CARBON DIOXIDE EMISSIONS FROM ENERGY CONSUMPTION IN THE INDIAN ECONOMY (1970/71-1989/90): A STUDY OF ENERGY-ENVIRONMENT INTERACTION

Dissertation submitted to the Jawaharlal Nehru University in partial fulfilment of the requirements for the award of the Degree of

MASTER OF PHILOSOPHY

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Certificate

Certified that this dissertation entitled **Carbon Dioxide Emissions from Energy Consumption in the Indian Economy (1970/71-1989/90): A Study of Energy-Environment Interaction** submitted by **Milind K. Pathak** in partial fulfilment of the degree of **Master of Philosophy** is entirely his own work and has not been considered for the award of any other degree either at this or any other University.

We recommend that this dissertation be placed before the examiners for evaluation.

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Milind K. Pathak

Chapter 1

Introduction

"Be it known to all within the sound of my voice whosoever shall be found guilty of burning coal, shall suffer the loss of his head."

"...look you, this brave o'erhanging firmament, this majestical roof fretted with golden fire, why, it appears no other thing to me but a foul and pestilent congregation of vapours."

"We have met the enemy and he is us."

- A.L.Plumley[1]

[1.1] Each of the above quotation is a vocalization of the frustration of man upon the realization that his environment is becoming overloaded with waste. It appears from the first quotation that King Edward I of England, in 1276, dealt with offenders in a fashion that we would consider unacceptable today.

1 *Obtained from, A.L. Plumley (1973), Present Fossil Fuel Systems and Their Emissions', in R.L.Seale and R.A. Sierka (ed.), Energy Needs and the Environment, The University of Arizona Press, Arizona, 1973, p.165.*

The second, Hamlet's description of Elsinore castle, written by Shakespeare in 1600, is befitting most urban societies in our present day world. Indeed, the third statement, made by the comic strip character Pogo and recently quoted by the keynoter of an air pollution control conference, is a succinct recognition of the fact that technological man has provided the means of polluting the atmosphere - but he also holds the key to minimizing emissions.

Over the last two decades, scientific debate about life on other planets has recognized that something we usually take for granted is in fact remarkable. This is that conditions on Earth are 'just right' for living things. This is all the more surprising when we compare Earth with Mars and Venus. All three planets are formed from the same materials and started with atmospheres consisting largely of carbondioxide. Today Mars has virtually no atmosphere, so temperatures on the surface fluctuate enormously between day and night, and average -60^{0}C.[2] Venus, on the contrary, has a very dense atmosphere of carbondioxide and surface temperatures average 460^{0}C.[3] By contrast, large areas of Earth's surface have fairly equable temperature regimes as well as moderate variations in wind and water availability. Just as Goldilocks found some things in the three bear's cottage too hot or too cold or too soft, but others 'just right', so the Earth is remarkably well suited to

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2 *Philip Sarre and Paul Smith (with Eleanor Morris) (1991), One World for One Earth: Saving the Environment, Earthscan, London, with The Open University, 1991.*

3 *Ibid.*

complex life forms. The key to these conditions is the nature of the Earth's atmosphere, because without it, surface temperatures would, like the moon, average - 18^0C.[4]

When we look at the Earth's atmosphere and ask how it happens to be 'just right' for life, we find that the mystery deepens. Geologists have been able to show that the present atmosphere is completely different from the atmosphere which existed in the early part of the Earth's history. So what actually transpired was that over thousands of millions of years, blue-green algae removed carbon from the atmosphere. The presence of deep ocean, shallow seas and swamps provided a variety of ways for this carbon to be locked away from oxygen. In the process, the atmosphere became cooler as the proportion of carbondioxide decreased, and large quantities of oxygen was released into the atmosphere where it was available for respiration and combustion. The 'just right' condition for complex life forms were actually created by simple life forms. As living things have evolved into more complex forms, the environment also has evolved in parallel and the actual adjustment of living things and inanimate materials and processes is more than co-incidental.

But the balance between atmosphere and life is not static. Change one and the other must respond. The centre stage here is captured by none other

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4 *Ibid.*

than us, humans. This is amply guaranteed by a list - Table (1.1.1), of some of the items of concern and constituting an environmental problem. From the list, given in Table (1.1.1), by analyzing the items one can easily identify, atleast, four types of environmental damage. These are :

1. Threat to human health and safety.
2. Damage to economic resources and to material well-being.
3. Reduction in 'enjoyment of life' of a psychological/aesthetic character.
4. Damage to non-human environments - to nature.

Table [1.1.1]

Partial List of Items of Environmental Concern

Water pollution	Land-use	Urban decay
Air pollution	Energy utilization	Suburban sprawl
Resource depletion	Transportation - mass transit	Agricultural malpractices
Radioactivity	Feed-lots - 'Sewage' disposal	Solid-waste disposal
Noise pollution	Thermal pollution	Visual pollution
Fertilizer runoff	Pesticides	Wilderness preservation
Soil misuse-erosion	Bad lumbering - clear cutting	Oil spills

Source: AUTHOR
Note: Here, not only do some items overlap, but also many items are related to one another. This is chiefly due to the fact that, at times, individual items cannot be dealt with in isolation.

Moreover, we rightly have the environmental problems placed on a man-nature continuum. Here, we have 'harm to humans only', at one end and 'harm to nature only' at the other end. This continuum is presented in Figure (1.1.1).

Hence, the saying of Edward H.Thornadike in his 'Energy and Environment: A primer for Scientists and Engineers', (1976, p.107), which goes as, 'Since environmental problems are quantitatively based, we must continually ask, "How much is too much?" But ecosystems are very complex and our knowledge about them rather meagre. Since nature is a working system, it behooves us to be very careful in tampering with it. As a rule of thumb, we can use a "one percent law" - when anything man is doing approaches one percent of what nature is doing (on a regional scale), think very carefully before proceeding'.

[1.2] The extant and severity of human impact on the environment depend on the way societies organize production and consumption. Three broad methods have existed. For most of human history, human groups were small and mobile and lived as hunter gatherers. From about 10,000 B.C., agricultural societies began to appear, at first in the Near-East and then spreading into Asia and Europe. Over the last few centuries, industrialized societies have appeared, starting in U.K. and spreading into Europe, USA and East-Asia. Industrialization has not only transformed relations with the environment in industrialized areas or countries, it has done so even in surviving agricultural and hunting societies. This 'rippling out' of the effects of industrialization was felt by Ruskin and Muir a century ago; now it covers the whole globe and even reaches into space. So where the early impact on environment were local and often reversible, today's impact is global and perhaps irreversible.

But, can this go on and on? Should it go on and on ? Or just as the three bears reacted to Goldilocks' intrusion by chasing her out of their home, the ecosystems may also react to disturbances, ala Malthusian cycle. So, should it not so happen that if the disturbances becomes too extreme, our whole ecosystem may become unviable and change rapidly towards a new balance. In these cases where do we go. So how about conservation, if only 'for our own needs'.

[1.3] Although environmental conservation has had important pioneer thinkers and pressure groups in past centuries, surveys of the media, academic literature, dictionaries and encyclopedias show that there was a decisive change in about 1970. Before that time, environmental issues were discussed in a rather fragmented way, often under headings like ecology or conservation. Since then, the term 'environmentalism' (previously used to identify a theoretical position within psychology) has come into common use to identify a new way of thinking about such issues. This new usage stresses the integrated, even holistic, nature of environmental problems and the need to bring about social changes in order to improve matters. But serious problems remain: exactly how environmental problems are caused is difficult to specify; how society ought to change is even more contentious. A variety of value positions exist, and different individuals and organizations may hold views which combine aspects of each. Since values are crucial to policy, it is necessary to construct a clearer picture of the alternatives.

The question would be much easier to handle if, as mass media treatments sometimes imply, the protagonists could be unequivocally identified as exploiters versus environmentalists (now more familiarily known as 'greens'). But in practice, few are willing to admit to being exploitators of environments and most individual companies and government departments will pay lip-service to environmental criteria. Even avowed environmentalists are divided between dark (or deep) and light greens. The German Green Party, one of the few environmentalist groups to have held political office, has had intense debates between 'Fundis' (those whose environmental goals are paramount) and 'Realos' (those willing to compromise with the mainstream views in order to implement something).

Some of these complexities were already apparent from the nineteenth century. For example, the argument between Muir (the preservationist) and Pinchot (the conservationist) over damming of Hetch Hetchy split even the sympathetic Sierra club because some saw wilderness preservation as more important than municipal water supply and others did not.[5] Today, the attitudes to environment can be broadly classified as:[6]

1. **Environmental Imperialism** - To many in developed societies, whether in mid-nineteenth century Britain or in the USA of Ronald Reagan, the environment existed primarily as a resource. The main aim of society was to exploit resources for profits. In this view, demand for environmental resources would give them economic value, and to the extant that they had value they would be conserved in the sense of being rationed in use.

2. **Utilitarianism or Hedonism** - Born as a challange to laissez-faire, this view argues that the fundamental criterion for preferring one course of action to another is that it should maximise pleasure and minimize pains. While this principle seems clear and democratic, the calculation of pleasure and pain has always been contentitious - not least in the modern form of cost benefit analysis. In practice, pleasure has tended to be replaced by 'demand' and economic calculation to become central.

3. **Stewardship** - While the Judaeo-Christian tradition has often been seen by environmentalists as encouraging humanity to multiply and to have domain over Nature, it also produced the concept of Stewardship.

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5 *Ibid.*

6 *Ibid.*

Here, current occupiers are seen not as owning land or resources but as managing them on behalf of the creators. So they have to manage them responsibly and with an expectation of being held to account. A more modern version of Stewardship sees responsibility to future generations rather than to God.

4. **Romanticism** - Feelings very like those of Wordsworth are still current among people taking countryside recreation. A modern variant on the pantheism of Romanticism is the idea of a Gaia (the Greek goddess of Earth). However, Gaia is a more vengeful goddess than the 'oversoul' of Emerson, and threatens to eliminate the human species unless it mends its ways.

5. **Radical Environmentalism**- Evident as in the Greenpeace view that all species have equal rights to survive or in the Green party critique of industrial society. But in practice there has to be some compromise between people's need for even minimal supplies of food and clothes and the interests of the natural environments replaced by agriculture. There is also a problem of how to react to non-green people: is it sufficient to drop out of the mainstream and adopt the basic life style of Philosopher Arne Naess or should radical environmentalists actively oppose development activities, as do menbers of 'Earth First !'?

Further, a vital element of this new environmentalism has been the United Nations. It responded quickly to the new mood by holding the

Stockholm conference on Human Environment in 1972. This led to the 'Declaration on the Human Environment', which identified a fundamental human right to adequate conditions of life in an ungraded environment and the consequent duties to protect and improve the environment for further generations. It also led to the establishment of the U.N. Environmental Programme (UNEP) which initiated a monitering system for global pollution and climatic change. In 1983, the UN General Assembly set up the World Commission on Environment and Development under Gro Harlem Brundtland. The onus on it was to turn concern into co- operation, to identify long-term environmental issues and ways of tackling them and to propose strategies for sustainable development. Although the concept of sustainable development has proved difficult to define, it is the nearest that the international community has come to an integrated position on environmental issues and their solution. The Commission considered six challenges: growing population, food security, species and ecosystems, energy, industry and urbanisation. They proposed a range of linked policies, legal and institutional changes in their 1987 report 'Our Common Future'. This position was justified not only by appeals to human rights but by analysis which showed that many environmental problems are the result of excessive affluence while others result from grinding poverty. In tackling sustainable development in this way, the commission was reflecting a membership that spoke for the less developed countries as well as for more developed countries. In effect, they presented a powerful case for 'One World' response.

So infact, concern over environmental issue has come a long way. From being preserve of some 'rebels', it has been embraced by even those sections of business whose interests, it would seem, clash with any notion of regulation in the name of envirionment. How within such a short time, such a sea change has occured is still a bit of a puzzle but the fact of the matter is that these issues have become popular and if the trend continues then environmental regulation is going to be one of the bigger items on economic agenda in the near future.

[1.4] Now when the 'environmental revolution' arrived in the 1970s, economist were ready and waiting. The economic literature contained an apparently coherent view of the nature of the pollution problem together with a compelling set of implications for public policy. In short, economists saw the problem of environmental degradation as one in which economic agents imposed external cost upon society at large in the form of pollution. With no 'prices' to provide the proper incentives for reduction of polluting activities, the inevitable result was excessive demands on the assimilative capacity of the environment. The obvious solution to the problem was to place an appropriate 'price', in this case a tax, on polluting activities so as to internalize the social costs. Marshall and Pigou had suggested such measures many decades earlier. Moreover, pollution and its control through so-called Pigouvian taxes had become a standard text book case of the application of the principles of microeconomic theory. Economists were thus ready to provide counsel to policy makers on the design of environmental policy. This acceptance of economics, as a prime tool, to deal with problems of environmental degradation is best realised by the most recent treatise on environment, 'Our Common Future' - the U.N. Commision report on Environment and Development. Here, the prime focus is to forge a coherent link between environment and economics, the aim of the report being to bring about a marriage between environment and economics.

Environment and economics have indeed been together since time immemorial in an irresponsible relationship, bringing forth menance to society largely as a result of the underlying cycle of production and consumption. If the report succeeds in bringing about socially and legally acceptable junction of economics and environment and thereby proper recognition and planning of their joint results, there then ceases to be a public menance but, infact, may rather turn into a blessing for the society. Such coterminus environmental and economic issues can be seen as:

- Population and human resources: poverty of the majority of the world's population.
- Food security: sustaining the potential
- Species and eco-systems: resources for development.
- Energy: choices for environment and development

- Industry: producing more with less technology
- The urban challange: an ecological disarray.[7]

Thus, it is indisputable that any environment issue is an economic issue. Henceforth also Nordhaus's statement regarding environmental problem as the "grand daddy of all public goods".[8]

[1.5] The economics of pre-industrial agricultural societies is typified by Kautilya's 'Arthashastra'. Kautilya did not have to worry about manufacturing processes, output and its transportation. He did not have to worry about the use of chemical fertilizers and pesticides in agriculture and its resulting in problems of ecology. Infact Kautilya had a heaven to manage-forests, waters of springs and rivers, tanks for irrigation, and cultivation of food grains, vegetables, fruit gardens and dairy farming, all on a small scale. He did not have to bother about theories of economics, as his only concern was the economics of production, distribution and revenue, which primarily depended on the kings, and to care for royal stores that might perhaps be opened to the people in times of need. Therefore, the question of environmental damage, rights and privileges per se, did not arise.

With the advent of the Industrial Revolution came a new technology of

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7 *K.Rajaratnam (1993), Development and Environmental Economics: The Relevance of Gandhi, Centre for Research on New International Economic Order, Madras, 1993.*

8 *W.Nordhaus, A Sketch of the Greenhouse Effect, American Economic Review, Papers and Proceedings 81, pp.146-150.*

increasing production with less cost and greater profit, aided by founding of empires that were actually markets for the manufactured goods produced by the metropolitan country. New economic theories in relation to production, distribution, returns for factors of production and new theories of international trade were developed to rationalise the new trade potentials between the manufacturing centre and industrial raw material centres. The Western mind obviously could not operate without rationalising the production and distribution functions in terms of a so-called scientific theory.

Today industrial production, thanks to modern technology, has phenomenally expanded all over the world. The key to maximization of profit is the cost. The lower the cost, the greater is the demand and the profit. The producer considers only 'visible', and directly handled factors of land, labour, capital and organization, as cost factors. In the process, only the text-book factors of production, land, labour, capital, organization were taken into account for cost purposes ignoring some vital costs to the environment - short term and long-term - such as industrial waste, effluents, emissions, irresponsible use of non-renewable resources and other natural resources like forests for timber for exports, construction of huge hydro- electric dams submerging forests and uprooting human habitats, large-scale mineral development projects, construction of aerodromes, pollution of oceans, nuclear plants endangering lives of people all over the world, deforestation and other measures of unsettling tribal people, and fisherfolk on land and sea-coasts, and people living by river beds. Finally, the damage to ecosystems all over the world, resulting in global warmings, and the rise in sea level, endangering coastal cities, towns and villages, and polluting the water and fresh air all over the world, has endangered life on Earth. This is the cost, the social cost or the 'externalities' that the market equilibrium theory of perfect market has totally ignored. Confronted with the destructive impact of modern economic activity, economists have admitted that the market fails to deal with 'externalities' such as pollution and resource exhaustion. However, the basic model of the economy created by Adam Smith two centuries ago survives intact, with no admission that pollution and destruction of natural resources are internal and not external to the economic process. Nonetheless, Adam Smith's myth of the 'Invisible Hand' did work, making the few owners of capital and new technology phenomenally rich, at the expense of, amongst others, the global environment.

But the exploitation has now come a full circle. The optimism of the rich exploiter is rudely shaken by the environmental damage, and the cost to the environment has became apparent as the cost to society as a whole. It has to be reckoned with as part of the cost of production of goods and services, and which will tilt the equilibrium of the market price.

Although time and geography leave their imprint on the economic theories of Adam Smith, Alfred Marshall, Karl Marx, John Maynard Keynes and Samuelson, today we are forced to recognize the importance of environmental economics. The time therefore has come to launch a 'New Economics' in which the price theories, cost-benefit analysis, profit motive, and the market mechanism as reliable instrument of allocation of resources for production and distribution, will have to be revised. Thus in 1990, when the previously free market inclined Conservative government produced a White Paper on environmental issues, they chose to call it 'This Common Inheritance'. The value position it stated was that, while economic growth remained a desirable goal, the current generation had a duty to leave behind it an environment which would not prejudice the prospects of future generations. This is consistent with the concept of Stewardship. But to achieve this desirable end in practice requires significant changes to the way economic and political calculations are made. The economic calculations would have to change in two key respects. First, the costs of using stocks of resources or of polluting natural systems would have to be recognized - costs which at present lie outside our considerations and are known as 'externalities'. Second, decisions would have to be made in a much longer time-scale if the interests of future generations are to be secured. Such changes would have to extend not only to the budgets of every organization, but also to the way economic growth is measured. Currently, the concept of gross national product (GNP) is used, but it takes no account of environmental assets consumed and even gives credit for the additional economic activity brought about by accidents and disasters. Hence, as we see, any change of this magnitude would require determined government action and probably international agreement.

In other words, the forces of free market economy are no longer dependable instruments in allocating resources. Indeed, these instruments have, over the last two hundred years destroyed life giving resources and have brought mankind to the brink of disaster. It is in this light that the opening statement in John Broome's recent book, "global warming raises unique question about our responsibilities to future generations", becomes all the more important for the responsibility to take action today so that the future generations is not adversely affected is a very strong moral argument to bypass.[9] And in this respect, i.e., in relation to global warming as a potent global environmental concern, K.Ya. Kondratyev (1988) in his 'Climate Shocks: Natural and Anthropogenic', is of the opinion that primarily an increase in carbondioxide concentration intensifies the greenhouse effect, which, in turn, leads to global climate warming. So, what does greenhouse effect/global warming imply and how does it come into play. Simply put, how are we at the receiving end in all this.

[1.6] Greenhouse effect is not new. It is a natural geophysical process, a part of Earth's history for millions of millennia. Before humans or other living

9 *John Broome (1992), Counting the Cost of the Global Warming, The White Horse Press, Cambridge, 1992.*

species existed, this heat trapping process transformed the character of the planet, making Earth hospitable to life -'just right' for life, instead of a bleak, ice covered rock.

Indeed, most of energy available on Earth comes from the sun, arriving as electromagnetic radiation in the short wave part of the spectrum. More than 30%[10] of the incoming energy from the sun is reflected back to space by clouds and by water, land, and structures on the Earth's surface. Of the remainder, most is absorbed by the planet's surface. If the tale ended here, Earth's surface would long ago have heated up and melted, like an iron bar left in a furnace. But Earth's surface is kept in a perfect energy balance with its surroundings, radiating away as much energy as it absorbs. Because the Earth's surface temperature is so much lower than that of the sun, it radiates energy at a longer wavelength, principally in the infrared (IR) part of the electromagnetic spectrum.

Further, since the beginning in primordial times, molecules of several simple gases appeared in Earth's atmosphere. Some of these molecules, including water-vapour, carbon dioxide, and ozone are transparent to the incoming short wave solar radiation that passes through the atmosphere and is absorbed by the planet's surface. The energy is subsequently released as long wave, infrared radiation from the surface, which these simple gases can

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10 *Irving M. Mintzer and J.Amber Leonard (1994), 'Vision of a Changing World', in Irving M.Mintzer and J.Amber Leonard (ed.), The Inside Story of the Rio Convention, Cambridge University Press, Cambridge, 1994.*

absorb. Having absorbed the IR radiation from the surface, these molecules release energy isotropically (i.e., in all directions). Thus, for billion of years some of the infra-red energy released from Earth has been absorbed in the atmosphere and re-emitted downward, warming the surface. This process is popularly referred to as the 'green house effect', and gaseous molecules which are transparent to sunlight but absorb and re-emit in the IR part of the spectrum are called greenhouse gases (GHGs).

Nevertheless, the natural background greenhouse effect raises the planet's temperature by about 33° centigrade (C), from - 18°C to +15°C.[11] As a result, the ensuing surface warming has allowed water to exist on the planet's surface as a liquid rather than as a solid (ice), which, over the millennia has provided a rich substrata for the biological evolution of life.

But, thing are not as rosy as they seem to be. Just as 'everything in excess is poison', the recent trends in the average Earth-surface temperature goes far to cast a doubt on the benign nature of greenhouse effect. Infact, Mitchell's result (S.F.Singer, 1970a) shows a net warming of about 0.6°C (1°F) from 1880 to 1940 decade, and a net cooling since then of about 0.3°C (0.5°F). Is this a significant effect? As Mictchell points out, the magnitude of a 0.6°C fluctuation is about 10% of the 6°C change that distinguished the glacial from the interglacial conditions during the Pleistocene Ice Age. W.D. Sellers' (1969)

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11 *Ibid.*

calculation indicate that a decrease in the solar constant of 5% would be conclusively sufficient to start another ice age. This corresponds to an Earth-surface temperature change of about 4°C.[12] W.D.Sellers (1969), further indicates that a change of about 2% would increase the ice-caps. Thus it is clear that we should give serious consideration to environmental effects that cause global changes on the order of 0.5°C. Hence, on the global atmospheric concentration of the GHGs hangs the 'death-knell' of our 'just right' Earth. So, the question that do we have sufficient emperical evidence to support our claim of an impending catastrophe of global nature, becomes our 'Roshomon'- the gateway of truth.

In this case, regarding the global atmospheric concentration of GHGs and the global natural and anthropogenic sources and absorption of GHGs, we present the relevant information in the Tables (1.6.1.) and (1.6.2). The first thing which strikes us, when we go through the tables is the importance accorded to carbondioxide. Infact Mitchell (S.F.Singer, 1970a) points out that we can attribute about one-third of the noted world-wide warming trend from 1880 to 1940 to the increase in CO_2. Thus, even though CO_2 may have had only a small effect to date, it appears that the CO_2 build-up coming in the next century maybe of sufficient magnitude to cause major concern. The next thing

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12 *'Remembering that thermal radiation is proportional to the fourth power of the absolute temperature, we can calculate the temperature change as follows, $Q1/Q2 = (T_1/T_2)^4$ where $T = 288°K$, the average surface temperature of the Earth. If the solar input drops by 5% then we take $Q_2 = 0.95\ Q_1$, so $1.053 = (T_1/T_2)^4$, or $T_2 = 288/1.013 = 284°K$', in Henry C.Perkins (1974), Air Pollution, McGraw Hill Kogakusha Ltd., Tokyo, 1974, p.22.*

Table [1.6.1]

Global Atmospheric Concentrations of GHGs

Item	Carbon dioxide	Methane	Nitrous oxide	CFC-11	CFC- 12
		(Parts per million)		(Parts per trillion)	
Pre-industrial atmospheric concentration	280	0.80	0.29	0	0
1990 atmospheric concentration	353	1.72	0.31	280	484
Average change (ppm or ppt/year)	1.8	0.02	0.008	10	17

Source: R.T.Watson et al., (1992).

