



Energy Use In Developing Countries

Developing countries produce 43% of the world's energy but account for only 29% of total energy consumption (Fig.1). However, energy consumption varies greatly between these countries. Developing countries within Asia (China, India, Korea, Thailand and Indonesia), for example, consume 60% of all energy in the developing world.

Fig 1. Share of energy consumption, 1993

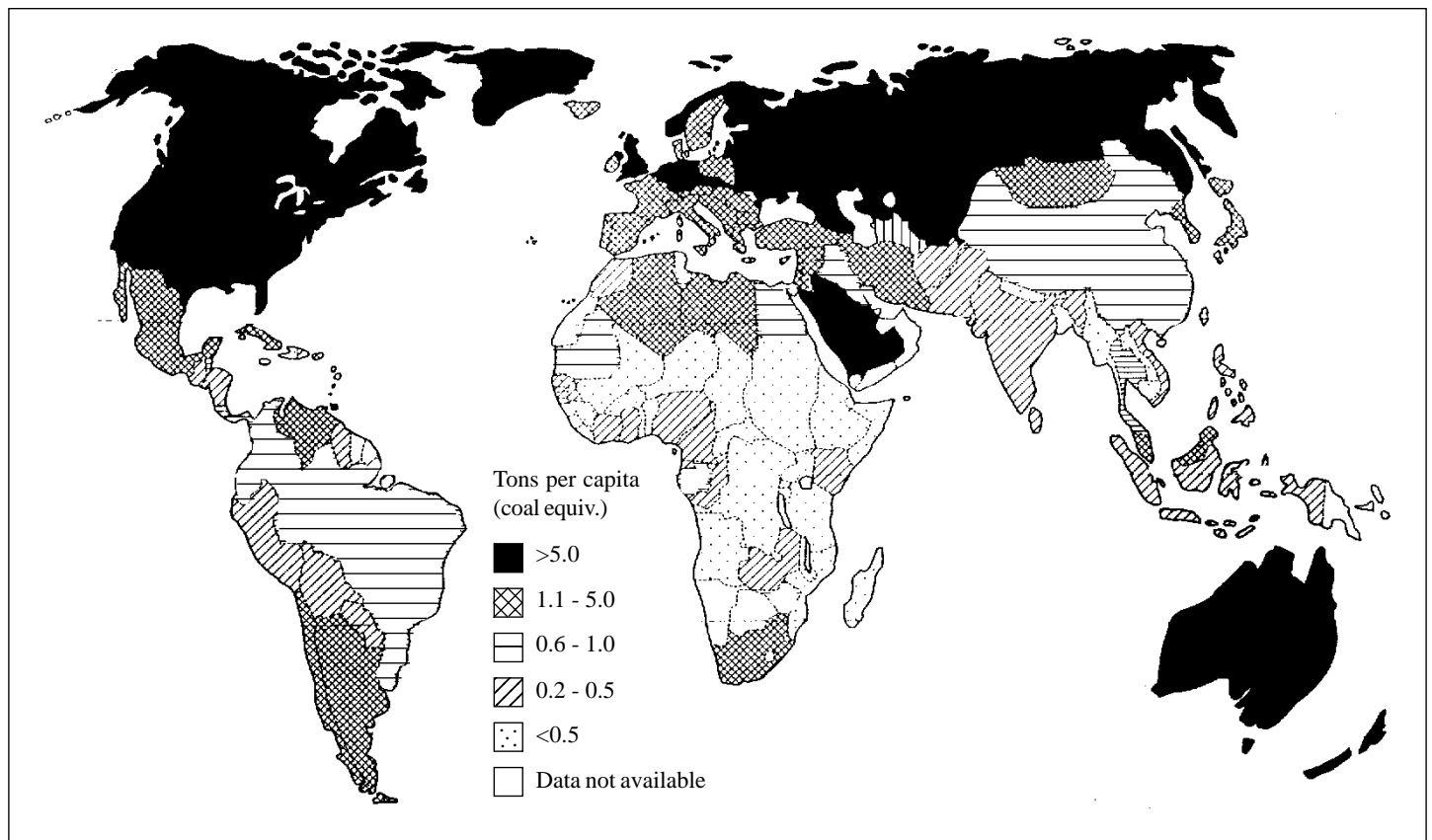
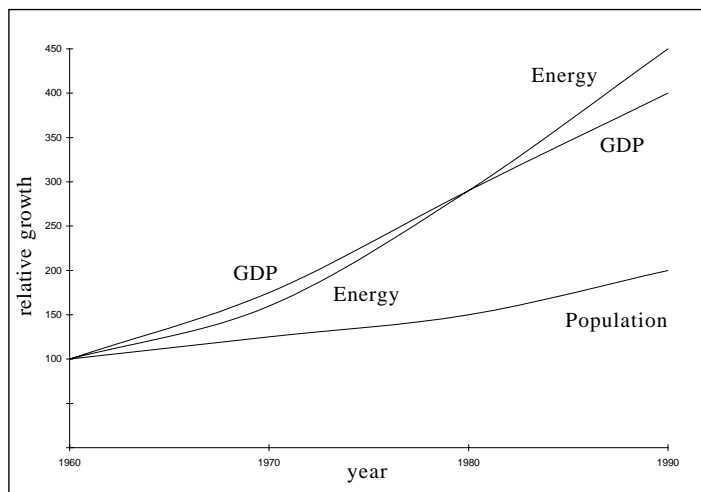


