UNIT 9 ECONOMIC APPROACH TO THE ENERGY PROBLEM

Structure

9.1 INTRODUCTION

In addressing and considering issues related to energy and environment from the perspective of development economics, it is very difficult for anyone to remain objective. The questions are complex, the decisions are difficult, and the answers are crucial. It is upon these answers that the future welfare of our entire species and planet hangs; if we do not act swiftly and decisively now, we jeopardise both the present generation's fundamental rights and, more importantly, those of our future generations.

Energy and environmental issues have, perhaps more than any other recent economic topic, stretched the computational and analytical capacities of economists. Perhaps it is the high-stakes involved in these particular issues that make this so; whatever the cause, these issues have thus far been at the forefront in the minds of the economists and will probably continue to be so for some time to come.

In this unit we introduce the economic dimension of the energy-environment relationship. We follow it up with a discussion on the different economic approaches to the energy problem. In the next unit, we consider these issues in greater detail from the macro as well as micro-economic perspective.

Objectives

After studying this unit, you should be able to:

- explain the concerns addressed by energy economics and environmental economics;
- discuss the general economic approaches to energy problem; and
- analyse the economic aspects of energy in relation to sustainable development.

9.2 INTRODUCTION TO ENERGY AND ENVIRONMENTAL ECONOMICS

Energy is a key factor in the economic development of a nation. The primary consideration for developing countries is increasing their rate of economic growth. Economic growth depends on a number of factors:

- In a macroeconomic context, it involves increasing consumption, investment, government spending, and trade.
- In a microeconomic context, it involves physical resources, labour resources, and technology as applied to production.

- Microeconomic concerns oblige us to think in terms of efficiency and productivity. Macroeconomic issues require us to think in terms of savings flowing to investments in productive activities.

Thus, the economics of energy and environment is closely linked with development. Most important within the field of development, especially when environmental and energy issues are under consideration, is the still stricter criteria of sustainable development. This, as you know, is defined as "adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future".

In recent years, many experts on the Earth's environment have been very alarmed, and perhaps not without cause. On November 20, 1992, a declaration was signed by 1,575 scientists, including no less than 99 Nobel Prize winners, cautioning that: The Earth is finite. Its ability to absorb wastes and destructive effluent is finite. Its ability to provide for growing numbers of people is finite. And we are fast approaching many of the Earth's limits. Current economic practices cannot be continued without the risk that global systems will be damaged beyond repair. Pressures from unrestrained population growth and resource uses put demands on the natural world that can overwhelm any efforts to achieve a sustainable future.

You have studied in Block 1 that energy production and use pollutes the environment more than any other human activity. You know that human society relies upon a continuous supply of raw energy to function, and development cannot occur without a surplus of raw energy. This makes the sustainable production of raw energy instrumental in sustaining environmental quality. At present, agricultural production of raw energy in the form of food stuffs is the sector of raw energy production that allows the greatest return on investment, both in terms of total social good produced and monetary returns.

These considerations bring us to the question: Which conditions related to energy and environment are most conducive to economic development? In answering this question, we will take up the energy and environmental issues separately. Although there are undeniable links between the two, you will certainly find your attention less likely to waver if we discuss each one of them separately. We first talk about the slightly simpler topic of energy economics.

9.2.1 Energy Economics

The study of human utilisation of energy resources and energy commodities and the consequences of that utilisation is known as *energy economics*.

You have learnt in MED-001 that energy is the capacity for doing work, e.g., lifting, running, producing electricity or heating material. **In economic terminology, energy includes all energy resources and energy commodities, commodities or resources that embody significant amounts of physical energy and thus offer the ability to perform work.**

Energy resources are obtained from nature and can be harvested to produce energy commodities. Examples are crude oil, natural gas, coal, biomass, hydro, uranium, wind, sunlight, or geothermal deposits.

Energy commodities are used to provide energy services for human activities, such as lighting, space heating, water heating, cooking, motive power, electronic activity. Examples are petrol, kerosene, diesel, CNG, hydrogen, or electricity.

Fig.9.1: Energy resources and energy commodities

Energy economics studies factors and forces that lead economic agents (such as firms, individuals, governments), to

- supply energy resources,
- convert those resources into other useful energy forms,
- transport them to the users,
- use them, and
- dispose of the residuals.