Table [1.6.2]

Global Natural and Anthropogenic Sources and absorption of GHGs

GAS	Source: Natural	Source: Man-Made	Absorption	Annual Increase in Gas in the Atmosphere
Carbondioxide (million metric tonnes of carbon)	160,000	8,000	165,000	3,200-3,600
Methane (million metric tonnes of gas)	160	370	500	28-37
Nitrous oxide (million metric tonnes of gas)	11	3	10	3-5

Source: Summarized from ranges appearing in R.T.Watson et al. (1992).

which should be noted is the predominant presence of GHGs in our atmosphere. So, the fact is that greenhouse effect, as a bad, is in operation andglobal warming a not too distant reality. Hence, unless we consciously act so as disprove Gro Harlem Brandtland's 'the world is one, but we are not' (Our Common Future, 1987), our 'just right' Earth may soon became a myth.

[1.7.] It is in this light that global negotiations on climate changes have generated considerable interest among environmental policy makers, economists, atmospheric scientists and various other parties. As fleetingly mentioned earlier - as seen in the Tables (1.6.1) and (1.6.2), there are four major GHGs: Carbondioxide (CO_2), Methane (CH_4), Chloroflurocarbons (CFCs), and Nitrous oxide (N_2O). Within the GHGs, CO_2 and CH_4 are most important. The role of N_2O in global warming has been down-graded in recent years, and agreement has been reached on the phasing out of CFCs. CO_2 is resident in the atmosphere for a period which is estimated at being between 50 to 200 years, while CH_4 has a shorter residence time of about 10 years. Consequently, the long term effects of emissions are substantially greater in the case of CO_2 whose emission is mainly due to the combustion of fossil fuel i.e., a result of energy consumption. On the other hand there is substantial uncertainity about the extent of anthropogenic CH_4 emissions. So, amongst all these GHGs CO_2 receives the most attention and rightly so. For this reason various authors have carried out analyses of CO_2 emissions at global and national levels.

While global approaches highlight the policy direction and the magnitude of the efforts required, C.R.Blitzer et al., (1991) have pointed out that the possibilities of GHG emission reduction needs to be discussed with country-level models with sufficient structural detail (- their model for Egypt shows that if Egypt curtailed GHG emissions in 20 years by 20% over base year CO_2 production levels, it would reduce the GDP growth rate by 3.13%. A reduction of 40% would slow GDP growth by 32.4%). And, alternatives at country level depend interalia on :

- Energy resources and technologies used (i.e., coal, oil, gas, hydro or nuclear).
- Development patterns (whether agrarian, industrial, or service oriented economy).
- Obtaining reliable emission estimates (easily ascertained from the energy balances of each country because they are directly related to energy consumption and cement manufacturing).

In this respect, India and China are increasingly being considered to be major players in global climate change because of their likely increase of CO_2 emissions due to increases in income and level of population, and because of their strong dependence on coal.

A case study of India is of particular interest to us, besides our being Indians, because India maybe the most populated country in the world by 2025, and its GHG admissions may rise substantially, despite the fact that at present it is the sixth largest CO_2 emitter in the world.[13] J.Parikh et al.,(1991)[14] have shown that, to accommodate even a modest rise of emissions by only India and China, the developed countries have to reduce their GHG emission by 30% by 2025, to keep global emission in 2025 at the same level as in 1986. India's emissions are projected to increase fourfold compared to 1986,and they would be only 0.36 tonnes per capita below the world average of 1.2 tonnes per capita in 1986.[15]

There is yet another concern about India's future fossil CO_2 emissions, for its major energy source is coal. This is because the proven coal resources are estimated at 56 billion tonnes, while oil and gas resources are only 756 million tonnes and 686 billion cubic meters respectively.[16] Thus, coal will continue to provide more than 60% of India's energy needs.[17] And to top it all, coal in India has the highest CO_2 emission co-efficient per primary Giga Joule (GJ).[18]

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13 *Jyoti Parikh and Subir Gokarn (1993), Climate Change and India's Policy Options: New Perspectives on Sectoral CO_2 Emissions and Incremental Costs, IGIDR, Bombay, September 1993.*

14 *J.Parikh, K.Parikh, Subir Gokarn, J.P.Painuly, Bibhas Saha and Vibhuti Shukla (1991), Consumption Patterns: The Driving Force of Environmental Stress, IGIDR, Bombay, 1991.*

15 *Jyoti Parikh and Subir Gokarn, op.cit.*

16 *Ibid.*

17 *Ibid.*

18 *Ibid.*

So, the combination of high population, coal predominance in energy use and high potential growth due to the current low income levels cause great concern about India's carbon emissions in international circles. It truly paints a real awesome picture. And, to be honest, herein also lies the motivation of our present work.

[1.8] In this work, what we will simply try to do without any eloquent grand ideas from the outset, is to address the question of global warming (-greenhouse effect) indirectly via generation of carbondioxide emissions. For this, we will take up the case study of India and a period spanning twenty years i.e., from 1970/71 to 1989/90. Our entire work will be based on actual for the Indian economy, and will involve the conventional methodology of generation of CO_2 emissions through, or rather from, fossil fuel consumption. Here, the only deviation which we will undertake is to incorporate in the consumption (ineffect, gross generation) of electricity within our calculation. Our only answer to this is that as our entire exercise involves not only an economy wide generation exercise, but we also will attempt to distribute this generation sectorally and, so, the major sectors into which we divide our economy (so as to capture its essence in toto) are: Agriculture, Transport, Power, Industry (inclusive of Services) and Domestic. Moresoever, as electricity cannot be stored and is in turn consumed by the rest of the sectors in our sectoral classification, to get the correct picture, we have to reallocate the emissions due to its generation to rest of its consuming sectors. This is all the more important because, along with our generation exercise, we will also calculate the energy consumption in terms of energy units so as to relate the emissions of CO_2 with the amount of energy consumed, for if we do not do this then our entire exercise of generation of CO_2 emission out of consumption of energy fuels will prove to be futile as its essence will be lost. Again, without energy consumption data, our attempts at analysis and projections will be strangled.

After obtaining the much needed inventory on CO_2 emissions out of fossil fuel consumption, for the entire economy as well as sectorally, we will attempt our hand at analysing the data obtained and, on its basis, try to carry out some projections for the Indian economy. This is in effect what our entire work will contain. Although it is certainly not a pathbreaking attempt, nor does it lead to any CO_2 emission reduction exercise, we still feel it is of great importance for it attacks the question of global warming (-greenhouse effect) on its head.

This it does by giving a database-an emperical evidence-of its causal factor (CO_2) and, along with it, the corresponding energy consumed which leads to its production. Thus, using the database, one can now go ahead and get into the question of policy implications, reduction feasibility, etc. Again, the work gives us a consistent, and sound, methodology applicable to the Indian economy. Finally, as it is based on actuals, the work provides us with facts on what has taken place and so, ceteris paribus, where we are heading.

Before we go into out work proper, it is our right to bring our shortcomings to notice, for never have we nor are we going to claim to produce a perfect exercise. Our major shortcoming is not being able to carry-out a similar exercise for CO_2 emissions from land-use and deforestations i.e., via the biota cycle. Here, more than any another factor, the time factor is responsible. But, we feel that, despite this flaw, we can still proudly present our work and go into the methodology of the work proper on the same note as the conclusion of the first World Climate Conference, organised by the World Meteorological Organisation (WMO) in Geneva in 1979 and which stated, '... it can be said with some confidence that the burning of fossil fuels, deforestation, and changes of land use have increased the amount of carbondioxide in the atmosphere by about 15% during the last century and that it is at present increasing by 0.4% per year ... it appears plausible that an increased amount of carbondioxide in the atmosphere can contribute to a gradual warming of the lower atmosphere...'[19]

[1.9.] The next chapter will include a more detailed introduction to our work. There, we will talk more about carbondioxide, necessity of energy consumption and how we can use these for our purpose. A brief outline of the methodology

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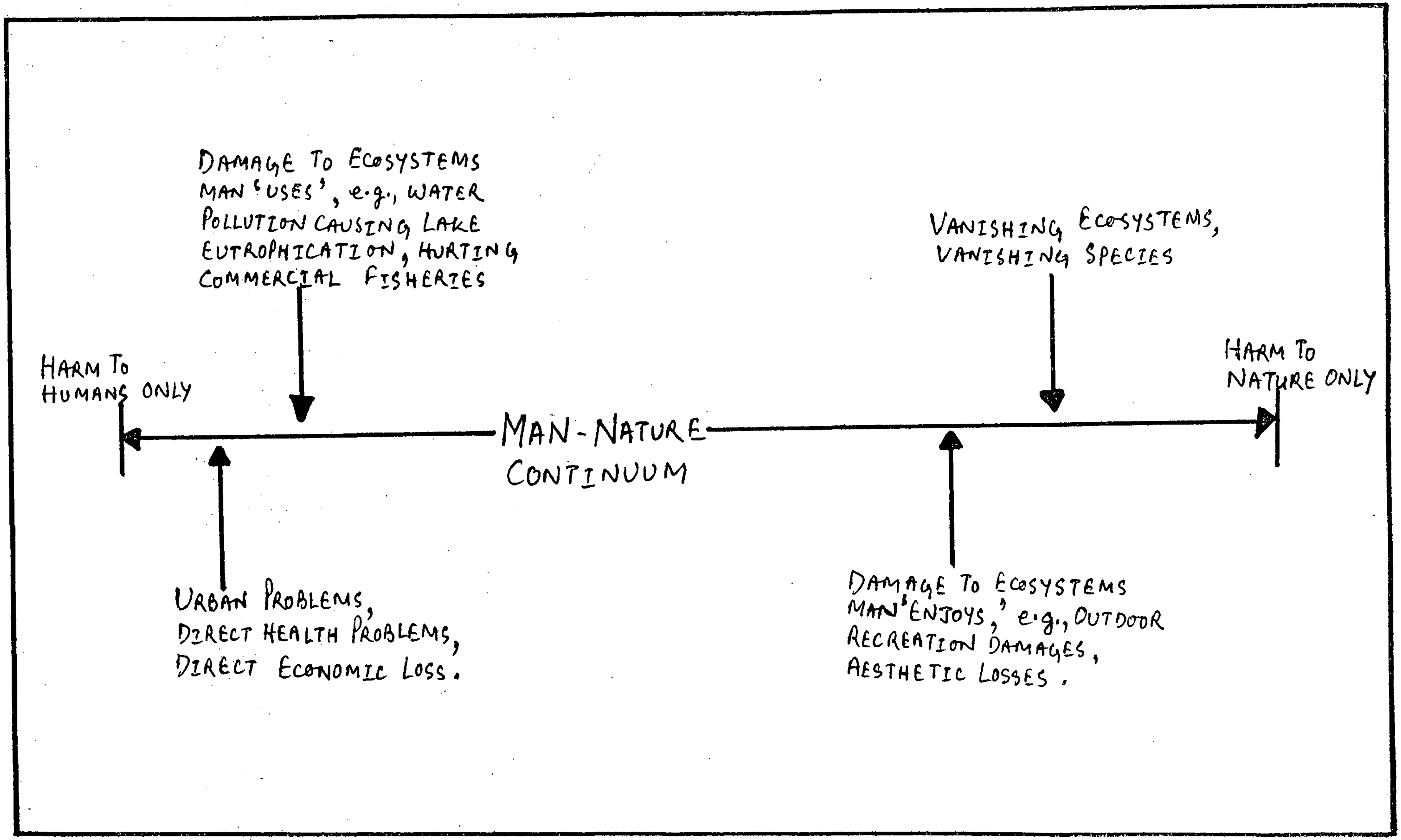
19 *Chandrashekhar Dasgupta (1994), 'The Climate Change Negotiations', in Irving M.Mintzer and J.Amber Leonard (ed.),* *Negotiating Climate Change: The Inside Story of Rio Convention,* *Cambridge University Press, Cambridge, 1994, p.129.*

adopted will be presented in that chapter. Then in chapter 3, we will re-iterate our stand on environment and economics and, infact, delve into the generic category of ecological economics. This chapter may, to some, seem unnecessary and redundant. But, we feel its importance for not only it justifies our undertaking of this work, but also brief us about the necessity of this 'new kind of economics' fast gaining importance. Following this chapter, the next three chapters - chapters 4, 5 and 6 - will contain description of the methodology adopted for our exercise. They, in addition, will also give us our first sight at the kind of data which we are trying to obtain. In chapter 7, we will discuss a paper presenting an alternative to the methodology which we have adopted, in achieving generation of CO_2 emissions. And in the concluding chapter (Chapter 8) we will not only discuss our results obtained, but also get around to making some projections and discussing the ensuing policy implications. Naturally, the conclusions following our work will also be presented here.

Figure to Chapter 1

FIGURE [1.1.1] THE ECONOMY-ENVIRONMENT INTERACTION.



SOURCE : B. BOLIN (1989).

Chapter 2

Energy and Carbondioxide

[2.1] Imagine, if you can, a world in which energy could not be produced, stored, distributed, or used as it is today. Think of the silent roads, buildings half-complete, factories halted. Imagine no cement, no steel, no glass. Think of homes unheated and food uncooked. Just think.

Energy is an essential input in all production and many consumption activities. With existing technologies, increasing per-capita productivity needed to increase per-capita income requires increasing amount of energy. Infact, without an assured supply of energy, rapid economic development is not likely. Schumacher aptly sums this overwhelming importance of energy in any economy when he says, 'There is no substitute for energy, the whole edifice of modern life is built upon it. Although energy can be bought and sold like any other commodity, it is not just another commodity, but the precondition of all commodities, a basic factor equally with air, water and earth'.[1] Infact, we can safely say that industrialized societies today are characterized by consumption patterns demanding large qualities of energy and fuel, and modern technology and living styles have evolved on the expectation of uninterrupted supplies of conventional energy forms. Table (2.1.1) shows us the history of energy use, and one thing which we infer straight away is the phenomenal growth in

Table [2.1.1]

History of Energy-use

Year	World Population	World Av. P.C. Energy use (Kcal/man-day)	Most Adv. Cult.	P.C. Energy use (advanced culture) (Kcal/man-day)
10^6 year ago	1×10^6	2×10^3	Primitive man	2×10^3
10^5 year ago	2×10^6	3×10^3	Hunting man (Europe)	5×10^3
5000 B.C.	35×10^6	9×10^3	Early Agr. man (Fertile Crescent)	12×10^3
1400 A.D.	0.5×10^9	15×10^3	Adv. Agr. man (N.W.European)	26×10^3
1875	1.5×10^9	25×10^3	Ind. man (England)	77×10^3
1970	4×10^9	60×10^3	Tech. man (U.S.)	230×10^3

Av. = Average; P.C. = Per Capita; Adv. = Advanced; Cult. = Culture; Ind. = Industrial; Tech. = Technological; Agr. = Agricultural.
Source: Adapted from E.Cook, 'The Flow of Energy in an Industrial Society', Sci. American 224, 1971.

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1 *Taken from G.Kirk (ed.) (1982), Schumacher on Energy: Speeches and Writings of S.F.Schumacher, Jonathen Cape, London, 1982, p.1.*

energy use vis-a-vis the corresponding growth in the development of mankind. The conclusion which we derive simply re-inforces our stance i.e., energy use and economic development are inseperable and interdependent.

In India, the importance of the energy sector is best depicted by Table (2.1.2). The table clearly shows energy to be the forerunner of development, for the sector does garner in 28.2% of the planned outlay - the largest sector in terms of plan outlay; 7th five year plan.

Table [2.1.2]

Share of Energy Sector in Plan Outlay (%)

PLANS	POWER	PETROLEUM & GAS	COAL & LIGNITE	TOTAL
FIRST	19.7	N.A.	N.A.	19.7
SECOND	9.7	0.8	1.9	11.8
THIRD	14.6	2.6	1.3	18.5
ANNUAL	14.1	2.7	1.1	17.9
FOURTH	18.6	1.9	0.7	21.2
FIFTH	18.7	3.6	2.9	25.2
ANNUAL	18.4	4.2	0.2	22.8
SIXTH	16.7	7.8	3.5	28.1
SEVENTH*				28.2

[* - "Breakup" data not available (N.A.)]

Source: Compiled form,

1) Prof. R.P.Sengupta, (1993), and
2) Govt. of India, Planning Commission, <u>8th FYP</u>, vols.I & II, 1992/93-96/97.

Not only this, the elasticity of energy consumption (commercial) with respect to gross domestic product (GDP), for India, is also exceeding unity - Table [2.1.3].

Table [2.1.3]
Elasticity of Consumption of Commercial Energy with Respect to GDP.

PERIOD	COAL	OIL	ELECTRICITY	TOTAL COMMERCIAL ENERGY
1953/54 - 60/61	1.10	2.14	3.02	1.37
1960/61 - 70/71	0.53	2.31	3.04	1.16
1970/71 - 80/81	0.98	1.83	2.06	1.37
1980/81 - 90/91	0.31	1.12	1.57	0.82

Source: Govt. of India, Planning Commission, 8th FYP, vols.I & II, 1991/92-96/97.

What the table implies is that any acceleration in the growth of GDP would require an increase in the share of investment in the energy sector and thereby augmenting the incremental capital-output ratio (ICOR) of the economy. So, it is obvious that commercial energy sets the effective constraint on the achievable rates of growth of the economy, as the capacities of all other producing sectors would remain underutilised, and would have an adverse effect on the overall productivity of capital in the economy, if the various forms of energy are not adequate in supply. Hence, the necessity of energy in the development of the Indian economy is of prime importance. But this is just one half of the story encompassing the energy sector.

When we look at the other half of the story, our findings take on a scary demeanor, and what we experience is a rollercoaster ride into the 'Dr. Jekyl and Mr. Hyde' drama. Table (2.1.4) apphensibly tries to capture the essence of this 'dark side' of the energy sector.

From the table i.e., Table (2.1.4), it is crystal clear that energy use (-specially the use of fossil fuels) is primarily responsible for environmental damage. Infact, on the numberline of energy use, we have development of any economy on the positive axis and environmental degradation on the negative axis. Thus, these two also seem to be inseparable - sealed by the necessity of energy use.

Amongst the various kind of environmental damages caused by the use of fossil-fuels, in lieu of energy needs, polluting the atmosphere by emitting carbondioxide and strengthening the formative effects of global warming, in the longrun, is a common thread running across these energy constituents. Infact, since the Industrial revolution, atmospheric concentration of carbondioxide have risen more than 25%, principally because of fossil fuel combustion (IPCC 1992) - which accounts for more than 99% of total U.S. CO_2 emissions[2]. This concentration of CO_2 emissions, as a result of energy use, is

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2 *U.S. Department of State (1994), <u>Climate Action Report: Submission of the United States of America under the United Nations Framework Convention on Climate Change</u>, U.S.Government Printing Office, Washington D.C., 1994.*

Table [2.1.4]

Environmental Analysis of Various Energy Resources

Type of Energy	Energy Sig.	Non renewable	Renewable	Air Polln.	Water Polln.	Land Impact	Visual Polln.	Thermal Polln.	Wilderness Impact	Noise Polln.
Oil	4	x		3	2	4	3	2	3	2
Natural Gas	3	x		1	1	1	1	2	1	1
Coal	4	x		4	3	3	2	3	3	1
Syn.Fuels	Exp.	x		1	3	3	2	2	2	2
Nuclear Fission (normal Operation)	2	x		1	1	1	1	2	1	1
Nuclear Fission (Accident)		x		4	4	4	?	3	4	?
Nuclear Fusion	Exp.	?	?	?	?	?	?	?	?	?
Geo-Thermal	1	?	?	1	1	1	2	1	2	1
Solar	2		x	0	0	1	1	0	1	0
Hydro	2		x	0	1	3	1	0	2	0
Wood	2		x	4	1	1	2	1	1	1
Wind	1		x	0	0	1	2	0	1	2
Bio-Mass	1		x	1	1	2	1	1	1	0
Tidal	1	?	?	0	1	0	1	0	1	0
OTEC	Exp.		x	0	1	0	1	1	?	0
Wave Power	Exp.		x	0	1	0	2	0	2	1
Conservation	3		x	1	0	0	1	0	0	0

Exp.: Experimental; O: Negligible; 1: Some; 2 : Considerable; 3: very much; 4: extreme; ?: unkown; Sig.: Significance
Source: Based on a Chart Developed by Jane Albee, Vermont Technical College, Randolph Centre, VT. Obtained from Russell Mills and Arun N.Toke (with Susan Mills, 1985).

best exemplified by the case of United States of America, where 88% of U.S. energy is produced by the combustion of fossil fuels.[3] This is shown in Table (2.1.5)

Table [2.1.5]
Source of CO_2 Emissions for U.S.A: 1990
(Million metric tonnes)

Source/Sinks	CO_2 Emissions (Molecular basis)	CO_2 Emission (Carbon Equivalent)
Sources	4,956.6	1,351.7
Fossil fuels consumption	4,895.0	1,335.0
Fuel production and processing	6.6	1.8
Industrial process	55.0	15.0
Sinks	(436.0)	(119.0)
Forestry and land use	(436.0)	(119.0)
Total Net Emission	4,520.6	1,232.7

***Source*: Compiled from US EPA, 1994. Obtained from *Climate Action Report* (1994).**

[2.2] Now carbondioxide (-the inevitable result of combustion process), at standard temperature and pressure, is a colorless and odorless gas. It can be solidified as the familiar 'dry ice'. Our interest, here, in CO_2 exists because it is one of the prime gases that absorbs thermal radiation. Carbondioxide, primarily, absorbs radiation in the infrared zone and not in the visible zone.

3 *Ibid.*

Consequently, it passes solar radiation without much interference, but absorbs and reradiates much of the terrestrial radiation emitted from the earth. In particular, it has radiation absorption bands of about 2.7 microns, 4.3 microns, and in the 12 - to 18 - micron wavelength range. So, as CO_2 is an absorber of radiation in the infrared, particularly in the 12-18 micron range, it acts to put a lid on radiation from the earth to space. Incoming solar radiation is essentially unaffected.[4] Thus, we have absorption and re-emission (at the lower temperature of the upper atmosphere) by CO_2 as noted in Figure (2.2.1). Therefore, as carbondioxide builds up, absorption increases and it is more difficult for terrestrial radiation to get out into space. (A primer to carbondioxide is presented in the appendix - Table 2A, to this chapter).

What is the magnitude of this effect? Calculations by Manabe (S.F.Singer, 1970a), which include the positive feedback effect of increased water vapour with higher temperatures, yield a 0.5°C surface warming for a change from 320 parts per million (ppm) to 375 ppm - Table (2.2.1), and a 2°C warming for a doubling of atmospheric CO_2. The former temperature increase is significant and the latter is a very large change, which undoubtedly would cause major global climate changes, among them the melting of polar ice.