Fig 2. Growth in energy use, GDP and population in developing countries (1960-90)



Although total energy use is increasing in all developing countries (and faster than both population and economic growth (Fig.2). Per capita consumption is still very low compared to that in developed countries; an average US citizen uses as much energy as 2 Swedes, 3 Greeks, 33 Indians or 295 Tanzanians.

Sources of Energy

Oil

Developing countries have copied the paths which their developed counterparts took in using oil to fuel industry, transport and electricity production (75% of developing countries are oil importers). All oil-importing countries are susceptible to sudden price increases caused by economic and political crises and oil import bills continue to cripple many developing countries. For example, 30% of sub-Saharan and African export earnings are spent on oil imports and 87% of the Indian import bill in 1992 was attributed to oil. This used up over one-third of everything that India earned from exports in that year.

Oil importing developing countries have two main problems:

1. The cost of importing oil diverts funds from essential development of indigenous energy supplies as well as from the development of water, sewage, infrastructure and industry.
2. The environmental impacts of increasing use of fossil fuels. The combustion of fossil fuels is the major cause of global air pollution so increasing use of fossil fuels will inevitably exacerbate existing problems. Global warming, as a result of increasing carbon dioxide emissions will lead to rising sea levels and it has been estimated that this will threaten 30 island nations as well as populous regions of Bangladesh and Egypt with inundation. Agricultural productivity may well drastically decline in large areas of the lower latitudes. Whilst such global pollution problems are largely a result of the developed world, the impact of developing countries should not be underestimated (Table.1)

Table 1. Regional analysis of greenhouse gas emissions (% contribution)

	USA	Rest of OECD	Developing countries
Fossil fuel based energy production	70	56	23
CFC applications	25	35	8
Agriculture	4	7	36
Forest/wood burning	0	0	30
Other industrial uses	1	2	3

Coal and natural gas

USA, Austria and the former USSR contain 75% of the world's coal reserves. In the developing world China and India possess huge resources but Nigeria, Zimbabwe and Korea still produce significant, if much smaller amounts.

Much greater utilisation of natural gas is possible in the developing world. When gas is found by oil companies in developing countries, it is usually written off as non-viable. A commercial scale field of natural gas needs to be 100 times greater than a find that could be considered cost-effective for local use. Natural gas is, in fact, a utilisable substitute for almost any current energy source. Compressed gas can be used as a cost-effective substitute for diesel in motor vehicles and can replace oil and coal for most industrial, commercial and domestic purposes. Furthermore, it is cheaper to produce electricity from gas than from either coal or oil and combustion of gas releases less pollutants.

