

The global energy scenario

According to conventional wisdom, the world is unlikely to run out of energy in the near future. However, current patterns of energy production and use have destructive impacts on the environment and, in recent years, environmental issues such as possible climate change resulting from greenhouse gas emissions have thrown the spotlight onto the links between energy and the global environment.

At the same time, there is a need, especially in developing countries, for higher levels of energy supply and use to fuel economic development – at present, 'energy poverty' hinders the economic and social development of very large numbers of people.

This chapter presents and examines current patterns of energy supply and demand and introduces some of the advantages of energy efficiency in the light of the energy and development scenarios presented. The information presented forms the background to the practical energy-efficiency guidelines in subsequent chapters.

CHAPTER 1 – THE GLOBAL ENERGY SCENARIO

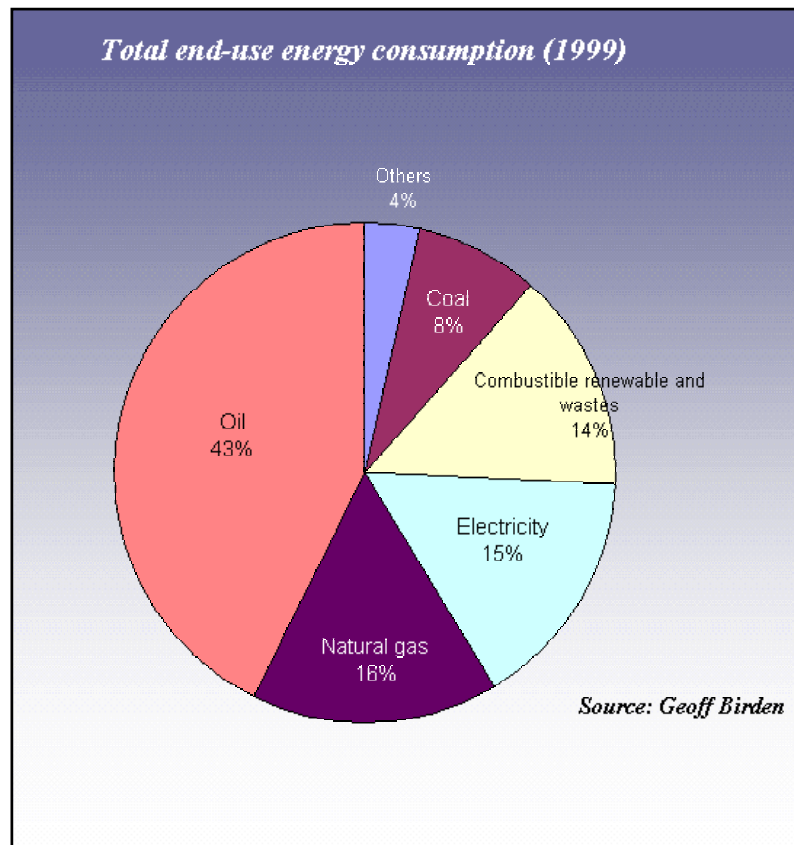
Primary energy supply

Coal, oil, gas and nuclear energy are the major sources of primary energy, followed by renewable combustible wastes (biomass, animal products, municipal wastes, industrial wastes), hydro, and other sources.

In 1999, the global supply of primary energy was equivalent to 9,744.48 million tonnes of oil (Mtoe). Table 1.1 shows in what proportions the sources mentioned above contributed to this global figure. Exploration for new energy sources and resources is on-going and will continue in the future. The projected total energy supply for the year 2010 is 11,500 Mtoe. It is expected to reach 13,700 Mtoe by 2020.