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4 *This is the origin of the term 'greenhouse effect', since the glass in a greenhouse is also transparent to short-wavelength solar radiation. But like CO_2, the glass absorbs the long wavelength radiation emitted from inside the greenhouse. However, the glass also reduces convective cooling of the plants by the outside air and this is the dominant effect.*

Table [2.2.1]

Change in Equilibrium Temperature of the Earth's Surface in °C, Corresponding to Various Changes of CO_2 Content of the Atmosphere

Change of CO_2 Content (ppm)	Fixed absolute humidity		Fixed relative humidity	
	Average cloudiness	Clear	Average cloudiness	Clear
300-->150	-1.25	-1.30	-2.28	-2.80
300-->600	+1.33	+1.36	+2.36	+2.92

Source: Manabe in S.F.Singer, (1970a).

[2.3] The evolution of the concentration of carbondioxide in the earth's atmosphere during the last 100 million years may be divided into three stages.[5] During the first stage, from 10^8 years B.P. until the last ice age - 10^4 years B.P., very large, and as yet poorly understood, changes in the atmospheric CO_2 level are thought to have occurred. From an initial concentration, perhaps as high as several thousand parts per million (ppm) in Cretaceous times, the atmospheric CO_2 level fell gradually toward much lower values (200-300 ppm) characteristic of the glacial - interglacial cycles of the past few million years. The CO_2 level seems to have varied in a regular, periodic fashion, cycling at the ice-age frequency (- 10^5 years) between a low

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5 *Obtained from R.H.Gammon, E.T.Sundquist and P.J.Fraser (1985), 'History of CO_2 in the Atmosphere', in John R.Trabalka (ed.),* Atmospheric Carbondioxide and the Global Carbon Cycle, *U.S.Department of Energy, December 1985.*

value near 220 ppm (cold, glacial phase) and a high value near 270 ppm (warm, interglacial phase) several times during the last million years.

The second stage was the postglacial period of relatively steady atmospheric CO_2 concentration (260-290 ppm), which lasted from 10,000 year B.P. until the beginning of the 19th century. The small variations in CO_2 level observed or inferred during this period are considered natural, and human influences on these variations minimal until recent millennia.

The third stage, from 1800 B.P. to the present is the one in which the human impact on the global carbon cycle becomes clearly measurable in the atmosphere in tree rings, in ice cores, and in the ocean. Initially during the 19th century through land-use practices (ie., deforestation) to meet needs of a growing global population, and later during the 20th century through the increasing reliance of the world on fossil fuel energy resources, human activities rapidly came to dominate all natural sources of CO_2 variability.

The modern period of very precise (<0.1%) time series measurements of atmospheric CO_2 began with Kneeling's pioneering infrared measurements in Hawaii in 1958. But before him, the Swedish chemist Svante Arrhenius (1896) had already pointed out, before the end of the last century, that an increasing amount of carbondioxide in the atmosphere might cause a warmer climate. This idea has remained alive in the 20th century, for thereafter Callender (1938) showed rather convincingly in the 1930s that the atmospheric CO_2 concentration was increasing. We now have 30 years of continuous measurement, principally due to C.D.Kneeling

The observations from Mount Loa on Hawaii {shown in Figure (2.3.1)] have become classical of man's global influence of CO_2 on the composition of the earth's atmosphere. The average annual increase has accelerated from 0.7 ppm per year in 1957 to 1.3 ppm per year at present.[6] Further, the pre-industrial CO_2 concentration in the atmosphere was around (280 $\pm$ 5) ppm (A.Neftel et al., 1985), whereas the increase during the industrial era since, say, the beginning of 19th century, has been (70 $\pm$ 5) ppm, which is equivalent to (148 $\pm$ 11) x 10^9 tonnes (t) of carbon.[7]

The change in recent years is undoubtedly due to human activities. Estimates yield a total emission of carbon in the form of CO_2 by burning fossil fuels since 1860 at (190 $\pm$ 2)x10^9 t of carbon (R.M.Rotty and G.Marland, 1986) and a decrease of carbon stored in living and dead organic matter on land, over the same period of (150 $\pm$ 50) x 10^9 t of carbon (B.Bolin, 1986). Thus, an estimated (340 $\pm$ 62) x 10^9 t of carbon has been emitted as CO_2 over the industrial era, but we observe a rise of CO_2, in the atmosphere, equivalent to (148 $\pm$ 11) x 10^9 t of carbon. So, if less than half (45 $\pm$ 10%) of the CO_2 emitted in the atmosphere has remained there (-which itself is more than sufficient to

6 *Bert Bolin (1989), 'Changing Climate', in Laurie Friday and Ronald Laskey (ed.), The Fragile Environment, The Darwin College Lectures, Cambridge University Press, Cambridge, 1989.*

7 *Ibid.*

sound the doom of our 'just right' earth), where has the rest gone?[8]

To answer this question we need to analyze the pathways of carbon in nature i.e., the carbon cycle. Since carbon is the fundamental element of life, the global carbon cycle also describes the basic global characteristics of both the terrestrial and marine ecosystems. Although a detailed study of these very complex systems is necessary before we truly understand their behaviour, an overall picture of the major carbon reservoirs in nature and their large-scale exchange of carbon is helpful in the present context; Figure (2.3.2) shows the gross features of interest. We note that the amount of carbon in living matter on land, (560×10^9)t, is merely about 75% of the amount presently found in the atmosphere, (735×10^9)t, while on the other hand the amount of carbon in the form of coal, oil and gas within possible reach, although not commercially exploitable at present, is 10-12 times larger than the amount temporarily stored in terrestrial biota.[9] We, therefore, conclude that continued exploitation of world forests would contribute to a modest increase of atmospheric CO_2, while the use of future fossil fuels might cause a major change.

Finally, if we limit our fossil-fuel use to that which will double atmospheric CO_2 - already a rash thing to do - then assuming half of the fossil fuel carbon stays in the atmosphere, we can burn only 1400 billion more tonnes of fossil fuel carbon, which is about 20% of the world's coal supplies. At present

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8 *Ibid.*

9 *Ibid.*

levels of use that would take 300 years; at present growth rates, 65 years.[10] The preceding limit assumes that fossil fuels are burned 'suddenly', over a period of hundred years. If they were burned 'slowly', then the CO_2 concentration in deep ocean would have time to come to equilibrium with that of the surface layers, and a much larger total amount of fuel could be burned for the same atmospheric CO_2 increase. The time required for this equilibrium is of the order of a few thousand years, implying that we must use fossil fuels more slowly than we do now if we are to avoid the 'greenhouse limit' of 20% of the supplies (given above).[11]

[2.4] Thus, since 1988, hundreds of scientists have been working under the auspices of the Intergovernmental Panel on Climate Change (IPCC), to improve our understanding of the greenhouse issue. There is clear evidence that average global temperatures have increased by between 0.3°C and 0.6°C during the last hundred years.[12] Also in the last century, sea levels have risen, on average, by between 10cm and 20cm.[13] Glaciers world-wide have been melting. These changes are consistent with those that could be expected

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10 *Edward H.Thornadike (1976), Energy and Environment: A primer for Scientists and Engineers, Addison - Wesley, 1976.*

11 *Ibid.*

12 *Adam Markham, Nigel Dudley and Sue Stolton (1993), Some Like it Hot: Climate Change, Biodiversity and the Survival of Species, WWF, Switzerland, 1993.*

13 *Ibid.*

as a result of the growing concentration of greenhouse gases in the atmosphere since the industrial revolution.

Consensus in the IPCC predicts that if greenhouse gas emissions continue to grow at the current rate (the so-called Business-as-Usual Scenario), the following will become apparent:

1. Global mean temperature will raise at a rate of 0.3°C per decade to, 1°C above the current value in 2025 and, 3°C above before the end of the next century.[14]
2. Global sea levels will rise by approximately 6 cm per decade, to about 20 cm above present levels in 2030, and will be 65 cm higher by the end of the next century.[15]
3. Global warming will not be uniformly distributed. The greatest warming will be experienced at higher latitudes in the northern hemisphere. Some areas of North America might warm by 8°C for instance, whilst warming in the tropics might not be by much more than 1°C.[16]
4. In general, rainfall will increase throughout the year in the tropics and nearer the poles. In mid latitudes the increase will occur in winter. However, rainfall changes are extremely difficult to predict at a regional

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14 *Ibid.*

15 *Ibid.*

16 *Ibid.*

scale, and many regions will experience significant reduction in precipitation.

5. In many places increases in rain-fall will not compensate for increased evaporation and evapotranspiration due to temperature rise, and drying of soils will occur.

6. There will be considerable changes in daily and seasonal weather patterns. Increased sea-surface temperatures are likely to lead to an increase in the frequency and intensity of tropical storm events as well as an expansion of their geographical extent.

So, we see that effects associated with carbondioxide goes beyond the phenomena of greenhouse effect. Infact the interrelations among the phenomena associated with the CO_2 is vividly captured in the Figure (2.4.1). It is in this light that we have undertaken the task of carrying out our present exercise, namely a case of CO_2 generation through energy consumption, and its distribution sectorally, for the Indian economy. Also, our reason for adopting a methodology which calculates CO_2 emissions via the conventional energy consumption side is ably enumerated above - in the importance of fossil fuel combustion in the generation of CO_2 emissions. And, we have taken-up a case study of India, not only because of its population (-and its projection), or its dependence on coal, but also because by using the 'carrot' of world trade agreements and international trade, such third-world developing countries with a lower per-capita emissions may very well get the 'stick' by its being transformed into 'pollution heavens'. Finally, this country specific generation exercise will give us a database for important policy decisions and policy projections, and would go a long way in making people aware of the impending 'doom' to their 'just right' earth, and crystallize India's position vis-a-vis the rest of the world's upon the question of global warming and bearing the onus of its responsibility.

[2.5] The methodology (to be given in great details in the following chapters 4, 5 and 6) which we will adopt, for our exercise, is based on the following concept:

Estimates of CO_2 emissions from fossil fuel depend on three factors - consumption of the fuel, the amount of carbon in the fuel, and the fraction of fuel that is oxidized. The reliability of the estimates depends on the quality of the available quantitative data concerning these factors. Fuels are categorized as solids, liquids, and gases and the three factors are analyzed for each category (G.Marland and R.M.Rotty, 1983, 1984). For each fuel type the CO_2 emissions ar given by-

$CO_2 = (P_i)\ (FO_i)\ (C_i)$,[17]

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[17] *Obtained from R.M.Rotty and C.D.Masters, 'CO2 from Fossil Fuel Combustion: Trends, Resources, and Technological Implications', in John R.Trabalka (ed.), Atmospheric Carbondioxide and the Global Carbon Cycle, U.S. Department of Energy, December 1985.*

Where CO_2 represents the carbon emissions for a particular fuel type (i), P is the annual consumption of that fuel, FO is the fraction of that year's fuel consumption which is oxidized, and C is the average carbon content of that fuel Further, for a more meanful and precise definition of the carbon content of the fuel, chemical composition can be (and infact maybe) correlated with heating value. Finally, specifically in the case of natural gas (where reinfected gas is not counted, and gas flared is treated separately), gas liquids are grouped with liquid fuels. For, liquid fuels is defined as the sum of petroleum products and natural gas liquids (G.Marland and R.M.Rotty, 1984). So, the largest uncertainty in estimating CO_2 emission from fossil fuels is associated with fuels consumption data.

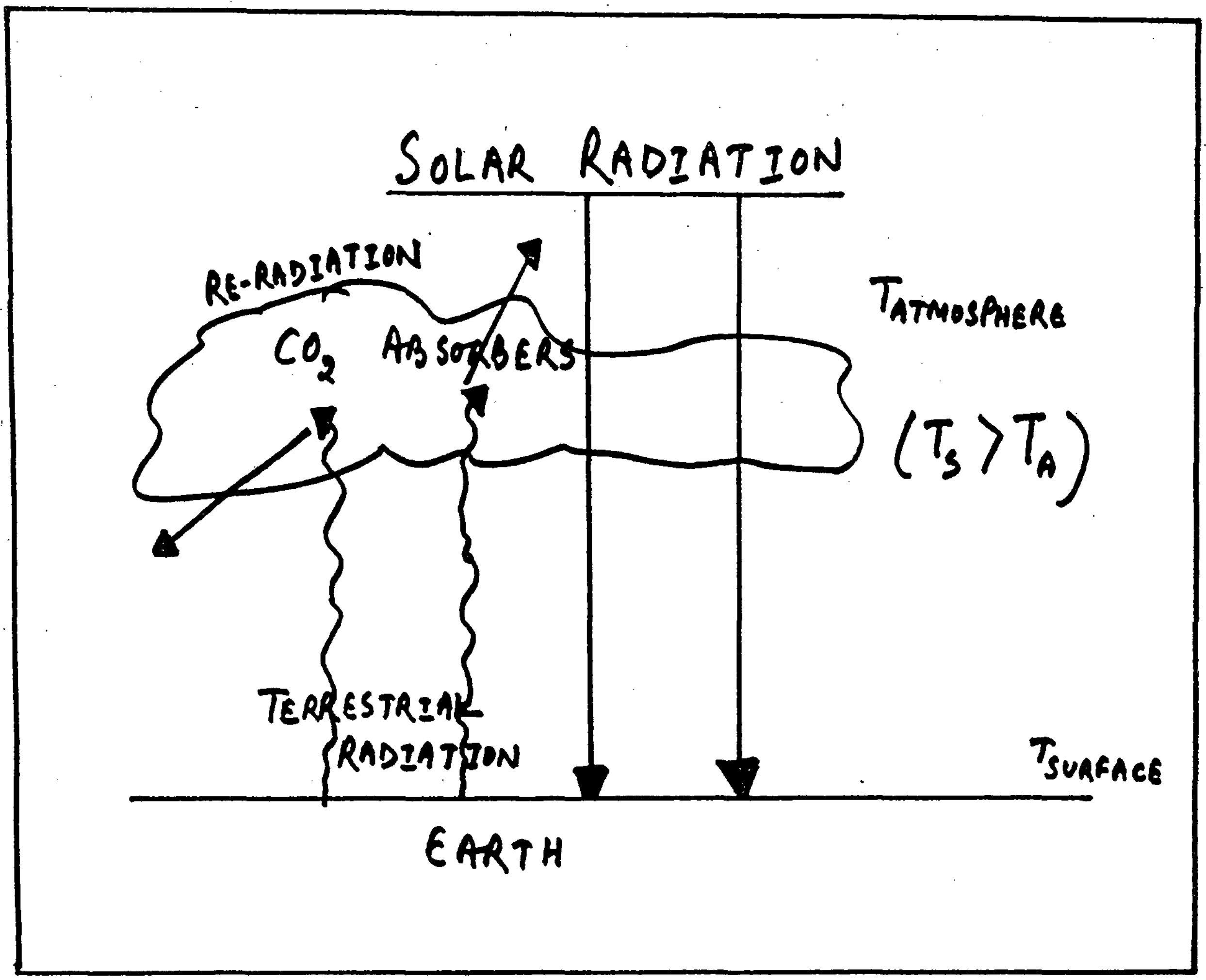
We will follow this methodology in our generation exercise and make the necessary modification as and when required.

But before we go into a proper description of our methodology, along with its immediate results, we would make a deviation and explore the sphere of 'environment' and 'economics' a bit more so as to justify why have we chosen to do our present exercise within the canopy of economics.

Figures to Chapter 2

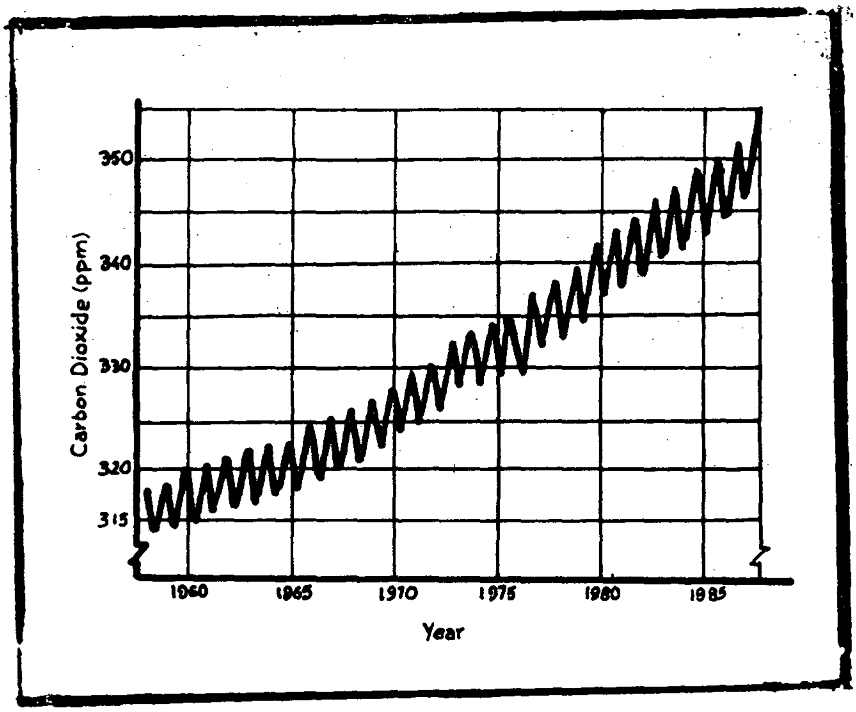
FIGURE [2.2.1]

THE GREENHOUSE EFFCT



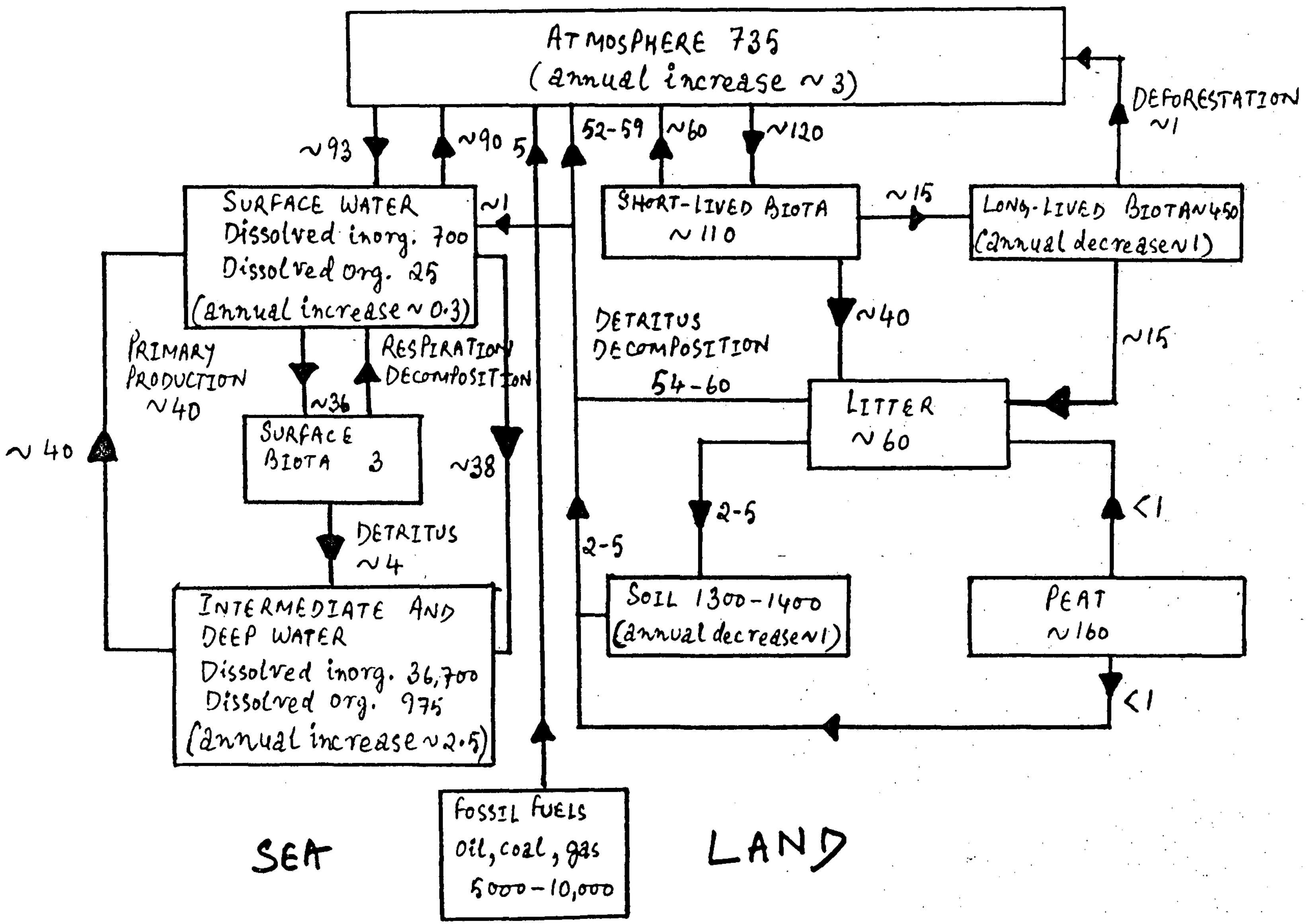
SOURCE: HENRY .C. PERKINS (1974).

FIGURE [2.3.1] THE CARBONDIOXIDE RECORD FROM MOUNT-LOA SINCE 1958.



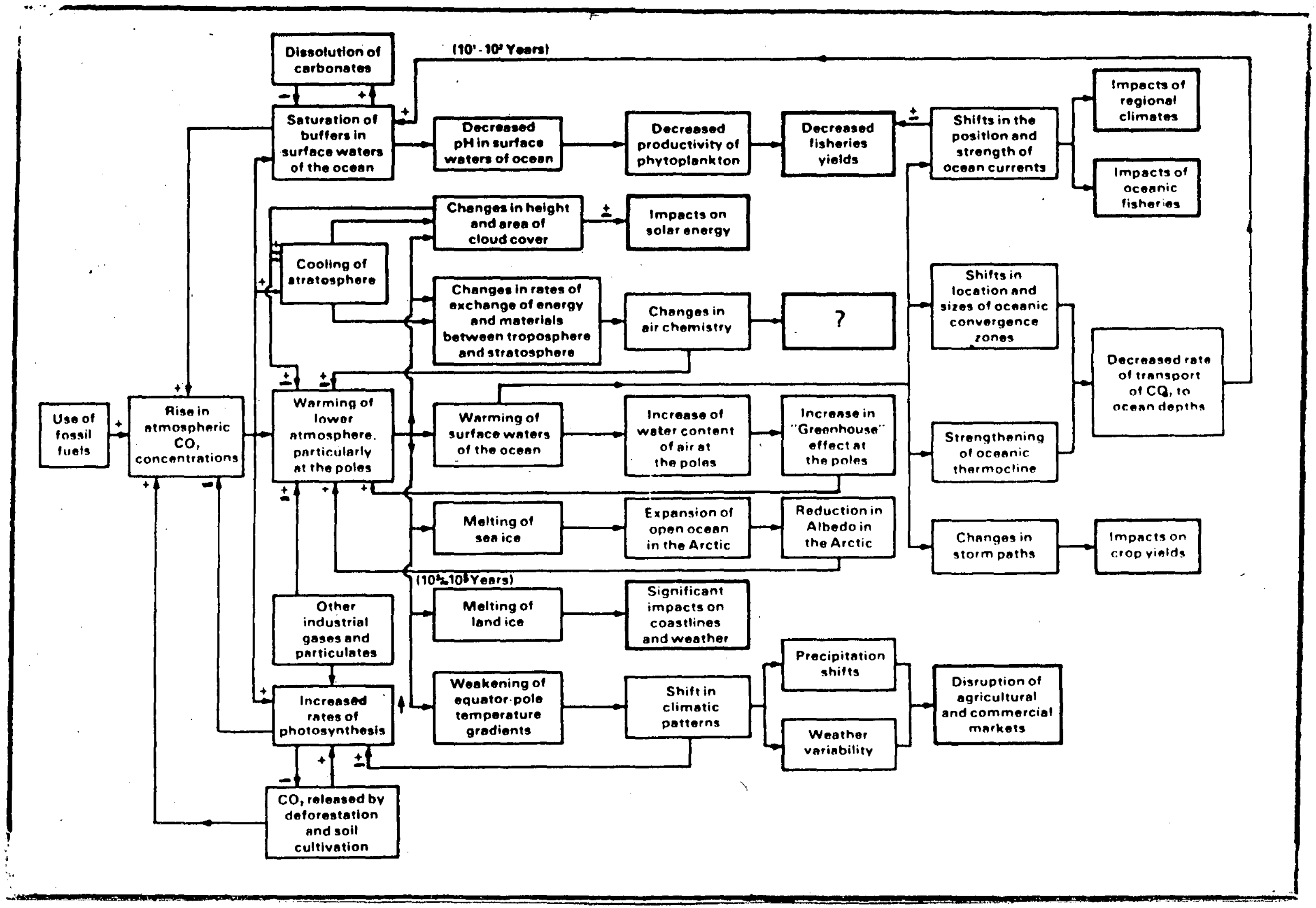
SOURCE: Obtained from JACK FISHMAN & ROBERT KALISH (1990).

