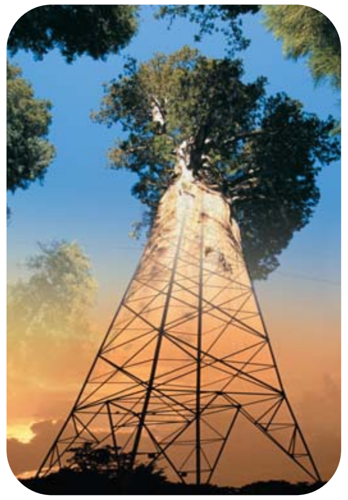

Energy and Sustainable Development

Energy plays a strong role in sustainable development. It contributes to economic activity and higher living standards, but is also costly and the source of considerable environmental degradation.

This series examines six facets – energy security; improving energy efficiency; renewable energy; making markets work; transportation; and environment, health and safety – of sustainable development in the energy sector. It envisages a sustainable energy system as providing ***universal access to adequate supplies (now and for future generations) of affordable, safe and reliable energy produced, distributed and used in a manner that is efficient and environmentally-friendly.***

All countries – developed and developing – will need to design their own policy mix. National circumstances will affect the scope for action and the appropriate policy choices in and between countries.

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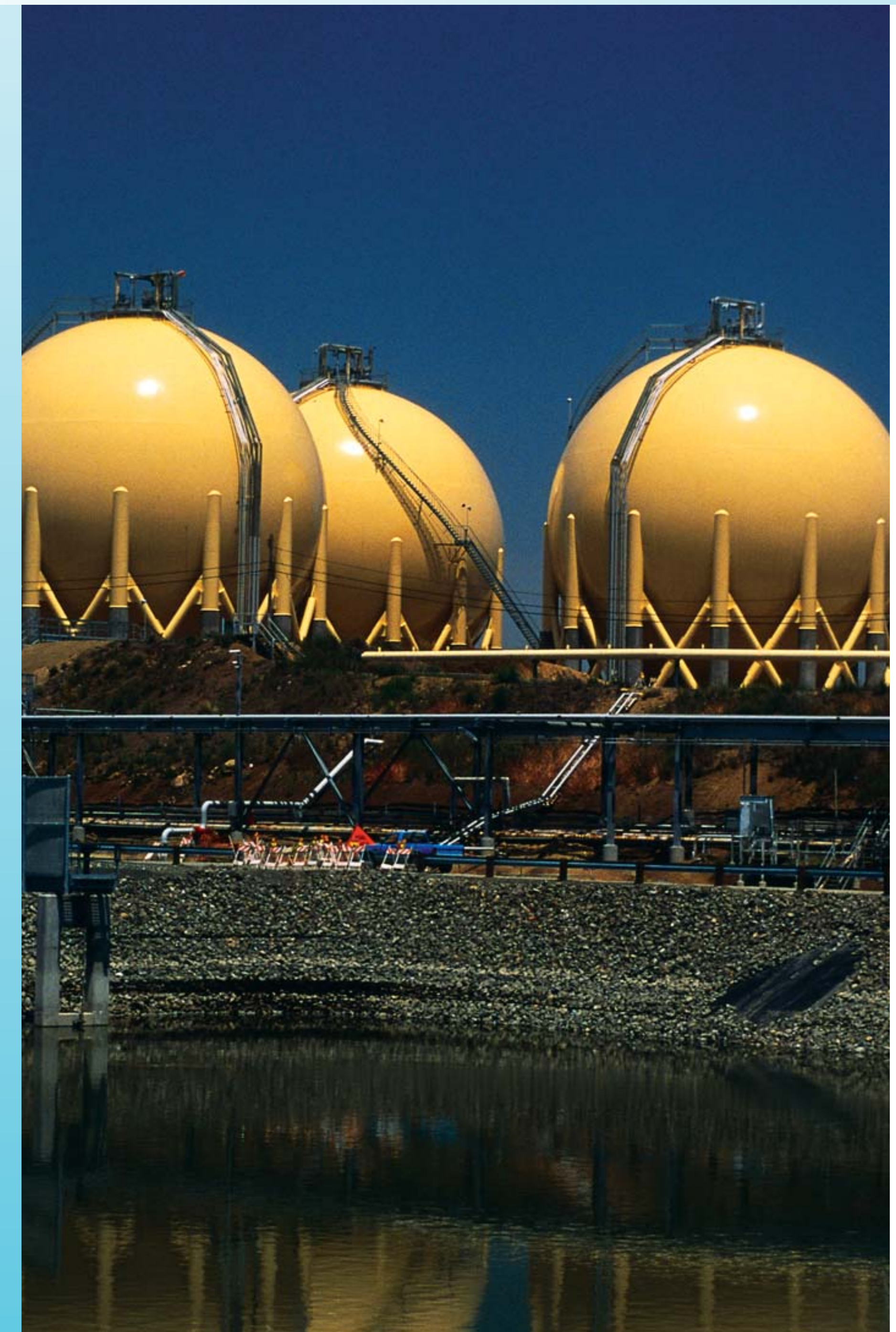
energy Security



JOHANNESBURG

August - September 2002

World Summit on Sustainable Development

Energy Security

ENERGY SECURITY

Energy is a fundamental ingredient of many services – comfortable indoor temperatures, food preservation and cooking, illumination, transportation, communication, and commercial and industrial processes – that improve quality of life and enable economic and social development. A secure – adequate, affordable and reliable – supply of energy is thus a necessary precondition for sustainable development. It underpins the development of rich and poor countries alike.