Source	Contribution to total energy supply (%)
Oil	35.1
Coal	23.5
Natural gas	20.7
Renewable combustible wastes	11.1
Nuclear	6.8
Hydro	2.3
Others	0.5

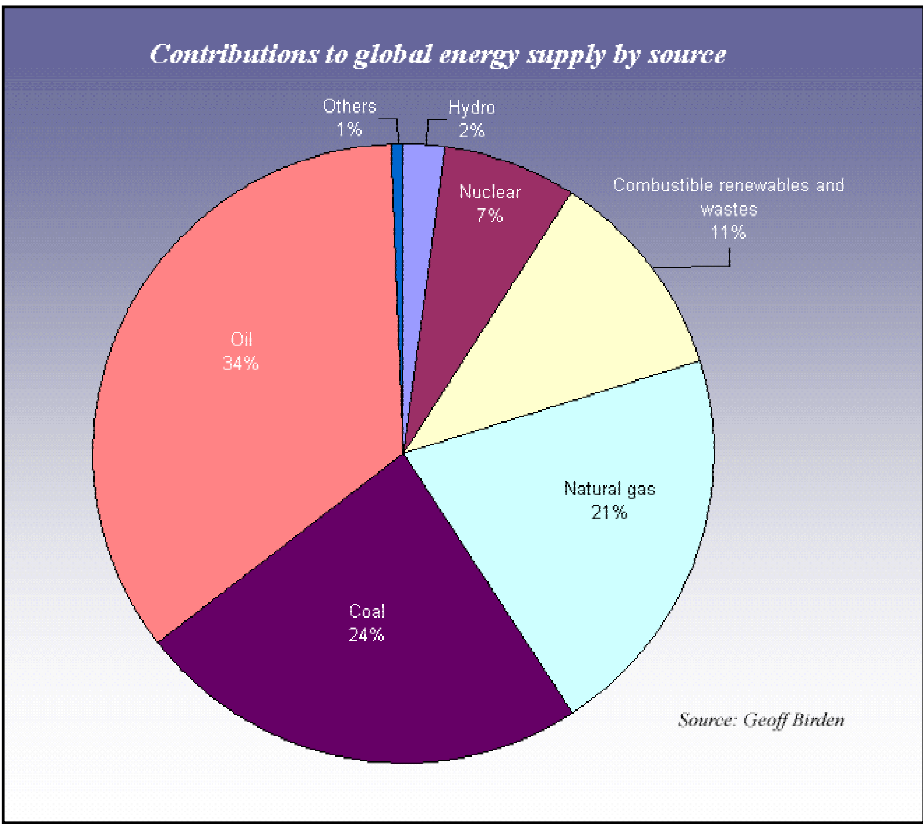
Table 1.1: contributions to global energy supply by source (1999)



Total energy consumed by end users in 1999 amounted to 6,753 Mtoe, with the proportions per source as shown in Table 1.2.

Energy	Contribution to total energy consumption (%)
Oil	42.7
Natural gas	16.0
Electricity	15.4
Renewable combustible wastes	14.2
Coal	8.2
Others	3.5

Table 1.2: Total end-use energy consumption (1999)



The global context

Some global parameters that allow further analysis of the global energy scenario are given in Table 1.3. All figures are for 1999:

World population	5,921.39 million
GDP	US\$32,445.29 billion (1990 dollar)
Total primary energy supplied	9,774.48 Mtoe
Electricity consumed	13,502.41 TWh
CO ₂ emissions	22,955.80 million tonnes

Table 1.3: some global parameters

Such data can be used to develop energy indicators. Selected examples are given in Table 1.4. All figures are for the year 1999 and financial quantities are based on the 1995 US dollar.

Indicator	Units	1999 figure
Total primary energy supplied	toe/capita	1.65
Total primary energy supplied	toe/US\$1000 GDP	0.50
Total primary energy consumed per capita	kWh/capita	2229.6
CO ₂ emissions per toe of primary energy supplied	tonnes CO ₂ /toe	2.63
CO ₂ emissions per capita	tonnes CO ₂ /capita	3.88
CO ₂ emissions per US\$ of GDP	kgs CO ₂ /US\$	0.708

(Source: IEA Statistics)