FIGURE [2.3.2] THE CARBON CYCLE DESCRIBING THE MAJOR CARBON RESERVOIRS IN NATURE AND THEIR INTERCHANGE OF CARBON.



SOURCE: FROM B. BOLIN (1986).
(Reservoir sizes in units of 10^9 tonnes (t) of carbon and fluxes between reservoirs in units of 10^9 t of carbon per year.)

FIGURE [2.4.1] INTERRELATIONS AMONG PHENOMENA ASSOCIATED WITH CO_2 EFFECT.



SOURCE: OBTAINED FROM O.W. MARKLEY AND RICHARD CARLSON (1980).

Primer on Carbonioxide

Trace Gas	**Sources**	**% of Total Sources Related to Energy**
CO_2 (Carbon dioxide)	Natural Source: Gross annual ocean release: 104,600 ± 1,900 Tg C/yr Gross annual release from land 8,700-120,000 Tg C/yr Man-made Source: Fossil fuel use: 5,00 ± 500 Tg C/yr Annual net carbon flux from land use conversion: 1300 ± 1300 Tg C/yr (Trabalka, 1985)	All Sources: 2-4% Man-made: 65-100% Note: Increase in atmospheric concentrations of CO_2 due entirely to human related sources.
Sinks	**Current Concentration**	**Atmospheric Lifetime**
Oceans: Gross annual uptake: 107,000 ± 1,000 Tg C/yr, Net annual uptake: 2400 ± 900 Tg C/yr Land: Gross annual plant CO_2 uptake: 120,000±900 Tg C/yr Net primary plant production: 60,000 ± 10,000 Tg C/yr Atmosphere: =0, until photolyze in upper mesosphere	Concentration: 345 ppmv (annual average, 1985) Annual cycle: 0-15 ppmv Stock in the atmosphere:720,000 Tg C (1982) Reservoirs: Surface layer (0-75m): 630,000 ± 60,000 Tg C Intermediate and deep oceans: 38,000 ± 4,000 Tg C Ocean sediments: 100,000,000,000 Tg C. Terrestrial biosphere: 560,000 Tg C Soils: 1,700,000 Tg C	500 years for combined lifetime for atmosphere, biosphere, plus upper ocean. Biogenic seasonal cycle causes annual variations in surface concentrations.

Current Atmospheric Trend 0.4%/yr (1.5 ± 0.2 ppmv/yr)	**Radiatively Interactive?** Yes, it is one of the most important absorbers of infrared radiation. Rough spectral range for important lines are 550-800, 850-1100, and 2100-2400 cm^{-1}.	**Chemical Interactive** No, except for amounts that photodissociate in the mesosphere and above. CO_2 is the fully oxidized state of carbon.
Direct Chemical Effect None.	**Direct Climate Effect** Infrared absorption affects the radiative fluxes that determine the climate. Doubling of the CO_2 concentration could increase the global average equilibrium surface temperature by 1.5-4.5°C, based on current model results including climatic feedbacks. The direct radiative effect due to a doubling of CO_2 would increase surface temperature by about 1.3°C.	**Index of Radiative Sensitivity Compared to CO_2 (=10)** 10 Note: Relative measure of contribution to radiative forcing over the period circa 1980 to circa 2050 for a typical scenario based on current growth rates. For example, if ΔT_s = 2K for CO_2 over this period, an index of 3 would correspond to a change of 0.6K.
Chemical-Climate Interactions CO_2 fertilization of plants and climate change may alter surface albedo. Changes in the atmosphere's temperature profile may affect reaction rates for chemically active gases. Changes in stratospheric temperatures may lead to change in the ozone distribution, thereby producing foodback on climate change.	**Uncertainties in Basic Chemistry** None.	**Uncertainties in Applied Chemistry** None.

Uncertainties in Radiative Transfer Life half-widths and temperature dependencies of the CO_2 lines should be further refined. This uncertainty would likely have a minor effect on projected climate change Overlap with H_20 absorption is important to determining CO_2 climate effects. These properties need to be better understood		**References** 1) MacCracken and Luther (1985). 2) WMO (1985) 3) Trabalka (1985) 4) Wang et al. (1985, 1986) 5) Strain and Cure (1985) 6) Schlesinger (1985) 7) Luther and Ellingson (1985) 8) NAS (1983)

Source: Obtained from, Donald J.Wuebbles and Jae Edmonds, A Primer on Greenhouse Gases, U.S.Department of Energy, March 1988.

Note: Tg C = Tera grams of Carbon.

Chapter 3

More About Environment and Economics

[3.1] Strictly speaking, after introducing our work (in the previous chapters), we should now straight away go into the methodology adopted in carrying out the entire exercise and from thereon progress to developing the delicate nuances associated with our work and its results. But this we have not done, as this chapter would testify. For, even after introducing our subject, we still possess that nagging feeling which says that enough has not been said on the 'Environment' and the 'Economy' relation. And, if this relationship is still in doubt, then our entire work falls down on its face like a house of cards; for are we not attempting to generate, analyze and project carbondioxide emissions for the entire Indian economy (-as a case study)? So, are we not carrying out our work under the auspices of 'Economics'? If so, then are we justified in our current line of reasoning and, hence, in the ensuing fruition of our work? As a result, without any further beating around the bush, what we are now going to do is to allay our fears, here, in this chapter, and from the next chapter onwards, we will go about doing our work undertaken and introduced in the opening chapters. So here, instead of environment and economics, we will talk about the parent-ecology and economics, for if we agree upon the proper set ecology, then the subset environment is already agreed upon. Infact, environment bridges ecology and economics.

[3.2] The disciplines of ecology and economics have many things in common. Both of them attempt to understand and predict the behaviour of complex interconnected systems in which both individual behaviour and large-scale flows of energy and material are important. The two disciplines use similar quantitative tools such as input-output analysis, simulation, and maximizing calculus. They share similar concepts such as competition and specialization, and they are both concerned with open systems having one major external input, energy that is not reusable -sunlight for ecosystem and mainly non-renewable fuels for economic systems. Both are structured by the decisions of individuals, who function in the context of hierarchies of group organizations, interacting with their environment. This, however does not mean that either the role of the environment in supporting the economy and its relation to growth and sustainability issues, or the various prospective interrelations between socio-economic development and life-supporting ecosystems is put under shade.

Infact, now a days, it has become evident to a growing number of people that socio-economic systems not only affect the environment but they also depend on the life supporting ecosystems in order to function. In recent review of the book 'Ecology and Our Endangered Life-Support Systems' (E.P.Odum, 1989a) it was stated that 'despite all the advances in modern technology, society remains irrevocably dependent upon natural system for life support - a condition that is unlikely to change in the forseeable future' (R.E.Ulanowicz, 1989).

Thus, the life-support environment has been defined as that part of the Earth that provides the physiological necessities of life, namely food and other energies, mineral nutrients, air and water. The life-support ecosystem is the functional term for the environment, organisms, processes, and resources interacting to provide these physical necessities (E.P.Odum, 1989a). So, from this perspective, one can divide ecosystems into three categories:[1]

1. **Natural Environments or Natural Solar-Powered Ecosystems:**

   These are the basic life-support systems, such as open oceans, upland forests, estuaries, wetlands, rain forests, lakes, rivers. They are self-supporting and self-maintaining, and some of them produce excess organic matter that maybe exported to other systems or stored.

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1 *Obtained from, Carl Folke (1991), 'Socio-Economic Dependence on the Life- Supporting Environment', in Carl Folke and Tomas Kaberger (ed.), Linking the Natural Environment and the Economy: Essays from the Eco-Eco Group, Kluwer Academic Publishers, Dordrecht, 1991, p.78-79.*

2. **Domesticated Environments or Man-Subsidized Solar-powered Ecosystems:**

There are the food and fiber producing systems such as agriculture lands, managed woodlands and forests, aquaculture. They are supported by industrial energy (e.g. fossil fuels, electricity) supplied by man, to run the tractors, to produce the fertilizers, etc.

3. **Fabricated Environments or Fuel-powered Urban-Industrial Systems :**

These are mankind's wealth-generating but also pollution generating, systems, such as cities, suburbs, industrial areas, airports. In these systems the sun has been replaced as the major direct energy source by the use of fossil fuels and other industrial energies.

So, using this division, it becomes evident that the fabricated environments are not self supporting or self maintaining. To be sustained, they are dependent on the solar powered natural and domesticated environments the life-supporting ecosystems outside their own borders. Such ecosystem economy interrelation are especially obvious for densely populated countries such as Japan and Israel (E.P.Odum, 1989a). These countries could not be sustained without substantial imports of energy and matter from ecosystems outside their borders. Furthermore, it has been argued that ecosystem areas atleast similar in size to these producing the inputs to an economy, a city, or a household will, in due course, be required to process the outputs that is the disposal of wastes and polluting substances from human activities (C.Folke et al., 1991).

Now, many of the environmental services produced and sustained by the life supporting environment are indispensable to humanity, such as the maintenance of the gaseous quality of the atmosphere and thus of the climate, operation of the hydrological cycle including flood control and drinking water supply, waste assimilation, recycling of nutrients, generation of soils, pollination of food crops, provision of food from the sea, maintenance of a vast genetic library, etc. (P.R.Ehrlich, 1989). R.S.de Groot (1988) has provided such environmental functions into four categories, namely : Regulations functions, Production functions, Carrier functions and Information functions-Table (3.2.1). However, it must be emphasized that none of these environmental functions can take place in isolation. They are each the result of the dynamic and evolving structures and functions of their total ecological sub-system, and the fact that the socio-economic values of environmental functions and ecological sub-system are directly connected to their physical, chemical, and biological role in the overall global system.

Table [3.2.1]

Life Support Functions of the Natural Environment

Functions		
1.	**Regulation**	Protection against harmful cosmic influences. Climate regulation. Watershed protection and water catchment. Erosion prevention and soil protection. Storage and recycling of industrial & human waste. Maintenance of biological and genetic diversity. Biological control. Providing a migratory nursery and feeding habitat.
2.	**Production**	Oxygen. Food, drinking water and nutrition. Water for industry, households, etc. Clothing and fabrics. Building, construction and manufacturing materials. Energy and fuel. Minerals. Medical resources. Biochemical resources. Genetic resources. Ornamental resources.
3.	**Carrier**	Providing space and a suitable substrate inter alia for- Habitation. Agriculture, forestry, fishery, aquaculture. Industry. Engineering projects such as dams, roads. Recreation. Nature conservation.
4.	**Informatiom**	Aesthetic information. Spiritual and religious information. Cultural and artistic inspiration. Educational and Scientific information. Potential information.

Source: Modified from R.S.de Groot (1988).

Nevertheless, the stress caused by the disposal of wastes and pollutants, negatively affects recycling, feed -back loops, and control mechanism in the life-supporting ecosystem, and thereby the production and maintenance of environmental goods and services. Infact, ecologists (e.g, A.J.Lotka, 1992; H.T.Odum, 1971; E.P.Odum, 1975; J.Zucchetto and A.M.Jansson, 1985; C.Holling, 1986; P.R.Ehrlich, 1989) and a growing number of economists (eg., K.E.Boulding, 1966; N.Georgescu-Roegen, 1971; H.E.Daly, 1977; R.Hueting, 1980; M.M.Hufschmidt et al., 1983; J.L.R.Proops, 1985; C.Perrings, 1987; E.B.Barbier, 1989; D.E.James et al., 1989; D.W.Pearce and R.K.Turner, 1990) are well aware that the workings of ecosystem are pervasive in the economic system. 'This pervasiveness arises from the simple fact that all economic activity uses up materials and resources and requires energy, and these, in turn, must end up somewhere-in dumps, dissipated in the atmosphere, disposed of to the oceans or whatever' (D.Pearce et al, 1989).

Hence, from the dominating approach of regarding the economy as superior to and separated from whatever else takes place in the environment, in recent years the environment (or more specifically environmental problems and concern) has achieved more attention, to a large extent due to the monetary costs associated with environmental degradation and the economic benefits of pollution control and preservation of the environment - Figure (3.2.1). This transformation is beautifully and vividly captured by the two figures - Figures (3.2.2) and (3.2.3). However, despite everything said and done, environmental issues have often been treated as occasional or incidental problems which need not cause concern until the environmental damage has occurred, or when three are obvious threats to human welfare, such as acidifiction or global warming.

Thus, to sum up, environmental life support and technological change are complementary rather than substitutable and socio-economic development is dependent on both. Today, environmental goods and services (the natural capital) are increasingly replacing the man-made capital as the limiting factor for economic development (H.E.Daly and J.B.Cobb, 1989; H.E.Daly, 1990). It is only possible to approach a sustainable development with this broadened ecological-economic framework and a longer time-scale perspective. Economic analysis cannot be abstracted from the wider physical environment in which production takes places (C.Perrings, 1987). So, herein also lies our justification in pursuing the work which we intend to do, and also here we find the basis for following the particular approach which we have chosen to follow for generating an inventory of carbon dioxide emission for the Indian economy. The work undertaken and the approach to be adopted for seeing it through have already been introduced earlier. Now what is required is to go about carrying out our work. For this the next step is the start with the methodology adopted for our generation exercise. This is so done and explained in the following chapter. But, before we go into that, we think it is important to briefly explain the evolution of paradigms in the 'Environment-Economy' interface as an apt conclusion to this brief deviation in which we have indulged ourselves, here in this chapter.

[3.3.] There has been a diversity of scientific books and articles describing the development of paradigms and approaches for analyzing the environment-economy interface (e.g., D.Worster, 1977; J.F.Richards, 1986; L.C.Braat and W.F.J. van Lierop, 1987; C.J. Cleveland, 1987; J.Martinez-Alier, 1987; R.W.Kates, 1988; R.K.Turner, 1988; E.B.Barbier, 1989; M.E.Clark, 1989; P.Mirowski, 1989; H.A.Regier et al., 1989; D.A.Underwood and P.G.King, 1989).

In their recent book on economics of natural resources and the environment, D.W.Pearce and R.K.Turner (1990) summarize the evolution of economic paradigms and ideas that have influenced the development of environmental economics-Figure (3.3.1). They briefly review the classical, marxist, neoclassical and humanistic paradigms, as well as institutional and coevolutionary ways of thinking about natural environments, and emphasize that a pluralistic view of the contribution that economics can make would guard against narrowness in economics, as well as fostering more interdisciplinary analytical linkages, and that this is necessary for improving our understanding of economy- environment interactions.

M.E.Colby (1990) has contributed to this understanding by synthesizing many ideas and perspectives from the scientific literature and the environmental debate. He gives his view on the evolution of paradigms in ecology, economics and social system concerning environmental management in development. He proposes five broad, fundamental paradigms of human nature relationships, each based on different assumption about human nature and activity about nature itself, and about the interactions between nature and humans. Each paradigm asks different questions and perceives different evidence, dominant imperatives, threats or risk, and different preferred solutions and management strategies. Each of them encompasses several schools of thought, and of course there is also some overlapping between the paradigms. Figure (3.3.2), modified from M.E.Colby (1990), attempts to illustrate the nature of the evolutionary relationships between the paradigms. From frontier economics to the diametrically opposite deep ecology, paradigms of environmental protection, resource management and ecodevelopment are evolving. As illustrated in Figure (3.3.2), there has been a progression from the two dichotomous paradigms of frontier economics and deep ecology towards perspectives which involves increasing integration of economic, ecological, and social systems.

The type of relationship between society and nature described by the frontier economics paradigm is common to both decentralized capitalist economies and centrally- planned Marxist economies, and it has dominated during the industrial development. Although they differ in strategies for organizing development within the economy, the underlying world views about humans and nature are similar, often with a vision of infinite economic growth and human progress. From this perspective technologies are developed with the purpose of increasing the power of the socio-economic system to extract resources and increase production of desired goods from the life supporting environment, as well as to damp the negative impacts of nature's variability on economic activities. It is believed that environmental damage can easily be repaired where necessary, and that infinite technological progress founded in human ingenuity together with economic growth will provide affordable ways to mitigate environmental problems.

The opposite pole is deep ecology. This paradigm has not been directly linked to the science of ecology. It is more of a philosophical, value/ethical movement, generally rejecting the structure and functioning of modern industrial society. It is non-anthropocentric, it emphasizes for example species equality or the intrinsic value of all non-human nature. It stresses the desirability of major reductions in human population and of bioregional autonomy, which means reducing economic, technical, and cultural dependencies and exchanges to confirm them within regions of common ecological characteristics. The deep ecology paradigm also emphasizes promotion of biological and cultural diversity, decentralized planning utilizing multiple value systems, non growth economics, and simple or low technology levels. The advocates of deep ecology propose major changes in the patterns of human modification of nature, and among deep ecologists there are those who strongly argue for a return to pre-industrial, rural life-styles and standards of living.

The principal strategy of the environmental protection paradigm could be expressed as legalizing the environment as an economic externality. It is a modest variation on the frontier economics paradigm of development. The environmental protection perspective is defensive or remedial in practice, concerned mainly with ameliorating the effects of human activities. This approach focuses largely on damage control, on repairing and setting limits to harmful human activities, rather than trying to find ways to improve both development action and ecological resilience. Governmental agencies are often created and are responsible for setting these limits. Environmental impact statements or assessment are institutionalized in may industrial countries as a rational means of assisting in weighting the costs and benefits of economic development before they are started. Relatively small areas of common property are set aside as state property for preservation or conservation as national parks and wilderness reserves. Resource depletion and ecosystem services are generally not perceived in policy making as serious limiting factors for economic development. The interaction between human activity and nature in the environmental protection paradigm is seen as a question of development versus environment, not recognizing that they are two sides of the same coin.

The basic idea with the resource management approach is to incorporate all types of capital and resources (ie. biophysical, human, infrastructural, and monetary) into calculation of natural accounts, productivity, and policies for development and investment planning. The objective is to take more account of the interdependence and multiple values of various resources, and management of global common resources, are often in focus. It is recognized that ecosystem processes, rather than just stocks of physical resources need to be considered as resources and capital which should be maintained, as well as used more effectively, by the use of new technology. Resource managers view the stabilization of population levels in developing countries and reductions in the per capita consumption, through increased efficiency, in the industrial nations as essential to achieving sustainability. It is understood that the scale of human activity is now so large that it affects the life supporting environment as much as Nature affects Man, and that these impacts have a feed-back effect on the quantity and quality of human life that is achievable. The resource management approach is the basic theme of reports such as the Brundtland Report - 'Our Common Future' (1987) and World Resources Institute's annual World Resources reports. The perspective is anthropocentric and the concern for the life-supporting environment is based on the insight that hurting nature is also hurting Man. In a sense ecology is being economized by trying to encompass some basic ecological principles in an attempt to maintain the stability of the life supporting environment for the support of sustainable development.

Ecodevelopment more explicitly sets out to restructure the relationship between society and nature, by reorganizing human activities so as to be synergetic with ecosystem processes and functions. This emerging paradigm moves from economizing ecology to ecologizing the economy, or whole social systems, and stresses that there are great economic and social benefits to be obtained from fully integrated ecological economic approaches to environmental management. It attempts to move away from the conflicts between anthropocentric and biocentric values, but it can be said to follow from the limitations inherent in the environmental and resource management paradigms. The ecodevelopment approach recognizes the need for management of adaptability, resilience and uncertainty, and for coping with the occurrence of non linear phenomena and ecological surprises. Rather than asking how can we create, and then, how can we remedy ecodevelopment attempts to provide a positive, interdependent vision for both human and ecosystem development. This approach emphasizes that planning and management ought to be embedded in the total environment of the system under consideration, including all of the sectors concerned which means that global system awareness must be coupled with local responsibility for action. 'Eco-signifies both economic and ecological, and the term development, rather than growth, management or protection, connotes an explicit reorientation and upgrading of the level of integration of social, ecological and economic concerns in designing for sustainability'.[2] This perspective emphazies a shift from a system in which the polluter pays to one in which pollution prevention pays, and the need to move from throughput- based physical growth to qualitative improvement. Such development does not only imply becoming more efficient in the use of energy, resources and ecosystem services but it also emphasizes the room for improvements in terms of synergies gained from designing agricultural and industrial processes to mimic and use ecosystem processes in an explicit manner.

As stated by R.Constanza (1990) 'Ecological system are our best current models of sustainable systems. Better understanding of ecological system and how they function and maintain themselves can yield insight into designing and managing sustainable economic systems. For example, there is no 'pollution' in climax ecosystems-all waste by-products are recycled and used somewhere in the system or dissipated. This implies that a characteristic of sustainable economic systems should be a similar 'closing the cycle' by finding economic uses and recycling currently discarded 'pollution', rather than simply storing it, diluting it or changing its state, and allowing it to disrupt existing ecosystems that cannot use it'.

According to Colby, the fundamental flaw of Frontier Economics is a lack

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2 *Carl Folke and Tomas Kaberger (1991), 'Recent Trends in Linking the Natural Environment and the Economy', in Carl Folke and Tomas Kaberger (ed.), Linking the Natural Environment and the Economy: Essays from the Eco-Eco Group, Kluwer Academic Publishers, Dordrecht, 1991, p.283.*

of awareness of the biophysical basis of human economies, their dependence on the life-supporting environment, and a major criticism of Deep Ecology is that it tends not to be creative, one of the fundamental drives in the evolution of both nature and human society. A major fault with Environmental Protection is that it separates environment and development. A common fault of both Environment Protection and Resource Management approaches is the mislabeling of the various social masses as environmental problems, enabling professional to conceive them as externalities. Furthermore the myriad problems of development are frequently mismatched with the nature of technical-economic rational logic and its tools on which professionals have come to rely. M.E.Colby states that there is need for a new, mutually positive synthesis of environment-economy development and management, and believes that ecodevelopment is the most promising paradigm for the future. But he also stresses that no single paradigm has the best answer to every type of environmental problem, that change is often resisted due to behavioral and cultural inertia, and that there is an urgent need for effective cooperative and institutional innovations to meet the great challenges of the coming decades.

