi Arabia	10,492.6	266.810	2.319	241.840
Syria	451.0	2.500	0.251	8.500
United Arab Emirates	2,760.1	97.800	1.635	214.400
Yemen	425.1	4.000	0.000	16.900
Other Countries	2.9	0.000	0.039	1.600
Middle East	**24,618.9**	**743.408**	**9.946**	**2,565.405**
Algeria	1,966.8	11.350	2.830	160.505
Angola	1,051.5	5.412	0.026	1.620
Chad	170.6	1.500	0.000	0.000
Congo (Brazzaville)	235.2	1.506	0.000	3.200
Cote d'Ivoire (Ivory Coast)	35.9	0.100	0.046	1.000
Egypt	702.7	3.700	1.150	58.500
Equatorial Guinea	371.7	0.012	0.004	1.300
Gabon	238.8	2.499	0.004	1.200
Ghana	7.5	0.017	0.000	0.840
Libya	1,582.6	39.126	0.285	52.650
Nigeria	2,332.6	35.876	0.770	184.660
South Africa	229.9	0.016	0.079	0.001
Sudan	344.7	0.563	0.000	3.000
Tunisia	81.5	0.308	0.085	2.750
Other Countries	91.1	0.597	0.006	14.615
Africa	**9,442.9**	**102.581**	**5.284**	**485.841**
Australia	557.6	1.437	1.308	27.640
Brunei	204.6	1.350	0.406	13.800
Burma	20.7	0.050	0.360	10.000
China	3,635.4	18.250	1.440	53.325
India	844.4	5.848	0.996	38.880
Indonesia	1,181.0	4.301	2.663	97.786
Japan	120.6	0.059	0.104	1.400
Malaysia	861.2	3.000	2.205	75.000
New Zealand	27.9	0.053	0.154	0.900
Pakistan	66.4	0.289	0.968	28.153
Papua New Guinea	45.6	0.240	0.005	12.200
Philippines	25.3	0.139	0.102	3.960
Thailand	257.7	0.291	0.790	14.754
Vietnam	403.3	0.600	0.106	6.800
Other Countries	83.1	0.030	0.493	7.047
Asia & Oceania	**8,334.7**	**35.936**	**12.099**	**391.645**
World Total	**83,004.7**	**1,292.547**	**98.620**	**6,112.040**

Table 4: Price of Imported Oil in the U.S.A.[19]
(Nominal US$ and Real US$ of 2005)

Year	Oil Price US$	
	Current	Constant (2005)
1968	2.90	13.05
1969	2.80	12.01
1970	2.96	12.06
1971	3.17	12.29
1972	3.22	11.97
1973	4.08	14.37
1974	12.52	40.43
1975	13.93	41.11
1976	13.48	37.61
1977	14.53	38.12
1978	14.57	35.71
1979	21.67	49.05
1980	33.89	70.33
1981	37.05	70.28
1982	33.55	59.99
1983	29.30	50.39
1984	28.88	47.87
1985	26.99	43.42
1986	14.00	22.04
1987	18.13	27.78
1988	14.56	21.58
1989	18.08	25.82

Year	Oil Price US$	
	Current	Constant (2005)
1990	21.78	29.91
1991	18.70	24.83
1992	18.20	23.63
1993	16.14	18.23
1994	15.51	19.27
1995	17.14	20.87
1996	20.64	24.66
1997	18.53	21.78
1998	12.04	14.00
1999	17.26	19.78
2000	27.70	31.06
2001	22.00	24.09
2002	23.71	25.52
2003	27.71	29.24
2004	35.90	36.91
2005	48.85	48.85



[19] Source: Energy Information Administration / Annual Energy Review 2005

Table 5: Natural Gas Consumption
(Trillion Cubic Feet)