There are many causes for breakdowns in the delivery of energy services. Political intervention may create energy security issues, as was the case in 1973 and 1979. Sabotage, technical failures of components with highly bundled energy flows, systemic failures and under-investment are also real problems. Their impact on the energy system may be greater than in the past, as there is an increasing rigidity in energy supply and demand.

Energy security is a broad and evolving concept. In the 1970s and 1980s, the term meant reducing the level of oil imports and managing the risks associated with those imports still required. Today, the term includes other types of energy, and risks such as accidents, terrorism, under-investment in infrastructure and poorly designed markets, all of which might curtail adequate supplies of energy at affordable prices.

Energy security does not stop at national borders, but goes all the way to the final consumer. The external (geopolitical), internal (operations and investment) and temporal (short- and long-term) components of energy security call for a multidimensional policy approach to protect against energy system disruptions. In the short run, emergency measures, such as co-ordinated use of energy stocks, temporary blackouts and redirected supply flows can help to minimise economic disruptions by allocating scarce supplies where they are most needed. In the medium and long run, policies to increase energy efficiency, diversify fuels and sources, and ensure adequate reserve margins can limit general exposure to disruptions and enhance flexibility.

Looking to the future, what the various short-term price and supply disruptions of the last few years have done is to re-emphasise the need for robust, multifaceted energy security policies. Such policies must aim to protect against failures in the energy system that cannot be handled by market mechanisms. These failures could cause unacceptable damage to the respective country's economy, environment and social conditions.

GEOPOLITICAL DEPENDABILITY OF SUPPLY

The geopolitical dependability of energy supplies, particularly oil, has been central to the IEA's mission from its inception. The principal method for assuring dependable supplies is fostering adequate resource development by a diverse group of suppliers through the creation of efficient markets, undistorted pricing, secure frameworks for investment and transparent relations between consumers and suppliers. This is backed up by emergency response measures (see Box).

Beginning in 1972 and lasting through 1985, most IEA countries experienced dramatic improvements in reducing oil dependence, increasing diversification and improving energy intensity as a result of higher prices, strong government policies and technological progress. Since 1985, though we have been successful in averting oil supply crises, there have been no equivalent improvements in moderating oil dependency. Moreover, according to the IEA's World Energy Outlook (WEO), all the traditional energy security indicators are trending down in the longer term. Oil remains the dominant fuel in the primary energy mix with a share of around 40%, and there is an increasing dependence for oil supply on a decreasing number of sources. Oil markets in IEA countries are also becoming less flexible. There is less potential for further substitutions or switches from oil as demand is becoming increasingly concentrated in the transport sector, an area where growth and dependence on oil have proven difficult to curb. New technologies and other policy levers could alter this demand path (see background paper on Transportation).

IEA Emergency Response Mechanisms

The IEA's emergency response mechanisms were set up under the 1974 Agreement on an International Energy Program (IEP). The agreement includes the commitment of Member countries to hold oil stocks equivalent to 90 days of net imports in the previous year.

IEP measures apply only in disruptions exceeding 7% of IEA or individual country supplies. The IEA also has a complementary set of measures known as Co-ordinated Emergency Response Measures (CERM). These provide a rapid and flexible system of response to actual or imminent oil supply disruptions of any size. At the time of the Gulf Crisis, the IEA implemented a 2.5 million barrel a day contingency plan, most of which was stockdraw.

To ensure the potential of the IEA countries for rapid and effective response to oil emergencies in changing oil market conditions, the Standing Group on Emergency Questions (SEQ) conducts a regular cycle of Emergency Response Reviews of IEA Member countries.

