CHAPTER I

INTRODUCTION AND BACKGROUND OF THE PROBLEM

In the wake of the "oil crisis" of the early 1970's two concepts emerged, related to energy. They were :

* Energy is a "key to development"; and

* Energy policy as the pre-condition to "successful" development policy.

The relationship between energy consumption and economic development has been recognized and examined by several researchers (Prasad & Reddy, 1976). A distinct positive relationship can be observed between per capita GNP & per capita energy consumption. Energy consumption increases with increasing GNP and in developing countries where both energy consumption and economic development are at relatively low levels, this relationship plays an important role in the process of catching up with the more developed nations. As Pachauri (1977) has observed, there is a tendency for the ratio of energy consumption to GNP to

decrease at higher levels of economic growth, but the energy consumption in absolute terms rises with corresponding increases in economic growth.

Tyner (1978) examined whether the close relationship between energy consumption and national income holds in the Indian context. Using data covering an 18 year period he regressed national income on total commercial energy consumption and found that both the linear and log-log forms gave very good fits. He, thus, concluded that "there was a very close correspondence between national income and energy consumption in India" (p.5). He further developed the theme that availability of ample energy supplies can provide a stimulus to economic development and that inadequate supplies can, correspondingly, inhibit economic growth.

While studies such as those of Tyner(1978) indicate correlation, they do not necessarily imply causation. Energy is a critical infrastructural input which plays an important role in economic development. Economic development implies transition from traditional modes of production to post industrial practices and techniques. Thus

important sectors of an economy such as agriculture and industry use increasing amounts of commercial energy as the output of these sectors increases. Increases in energy input along with other factors leads to an increase in the output of various sectors of an economy. In addition to increases in output, changing energy intensities and shifting from traditional energy forms to commercial ones leads to structural changes in an economy.

Thus energy policy has been seen to be of importance for the development process, since it affected not only long-run economic growth but also industrialization patterns, performance of agriculture, employment levels and the balance-of-payments position (Wionczek, 1982).

The energy sector is affected by GNP growth rates, but whether the impact of decisions in the energy sector would affect economic growth would depend on the elasticity of substitution of other inputs for energy. Hence, if this elasticity of substitution were high, the linkage would be one way i.e., GNP growth rates would have an impact on

energy policy; if this elasticity of substitution were low and energy could not be easily substituted for, then a two-way linkage between the energy sector and the rest of the economy would exist. In other words, a given energy policy would have impacts on the rest of the economy as would GNP growth rates on the energy sector (Hogan and Manne, 1976).

In the case of developing countries the growth rate of commercial energy consumption is higher than the growth rate of GDP i.e., the income elasticity of energy demand is greater than unity (WAES, 1977; Choe, 1978; Choe, 1979; Hoffman, L. 1978) whereas for the developed countries the income elasticity of energy demand is less than unity (Schmitt, 1978; Bain, 1979). Structural variables such as share of agriculture, mining and manufacturing, construction, and electricity in the GDP also affect elasticities. By explicitly introducing them in the estimation process, low income elasticities are encountered suggesting that the high income elasticities usually calculated for the developing countries are largely the result of structural change towards activities with high energy intensities (Hoffman, L. 1979).

Substitution of "non-commercial" energy by commercial energy sources may also be a reason for the high income elasticities calculated since these calculations consider commercial energy sources only and do not take into account 'non-commercial' energy sources (Desai, 1978).

Secondly, the per capita commercial energy consumption in non-OPEC developing countries is 400 Kgs. coal equivalent on the average compared to a world average of 2000 Kgs. c.e.; interestingly enough these countries contain 40% of the world population and consume about 10% of the world commercial energy. About 75% of the world population lives at or below a level which provides "basic human needs" even after non-commercial energy is taken into account. Apart from lower per capita energy consumption and the dependence on non-commercial energy, most non-OPEC developing countries are largely dependent on oil for their commercial energy needs, but for notable exceptions like India. The consumption of commercial energy is also growing rapidly. The prospects of developing countries which were not bright before the sharp increases in oil prices have worsened substantially after these increases (Palmedo, et

al., 1978) and most developing countries have still not adjusted their energy consumption and production patterns fully to reflect the higher costs of energy and particularly imported oil (World Bank, 1983). Developing countries which import oil have been caught in a dilemma of increasing foreign debt and/or reducing economic growth (Blitzer, 1982).

The developing countries must raise resources for an expanded programme of energy investments to reduce their dependence on oil imports while continuing to pay for these imports until the investments mature (World Bank, 1983). Energy investments in developing countries are capital-intensive and involve financing problems and difficulties in determining budget priorities as between investment in electricity generation capacity, oil exploration and natural gas production (Berrie & Leslie, 1978).

The energy scene in most developing countries is one of high income elasticities of energy demand; dependence on non-commercial sources of energy, which though declining in relative terms

is quite substantial in absolute figures; lower per capita consumption of energy; increasing financing problems as regards investments in the energy sector and difficulties in adjusting to higher energy prices without compromising economic growth.