Country	Actual			Projected[20]	
	1990	2003	Annual Growth	2030	Annual Growth
OECD Countries					
OECD North America	22.5	27.4	1.5%	36.6	1.1%
USA	19.2	22.3	1.2%	26.9	0.7%
Other	3.3	5.1	3.4%	9.7	2.4%
OECD Europe	11.6	17.8	3.3%	30.8	2.1%
OECD Asia	2.8	5.0	4.6%	6.8	1.1%
Japan	1.9	3.1	3.8%	3.8	0.8%
Other	0.9	1.9	5.9%	3.0	1.7%
TOTAL OECD	36.8	50.2	2.4%	74.2	1.5%
Non-OECD Countries					
Europe & Eurasia	26.7	23.6	-0.9%	40.5	2.0%
Russia	17.3	15.3	-0.9%	23.6	1.6%
Other	9.5	8.3	-1.0%	16.9	2.7%
Asia	2.9	7.5	7.6%	28.8	5.1%
China	0.5	1.2	7.0%	7.0	6.7%
India	0.4	1.0	7.3%	4.5	5.7%
Other	2.0	5.4	7.9%	17.3	4.4%
Middle-East	3.6	7.9	6.2%	19.6	3.4%
Africa	1.4	2.6	4.9%	8.1	4.3%
Central & South America	2.0	3.8	5.1%	10.8	3.9%
Brazil	0.1	0.5	13.2%	1.7	4.6%
Other	1.9	3.3	4.3%	9.1	3.8%
Total Non-OECD	36.5	45.3	1.7%	107.8	3.3%
TOTAL WORLD	73.4	95.5	2.0%	182.0	2.4%

[20] Source of projection: EIA – International Energy Outlook -- 2006

Table 6: Coal Consumption
(Million Short Tons)

Country	Actual			Projected[21]	
	1990	2003	Annual Growth	2030	Annual Growth
OECD Countries					
OECD North America	972.0	1,185.0	1.5%	1,948.0	1.9%
USA	904.0	1,095.0	1.5%	1,784.0	1.8%
Other	68.0	89.0	2.1%	163.0	2.3%
OECD Europe	1,298.0	887.0	-2.9%	928.0	0.2%
OECD Asia	280.0	404.0	2.9%	560.0	1.2%
Japan	126.0	176.0	2.6%	169.0	-0.2%
Other	154.0	228.0	3.1%	391.0	2.0%
TOTAL OECD	2,551.0	2,476.0	-0.2%	3,436.0	1.2%
Non-OECD Countries					
Europe & Eurasia	1,028.0	543.0	-4.8%	856.0	1.7%
Russia	447.0	251.0	-4.3%	382.0	1.6%
Other	581.0	292.0	-5.2%	474.0	1.8%
Asia	1,507.0	2,168.0	2.8%	5,855.0	3.7%
China	1,124.0	1,531.0	2.4%	4,645.0	4.2%
India	256.0	431.0	4.1%	887.0	2.7%
Other	127.0	206.0	3.8%	323.0	1.7%
Middle-East	6.0	16.0	7.8%	19.0	0.6%
Africa	152.0	203.0	2.3%	320.0	1.7%
Central & South America	27.0	35.0	2.0%	74.0	2.8%
Brazil	17.0	24.0	2.7%	46.0	2.4%
Other	10.0	11.0	0.7%	28.0	3.5%
Total Non-OECD	2,718.0	2,964.0	0.7%	7,125.0	3.3%
TOTAL WORLD	5,269.0	5,440.0	0.2%	10,561.0	2.5%

[21] Source of projection: EIA – International Energy Outlook -- 2006

Table 7: Electricity Consumption
(Billion Kilowatt-hours)