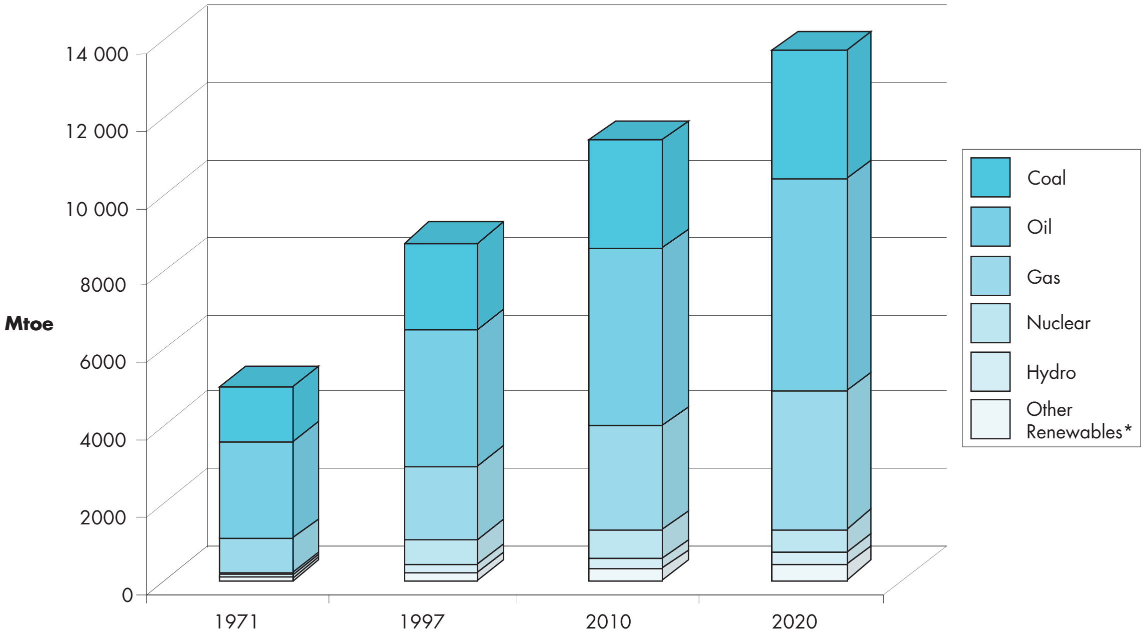
Energy Demand

The IEA projects that world commercial primary energy demand increases by 57% between 1997 and 2020, or at an average annual rate of 2% (Figure 1). This compares with an annual average growth rate of 2.2% from 1971 to 1997. Oil remains the dominant fuel in the primary energy mix, and the volume of world oil demand is projected at close to 115 million barrels per day in 2020, compared with 75 mb/d in 1997.

Natural gas is the second largest and fastest growing energy source after non-hydro renewables. Gas demand rises at 2.7% per annum over the projection period, and its share in world primary energy demand increases from 22% in 1997 to 26% in 2020. New power plants, using high-efficiency combined-cycle gas turbine (CCGT) technology, will provide the bulk of incremental gas demand.

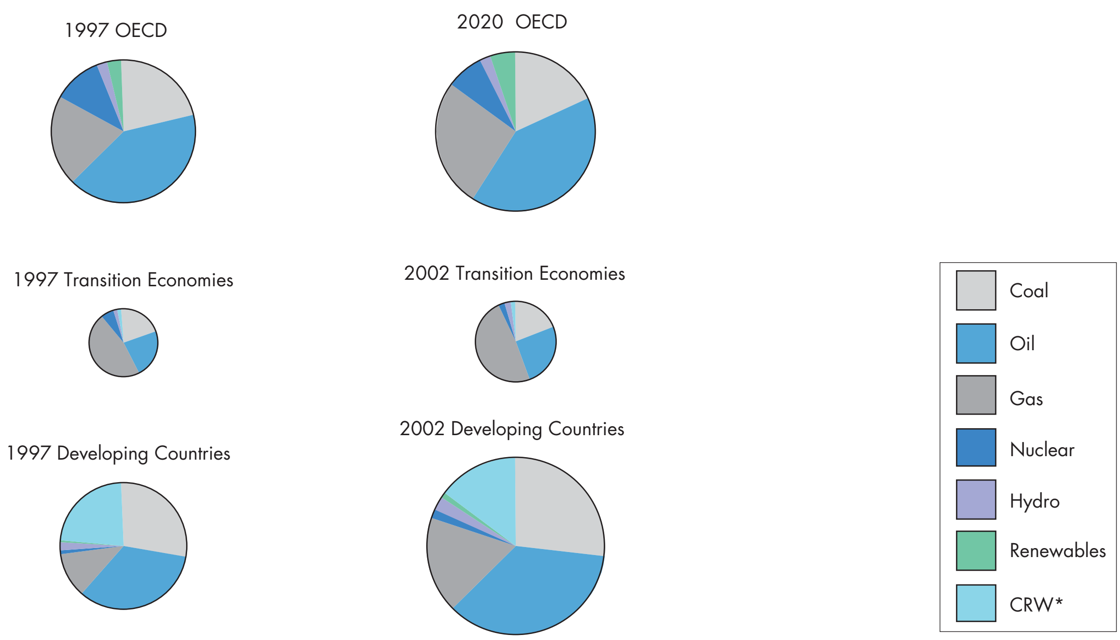
Projected world coal demand will advance by 1.7% a year, slower than total primary energy demand, so that its share declines slightly, from 26% in 1997 to 24% in 2020. In the OECD, virtually all the increase in demand for coal stems from power generation. China and India contribute more than two-thirds to the increase in world coal demand over the projection period.

Figure 1. World Commercial Primary Energy Demand by Fuel



Source: IEA (2000), *World Energy Outlook 2000*, historic data and reference case, OECD/IEA.
* Does not include combustible renewables and waste in transition economies and developing countries.

Figure 2. World Primary Energy Demand by Region and Fuel



* *Combustible Renewables and Waste in transition economies and developing countries.*

Source: IEA (2000), *World Energy Outlook 2000*, historic data and reference case, OECD/IEA.