The roles of alternative market and regulatory structures on these activities, economic distributional impacts, and environmental consequences fall in the purview of energy economics. Energy economics studies economically efficient provision and use of energy commodities and resources and factors that lead away from economic efficiency.

By definition, energy economics concerns itself with any sort of energy that is used in the world economy. However, at this juncture in our history, oil continues to be the predominant source of energy globally. Oil is used and traded in world markets to such an extent that any discussion of energy economics still focuses nearly exclusively on oil. In this discussion, our main focus will be on oil, as this energy resource has the maximum impact on the world economy.

The following factors need to be considered in any discussion on energy economics:

- Energy demand and its response to price.
- The connection between energy and other factors of production.
- The response of the aggregate economy to input price changes or shocks.

All these factors are highly empirical in nature.

Let us now discuss these considerations of energy economics in greater detail.

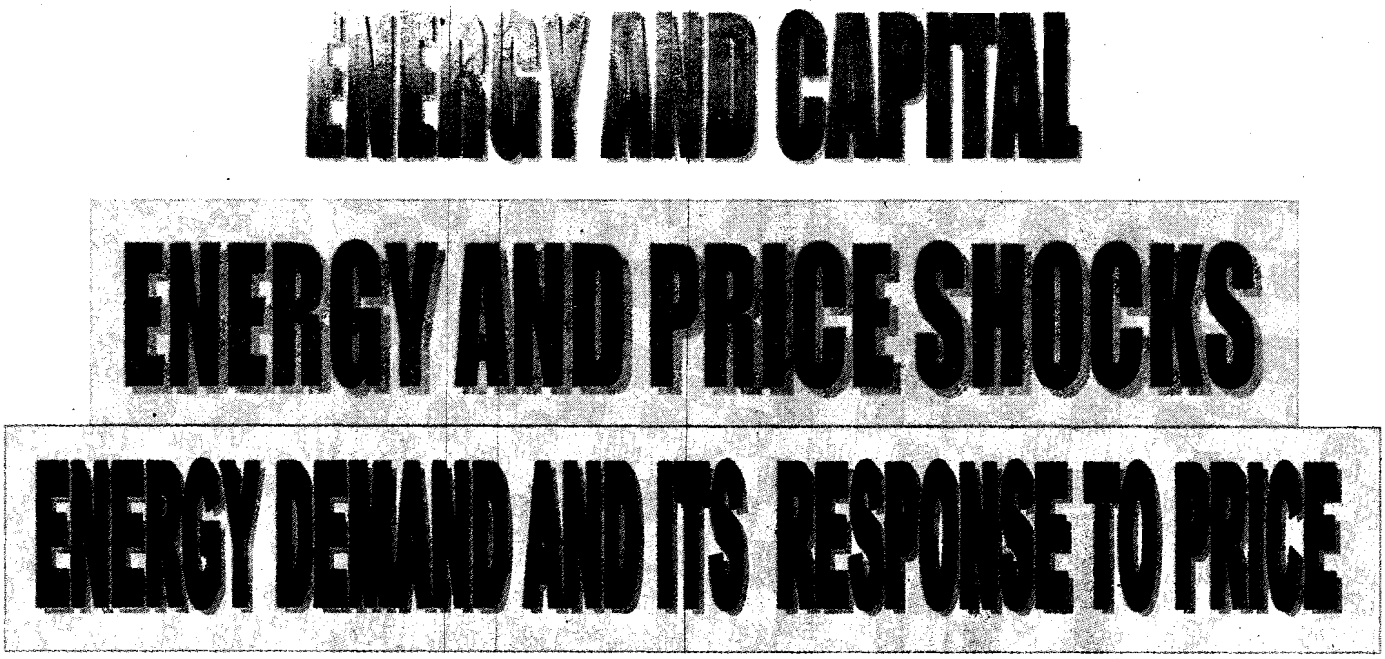

Fig.9.2: The major considerations in energy economics

- **Energy Demand and its Response to Price**

Price is a means of rationing goods, which is necessary to deal with scarcity. The main interest on the energy demand side is that of **price elasticity of demand**. Let us explain what this means.