We have used an illustration from D.Pearce and R.K.Turner (1990) [Figure (3.3.1), this chapter] to summarize paradigms and ideas that have influenced the development of environmental economics. M.E.Colby (1990), based on the work by Herman Daly, classifies the evolution of economic paradigm in terms of allocation, distribution, and scale approaches [Figure

(3.3.3)]. He claims that these major concerns of economies, have been seen as separate and conflicting since the late 1800's, with allocative and distributive economics as antagonists in focus, more or less ignoring biophysical issues. Neither free market nor socialist economics or economies have dealt with the necessity of the life-supporting environment and how to maintain and invest in natural capital, a major issue of the evolving ecodevelopment approach. With the risk of being accused of being too imperialistic, we suggest that the recent emergence of the research field of ecological economics could be a new economic synthesis that reintegrates these three types of concern while at the same time taking into account ecological aspects. Ecological economies is concerned with extending and integrating the study and management of ecology and economics, what we might call the ecology of humans and the economy of nature, the web of interconnections uniting the economic subsystem to the global ecosystem of which it is a part. As stated in the first issue of the journal 'Ecological Economics' (R.Constanza, 1989), 'this research field is intended to be a new approach to both ecology and economics, that recognizes, the need to make economics more cognizant of ecological impact and dependencies, the need to make ecology more sensitive to economic forces, incentives, and constraints, and the need to treat integrated economic ecological systems with a common (but diverse) set of conceptual and analytical tools'. Explicitly Table (3.3.1) discusses some of the major differences between 'conventional economics', 'conventional ecology' and 'ecological economics'.

Table [3.3.1]

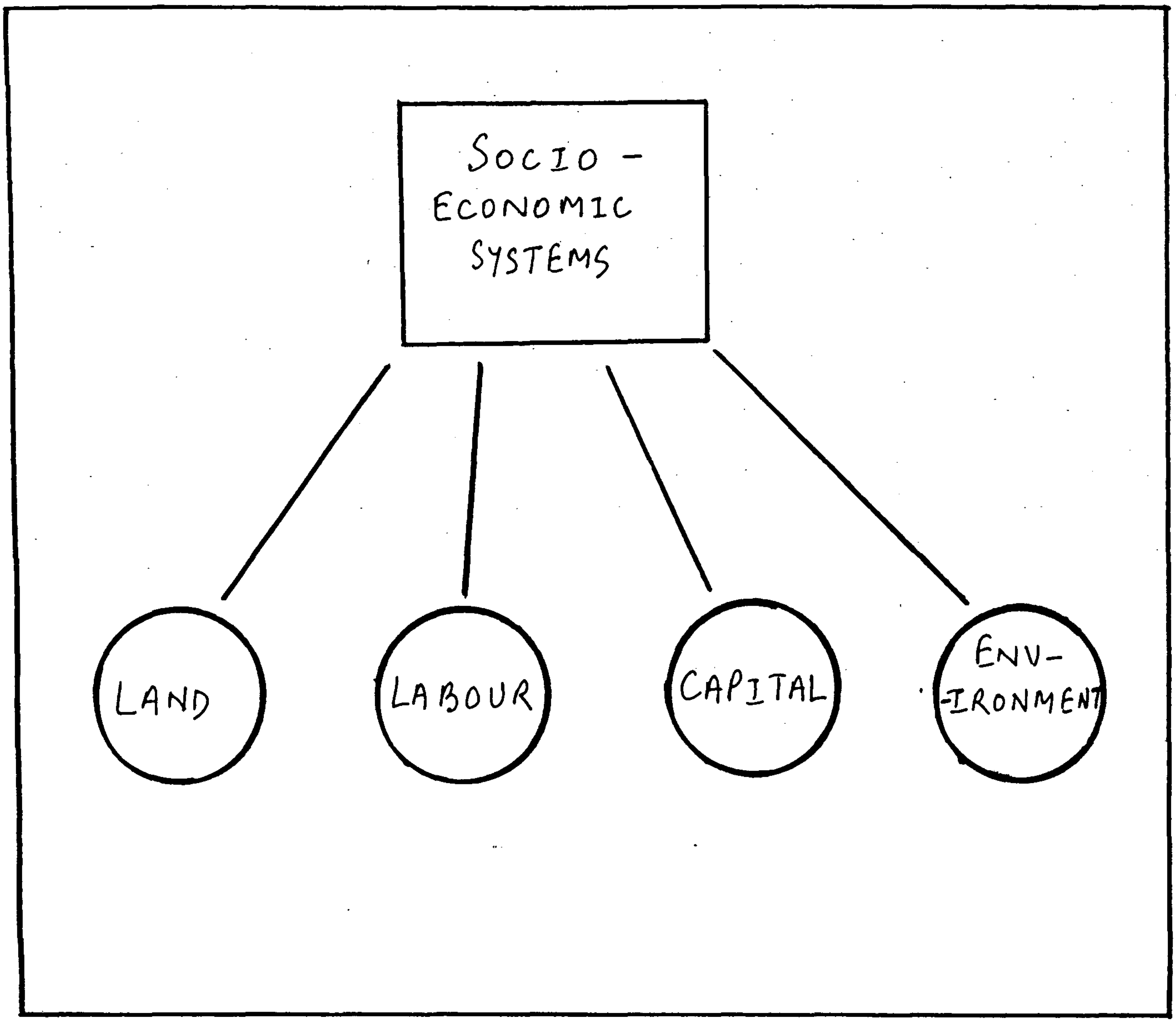
Comparision of "Conventional" Economics and Ecology with Ecological Economics

	Conventional Economics	Conventional Ecology	Ecological Economics
Basic World View	Mechanistic, Static, Atomistic individual tastes and preferences taken as given and the dominant force. The resource base viewed as essentially limitless due to technical progress and infinite substitutability.	Evolutionary, Atomistic evolution acting at the genetic level viewed as the dominant force. The resource base is limited. Humans are just another species but rarely studied.	Dynamic, Systems Evolutionary human preferences evolve to reflect broad ecological opportunities and constraints. Humans are responsible for understanding their role in the larger system and manageing it for sustainability.
Time Frame	Short, 50 years maximum, 1-4 years usual	Multi-Scale days to eons	Multi-Scale days to eons
Space Frame	Local to National country level at best, individual or firm basic unit of analysis	Local to Regional, most research focused on relatively small research sites in single-ecosystems	Local to Global, hierarchy of scales
Species Frame	Humans Only, plants and animals only rarely included for contributary value	Non-Humans Only, attempts to find pristine ecosystems untouched by humans	Whole Ecosystems Including Humans, acknowledges inter-connections between humans and the rest of nature.
Primary Macro Goal	Growth of National Economy	Survival of Species	Sustainability of Whole Planet
Primary Micro Goal	Max. Profits (firms) Max.Utility (individuals), all agents following micro goals leads to macro goal being fulfilled. External costs and benefits given lip service but usually ignored.	Max Reproductive Success, all agents following micro goals leads to macro goal being fulfilled	Must be Adjusted to reflect System Goals, myoptic following of micro goals can lead to problems which must be compensated for using appropriate cultural institutions
Assumptions About Technical Progress	Very Optimistic	Pessimistic or No Opinion	Prudently Pessimistic
Academic Stance	Disciplinary, monistic, focus on mathematical tools	Disciplinary, more pluralistic than economics, but still focused on tools and techniques. Few rewards for comprehensive integrative work.	Trandsiciplinary, pluralistic, focus on problems.

Source: R. Constanza, 1991.

Figures to Chapter 3

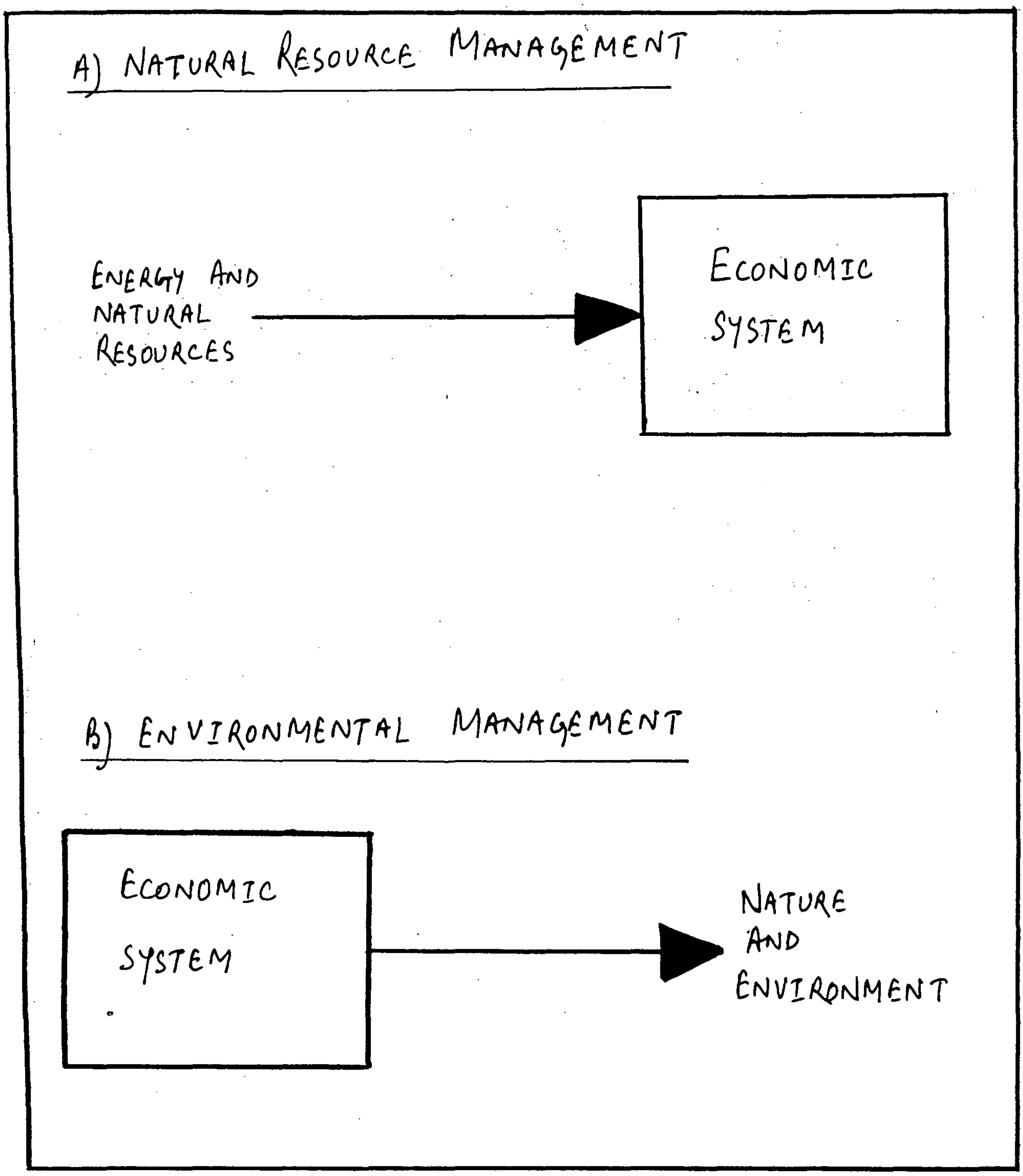
FIGURE [3.2.1] ECONOMY-ENVIRONMENT INTERACTION.



SOURCE: CARL FOLKE (1991).

[The dominating economy-environment perspective during industrial development. Land (natural resources), Labour, and man-made Capital have been viewed as the three independent primary factors of economic production. Within this perspective, the environment has been given higher priority in recent years.]

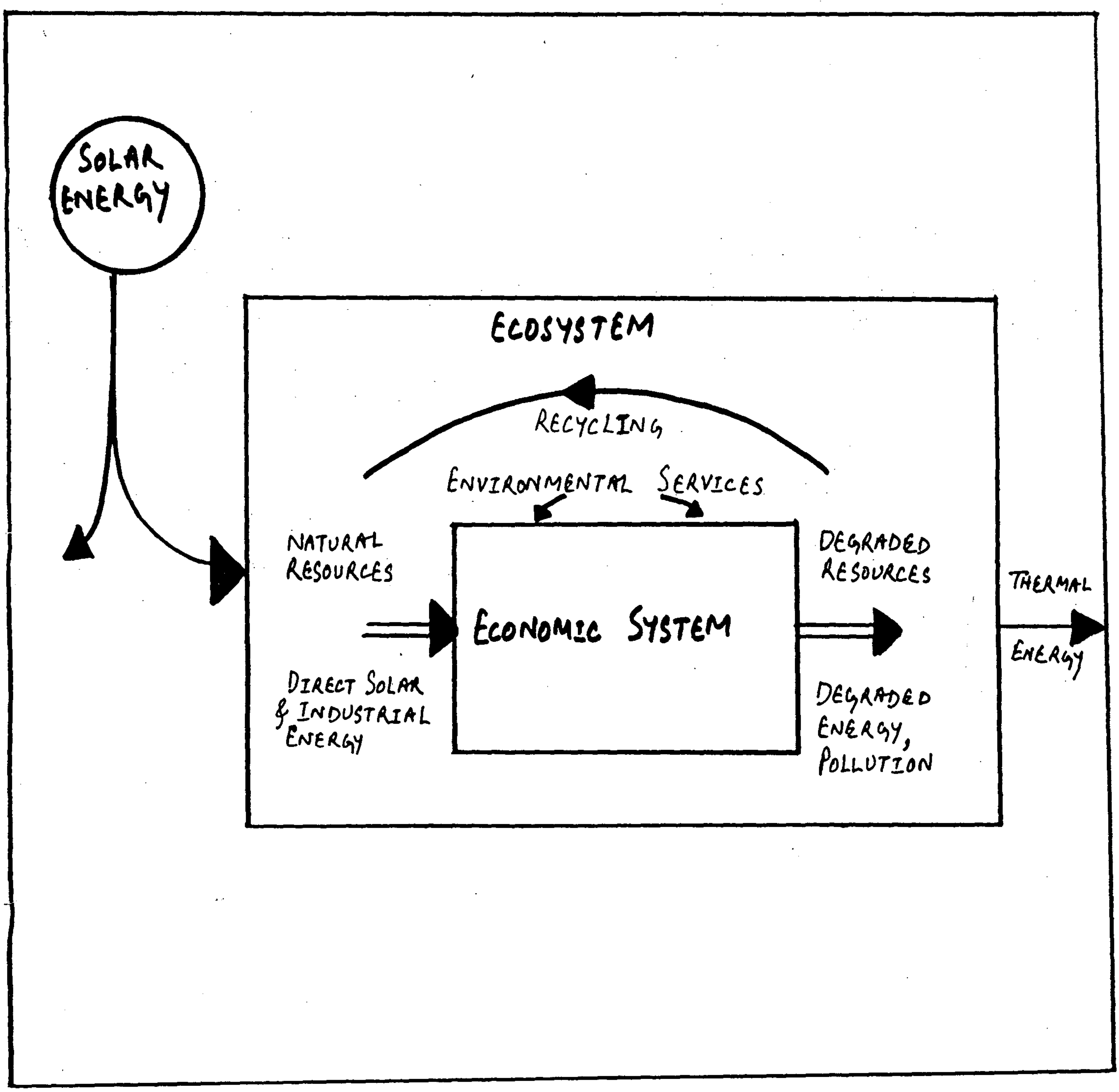
FIGURE [3.2.2.]



SOURCE : C. FOLKE (1990).

(The conventional division of the world outside the economy : a) Natural Resource management, b) Environmental management. In reality (a) and (b) are tightly linked. They are dealing with integrated parts of the same life-supporting environment, and both alter the production and maintenance of ecosystem goods and Services on which society depends.)

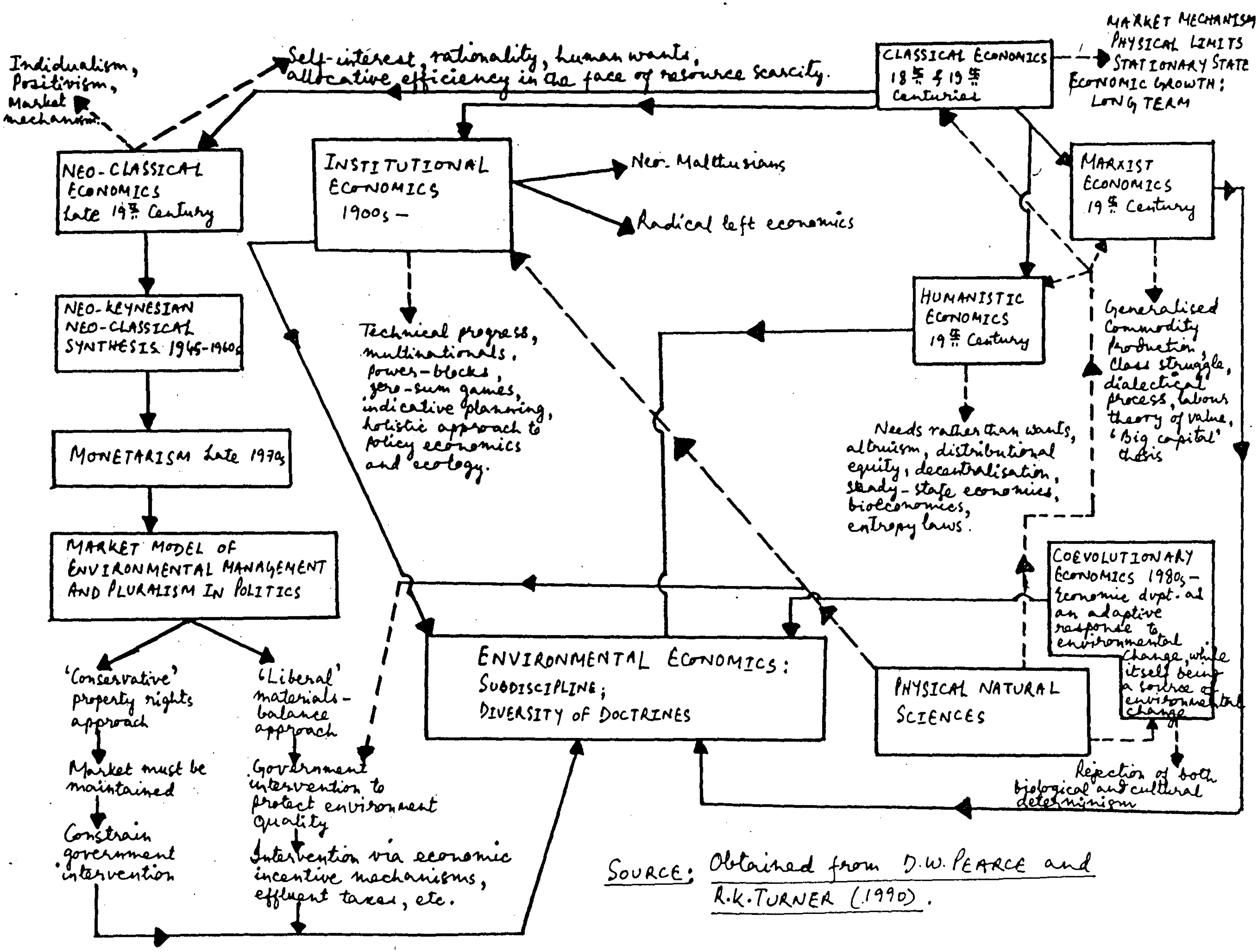
FIGURE [3.2.3]



SOURCE: From CARL FOLKE (1990)

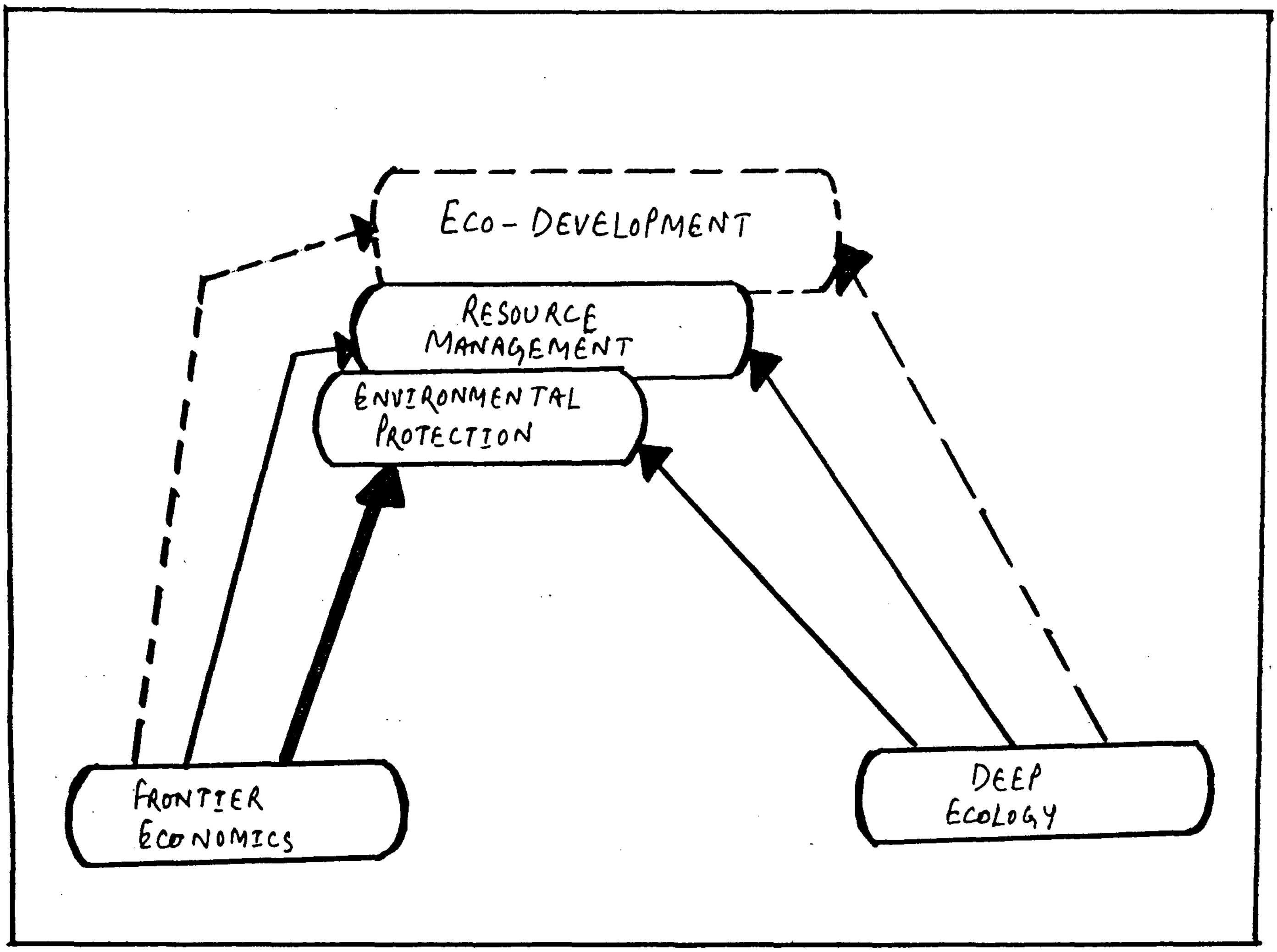
(The economic system is an open sub-system of the overall ecosystem. To make industrial development and technological change possible, ecosystems are used as sources for energy and natural resources and as sinks for waste outputs, and these activities effect the ecosystem contributions of environmental goods and services. As the scale of socio-economic systems have expanded relative to the eco-systems, economy-environmental interdependence and complementarity have become more obvious.)