Nuclear power

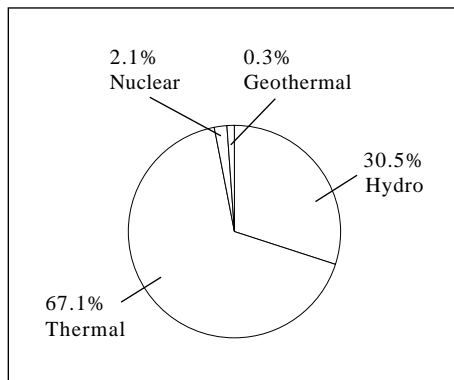
Despite huge set-up costs and continuing safety concerns, many developing countries still intend to invest in the development of nuclear power. Its advantages - it does not require either local energy resources or major fuel imports - have made it attractive to oil-import-dependent countries.

However, many governments are concerned that the safety record of the nuclear industry is already poor and that developing countries, keen to cut costs wherever possible, may not make sufficient investment in safety systems at operating plants, or make adequate safeguards for the disposal of nuclear waste.

The use of electricity

Latin America has the highest level of electrification and nearly 80% of the population now have some access to electricity. Throughout the developing world electricity remains the fastest growing form of energy end-use, largely as a consequence of increasing mechanisation of agriculture and industrial production and increased urban connection to a grid. Most electricity is generated using oil and coal (Fig.3)

Fig 3. Net installed capacity of electricity generating plants in developing countries by type 1993



Perhaps surprisingly, the sharpest increase in electricity use occurred during the 1970s, when oil prices rocketed. Since the vast majority of electricity production in developing countries is based upon oil combustion, it might have been expected that electricity consumption would decline but, generally speaking, government intervention prevented the electricity companies passing on their increased costs to consumers.

Many developing countries still face persistent electricity shortages. In many parts of Latin America, in India and in China shortfalls in cities during peak periods are still common and have resulted in riots, as in Bombay and Calcutta in the early 1990s. In countries which are unable to maintain urban electricity supplies there is very little possibility of extending electrification into rural areas. In most developing countries, the

extension of electrification to new families lags behind population growth.

Whilst most electricity in developing countries is generated from fossil-fuel based power stations, with coal being the most commonly used, the use of renewables has tremendous potential.

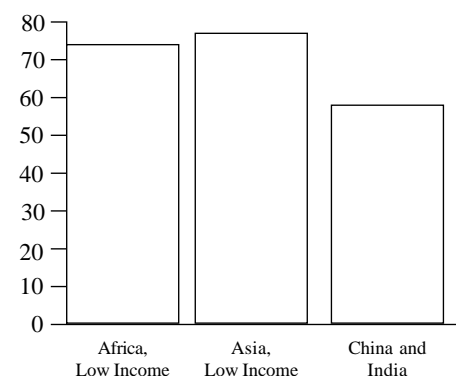
Two billion people in developing countries have no access to electricity at all and still depend upon biomass - firewood, charcoal, dung or crop residues. Such traditional fuels are still an important component of total energy production in oil importing developing countries in Africa (Table.2).

Table 2. Energy use in developing countries, 1991

Source	Share (%)
Biomass	35
Oil	26
Coal	25
Natural Gas	8
Other Renewables	5
Nuclear	<1

In most developing countries, commercial sources of energy are only used by the industrial and transport sections in urban areas. Meanwhile most of the population continue to be rural (Fig.4).

Fig 4. Rural populations as a percentage of total, 1989



Exam Hint - Candidates should not only be able to **describe** the main trends, but suggest explanations for them. The pattern of energy use in the developing world varies greatly from one country to another. Generalisation should be avoided

Renewables

Geothermal

Geothermal energy may be useful in volcanically active parts of the world such as in the 'ring of fire' of western South America, the Pacific islands and the Far East.