The price elasticity of demand measures how much consumers respond in their buying decisions to a change in price. If price increases by 10% and consumers respond by decreasing purchases by 20%, it means that the consumers respond a great deal to a change in price: the ratio of percentage change in sales to percentage increase in price is 2 in this case. If, on the other hand, a 10% change in price causes only a 5% change in sales, economists would say that the demand is **inelastic** as the above said ratio is 1/2.

Price demand is inelastic whenever the ratio of change in sales to price increase is less than one. When it is greater than one, the price demand is elastic.

Products that have few good substitutes generally have a lower elasticity of demand or are said to be **price inelastic** than products with many substitutes.

Energy tends to be price inelastic, even in the long run.

For example, when the price of petrol rose rapidly in the late 1970s, the only adjustment consumers could initially make was to drive less. With time, they could also move closer to work or find jobs closer to home, and switch to more fuel-efficient cars. But the use of oil did not decrease, in spite of increasing energy prices.

A **price floor** exists when the price is artificially held above the equilibrium price and is not allowed to fall. A **price ceiling** occurs when the price is artificially held below the equilibrium price and is not allowed to rise.

Thus, time plays an important role in determining both consumer and producer responsiveness for many items. The longer people have to make adjustments, the more adjustments they will make. This has one important policy implication. If we are to convince society to use alternative energy sources to any appreciable extent, **price floors** will not be a sufficient impetus; no matter how high they may reasonably be set.

- **Energy and Capital**

  The **key factor** in considering links between energy and other production inputs is **capital**. There has been much disagreement over the issue of whether energy and capital substitute each other or are complementary inputs in the process of manufacturing goods. The policy implications of each possibility are of large import in meeting the **goal of decreased energy demand**.

  Suppose we assume that energy and capital are **complementary**, i.e., an increase in the price of either one of them will lead to **less** of the second being demanded at any given available price of the second. Then we should **raise the societal capital costs if we desire energy demand to decrease.**

  On the other hand, suppose we assume that energy and capital are **substitutes**, i.e., an increase in the price of either one (other things being equal) will result in **more** of the second being demanded at any given available price of the second. Then to meet the goal of decreased energy demand, we should **lower** the capital costs.

- **Energy and Price Shocks**

  In considering the economic impacts of energy price shocks, we have to pay attention to the short term considerations and look at macroeconomic issues. A permanent increase in the real cost of energy can result from two different events:

  - Greater depletion of domestic energy resources, and
  - An increase in the price of energy imports.

Both these paths lead to the same end result: A decrease in real income for the country, whether it be an oil importer or an oil exporter.

Such **price shocks**, as they are called, are aptly named, for they can take place very quickly indeed, with little to no time for a nation to react suitably to minimise the damage to their economy.

In sum, higher prices or price shocks for oil, whatever their source, lead very definitely to decreases in income and capital for a nation so affected. The issue then becomes whether this is a worthwhile price to pay. Indeed, higher prices for oil will also lead to somewhat decreased quantities of the same being consumed; however, due to oil's relatively price inelastic demand as outlined above, the consumption will not decrease by that much relative to the income thus lost by the country.

This makes it even harder to convince countries to willingly raise their oil prices, even though decreasing consumption is one of the primary goals of environmentalists, and is necessary at some point if we are to achieve sustainable development. Thus more attention must be given to alternative fuel sources; this seems the only feasible method at this point of limiting and/or reducing the demand for oil.

SAQ 1

What do you understand by energy economics? Explain the factors that need to be considered in energy economics.

9.2.2 Environmental Economics

Environmental economics is a rather new field, essentially the creation of the present generation of economists. It is a subfield of economics concerned with environmental issues.

Environmental issues in general had never really been considered important until the latter half of the twentieth century. This was because the industrial production had not been at high enough levels of production for long enough to justify such concerns.

Further, we lacked the technology to really make fair and detailed diagnoses on just how worse the environmental problems had become. Thus we chose to assume they did not exist in the absence of contravening evidence. However, as environmental concerns became prominent, economists also took note of them and initiated studies in environmental economics.

Environmental economics undertakes theoretical or empirical studies of the economic effects of national or local environmental policies around the world. Particular issues include the costs and benefits of alternative environmental policies to deal with air pollution, water quality, toxic substances, solid waste, and global warming.

