CHAPTER - 6

ANALYSIS OF OBSERVATIONS

Major Chapter Objectives

To analyse major observations of the research study which involve:

1. Features of Indian energy statistics.
2. Methodology for national energy database design and development.
3. Accounting and integrating the data.
4. Repackaging of the database.
6.1 Introduction

The research study has enabled the development of a national energy balance database for India which provides data on energy production and consumption for the year 1985-86. The design of the database is based on a multipurpose energy balance structure obtained by the analysis of over 30 national energy balances. The methodology for database development included first collecting relevant data and developing an energy commodity balance and then integrating them into an overall energy balance by using a common accounting unit.

The observations on the design and development of the database can be analysed under the following heads: (1) Features of Indian energy statistics, (2) Methodology for database development and (3) Accounting and integration of the data along with (4) repackaging of the database. The specific observations pertaining to these aspects of the study are discussed below.
6.2 Features of Indian Energy Statistics

The observations on Indian energy statistics can be broadly classified and grouped under scope and coverage, organisational structure and publications that facilitate access to the data. These observations pertain to the statistical system that is available in the public domain only.

6.2.1 Scope and Coverage

It was found that Indian statistical system does not cover data on non-commercial sources of energy. However, there are some wild estimates according to which about 50 percent of the total energy demand is met by energy sources such as firewood, cowdung, agricultural waste etc the production and consumption of which do not pass through the commercial channels. The data on these sources are estimated on the basis of sample surveys and also derived from other data sources such as agricultural production, cattle population etc. Thus, the energy data system of India provides an incomplete picture of the energy situation.

In a related observation, it was found that India has a comprehensive data system covering commercial energy sources such as coal, oil and electricity. These data are collected
and compiled by energy producing agencies as a part of their own management information system. But it is observed that these agencies report the data back to their controlling ministries and planning agencies both at the individual enterprise level and at the national level. However, the data pertaining to energy consumption is incomplete and inadequate. One reason could be that the energy producing agencies are primarily concerned with the production and subsequent supply of energy. They are not concerned with the ultimate use of the energy by the consumers. The relatively large number of the consumers, their geographical distribution and the variety of use of energy make it difficult to monitor energy consumption. Hence, energy consumption data are available at the broad user category level such as agriculture, industry, residential sector, transport etc.

The annual survey of industries is intended to make available at least some data on the industrial sector. However, this statistics do not cover all aspects of energy consumption by the industries and hence do not provide a micro level picture of the consumption. While the reliability of the data is much debated, they are usually delayed making them less useful for analytical studies and decision making purposes.
6.22 Organisational Structure

It is found that energy data collection and reporting are the responsibilities of a large number of government departments and statutory bodies. Some of these agencies are department of coal, ministry of petroleum, central electricity authority etc. These agencies are responsible for energy data in their respective spheres of activity. Thus, we have coal data systems, oil data systems, power data systems etc but not energy data systems. There is no apex body responsible for coordinating all the energy data activities in India.

The organisational structure that support individual energy systems are wide spread and well coordinated with energy producing units at the bottom level and controlling ministries/departments and the statutory bodies at the apex level.

6.23 Publication of Energy Data

Subsequent to the fragmented approach to the energy systems, there is no single official publication that give data on the production, conversion and consumption of all the known commercial energy sources. It is a reflection of the prevailing situation that there is no central agency responsible for energy data as a whole. Therefore, one has
to acquire a large number of publications from different agencies and compare them and collate data for research on energy systems of India.

It is not only that the published sources of data are many but they are also made available after considerable delay. A typical example is the annual survey of industries which contains substantial data on industrial energy consumption, but published invariably after a delay of one to two years.

There appears to be some serious gaps in the published data. One reason for the existing gaps is the practice of not publishing the relevant data. An example is the economies of transportation of coal by different modes such as rail, road and waterways. One has to dig out actual records available with the coal companies and find out how much each means of transport costs. Another type of gap in data occurs due to non availability of reliable data. For instance, calorific value of different grades of coal produced in the country is not collected and made available on an annual basis.

It is found that a researcher who is interested in working with latest data cannot depend on published sources. This has resulted in at least few private efforts to collect and compile data. One such effort is made regularly by the
Centre for Monitoring Indian Economy, Bombay by their annual publication entitled "Current Energy scene in India".

6.3 Methodology for Database Development

The Indian energy balance database described in Chapter-5, was developed by following systematic procedure:

1) Systematic study of the subject of energy statistics.
2) Acquiring knowledge on the energy sources and energy flows through the Indian Economy.
3) Understanding the scope and coverage of energy data systems.
4) Development of a database framework.
5) Development of energy commodity balances for an accounting year.
6) Development of an overall energy balance for an accounting year.

The observations pertaining to the above specific steps are analysed in the following subsections.

6.31 Study of Energy Statistics

One of the pre-requisites for conducting the present research study was to gain a knowledge of energy statistics. This knowledge was obtained by examining the need for energy statistics, the terminology used in the literature, curriculum on energy statistics and special problems such as defining and delimiting the boundaries of energy statistics.
and the unit of energy accounting. Finally, the essential elements that constitute energy statistics were identified. This study was helpful throughout the research especially in analysing the structure of energy balances and developing the database for India.