Resource Base and Supply Diversity

The world has abundant reserves of energy, so exhaustion of resources is not likely to be a limiting factor through 2020 and well beyond. Oil will continue to be available throughout the early 21st century, although unconventional oil is likely to play a growing role. Proven reserves of natural gas, coal, and uranium are abundant. Renewable energy sources are plentiful, and in some cases, nearing cost competitiveness. Beyond 2020, new technologies such as hydrogen-based fuel cells, hold out the prospect of plentiful, clean energy supplies in a carbon-constrained world.

The principal uncertainty in the global energy supply outlook is cost. Advances in technology and productivity are driving production and transportation costs lower, but depletion of the cheapest reserves and the growing distances over which new supplies must be transported are, in many cases, pushing delivered energy costs up. The cost of supplying natural gas to the main markets is starting to rise with the depletion of near-to-market reserves and the growing need to ship supplies from further afield. On the other hand, renewable energy sources, which are usually exploited at a local or regional level, are generally becoming cheaper to produce. Moreover, there is the prospect that carbon dioxide (CO_2) values derived from climate change mitigation efforts will change the cost competitiveness of energy supplies.

Diversification provides one element of supply security. Fighting the temptation to « put all your eggs in one basket » – that is, to go all out for what appears to be the economic or political least-cost solution in the short run – is an essential part of risk minimisation. For the longer-term, energy diversity should be sought within and across sectors and the sources of the fuels used should be as diverse as practicable. Non-fossil energy services, particularly nuclear and hydroelectric power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

Oil

Proven oil reserves are sufficient to satisfy projected demand for at least the next two decades. To bring supplies to market will demand large and sustained capital investment, particularly in the Middle East OPEC countries. International trade is expected to double over the next twenty years due to the increasing concentration of production capacity in a small number of countries with large, low-cost reserves (Table 1). Unconventional oil will account for a much greater share of total oil resources and supply by 2020. Further reductions are expected in the cost of producing this oil, such as synthetic crude from oil sands and gas-to-liquids conversion. Enormous volumes lie in oil sands in Canada and in heavy and extra-heavy oil deposits in Venezuela. Global oil production need not peak in the next two decades if necessary investments are made.

Security issues related to oil have not dissipated, and may increase over the medium term. The oil market is not free. It is dominated on the supply side by a relatively small number of producers (and countries) that try to manipulate the crude flows according to a changing mix of political and commercial motives – and this trend is expected to continue. Middle East OPEC producers account for 26 per cent of world oil supply today: this share could grow to almost 50 per cent in 2020 as production in other areas peaks and begins to decline. The recent volatility of oil prices has again focused worldwide attention on the cartel power exercised over a large share of the world's production. Sharp increases in oil prices stemming from production restraints feed inflation and slow economic growth, particularly in developing countries. On the other hand, higher prices encourage broader deployment of more advanced technologies (e.g. more efficient or alternative-fuelled vehicles) and renewable energy, which could reduce overall fossil energy consumption and improve the environment.

Natural Gas

Proven gas reserves have doubled over the past twenty years, and represent 60 years of supply. There is an additional 110 to 140 years supply of less-economic resources, including undiscovered gas. Exploiting these sources of gas will require massive investment in production facilities and infrastructure to transport gas to market. The share of transportation in total supply costs will rise, as supply chains lengthen with the depletion of reserves located closest to markets. Pipelines will remain the principal means of transport for gas, but liquefied natural gas (LNG) is likely to play a growing role. LNG trade is set to expand dramatically in the Asia/Pacific and Atlantic Basin regions.

The situation in natural gas markets is structurally similar to the oil market, as gas markets in Europe and Asia rely on a small number of producing countries, some of which have experienced abrupt political change in the past. Two regions, the Former Soviet Union and the Middle East, account for 70 per cent of global reserves. Gas security is not an issue of absolute physical scarcity, but rather a question of regional distribution (e.g. Europe is expected to import 60 per cent of its gas demand by 2020) and the stability of supplier-customer relations.

Evidence suggests that increased efficiency gains and more market-driven investment decisions (in part through the structural reforms of the gas market) have contributed to a broader range of services and lower prices to most consumers. They have strengthened long-term security through increased development of transmission and storage facilities. However, there remains a role for government in enhancing both short and long-term security, for example in facilitating international trade and investment in pipeline interconnections, determining appropriate security levels for small consumers, and setting safety requirements.

Coal

World reserves of coal are enormous and well dispersed geographically compared with oil and natural gas. Economically recoverable proven coal reserves are close to one trillion tonnes, representing about 200 years of production at current rates. Almost half the world's reserves are located in OECD countries and many of the other supplier countries enjoy a certain degree of political stability. There is strong competition on price and quality. Because coal is relatively expensive to move and store, and because many countries have indigenous resources that meet part or all of their coal needs, only about 12% of world coal consumption is sold on the international market. The size and distribution of the reserves virtually obviates supply-security concerns about coal.

The two main factors affecting coal use in developed countries are its competitiveness against natural gas in power generation and environmental regulations. Efforts to reduce emissions of sulphur dioxide, particulates and nitrogen oxides are already having a significant effect on coal use and operating costs. The long-term future of coal will depend, among other things, on the market value set on carbon emissions (coal has the highest CO_2 emissions per unit of power generated) and on the development of cost-effective abatement technologies, e.g. for carbon sequestration. Reform of electricity markets and advances in combined cycle gas turbine technology have given gas an economic advantage over coal. This advantage could be eroded over the longer term by increases in natural gas prices. For some major developing countries with abundant indigenous coal resources (namely India and China), economic and security of supply concerns will result in continued growth in coal-generated electricity, and commensurate increases in CO_2 emissions unless more efficient technologies are used.