The main conflict with which the economists are concerned in thinking about the environment is, as with energy, the short term versus the long term. Although 'long term' in the context of energy economics implies effects which could conceivably be seen within a person's lifetime, it is not so with environmental economics.

One key problem in **environmental economics** is that the Earth has a very finite capacity to assimilate residual products of industrial production. In determining the level to which this capacity should be pushed, it must be realised that businesses and/or consumers themselves will have little to no motivation to either keep the environment clean through their own actions or paying others **unless national governments** (or, better yet, some sort of consortium of nations such as the U.N.) **decide that keeping a clean environment is their foremost priority**.

The main problem with *laissez faire* policy making in the case of environmental economics is that to fail to provide an answer (i.e., to not mandate acceptable levels of pollution and other environmentally unfriendly practices) is to leave matters by default to the market. This is a non-decision that has been shown to lead to the provision of a lower quality than would be optimal if individuals' willingness to pay could be summed and balanced against the cost of provision.

Once the necessity of some form and amount of government intervention is accepted, there are basically two possible analytical paths that may be followed in order to arrive at an acceptable answer to the questions of What? and How much? The first method is the well-known one of **cost-benefit analysis**.

Cost-benefit analysis

Under this scheme,

The collectivity should decide on environmental quality by adding up the benefits to whomsoever they may accrue and comparing the total to the costs.

One problem with this method is that since the willingness to pay is constrained by income, the result is heavily conditioned by the status quo. The other issue is that of the difficulties inherent in measuring such abstract notions such as the importance of *clean air* to breathe, *safe water* to drink, etc.

Voter Behaviour

The second method is to look to voting for solutions. In this method

Each person counts exactly the same, and the extent of an individual's prospective gain or loss is not important to the ultimate decision. All that matters is whether the individual is for or against the proposition.

The two possible ways of analysing voter behaviour in this scenario are by examining ethical issues and through an area of economics known as **public** or **social choice theory**. This way of looking at voter behaviour focuses exclusively on **the behaviour of the decision-making processes themselves rather than the normative nature of the decisions they might lead to.**

The main problem with this method is that it is singularly unable either to prescribe the correct constitution or to judge among the outcomes thrown up by alternative decision making arrangements.

In the light of this, **welfare economics** seems more enticing. Thus we are led back to the cost benefit analysis and must consider how to implement such an analysis.

SAQ 2

Compare the two methods of environmental economics used to ensure environmental quality.

The main issue in attempting to measure benefits and costs is that of empirical methodology. This is because due to the nature of environmental quality, the benefits to be expected from proposed changes in prescribed quality are difficult to measure. In estimating these benefits, we are drawn to two groups of methodologies for data collection:

- **indirect**, in which economists obtain benefit estimates from the records of other transactions, and
- **direct**, in which individuals are asked to state how much they are willing to pay for a specific environmental improvement.

There are three main indirect methods:

- the **travel cost method**,
- the method which **focuses on participation in activities dependent on the natural environment**, and
- the **biological response approach**.

The **travel cost method** is perhaps the best known method, whereby the value of a clean environment (at a particular place) is measured by peoples' willingness to pay to travel to the place. Thus, we assume that the demand to travel to a particular place will increase by some amount as its environment is made cleaner. The main inadequacy inherent in this method is that it posits environmental changes at a finite number of separable places around the world.

This is obviously not so; the environment is changing all the time all over the world, and, further, it changes at different rates and in different ways in different regions. These concerns led economists to develop a second method, focusing on **participation in an activity dependent on the natural environment** (e.g., recreational fishing.) This method argues that improvements in the environment will lead to increases in the supply of a natural resource, and thus lower the price of activities that depend on such resources. However, this model too has its problems. There are no expenses on the part of the participant that are directly linked to the decision to participate, and thus the model falls quite nearly flat on its face. We can attempt to place a value on a unit of participation itself, but this proves problematic in that there is nothing close to consensus on how to compute such a valuation.

The third method, the **biological response approach**, attempts to put a value, indirectly, **on the health of all living things**. It is assumed that environmental cleanliness, or moreover lack thereof, leads most surely to health problems in all organisms. When commercial products are involved, the valuation process is fairly

straightforward. However, when any other living thing is involved, especially aesthetic species and most of all humans, the analysis becomes complex and elusive, to say the least. Over time, economists have tried valuing human life through multiple avenues; property values and occupational risks and wages are among the most prominent. When it is not human life but instead merely sickness that is involved, even greater ingenuity is required.