FIGURE [3.3.1] ECONOMIC PARADIGMS AND THE ENVIRONMENT.



SOURCE: Obtained from D.W. PEARCE and R.K. TURNER (1990).

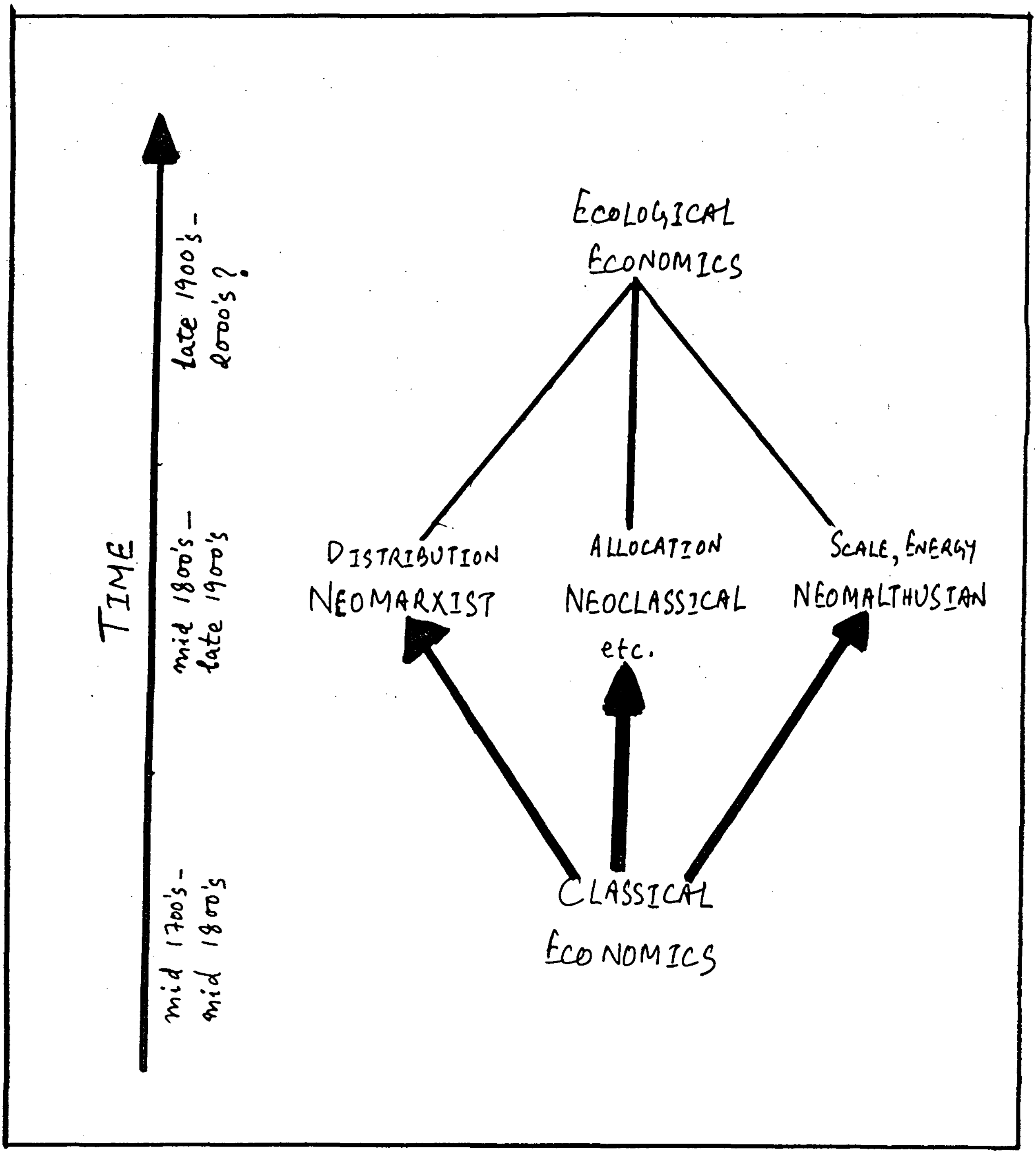
FIGURE [3.3.2] DEVELOPMENT OF MAJOR PERSPECTIVES IN THE INTERFACE OF ENVIRONMENT AND ECONOMY



SOURCE : FROM COLBY (1990)

FIGURE [3.3.3]

THE EVOLUTION OF ECONOMIC PARADIGMS FROM THE MID-1700's.



SOURCE: FROM COLBY (1990)

Chapter 4

Generation and Sectoral Allocation of CO_2 Emissions from Consumption of Fossil Fuels (Methodology-I)

[4.1] The focal point of our work, here is to generate a sectoral database for carbondioxide emissions, for the Indian economy, and the approach which we have chosen is calculation through energy-consumption. So we have collected disaggregated data on final consumption of coal, oil and natural gas. The basic source for this data is 'Energy Statistics', Government of India, 1988/89 and is shown in Tables (4.1.1) to (4.1.3). Next we have aggregated these data on the basis of sectoral classification which we deem fit to represent the Indian economy in total as well as its major sectors. These sectors are:

a) Transport (inclusive of Railways),

b) Agriculture,

c) Power (implying electricity),

d) Industry (inclusive of Services and Others), and

e) Domestic (i.e., the Household sector).

The sectoral end-consumption data is shown in Tables (4.1.4) to (4.1.6).

Once we have got our sectoral classification correct, we start our generation exercise which we have carried out, embracing a period of twenty years - 1970/71 to 1989/90. We have chosen this long period to work with for this will give us not only a precious database regarding CO_2 emissions and energy-consumption out of fossil-fuels for a considerable period of post-independent Indian economy, but also a sectoral database as well. Moreover, when seen from the view-point that no such database exists for the Indian economy, atleast to our knowledge, the work itself dons on a garb of great importance. But more important is the notion that a variety of growth patterns, projections and policy implications can be purposefully drawn on this database (and some of them have been attempted here, in this work). Finally, why have we chosen 1970/71 as the starting point of our entire exercise is for the elementary reason that 1970s was the watershed in not only the history of environmentalism, but also in the history of energy-use, for the energy-crisis did strike for the first time in 1970s only. And, due to lack of time and available data, we had to be content to curtail our work to 1989/90.

Now, calculation of carbondioxide emissions from fossil-fuel consumption is directly dependent on the carbon content of the particular type of fossil-fuel consumed which at times, differs from sector to sector. So of immediate importance is to first of all calculate the net carbon burnt in each of these fossil fuels and then from the carbon burnt calculate the amount of carbondioxide emitted. Once the net carbon burnt is calculated, then CO_2 emissions can be easily calculated using the basic reaction in chemistry [Table (4.1.7)] that is, under ideal conditions and upon complete combustion, $C + O_2 \rightarrow CO_2$. So using the unitary method based on first principles and revolving around molecular weights, one can very definitely come to the conclusion that as 14 units of carbon (-molecular weight of carbon) will give 46 units of CO_2 (molecular weight of CO_2), 1 unit of carbon will give (46/14) i.e., 3.3 units of CO_2. Thus CO_2 is so calculated.

Table [4.1.7]

Calculation of CO_2 emissions

$C + O_2 \text{--->} CO_2$
(14) + (2 X 16) ---> (14+2x16)
So, 14 units of C ---> 46 units of CO_2
Thus, 1 unit of C ---> 3.3 units of CO_2

Source: AUTHOR (Compiled from various Chemistry text-books)

[4.2] CO_2 Emissions from Coal Combustion

The sectoral classification of consumption of coal is given in Table [4.2.1]. Now, as the grade-wise (-directly related to the inherent heat content) consumption of coal differs not only inter-sectorally but also intra-sectorally and as the carbon content varies sector-wise with different grades of coal consumed, getting data on grade-wise sector wise consumption of coal was of prime importance. But as this kind of data was not available, we obtained information on the various grades of coal consumed by various components of the various sectors and then for each component we used a grade which was

Table [4.2.1]

Sectoral Classification for Coal

1.	Transport	Railways
2.	Agriculture	Cotton
3.	Power	Electricity
4.	Industry	Steel & Washery Cement Paper Fertilizer Others
5.	Domestic	Household

Source: AUTHOR

the average of the grades it consumed.[1] Thus we were able to obtain a grade-wise consumption of coal on a level which was even more disaggregated

[1] *Mr.Kanchan of CIL, in Coal Ministry was of extreme help to us here.*

then the sectoral classification. We then had to work at an intra-sector level till we got our net carbon burnt figures. From there onwards we could aggregate to the sectoral level and thus get our CO_2 emissions sectorally.

One other distinction which we had to make in the process was to differentiate the consumption of coal into coking, non-coking and soft-coke. Here, the entire consumption of Steel & Washery and Fertilizer industry, within the Industry classification, was taken to be consisting of coking coal, with an average grade of 5900 kcal/kg.[2] Further, the consumption of the domestic sector was seen to be consisting of soft coke. Here, the data on consumption in the domestic sector was not available in the original data obtained, but was included within the 'Others' category. So it was obtained from Mr. Kanchan of CIL within the Coal Ministry. Then this data was deducted from the data on 'Others' to obtain the correct data on 'Others' and thus the required classification was completed. The average grade of soft-coke was taken to be 4000 kcal/kg.[3]

Finally for the intra-sector constituents (specifically Paper and 'Others') for which a grade-wise classification of coal consumption was not available, the needful was done on a production-based grade-wise classification of coal (taking the relevant years and the corresponding grade of coal into consideration). This classification is shown in Table (4.2.3).

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2 *Figure obtained from the Coal Ministry.*

3 *Figure obtained from the Coal Ministry.*

Table [4.2.3]

Production Based Grades of Coal

Period	Average Grade (KCAL/KG)
Between 1970/71 - 1975/76	5000
Between 1976/77 - 1980/81	5329
Between 1981/82 - 1984/85	5200
Between 1985/86 - 1989/90	4796

Source: Prof. Ramprasad Sengupta (1993), Energy Modelling for India: Towards a Policy for Commercial Energy, Planning Commission, Government of India, 1993.

All of the above made manipulation and data assemblage is shown in the Tables (4.2.4) and (4.2.5).

Table [4.2.4]

Sector	Type of Coal Consumed	Grade of non-coking coal consumed	Average Gross Calorific Value (KCAL/KG)
TRANSPORT Railways	Non-coking	C & D	5450
AGRICULTURE Cotton	Non-coking	A & B	6200
POWER Electricity	Coking	E, F & G	4000
INDUSTRY Steel & Washery Cement Paper Fertiliser Others	 Coking Non-coking Non-coking Coking Non-coking	 - D on prod. basis - on prod. basis	 5900 5200 on prod. basis 5900 on prod. basis
DOMESTIC Household	Soft-coke	-	5000

prod. = production
Source: Partly compiled by the author and partly obtained from the Coal-Ministry, GOI.

Table [4.2.5]

Grading of Non-coking Coal

Grade	**Median Gross Calorific Value (Kcal/Kg)**
A	6300
B	6100
C	5700
D	5200
E	4700
F	4000
G	3000

Source: Tata Energy Research Institute, TEDDY 1994-95, TERI, New Delhi, 1994.

Now the next step is to calculate the net carbon burnt in the consumption of coal for my framework. This we have done using the equation:

Net carbon burnt = {Consumption * [(0.0248 * Gross calorific value * adjustment for low heating value) + 0.017] * fraction burnt}[4] - (1)

Here, the consumption figures as well as the corresponding Gross Calorific

4 *Meeta Mehra and Mala Damodaran (1993), 'Anthropogenic Emissions of Greenhouse Gases in India (1989/90)', in A.N. Achanta (ed.), Climate Change Agenda: An Indian Perspective, TERI, 1993.*

Values is obtained from Tables (4.1.4) and (4.2.4) respectively. Further, for adjustment for low heating value (necessary to convert Gross Calorific Values into Net Calorific Values) we have taken 95%[5] and 99%[6] to be the fraction burnt.

Thus, in this way we get the sectoral net carbon burnt (-when we add up the individual intrasector constituents). The only exception to the use of this above mentioned equation (1) is in the case of the Fertilizer Industry (i.e. non-energy use) where according to D.R. Ahuja (1989) 75% of the coal undergoes delayed oxidation. Hence, for this case we multiply our equation (1) with an additional factor of (25%) to get the net carbon burnt.[7]

Thus using the above mentioned methodology we get the net carbon burnt matrix. This is show in Table (4.2.6).

So now only the final step of calculating the carbondioxide emissions is left. This is obtained very simply by using the information from Table (4.1.7) onto Table (4.2.6) and what we get is Table (4.2.7) - the carbondioxide emissions from coal consumption.

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5 *OECD (1991), Estimation of Greenhouse Gas Emissions and Sinks, Final Report from OECD Experts Meeting, 18-21 February 1991, Prepared for Intergovernmnetal Panel on Climate Change.*

6 *G.Marland and R.M. Rotty (1984), 'Carbondioxide Emissions from Fossil Fuels: A Procedure for Estimations and Results for 1950-82', Tellus 36B: 232-261, 1984.*

7 *D.R.Ahuja (1989), Anthropogenic Emissions of Greenhouse Gases, Washington DC.: Office of Policy Analysis, US EPA, 1989.*

[4.3] Carbondioxide Emissions from Consumption of Petroleum Products:

The calculation of CO_2 emissions is carried out by using the information given in Table (4.1.7), once the net carbon burnt is calculated. And for the calculation of net carbon burnt, we have used the equation:

Net Carbon burnt = {[1-Fraction of carbon unoxidised] * [Consumption] * [Carbon content] * [1-Fraction undergoing delayed oxidation]}[8] - (2)

Since the analysis is being carried on a sectoral plane and as each sector consumes a different mix of petroleum products, for each of this individual petroleum- products the carbon-content as well as fraction undergoing delayed oxygen differs. But unlike in the case of coal consumption, here, the inter-sector consumption of the same product does not differ in any of the parameters included in the equation (2), above, and used for calculating the net carbon burnt. Data on the carbon content and the fraction undergoing delayed oxidation for the individual petroleum products is obtained from CSIR (1992) and OECD (1991) respectively and are shown in table (4.3.1). Finally, data on carbon un-oxidized is obtained as 1.5% (± 1%) from G.Marland and R.M.Rotty (1984).

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8 *Meeta Mehra and Mala Damodaran, op.cit.*

Table [4.3.1]

Petroleum Product	Carbon Content (%)[1]	Fraction undergoing delayed oxidation[2]
LPG	82.45	-
Mogas	84.85	-
Kerosene	86.15	-
ATF	85.91	-
HSD	86.11	-
LDO	88.00	-
FO	88.04	-
Refinery Fuel	85.00	-
Naptha	85.00	0.8
Bitumen	85.00	1.0
Lubes	85.00	0.5
Petroleum Coke	85.00	-
Others	85.00	-

Source: **Compiled from - (1) CSIR (1992); (2) OECD (1991).**

So, using the information given in Table (4.3.1) on the sectoral consumption of petroleum products, as given in Table (4.1.5), we get the data on sectoral net carbon burnt during the sectoral consumption of various petroleum products. This is shown in Table (4.3.2). Now using this data [(in Table (4.3.2)] in conjuction with the information given in Table (4.1.7), we get the carbondioxide emission from the consumption of petroleum products. This result is shown in Table (4.3.3). But in the process a number of manipulations and assumptions had to be made, primarily because of the lack of needful data and these began with the converting of figures for calender years into figures for financial years.

The data on sectoral consumption of petroleum products prior to 1976 was in terms of calender years, but from 1977 onwards it was in terms of financial years. A reason given, for this, by the officials in the Petroleum Ministry was that sometimes in the late 1970s the Petroleum Ministry came to stand on its own and also started publishing its own annual statistic under the heading 'Petroleum and Natural Gas Statistics' (P&NGS). Prior to this, the ministry also included the petro-chemicals department and hence their joint publication was called 'Petroleum and Petro-Chemicals Statistics', in which they followed a different pattern of accounting. So the reason very commonly placed in front of the public is that primarily the system of accounting changed in the late 1970s and hence the conversion from calender years to financial years in Central compilation of annual data. Thus, to get a common system of accounting in line with the rest of our work, what we have done is that used the standard formula given by equation (3) to convert the calender years into financial years. The equation (3) is :

$$Y_1^f = [3/4\ (Y_1^c) + 1/4\ (Y_2^c)] \quad - (3)$$

where (Y) stands for the Years, subscript (1&2) stands for the consecutive years from 1970 to 1976 and the superscript (c & f) stands for calender years and financial years respectively.

Besides this manipulation of the data, the assumptions undertaken in the process of obtaining CO_2 emissions from the consumption of petroleum products are:

- As the break-up for Kerosene (between Industry and Domestic) is not available except for the initial two years of 1970 and 1971, where the Industry sector garnered 3.97% and 3.73% respectively, we take the entire consumption of Kerosene to be for Domestic sector only.
- The FO, HSD and LDO comprising the Transport sector includes consumption out of Agricultural retail i.e for agricultural pump sets, etc. due to lack of appropriate disaggregated data.

Finally, the LPG consumption includes consumption out of Natural gas as it is treated as liquid fuel, and the 'Others' category includes those of light distillates, middle distillates and heavy ends.

Thus in this manner CO_2 emission out of the Petroleum products is calculated.

[4.4] **CO_2 Emissions from the Consumption of Natural Gas**:

In calculating the CO_2 emissions from the consumption of Natural gas, one has to differentiate the consumption of Natural gas, as in Table (4.1.6), across sectors. This is done on the basis of :

(a) Consumption for energy use - this is completely oxidised. Here, the consumption has to be net of LPG use as LPG is treated as a liquid fuel and hence for calculating CO_2 emissions, to be included within calculation of CO_2 emissions from the consumption of Petroleum products. This has already been taken care of during the compilation of Table (4.1.6). Further, also the two individual constituents of the Industry Sector (in our classification) - LPG shrinkage and Captive use, need to be removed for calculation purposes as they do not contribute (in any significant sense) to the emissions of CO_2. So, this has been done and hence the Table (4.4.1). Now this Table (4.4.1) has to be used for calculating the CO_2 emissions.

(b) Consumption for non-energy use - this is oxidised to the extant of 67%[9] in the same year. The non-energy use is basically within the Industry sector and comprise industries such as Fertilizers and Petrochemicals.

(c) Gas flared - it is assumed that all of this gets completely converted into CO_2.[10]

Once this task is complete, the process of calculating CO_2 emissions becomes much simpler for all it needs is a few more across-the-board conversions before the net carbon burnt is obtained and from there a simple use of Table (4.1.7) would give us the CO_2 emissions. Infact,, the entire procedure of calculating CO_2 emissions can now be captured within the single Table (4.4.2).

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9 *D.R. Ahuja, op.cit.*

10 *Meeta Mehra and Mala Damodaran, op.cit.*

Table [4.4.2]

STEPWISE PROCEDURE FOR CALCULATING CO_2 EMISSION FROM THE CONSUMPTION OF NATURAL-GAS

Variables	Sl. No.	Units	Methods
Consumption for energy use (net of LPG)[1]	1	Million Cubic Meters (MCM)/Year	
Consumption for non-energy use	2	MCM/Year	
Fraction of non-energy use oxidised	3	%	67% of 2[2]
Total Consumption-Burnt	4	MCM/Year	1 + 3
Fraction unburnt	5	%	1% of 4[3]
Net Consumption burnt	6	MCM/Year	99% of 4
Gas Flared	7	MCM/Year	
Total burnt	8	MCM/Year	6 + 7
Energy Content	9	Mega Joules (MJ)/M^3	
Total burnt in every units	10	Peta Joules (PJ)/Year	Applying 9 on 8, using unitary method
Carbon content	11	Gram/MJ	
Net Carbon burnt	12	Mega Tonne (MT)/Year, or Tera Gram (Tg)/Year	Applying 11 on 10, using unitary method
Emissions of CO_2	13	MT/Year or Tg/year	Using table (4.1.7) onto 12.

Source: Complied by the author

Note: 1. Net of LPG is net of not only LPG use, but also net of LPG shrinkage and Captive use.

2. D.R. Ahuja (1989).

3. G.Marland and R.M. Rotty (1984).

So, we have classified the data on consumption of Natural gas under differentiated consumption groupings, within a sectoral frame work-Table (4.1.6). With this, not only is it possible to separately work on each type of consumption of Natural gas but it is also possible to arrive at a sectoral end-result as throughout we are maintaining a sectoral stance and in the end its only a question of adding up same sectors across the consumption kinds. Hence, we can also get a result such as, say, a pattern of CO_2 emissions out of the Gas-flared (over and above the sectoral emissions) over a period of years. For our end result, we will add the calorific energy consumption and the ensuing CO_2 emissions due to Gas-flared to the Power sector (as our discussion with Prof. R.P. Sengupta on this point).

Now, we can tackle each of the consumption kinds separately. This is needed only till we arrive at the stage where we have obtained the gas burnt, converting it into energy-units which in turn is converted into net carbon burnt. Then its only application of Table (4.1.7) to get the CO_2 emissions.

The total gas burnt in each case (of differentiated consumption) is taken as the total gas consumed, except for the case of consumption for non-energy use where it is 67%[11] of the total consumed. Then in each case the net gas burnt is obtained as 99%[12] of the total gas burnt. Next we convert the net gas burnt into energy units.

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11 *D.R. Ahuja, op.cit.*

12 *G. Marland and R.M. Rotty, op.cit.*

This is done by using unitary method of calculation and using the conversion factor of $1m^3$ of natural gas burnt contains 36.60 MJ[13] - Table (4.4.3). Finally, we arrive at the net carbon burnt in each case by converting the consumption in energy-units into consumption in terms of net carbon burnt again by the unitary method. Here, the conversion factor (i.e., Carbon Content) used is 1 MJ of Natural gas burnt contains 13.66 grams of carbon (i.e., Carbon content is 510 g/m^3 of dry natural gas)[14] - Table (4.4.4). Now all that we have to do to use the Table (4.1.7) onto Table (4.4.4) and what we get is Table (4.4.5) i.e., CO_2 emissions out of consumption of Natural gas; and for obtaining sectoral CO_2 emissions, we now only have to add up the same sectors across the consumption kinds and we get our Table (4.4.6).

[4.5] Thus, it is seen how CO_2 emissions are calculated from the consumption of individual fossil fuels. Here, the methodology applied for one year is to be applied in ditto for the entire period of study.

This methodology for obtaining a sectoral classification of CO_2 emissions through energy consumption, via calculation and then distribution of CO_2 emissions, from the consumption of individual fossil fuels is very unique for it is potently double-edged, because not only has it proved extremely helpful in the sense that these fossil fuels together comprise a major part of our energy

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13 *Meeta Mehra and Mala Damodaran, op.cit.*

14 *Meeta Mehra and Mala Damodaran, op.cit.*

consumption constituents and in the process is also obtained the remaining constituent of our energy consumption (-namely electricity) along with its resulting CO_2 emissions, but in order to get a correct and complete sectoral classification of CO_2 emissions from energy consumption, without any further fuss, one is also easily beguiled into thinking that one only has to add up the CO_2 emissions from the consumption of individual fossil fuels sectorally and across the individual fossil fuels, for each year of our period of study. This is not so, for it not only results in our getting a series showing sectoral classification of CO_2 emissions resulting only from the consumption of individual fossil fuels which is incomplete as power, an important energy constituent, is not present, but it also results in a separate series of sectoral classification of CO_2 emissions for power, especially. Thus, this latter has to be somehow distributed amongst all the remaining sectors of our classification in order to paint the true color to the sectoral picture of CO_2 emission from energy consumption. And this is not as easy a task as it seems to be.