Table 1.4: selected energy indicators for global energy scenario

Points to ponder

Some important points readers might like to bear in mind

Oil

- *Crude oil prices are highly volatile. Supply is price driven and there is still untapped potential worldwide.*
- *World oil consumption by developing countries is around 22 million barrels per day. Industrialised countries consume about 43 million barrels a day.*
- *The global oil-price shocks of 1973–74 and 1979–80 spurred energy-efficiency initiatives in a number of countries. Initiatives include:*
 - * *structural adjustments;*
 - * *technical innovation;*
 - * *economic incentives;*
 - * *financial support; and*
 - * *appropriate legislation.*

Coal

- *World coal consumption has increased, though the trend varies from region to region.*
- *Coal consumption is increasing in USA, Japan, and the developing Asian countries. Consumption has declined in western and eastern Europe and former Soviet Union countries.*
- *Coal continues to be a key source of energy, especially for power generation.*
- *Poor coal quality is an emerging area of concern in many developing countries.*

Natural gas

- *Natural gas is the fastest growing source in world energy consumption.*
- *Natural gas is preferred for new power generation projects because it is a cleaner fuel, and because of high end-use efficiency.*

Hydro and renewable sources

- *The amount of electricity generated from conventional fossil fuels in the world has risen by a factor of 1.54 in the last two decades. It reached 8,800 billion kWh in 1999. In the same period, the electricity generated throughout the world from nuclear, hydro and renewable sources rose by a factor of 2.08. It reached 5,200 billion kWh in 1999.*
- *Development of renewables is largely dependent on fuel prices, tariffs and policy.*
- *It is predicted that the share of renewable energy sources will remain at around 8 per cent of the world's total energy consumption.*
- *Many hydro-electric power projects are being pursued in Asia where 3.7 per cent annual growth in renewable energy sources is envisaged over the next decade. With increasing capacity and development efforts, the capital costs of renewable technologies are falling.*

Energy in developed and developing countries

- *It is estimated that per capita energy consumption in developing countries is about one tenth of that in the industrialised world.*
- *Future growth in demand in developing countries may arise from an increased share of consumption attributable to domestic and commercial energy use.*

ENERGY AND DEVELOPMENT – GROWTH RELATED ISSUES

Economic growth is desirable for developing countries, and energy is essential for economic growth. However, the relationship between economic growth and increased energy demand is not always a straightforward linear one. For example, under present conditions, a 6 per cent increase in India's GDP would impose an increased demand of 9 per cent on its energy sector.

In this context, the ratio of energy demand to GDP is a useful indicator. A high ratio reflects energy dependence and a strong influence of energy on GDP growth. It is worthy of note that developed countries – by focusing on energy efficiency and lower energy-intensive routes – maintain their energy to GDP ratios at values of less than 1. The ratios for developing countries tend to be much higher.

In spite of their best efforts to keep pace with growing demand – often by developing additional capacity – many developing countries are currently unable to meet their growing energy requirements. This is resulting in a widening gap between energy demand and supply – a situation which now characterises developing countries in Asia and the Pacific region and elsewhere.

Several causes of high energy intensity and high demand in developing countries have been identified, they include:

- Technological causes
Inferior technology and poor efficiency because of low quality of energy supply and absence of energy efficient technologies, etc.
- Managerial causes
Inadequate systems and procedures for energy efficiency and energy management, at both corporate and government policy levels.
- Economic causes
Inadequate funds and economic incentives.
- Structural causes
A legacy of heavy industry with inherent high energy intensity

The nature of a country's industry can also influence energy demand. In India, for example, the proliferation of clusters of small and medium-sized enterprises (SMEs) is recognised as a welcome prospect for growth. However, the prevalence of older inefficient technologies in such enterprises leads to consumption of large amounts of energy and materials, resulting in higher waste streams and pollution levels.

Other areas of concern that reinforce the unsatisfactory relationship between development and energy demand are:

- A lack of resources for investment in rehabilitation of existing plants or in green-field technologies, or for resource conservation and pollution abatement (lack of capital is an acknowledged major barrier to bridging the energy demand/ supply gap in many developing countries).
- Lack of awareness of appropriate technologies, quality control, and best practices in both operation and maintenance.
- Lack of awareness of waste minimisation strategies and potential applications.

