Chapter 3: Energy Analysis and Energy Intensities for India

This chapter gives a general introduction to energy analysis. At the outset, a brief description of the theory of energy analysis and the techniques used are discussed. Following that, the application of the input-output technique of energy analysis to calculate energy intensities for India is presented. Results of this analysis are presented and trends in energy intensities of sectors in India examined for the period from 1983-84 to 1998-99. Finally, an assessment is also carried out of the likely accuracy of the results obtained, by accounting for some of the possible sources of uncertainties.

3.1 Introduction to Energy Analysis

The practice of calculating the energy content of goods and services or processes was termed energy analysis by the International Federation of Institutes of Advanced Studies (IFIAS) at a special workshop convened in August 1974. The official definition of energy analysis agreed upon by them was, "the determination of the energy sequestered in the process of making a good or service within the framework of an agreed set of conventions or applying the information so obtained" (Roberts 1975). The field of energy analysis received a particular fillip after the energy crises of the early 1970s when rising energy prices and a growing awareness of the negative environmental impacts of energy use caused increasing interest in conserving scarce energy resources. A number of researchers grappling with the problem of conserving energy turned to energy analysis as a means to furnish greater information on the total energy used in a particular productive or consumptive process and identifying where reductions on energy requirements of total processes could be made. Since then energy analysis has been used as a methodological tool in a number of different studies[1].

[1] Some of the early studies include that by Chapman to calculate the energy costs of aluminum (Chapman 1974); Leach's study that focused on the energy needed

3.2 Energy Analysis Methods in Practice

Two different methodologies have been developed to calculate the total energy requirements of different items and processes. One that developed out of the engineering profession was termed process analysis. The other had its origins in economics and is referred to as input-output energy analysis. A combination of the two techniques, termed hybrid analysis, has also been applied (Bullard et al. 1978). It combines the advantages of process analysis and the input-output technique. This section provides an overview of the methods of process analysis and hybrid energy analysis, while the next discusses input-output energy analysis in greater detail, along with how the method was adapted for calculating energy intensities in the Indian case. For a more detailed description and exposition on the techniques used in energy analysis refer to Spreng (1988) and Wilting (1996).

Process analysis uses a description in physical terms of the process in the life cycle of a product. It asks the question what goods and services were required to produce the target product. It then distinguishes between the energy and non-energy inputs required and further examines each non-energy input to determine the energy and non-energy inputs required for its production. This process continues, tracing through each stage of the production process, to finally tally all the energy inputs used in each successive stage of production to obtain the total energy required to produce the target product. The first energy input is called the direct energy requirement and the subsequent rounds of energy inputs comprise the indirect energy requirement. A very detailed description of the energy flows associated with the production process of the target product is thus arrived at. This methodology can provide very accurate results but requires extensive data and tends to be very laborious.

Hybrid analysis, as the name suggests, combines some stages of the process analysis technique with input-output energy analysis. The first few stages, in fact, are the same as those in process analysis. However, rather than tracing back through all the stages of production, as in process analysis, hybrid analysis only traces back the most important energy and material inputs required to produce the target product. It then uses input-output energy analysis to determine the total energy required for the material inputs used in the production of the target product. In this way, it minimizes some of the data and computational needs associated with process analysis.

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for food production (Leach 1976); Hannon's on the energy requirements of beverage containers (Hannon 1971); among others.