Table 1. Global Fossil Fuel Import Shares, 2000

1999	Oil		Natural Gas		Coal		Total	
	Net Imports (Exports) Mtoe	Import Share of Primary Energy Supply (%)	Net Imports (Exports) Mtoe	Import Share of Primary Energy Supply (%)	Net Imports (Exports) Mtoe	Import Share of Primary Energy Supply (%)	Net Imports (Exports) Mtoe	Import Share of Primary Energy Supply (%)
OECD Total	1 220	56%	227	20%	85	8%	1532	35%
North America	435	41%	3	0%	(33)		404	18%
Pacific	388	94%	71	66%	17	9%	476	68%
Europe	397	58%	154	39%	101	31%	652	47%
Non-OECD Total	(1 236)		(231)		(83)		(1 550)	
Africa	(270)		(63)		(42)		(376)	
Latin America	(140)		(2)		(14)		(156)	
Asia Excluding China	179	54%	(51)		16	6%	144	20%
China (Region)	94	40%	2	7%	(41)		56	6%
Former USSR	(212)		(108)		(15)		(335)	
Non-OECD Europe	22	73%	8	39%	5	19%	35	45%
Middle East	(908)		(17)		7	84%	(918)	

Source: IEA Statistics.

Renewable Energy

Renewable energy sources are plentiful and geographically dispersed, but at present, their exploitation in commercial markets is constrained by cost, and in some cases, intermittency. Their reliability in comparison with other fuels varies. In the case of wind power, for example, back-up generation is required. Production of primary energy from commercial renewable sources is expected to grow rapidly over the next two decades. Nonetheless, their share in the global energy mix will probably remain small in the absence of determined government intervention to reduce costs further. In the OECD, most of the growth is expected to come from wind and bioenergy. Hydropower is expected to be the fastest-growing renewable energy supply source in developing countries. Renewable energy sources are likely to benefit from governments' strategies to curb CO_2 emissions and increase diversity in the energy mix. Because they are indigenous, most renewable energy sources improve the security of supply.

Uranium and Nuclear Energy

The fuel needs of nuclear-power generation are currently met by primary production of uranium and by stockpiles and inventories. While supply from stockpiles has increased, uranium production has declined over the past few years. Known reserves and uranium from secondary sources guarantee a secure supply for at least the next twenty years.

Nuclear power gives rise to no major resource depletion issues, produces only negligible amounts of greenhouse gas emissions, and has significantly contributed to past reduction of CO_2 emissions in some OECD countries. In virtually all electricity markets, existing nuclear power plants are commercially viable, but new investment is more difficult to justify.

Most of today's nuclear plants will reach the end of their life some time beyond 2020. Decisions about their replacement will need to be taken well in advance.

Nuclear energy is often also socially contested due to perceived long-term risks stemming from radioactive waste management and disposal, and potential accidents at operating plants or during the transport of radioactive wastes. Some governments may seek to expand or introduce its use as a way of reducing CO_2 emissions or enhancing fuel diversification, but there will be countervailing environmental and safety pressures.

Zero Emissions Technologies for Fossil Fuels

There is a need to develop and deploy energy technologies that would not involve any significant emissions, including CO_2. Existing "clean fossil fuel systems" have significantly reduced pollution. However, while improving energy efficiency, they have not addressed the problem of CO_2 emissions. To address this problem, a number of promising "zero emissions technologies" are being developed. With these technologies, which are currently very expensive, fossil fuel plants can achieve near zero emissions of regulated pollutants and CO_2.

Zero emissions technologies are all based on the strategy of capture, transport, use and/or storage of CO_2. Capture would be achieved through flue gas, oxygen combustion or hydrogen/syngas techniques. Transport would be via a high-pressure pipeline or by tanker. Storage options include: storage in depleted oil and gas reservoirs, storage in deep saline aquifers, storage in unminable coal beds, mineralisation, and direct deep injection into the ocean.

Zero emissions technologies are expected to become feasible and available after intensive effort and significant progress in research, technological development and deployment in the areas of CO_2 capture and storage, including production and utilization of de-carbonised fossil fuels. Enormous resources will be necessary to achieve commercialisation of such technologies. These resources will be provided mainly by research programmes, funded by governments and industries, the scale of which could be reduced by international collaboration.