The volatility of international energy prices also influences economies. The impact is very significant for some developing countries that import oil:

- It is not uncommon to find as much as 20–30 per cent of the national budgets of developing countries being allocated to the energy sector and to energy imports. There is concern that the increasing demand made on national budgets by energy related spending will affect growth in other sectors of need such as health, education, etc.

ENERGY AND DEVELOPMENT – 'MACRO' ASPECTS

Environmental issues

Globally, the production and use of energy accounts for 50–60 per cent of emissions of greenhouse gases (GHG) to the atmosphere. Energy and environment are closely inter-related and there have been many calls for better integration of issues arising from energy production, supply and demand with environmental and quality of life issues. Box 1.1 outlines some important initiatives.

Integrated policy planning is called for at both corporate and government policy levels to catalyse a holistic approach to resource productivity and energy efficiency.

Economic aspects

For any nation, the burden of inefficient energy production, distribution and use may not be immediately perceptible at the micro level, because the cost of inefficiency is often passed from one segment of society to another (e.g. producer to consumer). However, an accumulation of micro-level losses will inevitably become manifest as an overall economic loss, resulting in much higher energy demand, elevated generating costs and increased infrastructure requirements. For example, a proliferation of inefficient but inexpensive domestic appliances in a growing market, as is the case in many developing countries, will lead to higher energy demand. Losses are also encountered in developing economies when increased consumer demand, both domestic and commercial, leads to unplanned, *ad hoc* growth of LT networks for electricity distribution, greatly increasing losses.

Shortfalls in utility generating capacity and quality of supply necessitate large-scale recourse to captive power generation, reflected in a greater dependence on costly oil resources that are often imported. Given that generating utility power using coal or gas is often more efficient and economic, use of diesel generator (DG) sets will result in an economic burden at the macro level.

Administered and protective energy pricing and subsidies distort energy markets and thus create difficulties in promotion of end-use efficiency.

Box 1.1 – Some global environmental initiatives

Eco-efficiency

Eco-efficiency (as propounded by the World Business Council for Sustainable Development (WBCSD) in 1992) emphasises the importance of economics in addition to environmental improvement. The concept goes beyond the focus on reduced material use and waste production to address resource productivity, i.e. maximising the value added per unit of resource input. The ultimate aim of eco-efficiency is increased value to the consumer by sustainable use of resources.

Factor 4

Efficiency and resource productivity are also at the basis of the 'Factor 4' concept developed by the Wuppertal Institute for Climate, Environment and Energy. The idea is that consumption of energy and resources must be improved by a factor of four if sustainable development is to be achieved.

More than 50 practical examples have been developed in diverse areas including: energy-efficient homes and office buildings; energy efficient kitchen appliances and lighting; farming systems; and motors.

Factor 10

The 'Factor 10 Club' is an international body of senior people from government, industry and academic institutions – also working out of the Wuppertal Institute – who believe that nations could achieve a ten-fold increase in the efficiency with which they use energy, natural resources and other materials

ENERGY AND DEVELOPMENT – 'MICRO' ASPECTS

In the global scenario, the major focal issues for SMEs include:

- competitiveness;
- regulations;
- assessment of impact of fluctuations in energy prices and availability;
- supply chain needs;
- global market needs;
- trade related voluntary agreements, e.g. ISO 14001;
- technology needs.