Conversely, developing countries would find it easier to transit to low energy consumption scenarios since energy is no longer "cheap or abundant" than would the industrialized nations as they are committed to a capital stock and lifestyles evolved in an era of cheap coal and oil (World Bank, 1980).

* In India too, the consumption of commercial energy has been growing quite rapidly over the past few decades (Government of India, 1974; Pendse, 1984). Electricity has shown the highest growth rate (9-12%) followed by oil (6-8%) and finally coal at more modest rates (2-5%) in the period 1953-54 to 1978-79 (GoI, 1979).

* "Non-commercial" energy which used to account for over 60% of total energy consumed in the 1950s, is estimated to have reduced to a little over 40% in the 1970s and early 1980s (GOI, 1979;

CMIE, 1984). "Non-Commercial" energy is a term which comprises such energy sources as firewood, animal dung, vegetable and agricultural wastes and the like. A small but increasing proportion of these fuels are traded in the market system, but due to the lack of appropriate nomenclature, they continue to be termed "non-commercial". Data regarding the production, storage and consumption of these fuels is not recorded, hence rough estimates, perforce, are used (Henderson, 1975; Satishchandran, 1985). It is also believed that these fuels are used in the industrial sector, especially the sugar industry and cottage industries. Since no reliable estimates of consumption in the industrial sector are available, its contribution to the industrial sector is ignored (Parikh, J. 1981; Henderson, 1975) or it is assumed to contribute only to the domestic sector (GOI, 1979).

* The increasing consumption of commercial energy is not only due to increase in aggregate energy consumption but also due to substitution of 'non-commercial' energy by commercial energy (CMIE, 1984).

This phenomenon of substitution would have progressed more rapidly but for sharp increases in the prices of commercial fuels such as Kerosene (from 1974 onwards) which has forced certain sections of the rural population to continue to look for "zero private cost" firewood (Pendse, 1984; Reddy & Prasad, 1980).

Though the share of "non-commercial" energy in the total energy consumption has been declining in percentage terms, there has been a growth in terms of absolute figures (GOI, 1979). This increasing consumption of "non-commercial" energy has a detrimental effect on the environment - large-scale degradation of forests - or tends to use resource in a non-optimal manner - dung is "better" used as fertiliser than as fuel (Henderson, 1975; GOI, 1974; Advisory Board on Energy, 1984).

Concomitant to the rising consumption of energy has been the phenomenon of shortages of various types of energy, especially electricity at different times in different regions of the country (Henderson, 1975; Prasad, 1979). These shortages and the dependence of a large percentage of the population

on "non-commercial" energy resulting in degradation of the environment without a corresponding attempt to replenish the source or substitute with a commercial energy form had already resulted in serious problems even before the happenings in the international oil markets in 1973 and thereafter (GOI, 1965; GOI, 1974; Reddy & Prasad, 1980; Satishchandran, 1985). With the change in the international oil scene in 1973, it would be difficult to see in India the kind of energy transition that occurred in the industrialized nations during the periods of their development, viz., transiting from firewood to coal to huge quantities of oil and oil products which influenced and was influenced by emerging lifestyles in the West (Marchetti, 1976).

The per capita consumption of energy in India of around 1 metric tonne of coal replacement is low in comparison with 11 MTCR per capital in U.S.A. and between 3 to 6 MTCR in Western Europe (Parikh and Srinivasan, 1977). The energy-GDP elasticity has been found to be greater than 1 in the case of India (GOI, 1979). With growth rates of the economy posited at 5%, it would be likely that

growth in energy consumption in the future will continue to be at the rates mentioned earlier, if not higher.

* This growing demand for energy has to be satisfied keeping in view the various issues discussed earlier. Any analysis of the problem of satisfying the demand for energy has to take into account the different linkages that exist between the subsectors like coal, oil, electricity and non-commercial. These linkages arise from the fact that demand exists not for a specific energy source but for the use of that energy type. For instance, demand exists for heat in the domestic sector for cooking. This demand can be satisfied by more than one energy source (viz., firewood, coal, LP, electric power). This is so for all the end-use sectors. Secondly, linkages exist on the supply side too; for instance, electric power can be generated from a variety of sources (viz., coal, oil, hydro-power, nuclear fuel). In the case of petroleum products, there is a choice of a range of products that can be refined out from the same crude using refinery process variations. Analysis of the overall energy system, including supply and demand from all end-use sectors as well as all

fuels and energy forms, is useful both to forecast energy demand and to situate energy planning in larger contexts of public policy. Such analyses highlight the question of inter-fuel substitution and resource definition in a comprehensive framework (World Bank, 1981).

The problem, therefore, is the analysis of the energy sector in an integrated framework in order to carry out energy planning for the whole country and also to evaluate the likely impacts and implications of various policy measures which are introduced from time to time, on the energy sector. The policy measures analysed in this study are limited to energy policy and do not include policy measures pertaining to the whole economy. Also, energy-economy interactions have not been modeled. Economic change, either systemic or policy driven is exogenous to the model and the impact of changes in the energy sector on the economy as a whole has not been examined since such an examination is outside the scope of this dissertation. This study therefore focuses on the analysis of energy policy using a model formulated for that purpose.