New Technologies

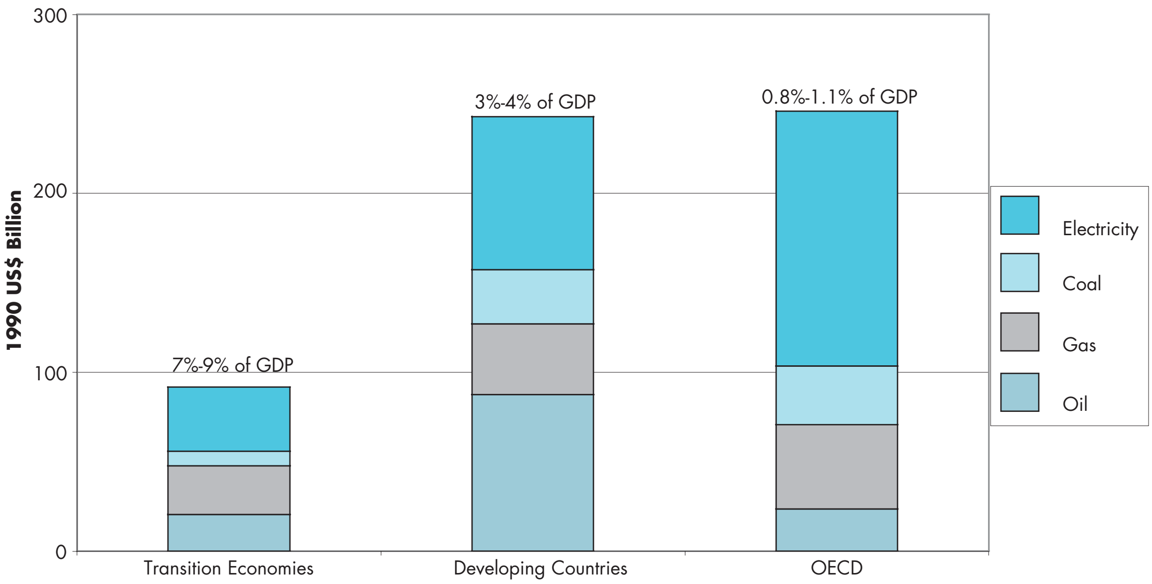
A number of technologies under consideration or active development could radically alter the long-term supply picture. Current research focuses not only on making the use of existing energy sources less environmentally damaging (e.g., clean fossil fuel technologies) and more cost effective (e.g., renewable energy technologies), but also on entirely new energy carriers (e.g., hydrogen). Hydrogen technology holds out the long-term prospect of large-scale energy supply with a substantially reduced environmental impact. Carbon sequestration – the separation of CO_2 from fuels and its storage in oceans or geological formations – could also have a profound impact on the long-term prospects for energy supply, if cost-effective solutions can be found.

Investment Needs

The adequacy of future energy supplies will depend on massive investments to bring new production capacity onstream and, particularly for natural gas, to build new infrastructure to transport supplies to market. The bulk of this investment is needed in developing countries, but the scale of investment will require major capital inflows from industrialised countries.

The World Energy Council (WEC) has concluded that annual investment requirements to 2020 will remain basically unchanged at about 3% to 4% of world GDP (Figure 3) [1]. Financing requirements vary by region depending on the level of economic development,

Figure 3. Average Annual Investment Requirements by Fuel and Region: 1990-2020



Note: Based on World Energy Council (WEC), Case B "Middle Course".

Source: IEA (1999), *Electricity Reform, Power Generation Costs and Investment*, OECD/IEA.

[1] World Energy Council (1998), *Energy for Tomorrow's World – Acting Now!*.

industrialisation, motorisation, etc. In terms of share of GDP, investment needs in transition economies are almost 10 times those of OECD countries. This is a function of their current low GDP levels combined with the need to invest in upgrading and renewing old, badly maintained and inefficient infrastructure and technology.

Market Transparency

In a globalised economy, producers and consumers have come to understand that they share a common interest in smoothly functioning international energy markets. This is particularly relevant in the oil market. Over the past ten years the producer-consumer dialogue has become increasingly productive as it has sought to balance the interests of both groups and allow for a better exchange of views on energy-related issues. While the framework for energy markets will be shaped by government policies, under normal circumstances markets work best and are more stable when allowed to operate freely. Energy producers and consumers agree that the functioning of the market could be improved in many areas. Access to better data is a common objective which is being constructively tackled on a co-operative basis. Producer-consumer dialogue can contribute to greater understanding between energy market players, improve market transparency and lead to a gradual improvement in market operations.

The California Electricity Crisis

The 2000 power crisis in California did not demonstrate the failure of the liberalised market. Rather, it confirmed that good market design is essential to market reform.

Several issues and market participants were responsible for creating the problem in California. The state's market fundamentals before reform – tight supply, rapidly rising demand and limited transmission capacity – required that particular care be exercised in the design of the new system. The reform plan was ambitious but flawed. California went for full market opening, but maintained retail price controls that muffled market signals. Lengthy licensing procedures and a sharp, unexpected growth in demand resulted in inadequate investment. When wholesale prices soared, some utilities found themselves in an unsustainable position. While key market participants faced a financial crisis, customers lost supply in a series of rolling blackouts.

Improvements have already been made. New capacity is now being built and restrictions on long-term contracts have been lifted.

The California crisis stemmed from a combination of issues unlikely to recur elsewhere. But it has highlighted some crucial lessons for reformers. It has demonstrated that reform is not just about competition but also about reliable supply and adequate investment in generation and transmission. Reformers must design systems that further all these aims. Most important, reformed systems must provide clear price signals which enable market players to respond quickly and effectively to changing supply and demand.