The main thing that has come clear through examination of these three diverse techniques of gathering data for cost benefit analysis is that the data necessary to complete such an analysis is almost never available; even when it is, there is a manifest lack of consensus among experts in the field on how to go about the analysis and which data is relevant.

Because of these great problems, some amount of attention has been devoted of late to a direct method of estimating the benefits of particular proposed environmental legislation: that of **contingent valuation** or, willingness to pay surveys. In using such a technique, individuals are asked, in more or less sophisticated ways, what they would be willing to pay for some carefully specified environmental good.

Once data has been collected and the methods for analysing it have been agreed upon, we can examine particular data and information from developing countries around the world and learn from it in our quest to finally make effective policy recommendations for the developing world, on local, regional, national, and finally international levels. The task is one well worth our attention if we are to preserve our terrestrial home for generations to come.

SAQ 3

Explain the indirect empirical methodologies of data collection in environmental economics.

9.3 ECONOMIC APPROACHES TO THE ENERGY PROBLEM

Modern economies are energy dependent. The provision of sufficient energy has been perceived as a central problem. Energy availability and consumption has been such an important consideration to economies worldwide that the **magnitude of energy consumed per capita has become one of the key indicators of modernisation and progress in a given country**. Recently, attention has begun to shift towards a more balanced perspective including concerns related both to demand-side and energy consumption patterns about which you have studied in Blocks 1 and 2. In any case, there is no escaping the fact that the use of energy is a necessary and vital component of development.

9.3.1 General Economic Approach to the Energy Problem

Energy is indispensable for modern life, and the oil price shock of the seventies has prompted serious studies on the economics of energy. Energy consumption is closely related to environmental degradation. Increasing awareness about cleaner environment and sustainable development has provided incentives for understanding the economics of environmental pollution.

Energy is, and will remain, a crucial traded commodity in the international economy. Many countries, however, have unrealised energy potentials when renewable energy options are taken into account. Thus, quite apart from the critical issues related to the supply of fossil fuels, the political, social, and economic institutions dealing with energy are facing a series of new challenges in energy production, distribution and use. New issues associated with energy are also emerging.

These include problems of economics such as

- access to capital,
- empowerment (self-reliance),
- equity, and
- environment.

Many of the human-based threats to the species and the biosphere are energy-related. Awareness of these issues has risen more recently, but they are still imperfectly understood.

Global energy strategies are linked to major global problems, including poverty, gender disparity (biases and discrimination against women), population growth, food, water and health, urban air pollution, climate change, acidification, land degradation, investment and foreign exchange requirements, energy imports and security, and nuclear proliferation. The implication of these linkages is that the issue of energy has to be tackled in such a way that other problems are not aggravated. Conventional energy strategies which are sectoral in nature tend not to address these other global problems in the responses, plans and solutions proposed. It will be argued that these linkages with energy can be utilised to help solve many wider problems. Within this perspective **energy can be used as an instrument to promote sustainable development**.

Demand-side, End-use, Energy-services Approach

You have learnt in Block 2 that people want the **services** that energy provides rather than energy resources. They do not demand oil or coal, or even petrol or electricity. They desire, e.g., provision of hot water in cold weather, cooling in warm weather, transport to go from one place to another, machines that run and produce goods, and so on. Therefore, it is essential to focus on the **demand side of the energy system**, the **end uses of energy** and **energy services**. Examples of energy services include: providing cooking, heating, cooling, lighting, and safe storage of food, clean water and sanitation, and other services required by society such as means of transportation, motive power for industry and agriculture, energy for commerce, communication and other economic activities. The **demand side, end use-oriented, energy-services approach stresses the end users' preference for service, quality, affordability, reliability, safety, impact on the environment, and accessibility**.