Tables to Chapter 4

TABLE [4.1.1] AVAILABILITY OF COAL IN THOUSAND TONNES (000'TONNES).

YEAR	PRODUCTION	CHANGES IN STOCK AT PITHEADS	CHANGES IN INDUSTRIAL STOCK	IMPORTS	EXPORTS	AVAILABLE FOR CONSUMPTION
1	2	3	4	5	6	7
1970-71	72940.00	-2480.00	1240.00	N.A.	470.00	71230.00
1971-72	72410.00	1710.00	170.00	N.A.	230.00	74060.00
1972-73	77220.00	1630.00	-180.00	N.A.	460.00	78210.00
1973-74	78170.00	-430.00	560.00	N.A.	620.00	77680.00
1974-75	88410.00	-920.00	-1350.00	N.A.	540.00	85600.00
1975-76	99680.00	-4280.00	-2740.00	N.A.	440.00	92220.00
1976-77	101040.00	-2670.00	2420.00	N.A.	640.00	100150.00
1977-78	100920.00	2320.00	1200.00	N.A.	660.00	103780.00
1978-79	101980.00	-2550.00	810.00	220.00	270.00	100190.00
1979-80	104000.00	710.00	40.00	940.00	90.00	105600.00
1980-81	114010.00	-4250.00	-780.00	550.00	110.00	109420.00
1981-82	124930.00	-2790.00	-1610.00	650.00	160.00	121020.00
1982-83	130600.00	-1370.00	-290.00	1380.00	150.00	130170.00
1983-84	138240.00	-440.00	-890.00	460.00	80.00	137290.00
1984-85	147430.00	-7340.00	900.00	670.00	120.00	141540.00
1985-86	154300.00	1250.00	-1830.00	2030.00	210.00	155540.00
1986-87	165690.00	110.00	-890.00	2100.00	160.00	166850.00
1987-88	179849.00	-4990.00	1550.00	2970.00	170.00	179209.00
1988-89	194375.00	-4350.00	-1410.00	3700.00	200.00	192115.00
1989-90(*)	200914.00	-2990.00	1300.00	4410.00	160.00	203474.00

NOTES:
*:Provisional.
(Source: Energy statistics -1989/90, CSO, GOI).

TABLE [4.1.2] AVAILABILITY OF PETROLEUM PRODUCTS IN THOUSAND TONNES (000'TONNES).

YEAR	PRODUCTION	GROSS IMPORTS	EXPORTS	NET IMPORTS	GROSS AVAILABLE
1	2	3	4	5	6
1970-71	17110.00	1084.00	332.00	752.00	17862.00
1971-72	18639.00	2147.00	136.00	2011.00	20650.00
1972-73	17830.00	3525.00	126.00	3399.00	21229.00
1973-74	19495.00	3548.00	161.00	3387.00	22882.00
1974-75	19603.00	2648.00	175.00	2473.00	22076.00
1975-76	20829.00	2218.00	170.00	2048.00	22877.00
1976-77	21432.00	2624.00	74.00	2550.00	23982.00
1977-78	23219.00	2879.00	47.00	2832.00	26051.00
1978-79	24193.00	3878.00	44.00	3834.00	28027.00
1979-80	25794.00	4724.00	88.00	4636.00	30430.00
1980-81	24123.00	7289.00	36.00	7253.00	31376.00
1981-82	28182.00	4884.00	55.00	4829.00	33011.00
1982-83	31073.00	5028.00	795.00	4233.00	35306.00
1983-84	32926.00	4328.00	1472.00	2856.00	35782.00
1984-85	33236.00	6092.00	933.00	5159.00	38395.00
1985-86	39881.00	3865.00	1973.00	1892.00	41773.00
1986-87	42761.00	3047.00	2491.00	556.00	43317.00
1987-88	44728.00	3932.00	3412.00	520.00	45248.00
1988-89	45699.00	6258.00	2295.00	3963.00	49662.00
1989-90(*)	48690.00	6543.00	2593.00	3950.00	52640.00

NOTES:
*:Provisional.
(Source: Energy statistics -1989/90, CSO, GOI).

TABLE [4.1.3] GROSS AND NET PRODUCTION OF NATURAL GAS IN MILLION CUBIC METERS (MCM).

YEAR	GROSS PRODUCTION	RE-INJECTED	GAS FLARED	NET PRODUCTION	UTILIZATION
1	2	3	4	5	6
1970-71	1445.00	36.00	762.00	647.00	647.00
1971-72	1535.00	49.00	768.00	718.00	718.00
1972-73	1565.00	141.00	653.00	771.00	771.00
1973-74	1713.00	115.00	836.00	762.00	762.00
1974-75	2041.00	139.00	951.00	951.00	951.00
1975-76	2368.00	162.00	1082.00	1124.00	1124.00
1976-77	2428.00	190.00	857.00	1381.00	1381.00
1977-78	2839.00	184.00	1191.00	1464.00	1464.00
1978-79	2812.00	148.00	953.00	1711.00	1711.00
1979-80	2767.00	127.00	964.00	1676.00	1676.00
1980-81	2358.00	67.00	769.00	1522.00	1522.00
1981-82	3851.00	110.00	1519.00	2222.00	2222.00
1982-83	4936.00	91.00	1888.00	2957.00	2957.00
1983-84	5961.00	45.00	2517.00	3399.00	3399.00
1984-85	7241.00	48.00	3052.00	4141.00	4141.00
1985-86	8134.00	66.00	3118.00	4950.00	4950.00
1986-87	9853.00	63.00	2718.00	7072.00	7072.00
1987-88	11467.00	54.00	3445.00	7968.00	7968.00
1988-89	13217.00	84.00	3883.00	9250.00	9250.00
1989-90(*)	16989.00	96.00	5721.00	11172.00	11172.00

NOTES:
*:Provisional.
(Source: Energy statistics -1989/90, CSO, GOI).

TABLE [4.1.4] SECTOR-WISE CONSUMPTION OF COAL.

Sectors (1)	1970-71	1971-72	1972-73	1973-74	1974-75
1.TRANSPORT (000'Tonnes)	15580.00	15920.00	15320.00	13920.00	14140.00
a) RAILWAYS	15580.00	15920.00	15320.00	13920.00	14140.00
2.AGRICULTURE(000'Tonnes)	1450.00	1640.00	1830.00	1780.00	2040.00
a) COTTON	1450.00	1640.00	1830.00	1780.00	2040.00
3.POWER (000'Tonnes)	13210.00	14580.00	16650.00	16640.00	20300.00
a) ELECTRICITY	13210.00	14580.00	16650.00	16640.00	20300.00
4.INDUSTRY (000'Tonnes)	40990.00	41920.00	44410.00	45340.00	45400.00
a) STEEL & WASHERY	13530.00	13490.00	13550.00	13780.00	15920.00
b) CEMENT	3520.00	3360.00	3700.00	3650.00	4380.00
c) PAPER	270.00	1100.00	1140.00	1000.00	1400.00
d) FERTILIZER	1503.33	1498.89	1505.56	1531.11	1768.89
e) OTHERS	22166.67	22471.11	24514.44	25378.89	21951.11
5.DOMESTIC (000'Tonnes)	N.A.	N.A.	N.A.	N.A.	3720.00
a) HOUSEHOLDS	N.A.	N.A.	N.A.	N.A.	3720.00
TOTAL (000'Tonnes)	71230.00	74060.00	78210.00	77680.00	85600.00

SOURCE: Compiled by the author.

TABLE [4.1.4]   SECTOR-WISE CONSUMPTION OF COAL.

Sectors (2)	1975-76	1976-77	1977-78	1978-79	1979-80
1.TRANSPORT (000'Tonnes)	14300.00	13170.00	12930.00	12130.00	11360.00
a) RAILWAYS	14300.00	13170.00	12930.00	12130.00	11360.00
2.AGRICULTURE(000'Tonnes)	2230.00	2410.00	2500.00	2340.00	1990.00
a) COTTON	2230.00	2410.00	2500.00	2340.00	1990.00
3.POWER (000'Tonnes)	23040.00	26850.00	25650.00	24800.00	30030.00
a) ELECTRICITY	23040.00	26850.00	25650.00	24800.00	30030.00
4.INDUSTRY (000'Tonnes)	49010.00	53430.00	59320.00	57890.00	59960.00
a) STEEL & WASHERY	18880.00	20340.00	21540.00	20280.00	19850.00
b) CEMENT	4440.00	4970.00	4730.00	4880.00	3870.00
c) PAPER	1260.00	1750.00	1880.00	1720.00	1540.00
d) FERTILIZER	2097.78	2260.00	2393.33	2251.11	2205.56
e) OTHERS	22332.22	24110.00	28776.67	28778.89	32494.44
5.DOMESTIC (000'Tonnes)	3640.00	4290.00	3380.00	3030.00	2260.00
a) HOUSEHOLDS	3640.00	4290.00	3380.00	3030.00	2260.00
TOTAL (000'Tonnes)	92220.00	100150.00	103780.00	100190.00	105600.00

SOURCE: Compiled by the author.

TABLE [4.1.4] SECTOR-WISE CONSUMPTION OF COAL.

Sectors (3)	1980-81	1981-82	1982-83	1983-84	1984-85
1.TRANSPORT (000'Tonnes)	11810.00	11260.00	10950.00	10700.00	9460.00
a) RAILWAYS	11810.00	11260.00	10950.00	10700.00	9460.00
2.AGRICULTURE(000'Tonnes)	1970.00	2370.00	2940.00	2560.00	2570.00
a) COTTON	1970.00	2370.00	2940.00	2560.00	2570.00
3.POWER (000'Tonnes)	38150.00	44420.00	49520.00	55830.00	57660.00
a) ELECTRICITY	38150.00	44420.00	49520.00	55830.00	57660.00
4.INDUSTRY (000'Tonnes)	54750.00	60680.00	64720.00	66400.00	70110.00
a) STEEL & WASHERY	21010.00	22010.00	22820.00	24890.00	25000.00
b) CEMENT	4750.00	5720.00	6100.00	7320.00	7290.00
c) PAPER	2140.00	2460.00	2500.00	2570.00	2830.00
d) FERTILIZER	2334.44	2445.56	2535.56	2765.56	2777.78
e) OTHERS	24515.56	28044.44	30764.44	28854.44	32212.22
5.DOMESTIC (000'Tonnes)	2740.00	2290.00	2040.00	1800.00	1740.00
a) HOUSEHOLDS	2740.00	2290.00	2040.00	1800.00	1740.00
TOTAL (000'Tonnes)	109420.00	121020.00	130170.00	137290.00	141540.00

SOURCE: Compiled by the author.

TABLE [4.1.4] SECTOR-WISE CONSUMPTION OF COAL.

Sectors (4)	1985-86	1986-87	1987-88	1988-89	1989-90
1.TRANSPORT (000'Tonnes)	9610.00	8120.00	7550.00	6740.00	5800.00
a) RAILWAYS	9610.00	8120.00	7550.00	6740.00	5800.00
2.AGRICULTURE(000'Tonnes)	2360.00	2440.00	2540.00	2970.00	2700.00
a) COTTON	2360.00	2440.00	2540.00	2970.00	2700.00
3.POWER (000'Tonnes)	68640.00	78580.00	91810.00	97220.00	108320.00
a) ELECTRICITY	68640.00	78580.00	91810.00	97220.00	108320.00
4.INDUSTRY (000'Tonnes)	73640.00	76440.00	76679.00	84955.00	86404.00
a) STEEL & WASHERY	24820.00	24220.00	26670.00	29770.00	30610.00
b) CEMENT	8040.00	8850.00	8770.00	9270.00	9530.00
c) PAPER	2660.00	2650.00	2820.00	3290.00	2900.00
d) FERTILIZER	2757.78	2691.11	2963.33	3307.78	3401.11
e) OTHERS	35362.22	38028.89	35455.67	39317.22	39962.89
5.DOMESTIC (000'Tonnes)	1300.00	1270.00	970.00	630.00	570.00
a) HOUSEHOLDS	1300.00	1270.00	970.00	630.00	570.00
TOTAL (000'Tonnes)	155550.00	166850.00	179549.00	192515.00	203794.00

SOURCE: Compiled by the author.

TABLE [4.1.5] SECTOR-WISE CONSUMPTION OF PETROLEUM PRODUCTS.

Sectors (1)	1970-71	1971-72	1972-73	1973-74	1974-75
1.TRANSPORT (000'Tonnes)	2633.25	3827.75	7125.00	7547.50	8200.75
F.O.	491.25	487.25	398.25	386.75	312.75
H.S.D	N.A.	1044.00	4273.00	4831.25	5739.50
L.D.O	N.A.	11.50	45.75	44.50	48.50
MOGAS	1453.00	1527.00	1592.00	1507.00	1264.00
A.T.F	689.00	758.00	816.00	778.00	836.00
2.AGRICULTURE(000'Tonnes)	183.25	193.00	186.75	209.50	157.50
F.O.	183.25	193.00	186.75	209.50	157.50
H.S.D.	N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.	N.A.	N.A.	N.A.	N.A.	N.A.
3.POWER (000'Tonnes)	1235.75	1382.25	1698.00	1816.50	1867.00
F.O.	1235.75	1346.50	1551.25	1667.00	1756.25
H.S.D.	N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.	N.A.	35.75	146.75	149.50	110.75
4.INDUSTRY (000'Tonnes)	6798.50	8095.75	10026.00	10516.75	9877.75
F.O.	2821.50	3091.25	3509.25	3612.00	3503.25
H.S.D.	N.A.	61.00	340.25	615.75	563.50
L.D.O.	N.A.	299.00	1183.25	1102.50	915.75
NAPHTHA	904.00	1164.00	1297.00	1534.00	1713.00
LUBRICANTS	545.00	362.00	609.00	612.00	475.00
BITUMEN	777.00	1011.00	1109.00	1066.00	899.00
PETROLEUM COKE	107.00	188.00	141.00	139.00	89.00
L.P.G.	36.00	41.50	50.25	54.50	59.25
OTHERS	385.00	650.00	525.00	552.00	463.00
REFINERY-FUEL	1223.00	1228.00	1262.00	1229.00	1197.00
5.DOMESTIC (000'Tonnes)	3422.00	3686.50	3710.00	3507.00	3061.00
LPG	139.00	169.50	194.00	213.00	233.00
KEROSENE	3283.00	3517.00	3516.00	3294.00	2828.00
TOTAL (000'Tonnes)	14272.75	17185.25	22745.75	23597.25	23164.00

SOURCE: Compiled from various volumes of "Petroleum and Natural Gas Statics", GOI.

TABLE [4.1.5] SECTOR-WISE CONSUMPTION OF PETROLEUM PRODUCTS.

Sectors (2)	1975-76	1976-77	1977-78	1978-79	1979-80
1.TRANSPORT (000'Tonnes)	8710.75	9151.50	9868.00	10740.00	11761.00
F.O.	366.75	377.75	377.00	313.00	331.00
H.S.D	6120.00	6473.75	6986.00	7694.00	8704.00
L.D.O	52.00	28.00	73.00	80.00	92.00
MOGAS	1275.00	1316.00	1391.00	1499.00	1490.00
A.T.F	897.00	956.00	1041.00	1154.00	1144.00
2.AGRICULTURE(000'Tonnes)	121.25	142.00	139.00	133.00	144.00
F.O.	121.25	142.00	139.00	133.00	144.00
H.S.D.	N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.	N.A.	N.A.	N.A.	N.A.	N.A.
3.POWER (000'Tonnes)	1837.75	1664.00	1919.00	2253.00	2205.00
F.O.	1755.75	1556.50	1834.00	2191.00	2134.00
H.S.D.	N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.	82.00	107.50	85.00	62.00	71.00
4.INDUSTRY (000'Tonnes)	9699.50	10714.75	11114.00	12311.00	13008.00
F.O.	3524.50	3629.25	3489.00	4031.00	4471.00
H.S.D.	538.00	618.00	750.00	944.00	1097.00
L.D.O.	763.50	881.50	1006.00	1074.00	1103.00
NAPHTHA	1836.00	2196.00	2290.00	2515.00	2413.00
LUBRICANTS	441.00	454.00	478.00	544.00	566.00
BITUMEN	690.00	882.00	908.00	943.00	1069.00
PETROLEUM COKE	151.00	175.00	146.00	155.00	185.00
L.P.G.	68.50	69.00	75.00	78.00	78.00
OTHERS	461.00	511.00	521.00	549.00	586.00
REFINERY-FUEL	1226.00	1299.00	1451.00	1478.00	1440.00
5.DOMESTIC (000'Tonnes)	3357.25	3582.50	3950.00	4282.00	4204.00
LPG	253.25	260.50	316.00	330.00	332.00
KEROSENE	3104.00	3322.00	3634.00	3952.00	3872.00
TOTAL (000'Tonnes)	23726.50	25254.75	26990.00	29719.00	31322.00

SOURCE: Compiled from various volumes of "Petroleum and Natural Gas Statics", GOI.

TABLE [4.1.5] SECTOR-WISE CONSUMPTION OF PETROLEUM PRODUCTS.

Sectors (3)	1980-81	1981-82	1982-83	1983-84	1984-85
1.TRANSPORT (000'Tonnes)	12121.00	12645.00	13686.00	14636.00	15711.00
F.O.	341.00	316.00	317.00	386.00	357.00
H.S.D	9050.00	9505.00	10403.00	11049.00	11839.00
L.D.O	83.00	97.00	99.00	102.00	95.00
MOGAS	1522.00	1599.00	1722.00	1891.00	2084.00
A.T.F	1125.00	1128.00	1145.00	1208.00	1336.00
2.AGRICULTURE(000'Tonnes)	198.00	401.00	313.00	299.00	307.00
F.O.	198.00	173.00	172.00	154.00	150.00
H.S.D.	N.A.	198.00	114.00	119.00	128.00
L.D.O.	N.A.	30.00	27.00	26.00	29.00
3.POWER (000'Tonnes)	2243.00	2120.00	2466.00	2589.00	2867.00
F.O.	2085.00	1765.00	2024.00	2225.00	2494.00
H.S.D.	N.A.	177.00	226.00	145.00	140.00
L.D.O.	158.00	178.00	216.00	219.00	233.00
4.INDUSTRY (000'Tonnes)	13145.00	13924.00	14186.00	14068.00	15129.00
F.O.	4849.00	4930.00	4789.00	4793.00	4942.00
H.S.D.	1295.00	1052.00	1269.00	1287.00	1589.00
L.D.O.	881.00	731.00	725.00	750.00	841.00
NAPHTHA	2325.00	2963.00	2958.00	2804.00	3125.00
LUBRICANTS	593.00	592.00	605.00	617.00	664.00
BITUMEN	1064.00	1292.00	1379.00	1050.00	935.00
PETROLEUM COKE	137.00	174.00	103.00	114.00	234.00
L.P.G.	78.00	68.00	71.00	86.00	99.00
OTHERS	558.00	538.00	549.00	632.00	667.00
REFINERY-FUEL	1365.00	1584.00	1738.00	1935.00	2033.00
5.DOMESTIC (000'Tonnes)	4555.00	5117.00	5744.00	6184.00	6813.00
LPG	327.00	424.00	530.00	660.00	854.00
KEROSENE	4228.00	4693.00	5214.00	5524.00	5959.00
TOTAL (000'Tonnes)	32262.00	34207.00	36395.00	37776.00	40827.00

SOURCE: Compiled from various volumes of "Petroleum and Natural Gas Statics", GOI.

TABLE [4.1.5] SECTOR-WISE CONSUMPTION OF PETROLEUM PRODUCTS.

Sectors (4)	1985-86	1986-87	1987-88	1988-89	1989-90
1.TRANSPORT (000'Tonnes)	16988.00	18564.00	20342.00	22147.00	24174.00
F.O.	294.00	362.00	417.00	464.00	469.00
H.S.D	12880.00	14008.00	15360.00	16822.00	18341.00
L.D.O	86.00	86.00	101.00	96.00	98.00
MOGAS	2275.00	2505.00	2810.00	3052.00	3491.00
A.T.F	1453.00	1603.00	1654.00	1713.00	1775.00
2.AGRICULTURE(000'Tonnes)	345.00	348.00	375.00	385.00	512.00
F.O.	166.00	163.00	166.00	201.00	205.00
H.S.D.	149.00	155.00	177.00	150.00	270.00
L.D.O.	30.00	30.00	32.00	34.00	37.00
3.POWER (000'Tonnes)	2745.00	2635.00	2755.00	2666.00	2773.00
F.O.	2330.00	2201.00	2295.00	2188.00	2322.00
H.S.D.	160.00	161.00	209.00	132.00	126.00
L.D.O.	255.00	273.00	251.00	346.00	325.00
4.INDUSTRY (000'Tonnes)	15956.00	16642.00	16819.00	18361.00	19265.00
F.O.	5110.00	5221.00	5265.00	5603.00	5824.00
H.S.D.	1697.00	1685.00	1911.00	1691.00	1989.00
L.D.O.	752.00	767.00	861.00	961.00	1020.00
NAPHTHA	3106.00	3249.00	2852.00	3364.00	3350.00
LUBRICANTS	700.00	755.00	791.00	847.00	926.00
BITUMEN	1126.00	1309.00	1379.00	1498.00	1695.00
PETROLEUM COKE	163.00	208.00	246.00	316.00	383.00
L.P.G.	141.00	157.00	271.00	370.00	458.00
OTHERS	670.00	679.00	721.00	921.00	956.00
REFINERY-FUEL	2491.00	2612.00	2522.00	2790.00	2684.00
5.DOMESTIC (000'Tonnes)	7329.00	7986.00	8646.00	9323.00	10049.00
LPG	1100.00	1341.00	1415.00	1592.00	1810.00
KEROSENE	6229.00	6645.00	7231.00	7731.00	8239.00
TOTAL (000'Tonnes)	43363.00	46175.00	48937.00	52882.00	56773.00

SOURCE: Compiled from various volumes of 'Petroleum and Natural Gas Statics', GOI.

TABLE [4.1.6] SECTOR-WISE CONSUMPTION OF NATURAL-GAS.