Where energy in developing countries is concerned, various studies have indicated that efficiency in energy supply and end-use in the industrial sector is still only at one-half to two-thirds of that achieved with the benchmark best-practices applied in the industrialised nations. There are a number of clearly identified barriers to improving energy efficiency at the micro level. The major ones are given below:

- Non-viable energy tariffs. For example, the subsidised agricultural energy tariff for irrigation pumpsets in India is an important contributor to the appallingly low levels of efficiency that prevail.
- High preference for channelling investment towards production related equipment and infrastructure. The cost of implementing energy efficiency is often perceived as daunting and difficult to justify in terms of return on investment, especially when energy tariffs are not conducive.
- Selection of oversized equipment to meet "worst-case" requirements, leading to inefficient part-loading.
- Preference for low-initial-cost options as against life-cycle costing for energy consuming equipment, often sacrificing energy efficiency. Low initial cost considerations also favour a proliferation of lower-efficiency, second-hand equipment, especially in SMEs.
- Aversion to risk of new technologies.
- Lack of technical knowledge amongst energy equipment buyers.
- Vendor sales pressure.
- Inadequate skills in operation and maintenance.
- Apprehension about energy supply and quality, especially in remote areas.
- Tendency to extend equipment service life by recycling or repair. This may save initial costs but leads to low energy efficiency when the quality of repair or recycling work is lower than that of original manufacture. Examples of areas where inefficiency can 'creep in' in this way are:
 - inefficiently rewound motors;
 - use of recycled lubricants and transformer oils;
 - use of reconditioned bearings;
 - impeller trimming carried out locally.

ENERGY EFFICIENCY

From the analysis so far it is clear that developing countries face a contradictory situation. On the one hand, they have a need for greater quantities of useful energy (i.e. energy available at the point of use) if they are to develop economically, on the other hand they are faced with possibly disproportionate increases in energy demand in relation to economic benefit and global energy-related environmental issues, in particular resource conservation and the need to reduce greenhouse gas emissions arising from energy production.

In this context, energy efficiency can be a powerful tool for tackling both the macro and micro problems outlined. Increasing energy efficiency means moving towards optimum energy supply at minimum cost. In real terms – for developing countries in particular – energy efficiency provides solutions whereby it is cheaper to avoid the use of a kWh of energy than to build new plants or reinforce infrastructure to provide that kWh. Energy efficiency means more useful kWh and less necessity for increased generating capacity.

The logical result is that a kWh of energy saved through improved energy efficiency will – especially in the longer term – be cheaper at the micro-level, i.e. to the entrepreneur.

ENERGY EFFICIENCY – MACRO PERSPECTIVES

The paragraphs below provide some illustrations of important 'macro' aspects of energy efficiency, mostly in the form of existing initiatives and actions:

- Energy efficiency legislation, regulations and economic incentives, setting of minimum efficiency standards and energy labelling are examples of successful 'macro-level' initiatives taken by various countries and which may be worth emulating. Examples are given in Table 1.5.
- In developing countries in Asia, and in particular for Asian economies in transition, external sponsors have played an important role in promoting energy efficiency. Examples are given in Box 1.2.
- Many countries have included energy efficiency into their regulatory framework to achieve resource conservation and promote rational use of energy.
- Internationally accepted Environmental Management Systems (EMS) such as ISO 14001 include resource conservation requirements and targets. Energy efficiency has often proved to be an excellent avenue for resource conservation.
- Energy efficiency markets are maturing very fast given the immense business potential and economic efficiency in many countries. Equipment leasing, performance contracting, and energy service companies are some popular current business models that are helping to minimise reluctance on the part of end-users to implement energy efficiency.
- The service sector – providing expertise in the areas of energy efficiency, be it in consulting, financing or providing allied services – has immense potential for growth.
- Institutions working on similar lines to NCPCs can add to their repertoire of services through value addition.

Box 1.2 – Examples of sponsorship of energy efficiency initiatives

A number of European Commission Energy Centres have been established since 1993 under the Technical Assistance to Countries of the Commonwealth of Independent States (TACIS) programme. Beneficiaries of the advisory services and technical assistance include countries of the former Soviet Union and China.

US agencies have also sponsored technical assistance programmes. Beneficiaries include, organisations such as the Beijing Energy Efficiency Centre, China; the Centre for Energy Efficiency, Moscow; the National Energy Conservation Programme, Pakistan; and the ECO Program, India; etc.