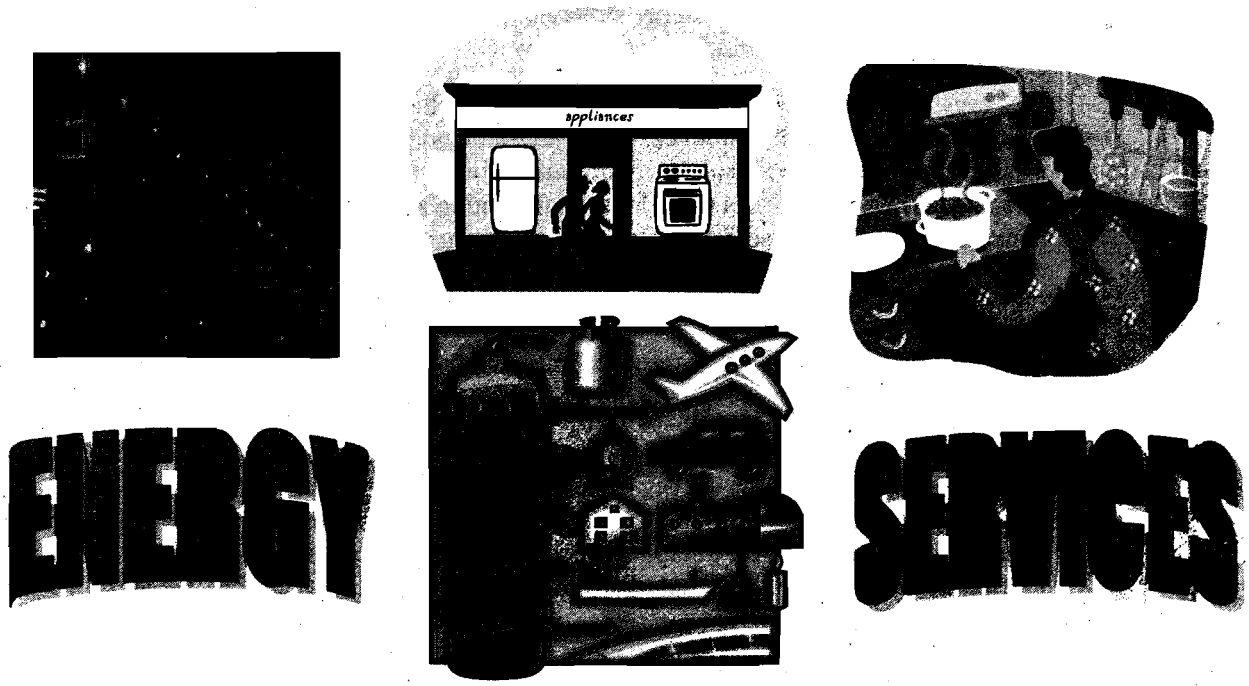

Fig.9.3: The demand-side, end-use, energy-services approach focuses on availability of energy services

Supply-side Approach

The traditional approach to the energy problem is the supply-side approach. The **supply-side approach** tends to focus on **forecasts of energy demand**, based on **projections of past and present economic trends**, considering factors such as demography and economic growth. It takes limited account of the large opportunities for improvements in energy efficiency, shifts to modern energy carriers, and dissemination of renewable energy technologies.

You have learnt in Block 1 about the potential of renewable sources of energy. These are now reaching commercial viability due to technology improvements and decreasing prices. Solar, wind, geothermal, and commercial biomass options offer feasible and attractive alternatives to conventional energy sources. The development of these resources has the potential to generate large scale economic activities in regions which currently face energy constraints. For the large numbers of people living in rural or remote areas, where grid extension of any sort will remain prohibitive based on infrastructure costs, decentralised renewable energy applications offer alternatives for the provision of affordable energy services while supporting local development and improved quality of life.

SAQ 4

Explain the supply-side approach to the energy problem.

9.3.2 Energy and Sustainable Development

The issues of supply and demand of energy are significant for sustainable development, particularly, with regard to:

- the role of energy in sustainable development;
- technological options to supply energy services; and
- experiences in energy policies to achieve objectives in areas linked to energy.

We need to understand the linkages between the current social, environmental, economic and security issues and energy in the framework of sustainable development. These linkages are not only the determinants of these problems, but actions related to energy can contribute to their alleviation, if not solution. Implementing sustainable energy strategies is one of the most important levers humankind has for creating a sustainable world.