Biogas

Anaerobic biogas digesters are used to break down organic matter and produce biogas, a 60:40 mix of methane and carbon dioxide which can be used as a fuel. It is estimated that 5 million biogas stoves are in use throughout India and China and are most commonly used for cooking, lighting and pumping drinking water. The residue from the digester is then used as a fertiliser.

HEP

Hydro-electricity provides 30% of electricity in developing countries and, through micro-hydro projects, there is tremendous potential for further increase. Sometimes a single colossal dam makes a significant contribution to a developing country's total energy supply e.g. Aswan (Egypt), Cobora Bussa (Mozambique), Owen Fall (Uganda). However, HEP causes huge amounts of land to be flooded, destruction of habitats and often, forcible relocation of people.


Woodfuels

In the poorest developing countries woodfuels (firewood and charcoal) account for 90% of the total energy used. In general, the poorer the country, the greater it's reliance upon wood (Fig.5)

Table 3. Advantages and disadvantages of different forms of energy generation in developing countries

	<i>Advantages</i>	<i>Disadvantages</i>
<i>Coal</i>	<i>Huge deposits e.g. China, India, Indonesia, South Africa and Turkey.</i>	<i>Expensive to transport. Coal combustion releases large quantities of CO₂ + SO₂ which contribute to the greenhouse effect and acid rain respectively. The World Health Organisation (WHO) estimate that 500 million people, mainly women and children, suffer from respiratory infections caused by high levels of carbon monoxide, particulates and carcinogens from coal. Acute respiratory infections are now the leading killer of children under the age of five.</i>
<i>Oil</i>	<i>Easy to transport, clean (relative to coal) and potentially, through refining, a basis for dozens of other industries.</i>	<i>Oil imports leave developing countries vulnerable to price rises and reduce spending on development of infrastructure.</i>
<i>Gas</i>	<i>Easy to transport. Cleaner than coal i.e. less emissions of CO₂, negligible SO₂. Combined cycle generation where waste heat is recovered and used to generate more electricity is more efficient and cheaper than coal-fired plants.</i>	<i>Initial tapping of gas often expensive. Pipelines to rural areas may prove expensive.</i>
<i>Hydro</i>	<i>No gaseous emissions. Running costs low compared with fossil-fuel plants. Micro-hydro installations may not need a reservoir for water storage.</i>	<i>May be long distance from large markets. Growing environmental and social concerns because of displaced people and flooding of natural habitats.</i>
<i>Nuclear</i>	<i>Technologically attractive. Uranium deposits are essentially finite. Significant in Argentina, China, India, Republic of Korea, South Africa.</i>	<i>Needs sophisticated research and development. Serious safety concerns.</i>
<i>Biomass</i>	<i>May be based upon waste materials e.g. crop residues, Biomass plantations help maintain microclimate, soil fertility and decrease soil erosion. Labour intensive, therefore may be important source of employment.</i>	<i>May affect groundwater reserves and lead to contamination of groundwater by fertilisers and pesticides. May increase demand for irrigation and accelerate deforestation. Use of dung as fuel means there is less available for use as fertiliser.</i>
<i>Wind</i>	<i>Set-up costs comparable to thermal plants. Low operating and maintenance costs. Short lead-in time. Can be local and decentralised.</i>	<i>Takes up large areas of land. May be unreliable and, through visual intrusiveness, may harm the development of some types of tourism e.g. ecotourism.</i>

Fig 5. Per capita GNP and wood use

	<i>Country</i>	<i>Per Capita GNP (US \$)</i>	<i>Fuelwood as % of total energy consumption</i>
	<i>Ethiopia</i>	<i>110</i>	<i>93</i>
	<i>Kenya</i>	<i>310</i>	<i>70</i>
	<i>Zambia</i>	<i>470</i>	<i>46</i>

In urban areas the majority of wood which is used is purchased and rising prices stimulates deforestation. As resources are depleted, collection times increase, which stimulates greater use of crop residues and dung as fuel, rather than as fertiliser.