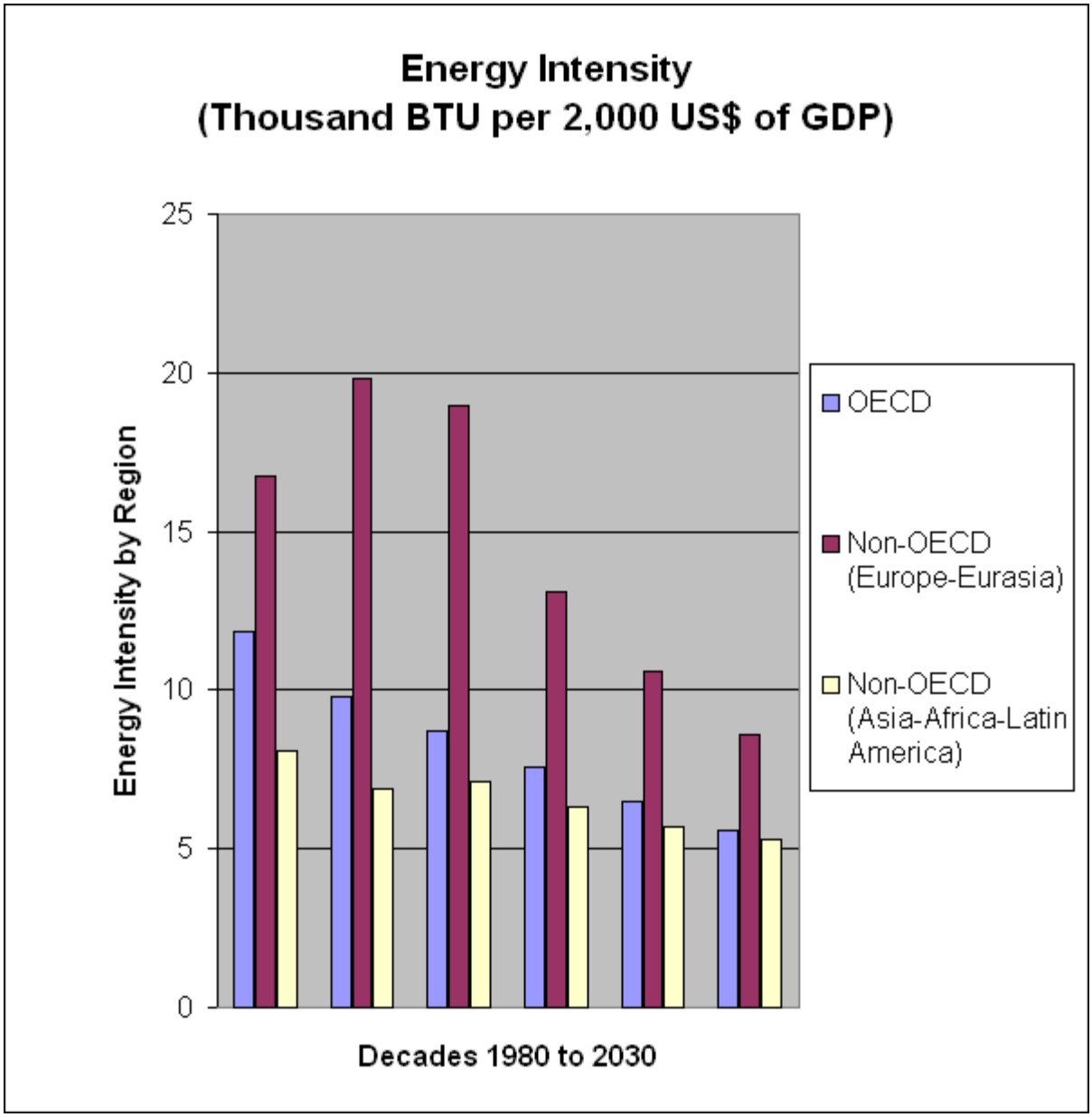
Country	Actual			Projected	
	1990	2003	Annual Growth	2030	Annual Growth
OECD Countries					
OECD North America	3,379.0	4,384.0	2.0%	6,969.0	1.7%
USA	2,837.0	3,669.0	2.0%	5,619.0	1.6%
Other	542.0	715.0	2.2%	1,350.0	2.4%
OECD Europe	2,355.0	2,965.0	1.8%	4,107.0	1.2%
OECD Asia	1,024.0	1,487.0	2.9%	2,132.0	1.3%
Japan	764.0	946.0	1.7%	1,151.0	0.7%
Other	259.0	541.0	5.8%	981.0	2.2%
TOTAL OECD	6,758.0	8,836.0	2.1%	13,208.0	1.5%
Non-OECD Countries					
Europe & Eurasia	1,672.0	1,350.0	-1.6%	2,850.0	2.8%
Russia	955.0	812.0	-1.2%	1,641.0	2.6%
Other	717.0	539.0	-2.2%	1,208.0	3.0%
Asia	1,150.0	2,917.0	7.4%	10,027.0	4.7%
China	551.0	1,671.0	8.9%	5,971.0	4.8%
India	257.0	519.0	5.6%	1,730.0	4.6%
Other	342.0	726.0	6.0%	2,326.0	4.4%
Middle-East	214.0	471.0	6.3%	1,034.0	3.0%
Africa	286.0	436.0	3.3%	951.0	2.9%
Central & South America	463.0	772.0	4.0%	2,047.0	3.7%
Brazil	229.0	371.0	3.8%	871.0	3.2%
Other	234.0	400.0	4.2%	1,176.0	4.1%
Total Non-OECD	3,785.0	5,944.0	3.5%	16,908.0	3.9%
TOTAL WORLD	10,543.0	14,781.0	2.6%	30,116.0	2.7%