Energy therefore must be an instrument for the achievement of sustainable development. It is vital to reveal the linkages between energy and the major global issues to identify the technical opportunities for sustainable energy, to bring the technical options together at a global scale, and to assess the manifold implications of sustainable futures associated with the implementation of these opportunities.

A promising and cost-effective means to finance and promote sustainable development is to phase out or remove **environmentally damaging subsidies.** These interventions distort the economy and subsidise waste and environmental degradation.

Although not precise, recent calculations indicate that large amounts are involved. For instance, a World Bank study estimates that developing countries spend over $230 billion a year subsidising energy – roughly four times the total amount of official development assistance. A common argument for environmentally damaging subsidies is that they serve social purposes: essential goods are made available at low prices to poor people. Removing those interventions would, therefore, be socially unacceptable.

However, there could be alternative policies for the intended assistance of poor population groups. Considering vested interests and social motives, it should be

recognised that it requires political courage to phase out or remove environmentally damaging subsidies, particularly in the water, energy and transport sector.

Policy measures and strategies should be developed for the phasing out or removal of environmentally damaging subsidies.

It is claimed that if market economies functioned perfectly, there would be no environmental problems. Unfortunately, this is far from reality. We should study the wide variety of market failures that lead to environmental problems, looking at them as theoretical issues and finding real-world examples of the theoretical failures. We should also examine the traditional approach toward regulation of such problems and contrast it with market-based approaches designed to address the specific market failure, rather than the particular environmental problem. In most cases, it does not make economic sense to have no restrictions on environmental harm, nor does it usually make sense to allow no environmental harm whatsoever.

Let us now summarise the contents of the unit.

9.4 SUMMARY

- The economics of energy and environment is closely linked with development. By definition, energy economics concerns itself with **the study of human utilisation of energy resources and energy commodities and the consequences of that utilisation**. Energy economics studies factors and forces that lead economic agents (such as firms, individuals, governments), to supply energy resources, convert those resources into other useful energy forms, transport them to the users, use them, and dispose of the residuals.

- In economic terminology, energy includes all energy resources and energy commodities. **Energy resources** are obtained from nature and can be harvested to produce energy commodities. **Energy commodities** are used to provide energy services.

- Energy economics is concerned with **energy demand and its response to price**, the **connection between energy and other factors of production** and the **response of the aggregate economy to input price changes or shocks**. The **key factor** in considering links between energy and other production inputs is **capital**.

- **Environmental economics** undertakes theoretical or empirical studies of the economic effects of national or local environmental policies around the world.

- **Cost-benefit analysis** and **voter behaviour** are two empirical methods of environmental economics for ensuring environmental quality. In the former, the **collectivity should decide on environmental quality by adding up the benefits to whomsoever they may accrue and comparing the total to the costs.** In the latter **each person counts exactly the same, and the extent of an individual's prospective gain or loss is not important to the ultimate decision. All that matters is whether the individual is for or against the proposition**.

- There are two empirical methods of data collection for cost-benefit analysis: **indirect**, in which economists obtain benefit estimates from the records of other transactions, and **direct**, in which individuals are asked to state how much they are willing to pay for a specific environmental improvement. There are three main indirect methods: the **travel cost method**, the method which **focuses on participation in activities dependent on the natural environment**, and the **biological response approach**.

- There are two principal economic approaches to the energy problem: The **demand side end use-oriented, energy-services approach** and the **supply-side approach**. The former **stresses the end users' preference for service, quality, affordability, reliability, safety, impact on the environment, and accessibility**. The latter focuses on **forecasts of energy demand**, based on **projections of past and present economic trends**, considering factors such as demography and economic growth.
- The issues of **supply and demand of energy** are significant for **sustainable development**, particularly, with regard to the **role of energy in sustainable development, technological options to supply energy services**, and **experiences in energy policies to achieve objectives in areas linked to energy**. A cost-effective means to finance and promote sustainable development is to phase out or remove environmentally damaging subsidies. Alternative policies for the intended assistance of poor population groups need to be implemented.

9.5 TERMINAL QUESTIONS

1. Outline the concerns that fall in the purview of energy economics.
2. What are the main areas of study in environmental economics?
3. Explain the demand side, end use-oriented, energy-services approach in energy economics.
4. Analyse the imperatives of energy economics for sustainable development.