ELECTRICITY SYSTEM ADEQUACY AND RELIABILITY

Ensuring a secure power supply is an important objective in all modern economies, since there are limited possibilities for replacing electricity by other forms of energy. In the short-term, electricity security refers to system reliability – the ability of the power industry to cover demand at all times. The California electricity crisis, the terrorist attacks of 11 September 2001, and the blackouts in India and Brazil, have all heightened political concern about short-term electricity system reliability.

In the long-term, it concerns the adequacy of the power sector's capacity for generating and transmitting electricity, and fuel diversification. In developed countries, the concern for the long-term is that investment in generating capacity might not be sufficient to "keep the lights on", particularly to cover peak demand. In developing countries, the concern can be more fundamental – getting investment to bring electricity to those with no previous access.

Governments have for a long time accepted a responsibility to ensure that there is security of electricity supply – both in the short and the long term. In fact, the broad ranging electricity market reforms of recent years have sparked questions about whether the market can adequately provide incentives for the provision of generating capacity or whether there is a need for government intervention.

Market mechanisms in principle allow participants to price – and value – secure energy supplies. Similarly price signals should in principle function to trigger "adequate" investment. But liberalised markets are, as yet, too new to provide convincing empirical evidence.

Adequate, timely and appropriate investment is essential to ensure security of electricity supply. Electricity is the fastest growing energy sector and the biggest challenge for financing in the future. The IEA projects global requirements for new power capacity over the

Table 2. Capital Expenditures on New Generating Plants (billion $US, 1990 values)

				Investment Needs	% of GDP
	1995-2000	2000-10	2010-20	1995-2020	1995-2020
OECD Europe	76	117	174	367	0.16%
OECD North America	54	99	155	308	0.14%
OECD Pacific	45	149	180	375	0.41%
FSU/ECE	25	153	210	388	0.75%
China	97	253	385	735	0.37%
Rest of the World	167	409	509	1 085	0.31%
World	463	1 181	1 613	3 257	
% of GDP	0.28%	0.28%	0.29%	0.28%	

Source: IEA (1999), *Electricity Reform: Power Generation Costs and Investment*, OECD/IEA.

period 1995-2020 at some 3,475 GW, about half of which is projected for China and the other developing countries and a third is required in OECD countries. Total investment needs are estimated at $3.3 trillion (1990 dollars). As a percentage of GDP, requirements are highest in the transition economies.

Due to the structure of the electric power industry and to government tariff policies, power generation projects in many countries have relatively low rates of return. Under these conditions, private investors have been reluctant to enter these countries, and most investment has been financed by governments. The situation cannot continue indefinitely. Already strained public resources cannot cope with the looming electricity capacity needs, especially in developing countries. The need for power sector financing, along with a desire to increase economic efficiency, has led many countries to seek private sector involvement in electricity supply systems. This corresponds with a world-wide trend in the electricity sector toward privatisation, deregulation, and commoditisation, and an increased focus on private sector financing. Private sector involvement also brings market-oriented management skills, access to the latest technology, and usually quicker implementation than would be the case under public sector management.

Governments are turning increasingly to private sources of investment through Independent Power Producers (IPPs) or the introduction of competitive generation markets. In the case of IPPs, power purchase agreements effectively commit distributors to purchase electricity at cost-based prices over a long-term period. Power purchase agreements are a basis through which IPPs can obtain financing.

The Costs of Unreliable Electricity

The reliability and quality of electricity supplies is becoming increasingly vital as society becomes more and more dependent on sophisticated electrical devices such as computers and telecommunications equipment. Power outages and frequency and voltage fluctuations due to system inadequacy and breakdowns, are more than mere inconveniences. They cause equipment failures, which in many cases are very costly. For example:

- interrupted, expensive-to-recover, data streams in financial services operations;
- loss of critical health services in medical facilities;
- long re-startup procedures and lost production in manufacturing plants; and
- product spoilage in food industries.

The costs also ripple downstream, as disruptions in one firms' operations cause problems for all its customers, its customers' clients, and so on.