Solar power

Solar power based upon photovoltaics is likely to be the least expensive way in which developing countries can develop renewables. Solar water heating is already well developed in many African countries - Gabarone, Botswana's capital reduced its annual electricity consumption by 15% in 18 months following widespread installation of over 4000 solar water heaters.

The relevant advantages and disadvantages of conventional and non-conventional energy generation are summarised in Table.3

Development and energy use

Three major agencies - The World Energy Council, The International Energy Association and the US Department of Energy - have made serious attempts to predict future energy use in both developing and developed countries. In making these predictions, assumptions have been made concerning future population growth, future economic growth, the size of known fuel reserves and developments in energy efficiency. All three models show a rapid increase in the percentage of energy used by developing countries, especially those in Asia and Central America. All three models expect oil to remain the dominant commercial source of energy, followed by coal, gas, renewables and nuclear energy. In all three scenarios fossil fuels continue to supply 75% of all the energy consumed.

It is usually argued that increasing energy use is an essential pre-requisite if very poor countries are to address some of their most urgent problems; provision of adequate supplies of clear drinking water, construction of roads and railways and the generation of non-agricultural sources of employment.

Industry already accounts for over half of all energy used in developing countries (Table.4)

Table 4. Energy use in developing countries, by sector, 1985

Sector	Commercial %	Biomass %	Total %
Residential & Commercial	28	90	44
Industrial	52	10	41
Transportation	20	0	15

Much industry is energy-inefficient particularly key industries such as steel and cement manufacture which are essential for infrastructure development - nearly 60% of Kenya's industrial energy use still goes towards energy manufacture.

Many observers feel that developing countries face a dilemma in trying to meet their growing energy needs by the use of conventional fuels. Increasing energy use, which is usually assumed to equal development, might actually hinder the development process if it leads to increased susceptibility to oil price increases, increased foreign debt or environmental problems. A better strategy perhaps, would be for developing countries to concentrate on increasing energy efficiency based upon cleaner domestic energy sources (Table.5)

Helping developing countries implement energy conservation policies is extremely difficult - improvements in industrial efficiency, transport,

Table 5. Reducing energy use in developing countries

Strategy	Effect
Develop industrial production of energy efficient goods e.g. energy efficient light bulbs, energy efficient domestic appliances.	Encourage domestic use, reduce need for new power stations, create exportable products which are in high demand
Improve efficiency of irrigation pumps.	Irrigation pumps account for 22% of energy used in India
Improve building design to reduce need for air conditioning	Chinese buildings use five times as much energy as US buildings maintained at the same temperature
Improve energy efficiency of biomass burning stoves	New stoves use 50% less than conventional stoves
Increased fuel efficiency of vehicles	Will decrease oil import bill and reduce local, national and international air pollution
Increased traffic management	
Increased development of public transport	

heating and agriculture would all be essential. Energy is lost at every stage of production, distribution and use, outdated, inefficient equipment, loss between power stations and theft by unauthorised connection account for 15% of the total supplies. Interestingly, in 1980 China launched an energy efficiency programme which, over the next decade reduced expected energy use by 50% but nevertheless was achieved over a period of intense economic development.

In the past economic development without dramatically increased energy use has been unthinkable. Concerns about the vulnerability of oil-import dependence, national and global environmental effects and the potential of rapidly improving technology have stimulated many developing countries to question whether this model is the most appropriate way forward. Since fossil fuels are finite it is almost certain that renewable energy in all its forms will become increasingly significant.

Acknowledgements;

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Exam Hint - Candidates should realise that, at this level, they are expected to be able to discuss, with examples, not only patterns of production and consumption, but the underlying causes and then the consequences of such patterns. Although the main emphasis of the question concerned the developing world, this is clearly an area where the activities of the developed and developing world meet head-on.