6.32 Knowledge of Indian Energy Sources/Flows

After obtaining the basic knowledge of energy statistics, the energy supply and demand situation in India was examined. It essentially involved a macro analysis of different energy sources especially their production and consumption. The analysis made by the Energy Advisory Board and annual non-official publications such as "Current Energy Scene in India" were helpful for conducting this part of the study which helped to examine the Indian energy data systems.

6.33 Indian Energy Data System

Various authors have studied the general characteristics of Indian energy data sub-systems and this part of the study involved identifying the institutional infrastructure, typology of data, published sources of the data and finally examining the gaps, if any, for each of the energy sources identified earlier.
6.34 Development of Database Framework

Developing a framework for recording energy data for each of the energy sources used in India was made possible by the following steps:

a) The analysis of energy balance structures described in Chapter - 3 has proposed a multipurpose energy balance structure.

b) The above structure was adopted for Indian conditions by identifying the relevant energy sources and energy flows.

c) In many cases, it was found that the energy flows are very complex. For instance, the database structure had to show the production of liquified petroleum gas (LPG) from two sources i.e., from petroleum refining and from natural gas. Hence, the data element under conversion had to be worked out carefully and the knowledge about the energy systems and energy flows was very useful.

This exercise resulted in the energy balance structure as described in Chapter - 5.

6.35 Development of Energy Commodity balances

The energy commodity balance for each of the energy sources was based on actual data for the year 1985-36. The
data were extracted from the published data sources. The rows of energy balance table served as a reference point while searching for the data in the data publications/tables. Also, it was necessary to decide the relevance of a particular row to a given energy source. For instance while compiling the commodity balance for crude oil, it was found that the entire quantity of crude oil including quantities produced, and imported were fed into the refinaries. In this case, the rows of consumption were totally irrelevant because crude oil is consumed not directly but as refined products. Similarly, the rows of supply were not relevant for soft coke produced by conversion of coal.

Thus, the preparation of energy commodity balances demanded knowledge of energy processes, data sources and a total understanding of the entire field of energy statistics.

6.36 Development of overall energy balance

The overall energy balance was prepared by integrating the energy commodity balances and later converting the data into a common unit of measurement. It proved to be a crucial test of the integrity of the data constituting the database. The overall energy balance for coal for instance
shows the complexity of the energy flows and also the built-in mechanism to check the validity of each data value.

The energy balance for coal shows that in 1985-86 a total of 158.05 MMT of coal was made available by imports, exports and stock changes in addition to the domestic production. There is also a separate account on how much coal was converted into softcoke and electric power as well as the quantities consumed by the various energy consuming sectors. The quantity of coal consumed and converted would tally with the total quantity made available. In other words, if each of the data values are not correct, it will not be possible to balance the data. Such a balancing problem has occurred in the case of electric power. The sectoral consumption of electricity is worked out at 1,33,308 GWH whereas the net electricity made available is on 1,33,138 GWH. The difference of 170 GWH or 0.014 MTOE is attributed to an error in the data obtained from various sources.

6.4 Accounting and Integrating the Data

In the overall energy balance, the energy data is presented in Million Tons of Oil Equivalent (MTOE) which is calculated at 10.2 million kilo calories. This conversion unit is based on the calorific value of the fuels. For instance, one ton of coal is estimated to contain the same
calories as in 0.49 ton of crude oil. However, it does not mean that in actual practice 0.49 ton of crude oil can be replaced by one ton of coal. It is because, the replacement is also dependent on the efficiency of energy conversion system. The purpose of converting the data into a common accounting unit such as MTOE is to have a comparable picture and also to know where the energy comes from and how it is being used.

Conversion of the data into a common accounting unit is the first step in integrating the data into a cohesive body of knowledge. The other stages in integrating the data are discussed below.

6.41 Vertical Integration

The energy systems go through a series of processes and at each stage something or other may happen to it. The purpose of vertical integration is to ensure that for each energy source all the relevant data are recorded in the appropriate column so that nothing significant is lost or remain unrecorded. The arithmetics of the data as per the database structure should be correct. For instance, consider the data on liquified petroleum gas. The country has consumed a total of 1.228 MMT of LPG. This quantity was obtained by conversion processes such as extraction from
natural gas (0.363 MMT) and petroleum refining (0.867 MMT). However, this quantity is in excess of consumption by 0.002 MMT.

The data show that a quantity of 0.002 MMT was added to the stock and hence the entire LPG produced is fully accounted. If there is any mismatch in the data, it may be necessary to go back to the original sources and examine their validity.

The vertical integration can be done at the stage of compiling commodity balances and also at the stage of compiling overall energy balances both in original units and in common accounting unit.