Bilateral technical assistance agencies such as Japan's International Cooperation Agency (JICA), the German Technical cooperation Agency (GTZ-GmbH), the French Environment and Management Agency (ADEME), and the Danish International Development Agency (DANIDA) have also supported projects aimed at promoting energy efficiency and capacity building.

In addition to their regular loan and financing programmes for industry and energy, multilateral organisations such as the World Bank, the Asian Development Bank and the International Bank for Reconstruction and Development have also supported energy efficiency initiatives in various countries

Demand Side Management (DSM) has emerged as a successful approach for macro-level energy efficiency programmes. While addressing end-use efficiency, DSM also applies to utility concerns such as capacity and energy shortfalls, transmission and distribution losses, interest rates, inflationary trends, costs of saved capacity, and saved energy at the macro-level

DSM is a popular initiative adopted by many of the electricity utilities to improve performance of energy sector entities.

DSM initiatives include:

- Energy audits.
- Support services.
- Incentive schemes.
- Tariff driven initiatives.
- Load research.

Table 1.5 – examples of national initiatives

NATIONAL ENERGY CONSERVATION / EFFICIENCY INITIATIVES – SOME EXAMPLES			
Country	Status	Objective	Accompanying Measures
China	Energy Conservation Provisional Regulation in 1984: Law under study	Promotion of nation-wide energy conservation	Reward for state-owned enterprises (1986)
Japan	Law on Rational Use of Energy implemented in 1979	Rational use of energy in all sectors	Tax incentives for energy conservation (1992); 10 year assistance for energy conservation and recycling (1993)
Philippines	Memorandum Order in 1992: Administrative and Executive Orders enacted in 1993	Mandate of the government to promote judicious use of energy; Constitute council of advisers and institutionalise committee on power conservation and demand management	Incentives depending on type and appropriateness of project (1987-1990); Technology transfer for energy management (TTEM) project
Republic of Korea	Act implemented in 1979	Promotion of rational utilisation of energy and sound development of the national economy	Financial support and tax incentives (1980), Credits in building electricity rate (1993)
Russian Federation	Federal Law on Energy Saving adopted by State Duma in April 1996	Promotion of nation-wide efficient use of energy	Training and demonstration projects by Energy Centres
Singapore	Building Control Act in 1979; Statutory Boards Act in 1982	Energy Conservation Standards for buildings; Electricity conservation in industry	Tax refund for buildings (1982); Accelerated depreciation for approved plants and machinery (1983)
Thailand	Energy Conservation Act implemented in 1992	Energy Efficiency in Industry and Commercial Buildings	Import duty reduction (1983), Energy Conservation Promotion Fund (1994)
Source:	<i>ECCJ (1996), Worldwide Energy Conservation Handbook, The Energy Conservation Centre, Japan</i>		

ENERGY EFFICIENCY – MICRO PERSPECTIVES

Energy is an important input to industry and one that provides considerable scope for cutting costs. Energy efficiency initiatives can help to ensure that industries grow and thrive. It is estimated that savings of 20–25 per cent are achievable with existing capital stock and another 30–60 per cent could be saved if investments are made in new, more efficient capital equipment. Some examples of areas to be considered are given below:

- Appropriately sized equipment, even with relatively lower efficiency, will generally consume less energy than larger energy-efficient equipment.
- Low initial cost can be deceptive. For example, the annual running cost for an electric motor is 8–10 times its initial cost. Selecting a high-efficiency motor could therefore make a big difference.
- Apart from efficiency, device service life is also important. For instance, an incandescent lamp may, at first glance, appear a good buy. However, if frequent replacements and running costs are taken into account, a fluorescent tube light or compact fluorescent lamp may well be preferable.

CONCLUSION

Options for meeting increasing energy demands are: to increase capacity – with the attendant environmental and cost implications of that choice – or to increase energy efficiency. Experience from all over the world has shown that improving end-use efficiency is a hands-down winner in economic terms when compared to capacity addition.