Table 8: Power Generation by Type in 2003

(Billion Kilowatt-hours)

Region/Country	Conventional Thermal	Hydroelectric	Nuclear	Geothermal Solar, Wind Wood and Waste	Total
Canada	154.55	334.18	71.15	9.53	569.41
United States	2,758.65	275.81	763.73	93.53	3,891.72
Other Countries	169.68	19.68	9.98	8.34	206.72
North America	**3,082.89**	**629.67**	**844.85**	**111.40**	**4,668.81**
% distribution by type	66.0%	13.5%	18.1%	2.4%	100.0%
Argentina	46.57	33.50	7.03	1.08	88.18
Brazil	26.68	302.56	13.40	15.97	358.61
Venezuela	29.34	60.03	0	0	89.37
Other Countries	127.59	164.20	0	7.06	205.79
Central & South America	**230.18**	**560.29**	**20.43**	**24.10**	**835.00**
% distribution by type	27.6%	67.1%	2.4%	2.9%	100.0%
France	52.23	58.57	419.02	5.64	535.45
Germany	354.78	19.07	156.81	30.92	561.57
United Kingdom	278.21	3.20	84.25	7.61	373.26
Other Countries	1,097.77	427.25	296.92	69.34	1,891.27
Europe	**1,782.98**	**508.09**	**957.00**	**113.49**	**3,361.56**
% distribution by type	53.0%	15.1%	28.5%	3.4%	100.0%
Russia	569.72	156.14	141.17	2.04	869.07
Other Countries	249.29	66.62	93.23	0.10	409.24
Eurasia	**819.00**	**222.76**	**234.40**	**2.14**	**1,278.30**
% distribution by type	64.1%	17.4%	18.3%	0.2%	100.0%
Middle East	**511.27**	**15.09**	**0.00**	**0.01**	**526.37**
% distribution by type	97.1%	2.9%	0.0%	0.0%	100.0%
South Africa	202.24	0.78	12.66	0.25	215.93
Other Countries	179.74	81.88	0.00	1.28	175.81
Africa	**381.98**	**82.65**	**12.66**	**1.52**	**478.81**
% distribution by type	79.8%	17.3%	2.6%	0.3%	100.0%
China	1,484.23	278.52	41.66	2.35	1,806.76
India	502.60	74.59	16.37	5.19	598.75
Japan	640.17	93.66	228.01	20.92	982.76
Other Countries	1,095.28	163.88	162.37	31.50	1,453.02
Asia & Oceania	**3,630.61**	**601.65**	**448.41**	**53.99**	**4,734.65**
% distribution by type	76.7%	12.7%	9.5%	1.1%	100.0%
World Total	**10,438.90**	**2,620.20**	**2,517.76**	**306.66**	**15,883.52**
% distribution by type	65.7%	16.5%	15.9%	1.9%	100.0%

FIGURE 9


Energy Intensity
(Thousand BTU per 2,000 US$ of GDP)
Energy Intensity by Region
25
20
15
10
5
0
Decades 1980 to 2030
OECD
Non-OECD (Europe-Eurasia)
Non-OECD (Asia-Africa-Latin America)

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