6.42 Horizontal Integration

Horizontal Integration of the data involves the data values in each of the rows i.e., individual energy processes or activities and ensuring that they balance as per the logic of the database. Since the energy processes such as energy production involve, more than one energy source which may be measured in different units, horizontal integration is possible only after converting the data into a common accounting unit. Subsequently, the energy production data can be integrated by adding up the production figures for each energy source and to obtain the total production (see energy balance table) as below.
Total energy production = Coal (75.57) + Crude Oil (30.168) + Natural Gas (7.343) + Hydro power (4.245) + Nuclear Power (0.415) = 117.748

Note: All the figures are expressed in MTOE.

At times, horizontal integration may also involve more than two rows. One such example is the production of LPG from natural gas and from petroleum refining. Since the processes may involve more than one energy sources, it will not be possible to add up the figures and arrive at the total production. What is possible is to ensure that the LPG production data from both the sources match with other segments of the database for supplies and consumption. This part of integration is similar to vertical integration.

6.43 Overall Integration

The purpose of overall integration is to ensure proper balancing and hence validity of the data. The prerequisite for overall integration is the conversion of data into a common accounting unit. In the case of the case study, MTOE was used as the common accounting unit.

The data recorded in rows can now be added up to make the "total" column. As already described, the columns are already integrated. Hence, the crucial test of validity of
the data is proper balancing of the total column as per the logic of the database, i.e.,

Production
+ Imports
- Exports
+ Stock falls
- Stock rise
= Consumption.

In the case of Indian energy balance database, there was agreement of the data as shown below:

Primary production of Energy as per rows of the energy balance Database:-

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>75.57</td>
</tr>
<tr>
<td>Oil</td>
<td>30.168</td>
</tr>
<tr>
<td>Gas</td>
<td>07.343</td>
</tr>
<tr>
<td>Hydro</td>
<td>4.245</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0.415</td>
</tr>
<tr>
<td>Total</td>
<td>117.741</td>
</tr>
</tbody>
</table>

As per "total" column

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand for consumption</td>
<td>101.334</td>
</tr>
<tr>
<td>Conversion losses</td>
<td>31.531</td>
</tr>
<tr>
<td>Stock requirements</td>
<td>2.384</td>
</tr>
<tr>
<td>Export demand</td>
<td>2.491</td>
</tr>
<tr>
<td>Total demand</td>
<td>137.740</td>
</tr>
<tr>
<td>Total Imports</td>
<td>19.999</td>
</tr>
<tr>
<td>Total Production</td>
<td>117.741</td>
</tr>
</tbody>
</table>

### 6.5 Repackaging of the Database

One purpose of information consolidation is to prepare a general purpose document which can be repackaged for specific purposes. The energy balance database compiled as part of the present research was found to be fully amenable for repackaging.

1) The database represents a highly consolidated version of the energy systems performance in a matrix form. The relationships between the data values are indicated by their position or placement. These relationships when expressed in textual form as explained in Sec. 5.53 and 5.61, a textual repackage can be obtained. The focus and corresponding relationships can vary according to the need.
2) Another important feature of the database is that it can be expanded or contracted as required. It may be in the form of addition of new energy sources and data related to them. It can also be in the form of further condensation or aggregation as explained in Sec. 5.62. Thus, depending upon the availability of data and needs one could think of different repackages of the data by expansion or contraction.

3) The database can also be restructured in the numeric form. One such possibility is the forecasting type energy balance described in Sec. 5.63. In this type of repackaging while the data values remain unchanged, their relationships and signs may be changed. For instance, on the forecasting type energy balance in the row for conversion losses, all the data with positive (+) signs became negative and all the data with negative (-) signs became positive as per the logic of the new database structure.

6.6 General Observations

The research study involved study of a new subject, development of a reference framework for an information product, collection of the data, development of the product as well as its repackaging. This study has resulted in the following general observations.
1) Substantial part of the research was devoted to the study of energy statistics and Indian energy statistics. This is justified because of the need to handle numerical information for which the information professionals will have to acquire adequate knowledge and skills in energy statistics. Another important observation is that it is not enough to have a knowledge of energy statistics, but one should also acquire indepth knowledge of the energy system of the country for the preparation of energy balance databases.

2) Another observation is that there is a definite methodology for preparation of energy balance databases. It starts with study of the subject, development of a reference framework, collection of the data and integration of the data into an overall energy balance. This methodology appears to be similar to the methodology developed for consolidating textual information which is described in the literature.

3) In the case of a textual information consolidation product, it was found necessary to consult subject experts especially for validation of the information. However, there is a difference in numerical database development. This difference arises from the fact that
the database structure provides a built-in facility to validate the data. If the data is inaccurate, the database will never balance. This feature of the energy balance database helps the information professional to do his own validation of the data and it may be considered an important finding of this study.

4) The present investigation has, as in the case of other information consolidation activities, generated a series of related products. These include a glossary of terms used in energy statistics and a curriculum for a course on energy statistics which are given in the appendix. Perhaps, what is more important is the knowledge of the energy systems, data sources, their strengths and weaknesses etc. which will help the investigator in compiling energy balances for subsequent years and also provide data services, if necessary.

5) The investigation shows that energy balance database work is an information work which if done as per the prescribed method will help the information professionals to produce new information products and services.

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