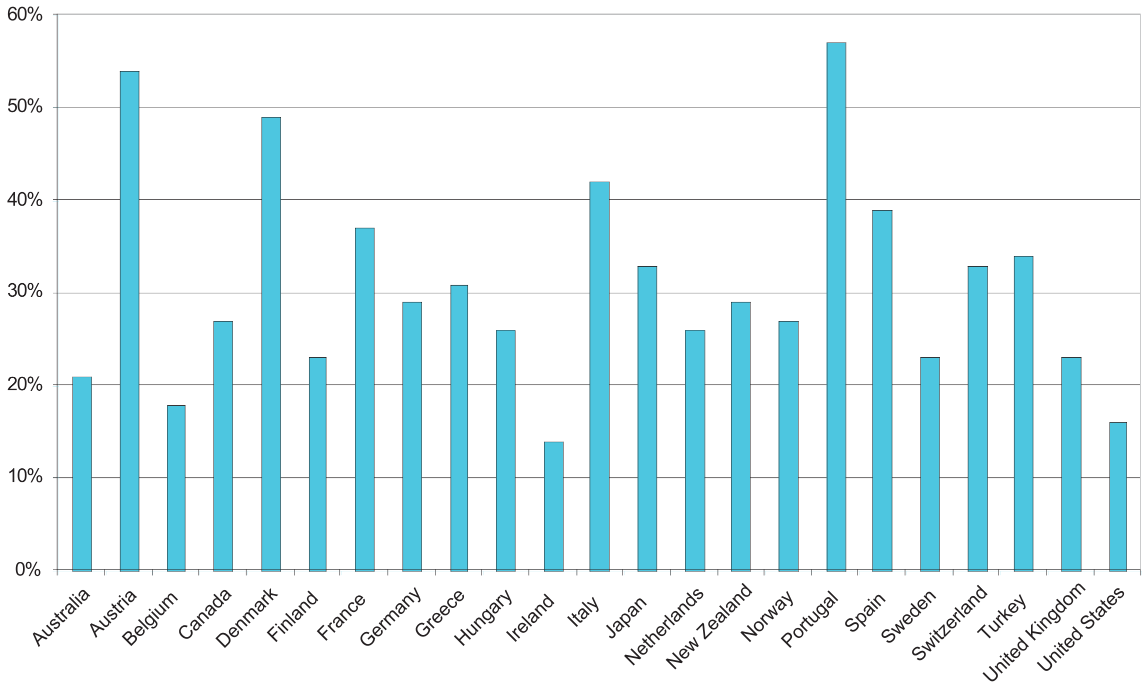
The systems aspect of power supply means that system inadequacy can result from any of a variety of weak links. There may be shortages of primary energy to fuel generating facilities, too little generating capacity to meet peak loads, or poor maintenance practices leading to reduced generating or grid capacity. As a result of problems such as these, half the public electricity supplies of some developing countries are inoperable at any given time [2]. Poor operation and maintenance of grids can also waste resources, in the form of

[2] United Nations Development Programme, *World Energy Assessment*, 2000.

generated, yet undelivered electricity and under-utilised generation capacity. Technical and non-technical power system losses exceed a quarter of generation in some developing countries and as much as half in a few [3].

Minimizing the risks of power outages and quality problems is itself costly. It can involve installing extra reserve generating capacity on the supply side, and standby power sources, backup generators and equipment/data redundancies on the end-use side [4]. It can also encompass systems for advance notification of outages. These are issues in developed and developing countries alike. Typically, at least a third of electricity supply industry investments go toward reserve generating capacity and redundant network facilities[5]. Reserve margins are generally high in IEA countries and have remained strong over the last 15 years, but there are significant differences among countries[6] (see Figure 4). As of 1999, Japan and a number of European countries showed reserve levels in the range of 30% to 50%, well in excess of typical engineering targets for reserves (in the order of 18 to 25%). In the US reserve margins have been receding since the mid-1980's and were rather low (below 20%) as of 1999.

Figure 4. Reserve Margins in IEA Countries 1999 (%)



Source: IEA (2002), *Security of Supply in Electricity Markets: Evidence and Policy Issues*, OECD/IEA.

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3 *World Energy Assessment*, 2000.

4 Backup generators are frequently based on diesel technologies, but can be based on a variety of "distributed generation" technologies.

5 *World Energy Assessment*, 2000.

6 Reserve margins are the share of installed capacity that is not used during a given period. It is defined as Installed Capacity-Peak Demand/Installed Capacity.

To a great extent, the costs of electricity insecurity are borne by industrial and commercial end-users (see Table 3). As most outages are caused by distribution systems, on-site protection is the only feasible solution. It has been estimated that in many developing countries, end-user standby generators account for 20 percent or more of total generating capacity. In Nigeria, for example, some 92% of firms had their own generators in the mid-1990s. The costs of installing these generators were about a quarter of total investment costs for small firms, and a tenth for large firms. In the United States, it is estimated that the costs might exceed $5 billion a year [7].

Table 3. Economic cost of electricity supply interruptions for non-deferrable economic activities in United States, 1997

Consumer class and average duration of interruption	Cost to consumer per outage (U.S. dollars)	Cost to consumer per lengthy outage (U.S. dollars)	Estimated total annual losses (billions of U.S. dollars)
Residential (20 minutes)	0-20	50-250	0.9-2.7
Commercial (10 minutes)	25-500	5-20 (per minute)	2.9-11.7
Industrial (less than 30 seconds)	200-500 (small plant) 1 000-10 000 (large plant)	5 000-50 000 (per 8-hour day)	1.1-13.5

Note: Assumes nine outages a year for each class of consumer.

Source: Newton-Evans Research Company (Summer 1998), "*Market Trend Digest*" .

[7] *World Energy Assessment*, 2000.

MEMBER GOVERNMENTS OF THE IEA AFFIRM

In light of these considerations, Member governments of the IEA affirm:

- **that there can be no sustainable development without a secure energy supply to underpin essential economic activity and provide services to society;**
- **that diversification of energy supplies and distribution – both by energy type and by source – is an important measure to help improve energy security; utilising renewable energy sources reduces the need for imports of fuels and provides energy security benefits;**
- **that countries should work toward greater transparency in world energy markets and develop mechanisms for effective responses to supply disruptions;**
- **the need to continue to foster dialogue and improve data co-operation between energy producers and consumers.**