Sectors (1)		1970-71	1971-72	1972-73	1973-74	1974-75
1.ENERGY USE	(MCM)	460.00	522.00	570.00	583.00	633.00
a) AGRICULTURE		15.00	19.00	20.00	22.00	29.00
TEA PLANTATION		15.00	19.00	20.00	22.00	29.00
b) POWER		261.00	313.00	339.00	323.00	354.00
POWER GENERATION		261.00	313.00	339.00	323.00	354.00
c) INDUSTRY		184.00	190.00	211.00	238.00	244.00
INDUSTRIAL FUEL		116.00	129.00	148.00	157.00	164.00
LPG SHRINKAGE		N.A.	N.A.	N.A.	N.A.	N.A.
CAPTIVE USE		68.00	61.00	63.00	81.00	80.00
d) DOMESTIC		N.A.	N.A.	N.A.	N.A.	6.00
DOMESTIC FUEL		N.A.	N.A.	N.A.	N.A.	6.00
2) NON-ENERGY	(MCM)	187.00	196.00	201.00	179.00	318.00
a) INDUSTRY		187.00	196.00	201.00	179.00	318.00
FERTILIZERS		187.00	196.00	201.00	179.00	318.00
PETRO-CHEMICALS		N.A.	N.A.	N.A.	N.A.	N.A.
OTHERS		N.A.	N.A.	N.A.	N.A.	N.A.
TOTAL UTILISATION	(MCM)	647.00	718.00	771.00	762.00	951.00
3) GAS-FLARED	(MCM)	762.00	768.00	653.00	836.00	951.00
GRAND TOTAL (1+2+3) (MCM)		1409.00	1486.00	1424.00	1598.00	1902.00

SOURCE:
1. ENERGY STATISTICS -1989-90, CSO, GOI.
2. TEDDY -1994-95, TERI, N.DELHI

TABLE [4.1.6] SECTOR-WISE CONSUMPTION OF NATURAL-GAS.

Sectors (2)	1975-76	1976-77	1977-78	1978-79	1979-80
1.ENERGY USE (MCM)	659.00	694.00	760.00	967.00	896.00
a) AGRICULTURE	33.00	38.00	39.00	43.00	39.00
TEA PLANTATION	33.00	38.00	39.00	43.00	39.00
b) POWER	366.00	344.00	372.00	560.00	514.00
POWER GENERATION	366.00	344.00	372.00	560.00	514.00
c) INDUSTRY	247.00	297.00	336.00	351.00	330.00
INDUSTRIAL FUEL	143.00	155.00	165.00	175.00	156.00
LPG SHRINKAGE	N.A.	N.A.	N.A.	N.A.	N.A.
CAPTIVE USE	104.00	142.00	171.00	176.00	174.00
d) DOMESTIC	13.00	15.00	13.00	13.00	13.00
DOMESTIC FUEL	13.00	15.00	13.00	13.00	13.00
2) NON-ENERGY (MCM)	465.00	687.00	694.00	744.00	780.00
a) INDUSTRY	465.00	687.00	694.00	744.00	780.00
FERTILIZERS	463.00	663.00	673.00	721.00	755.00
PETRO-CHEMICALS	N.A.	N.A.	9.00	5.00	7.00
OTHERS	2.00	24.00	12.00	18.00	18.00
TOTAL UTILISATION (MCM)	1124.00	1381.00	1454.00	1711.00	1676.00
3) GAS-FLARED (MCM)	1082.00	857.00	1191.00	953.00	964.00
GRAND TOTAL (1+2+3) (MCM)	2206.00	2238.00	2645.00	2664.00	2640.00

SOURCE:
1. ENERGY STATISTICS -1989-90, CSO, GOI.
2. TEDDY -1994-95, TERI, N.DELHI

TABLE [4.1.6] SECTOR-WISE CONSUMPTION OF NATURAL-GAS.

Sectors (3)		1980-81	1981-82	1982-83	1983-84	1984-85
1.ENERGY USE	(MCM)	890.00	1204.00	1774.00	2083.00	2505.00
a) AGRICULTURE		45.00	47.00	51.00	56.00	62.00
TEA PLANTATION		45.00	47.00	51.00	56.00	62.00
b) POWER		492.00	612.00	1025.00	1209.00	1454.00
POWER GENERATION		492.00	612.00	1025.00	1209.00	1454.00
c) INDUSTRY		339.00	530.00	684.00	802.00	971.00
INDUSTRIAL FUEL		163.00	166.00	185.00	230.00	250.00
LPG SHRINKAGE		N.A.	37.00	100.00	161.00	190.00
CAPTIVE USE		176.00	327.00	399.00	411.00	531.00
d) DOMESTIC		14.00	15.00	14.00	16.00	18.00
DOMESTIC FUEL		14.00	15.00	14.00	16.00	18.00
2) NON-ENERGY	(MCM)	632.00	1018.00	1183.00	1316.00	1636.00
a) INDUSTRY		632.00	1018.00	1183.00	1316.00	1636.00
FERTILIZERS		611.00	991.00	1155.00	1283.00	1603.00
PETRO-CHEMICALS		5.00	8.00	7.00	10.00	11.00
OTHERS		16.00	19.00	21.00	23.00	22.00
TOTAL UTILISATION	(MCM)	1522.00	2222.00	2957.00	3399.00	4141.00
3) GAS-FLARED	(MCM)	769.00	1519.00	1888.00	2517.00	3052.00
GRAND TOTAL (1+2+3) (MCM)		2291.00	3741.00	4845.00	5916.00	7193.00

SOURCE:
1. ENERGY STATISTICS -1989-90, CSO, GOI.
2. TEDDY -1994-95, TERI, N.DELHI

TABLE [4.1.6] SECTOR-WISE CONSUMPTION OF NATURAL-GAS.

Sectors (4)	1985-86	1986-87	1987-88	1988-89	1989-90
1.ENERGY USE (MCM)	2416.00	3711.00	4448.00	3807.00	4475.00
a) AGRICULTURE	78.00	93.00	99.00	87.00	78.00
TEA PLANTATION	78.00	93.00	99.00	87.00	78.00
b) POWER	1299.00	2041.00	2721.00	1823.00	2140.00
POWER GENERATION	1299.00	2041.00	2721.00	1823.00	2140.00
c) INDUSTRY	1018.00	1552.00	1594.00	1855.00	2216.00
INDUSTRIAL FUEL	223.00	257.00	281.00	526.00	695.00
LPG SHRINKAGE	275.00	366.00			
CAPTIVE USE	520.00	929.00	1313.00	1329.00	1521.00
d) DOMESTIC	21.00	25.00	34.00	42.00	41.00
DOMESTIC FUEL	21.00	25.00	34.00	42.00	41.00
2) NON-ENERGY (MCM)	2534.00	3361.00	3520.00	5443.00	6692.00
a) INDUSTRY	2534.00	3361.00	3520.00	5443.00	6692.00
FERTILIZERS	2500.00	3335.00	3490.00	5334.00	6578.00
PETRO-CHEMICALS	10.00			21.00	29.00
OTHERS	24.00	26.00	30.00	88.00	85.00
TOTAL UTILISATION (MCM)	4950.00	7072.00	7968.00	9250.00	11167.00
3) GAS-FLARED (MCM)	3118.00	2718.00	3445.00	3883.00	5721.00
GRAND TOTAL (1+2+3) (MCM)	8068.00	9790.00	11413.00	13133.00	16888.00

SOURCE:
1. ENERGY STATISTICS -1989-90, CSO, GOI.
2. TEDDY -1994-95, TERI, N.DELHI

TABLE [4.2.6] SECTOR-WISE CONSUMPTION OF COAL : NET CARBON BURNT.

Sectors (1)	1970-71	1971-72	1972-73	1973-74	1974-75
1.TRANSPORT (mln Tonnes)	8.54	8.73	8.40	7.63	7.75
a) RAILWAYS	8.54	8.73	8.40	7.63	7.75
2.AGRICULTURE(mln Tonnes)	0.90	1.02	1.14	1.11	1.27
a) COTTON	0.90	1.02	1.14	1.11	1.27
3.POWER (mln Tonnes)	5.37	5.93	6.77	6.77	8.26
a) ELECTRICITY	5.37	5.93	6.77	6.77	8.26
4.INDUSTRY (mln Tonnes)	21.39	21.85	23.12	23.60	23.74
a) STEEL & WASHERY	8.01	7.99	8.02	8.16	9.43
b) CEMENT	1.84	1.76	1.94	1.91	2.28
c) PAPER	0.14	0.55	0.57	0.50	0.71
d) FERTILIZER	0.22	0.22	0.22	0.23	0.26
e) OTHERS	11.18	11.33	12.36	12.80	11.07
5.DOMESTIC (mln Tonnes)	N.A.	N.A.	N.A.	N.A.	1.88
a) HOUSEHOLDS	N.A.	N.A.	N.A.	N.A.	1.88
TOTAL (mln Tonnes)	36.20	37.53	39.43	39.10	42.90

SOURCE: AUTHOR.

TABLE [4.2.6] SECTOR-WISE CONSUMPTION OF COAL : NET CARBON BURNT.

Sectors (2)	1975-76	1976-77	1977-78	1978-79	1979-80
1.TRANSPORT (mln Tonnes)	7.84	7.22	7.09	6.65	6.23
a) RAILWAYS	7.84	7.22	7.09	6.65	6.23
2.AGRICULTURE(mln Tonnes)	1.39	1.50	1.55	1.45	1.24
a) COTTON	1.39	1.50	1.55	1.45	1.24
3.POWER (mln Tonnes)	9.37	10.92	10.43	10.09	12.21
a) ELECTRICITY	9.37	10.92	10.43	10.09	12.21
4.INDUSTRY (mln Tonnes)	25.71	28.85	32.03	31.24	32.36
a) STEEL & WASHERY	11.18	12.04	12.75	12.00	11.75
b) CEMENT	2.33	2.60	2.48	2.56	2.03
c) PAPER	0.64	0.94	1.01	0.92	0.83
d) FERTILIZER	0.31	0.33	0.35	0.33	0.33
e) OTHERS	11.26	12.93	15.43	15.44	17.43
5.DOMESTIC (mln Tonnes)	1.84	2.16	1.70	1.53	1.14
a) HOUSEHOLDS	1.84	2.16	1.70	1.53	1.14
TOTAL (mln Tonnes)	46.14	50.65	52.81	50.96	53.18

SOURCE: AUTHOR.

TABLE [4.2.6] SECTOR-WISE CONSUMPTION OF COAL : NET CARBON BURNT.

Sectors (3)	1980-81	1981-82	1982-83	1983-84	1984-85
1.TRANSPORT (mln Tonnes)	6.47	6.17	6.00	5.87	5.19
a) RAILWAYS	6.47	6.17	6.00	5.87	5.19
2.AGRICULTURE(mln Tonnes)	1.22	1.47	1.83	1.59	1.60
a) COTTON	1.22	1.47	1.83	1.59	1.60
3.POWER (mln Tonnes)	15.51	18.06	20.14	22.70	23.45
a) ELECTRICITY	15.51	18.06	20.14	22.70	23.45
4.INDUSTRY (mln Tonnes)	29.57	32.37	34.50	35.44	37.39
a) STEEL & WASHERY	12.44	13.03	13.51	14.74	14.80
b) CEMENT	2.49	3.00	3.19	3.83	3.82
c) PAPER	1.15	1.29	1.31	1.35	1.48
d) FERTILIZER	0.35	0.36	0.38	0.41	0.41
e) OTHERS	13.15	14.69	16.11	15.11	16.87
5.DOMESTIC (mln Tonnes)	1.38	1.15	1.03	0.91	0.88
a) HOUSEHOLDS	1.38	1.15	1.03	0.91	0.88
TOTAL (mln Tonnes)	54.17	59.23	63.50	66.51	68.50

SOURCE: AUTHOR.

TABLE [4.2.6] SECTOR-WISE CONSUMPTION OF COAL : NET CARBON BURNT.

Sectors (4)	1985-86	1986-87	1987-88	1988-89	1989-90
1.TRANSPORT (mln Tonnes)	5.27	4.45	4.14	3.70	3.18
a) RAILWAYS	5.27	4.45	4.14	3.70	3.18
2.AGRICULTURE(mln Tonnes)	1.47	1.52	1.58	1.85	1.68
a) COTTON	1.47	1.52	1.58	1.85	1.68
3.POWER (mln Tonnes)	27.91	31.96	37.34	39.54	44.05
a) ELECTRICITY	27.91	31.96	37.34	39.54	44.05
4.INDUSTRY (mln Tonnes)	37.73	39.08	39.36	43.61	44.38
a) STEEL & WASHERY	14.70	14.34	15.79	17.63	18.12
b) CEMENT	4.21	4.64	4.59	4.86	4.99
c) PAPER	1.29	1.28	1.37	1.59	1.40
d) FERTILIZER	0.41	0.40	0.44	0.49	0.50
e) OTHERS	17.13	18.42	17.17	19.04	19.36
5.DOMESTIC (mln Tonnes)	0.66	0.64	0.49	0.32	0.29
a) HOUSEHOLDS	0.66	0.64	0.49	0.32	0.29
TOTAL (mln Tonnes)	73.04	77.64	82.91	89.00	93.58

SOURCE: AUTHOR.

TABLE [4.2.7] CONSUMPTION OF COAL : CARBONDIOXIDE EMISSIONS.

Sectors (1)	1970-71	1971-72	1972-73	1973-74	1974-75
1.TRANSPORT (mln Tonnes)	28.18779	28.80293	27.71739	25.18447	25.58250
a) RAILWAYS	28.18779	28.80293	27.71739	25.18447	25.58250
2.AGRICULTURE(mln Tonnes)	2.97383	3.36350	3.75318	3.65063	4.18387
a) COTTON	2.97383	3.36350	3.75318	3.65063	4.18387
3.POWER (mln Tonnes)	17.72806	19.56663	22.34460	22.33118	27.24297
a) ELECTRICITY	17.72806	19.56663	22.34460	22.33118	27.24297
4.INDUSTRY (mln Tonnes)	70.58420	72.11476	76.28907	77.86984	78.35710
a) STEEL & WASHERY	26.43673	26.35857	26.47580	26.92521	31.10663
b) CEMENT	6.08400	5.80746	6.39512	6.30870	7.53587
c) PAPER	0.44921	1.83013	1.89668	1.66376	2.32926
d) FERTILIZER	0.73435	0.73218	0.73544	0.74792	0.86407
e) OTHERS	36.87990	37.38642	40.78603	42.22425	36.52127
5.DOMESTIC (mln Tonnes)	N.A.	N.A.	N.A.	N.A.	6.18917
a) HOUSEHOLDS	N.A.	N.A.	N.A.	N.A.	6.18917
TOTAL (mln Tonnes)	119.47388	123.84782	130.10425	129.03613	141.55561

SOURCE : AUTHOR.

TABLE [4.2.7] CONSUMPTION OF COAL : CARBONDIOXIDE EMISSIONS.

Sectors (2)	1975-76	1976-77	1977-78	1978-79	1979-80
1.TRANSPORT (mln Tonnes)	25.87198	23.82755	23.39334	21.94595	20.55285
a) RAILWAYS	25.87198	23.82755	23.39334	21.94595	20.55285
2.AGRICULTURE(mln Tonnes)	4.57354	4.94271	5.12729	4.79915	4.08132
a) COTTON	4.57354	4.94271	5.12729	4.79915	4.08132
3.POWER (mln Tonnes)	30.92010	36.03319	34.42277	33.28205	40.30081
a) ELECTRICITY	30.92010	36.03319	34.42277	33.28205	40.30081
4.INDUSTRY (mln Tonnes)	84.84082	95.20872	106.69373	103.10322	106.79201
a) STEEL & WASHERY	36.89027	39.74302	42.08774	39.58670	38.78559
b) CEMENT	7.67414	8.59020	8.17538	8.43464	6.68895
c) PAPER	2.09633	3.09746	3.32755	3.04436	2.72576
d) FERTILIZER	1.02473	1.10397	1.16910	1.09963	1.07738
e) OTHERS	37.15535	42.67408	50.93396	50.93790	57.51433
5.DOMESTIC (mln Tonnes)	6.05607	7.13751	5.62349	5.04118	3.76009
a) HOUSEHOLDS	6.05607	7.13751	5.62349	5.04118	3.76009
TOTAL (mln Tonnes)	152.26251	167.14968	174.26062	168.17155	175.48707

SOURCE : AUTHOR.

TABLE [4.2.7] CONSUMPTION OF COAL : CARBONDIOXIDE EMISSIONS.

Sectors (3)	1980-81	1981-82	1982-83	1983-84	1984-85
1.TRANSPORT (mln Tonnes)	21.36700	20.37192	19.81106	19.35875	17.11531
a) RAILWAYS	21.36700	20.37192	19.81106	19.35875	17.11531
2.AGRICULTURE(mln Tonnes)	4.04031	4.86067	6.02970	5.25035	5.27086
a) COTTON	4.04031	4.86067	6.02970	5.25035	5.27086
3.POWER (mln Tonnes)	51.19800	59.61245	66.45674	74.92488	77.38077
a) ELECTRICITY	51.19800	59.61245	66.45674	74.92488	77.38077
4.INDUSTRY (mln Tonnes)	97.58209	106.81140	113.86526	116.95064	123.37269
a) STEEL & WASHERY	41.05215	43.00609	44.58877	48.63341	48.84835
b) CEMENT	8.20995	9.88651	10.54330	12.65196	12.60011
c) PAPER	3.78775	4.25189	4.32103	4.44201	4.89140
d) FERTILIZER	1.14034	1.19461	1.23858	1.350[illegible]	1.35690
e) OTHERS	43.39190	48.47231	53.17358	49.87232	55.67594
5.DOMESTIC (mln Tonnes)	4.55869	3.81000	3.39406	2.99476	2.89493
a) HOUSEHOLDS	4.55869	3.81000	3.39406	2.99476	2.89493
TOTAL (mln Tonnes)	178.74608	195.46645	209.55682	219.47938	226.03457

SOURCE : AUTHOR.

TABLE [4.2.7] CONSUMPTION OF COAL : CARBONDIOXIDE EMISSIONS.

Sectors (4)	1985-86	1986-87	1987-88	1988-89	1989-90
1.TRANSPORT (mln Tonnes)	17.38669	14.69094	13.65968	12.19421	10.49353
a) RAILWAYS	17.38669	14.69094	13.65968	12.19421	10.49353
2.AGRICULTURE(mln Tonnes)	4.84016	5.00424	5.20933	6.09122	5.53748
a) COTTON	4.84016	5.00424	5.20933	6.09122	5.53748
3.POWER (mln Tonnes)	92.11613	105.45579	123.21070	130.47102	145.36742
a) ELECTRICITY	92.11613	105.45579	123.21070	130.47102	145.36742
4.INDUSTRY (mln Tonnes)	124.51225	128.95357	129.89426	143.90718	146.45210
a) STEEL & WASHERY	48.49664	47.32428	52.11142	58.16861	59.80992
b) CEMENT	13.89642	15.29643	15.15816	16.02236	16.47175
c) PAPER	4.25156	4.23557	4.50729	5.25851	4.63516
d) FERTILIZER	1.34713	1.31456	1.44754	1.61579	1.66139
e) OTHERS	56.52050	60.78272	56.66986	62.84190	63.87389
5.DOMESTIC (mln Tonnes)	2.16288	2.11297	1.61384	1.04817	0.94834
a) HOUSEHOLDS	2.16288	2.11297	1.61384	1.04817	0.94834
TOTAL (mln Tonnes)	241.01812	256.21751	273.58781	293.71178	308.79886

SOURCE : AUTHOR.

TABLE [4.3.2] CONSUMPTION OF PETROLEUM PRODUCTS: NET CARBON BURNT.

Sectors (1)		1970-71	1971-72	1972-73	1973-74	1974-75
1.TRANSPORT	(MT)	2.22343	3.23567	6.03036	6.38961	6.94525
F.O.		0.42601	0.42254	0.34536	0.33539	0.27121
H.S.D		N.A.	0.88550	3.62429	4.09779	4.86815
L.D.O		N.A.	0.00997	0.03966	0.03857	0.04204
MOGAS		1.21438	1.27622	1.33055	1.25951	1.05642
A.T.F		0.58304	0.64143	0.69051	0.65835	0.70743
2.AGRICULTURE	(MT)	0.15891	0.16737	0.16195	0.18168	0.13658
F.O.		0.15891	0.16737	0.16195	0.18168	0.13658
H.S.D.		N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.		N.A.	N.A.	N.A.	N.A.	N.A.
3.POWER	(MT)	1.07163	1.19866	1.47244	1.57520	1.61901
F.O.		1.07163	1.16768	1.34523	1.44561	1.52301
H.S.D.		N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.		N.A.	0.03099	0.12720	0.12959	0.09600
4.INDUSTRY	(MT)	4.29143	5.10154	6.48459	6.77507	6.30788
F.O.		2.44679	2.68071	3.04320	3.13230	3.03800
H.S.D.		N.A.	0.05174	0.28859	0.52227	0.47795
L.D.O.		N.A.	0.25917	1.02564	0.95565	0.79377
NAPHTHA		0.15137	0.19491	0.21718	0.25687	0.28684
LUBRICANTS		0.22815	0.15154	0.25494	0.25620	0.19885
BITUMEN		0.00000	0.00000	0.00000	0.00000	0.00000
PETROLEUM COKE		0.08959	0.15740	0.11805	0.11638	0.07452
L.P.G.		0.02924	0.03370	0.04081	0.04426	0.04812
OTHERS		0.32234	0.54421	0.43956	0.46216	0.38765
REFINERY-FUEL		1.02396	1.02814	1.05661	1.02898	1.00219
5.DOMESTIC	(MT)	2.89877	3.12210	3.14115	2.96820	2.58900
LPG		0.11289	0.13766	0.15755	0.17298	0.18923
KEROSENE		2.78588	2.98445	2.98360	2.79521	2.39978
TOTAL	(MT)	10.64418	12.82535	17.29049	17.88975	17.59773

SOURCE : AUTHOR.

TABLE [4.3.2] CONSUMPTION OF PETROLEUM PRODUCTS: NET CARBON BURNT.

Sectors (2)		1975-76	1976-77	1977-78	1978-79	1979-80
1.TRANSPORT	(MT)	7.37866	7.75164	8.35909	9.09605	9.96275
F.O.		0.31804	0.32758	0.32693	0.27143	0.28704
H.S.D		5.19088	5.49093	5.92541	6.52592	7.38259
L.D.O		0.04507	0.02427	0.06328	0.06934	0.07975
MOGAS		1.06561	1.09988	1.16256	1.25282	1.24530
A.T.F		0.75905	0.80898	0.88091	0.97653	0.96807
2.AGRICULTURE	(MT)	0.10515	0.12314	0.12054	0.11534	0.12488
F.O.		0.10515	0.12314	0.12054	0.11534	0.12488
H.S.D.		N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.		N.A.	N.A.	N.A.	N.A.	N.A.
3.POWER	(MT)	1.59365	1.44297	1.66411	1.95376	1.91213
F.O.		1.52258	1.34979	1.59043	1.90002	1.85059
H.S.D.		N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.		0.07108	0.09318	0.07368	0.05374	0.06154
4.INDUSTRY	(MT)	6.26110	6.71128	6.95155	7.76638	8.31927
F.O.		3.05643	3.14726	3.02564	3.49566	3.87722
H.S.D.		0.45632	0.52418	0.63614	0.80069	0.93046
L.D.O.		0.66180	0.76408	0.87200	0.93094	0.95608
NAPHTHA		0.30744	0.36772	0.38346	0.42114	0.40406
LUBRICANTS		0.18461	0.19006	0.20010	0.22773	0.23694
BITUMEN		0.00000	0.00000	0.00000	0.00000	0.00000
PETROLEUM COKE		0.12642	0.14652	0.12224	0.12977	0.15489
L.P.G.		0.05563	0.05604	0.06091	0.06335	0.06335
OTHERS		0.38597	0.42783	0.43621	0.45965	0.49063
REFINERY-FUEL		1.02647	1.08759	1.21485	1.23746	1.20564
5.DOMESTIC	(MT)	2.83966	3.03053	3.34036	3.62158	3.56532
LPG		0.20567	0.21156	0.25663	0.26800	0.28963
KEROSENE		2.63398	2.81897	3.08373	3.35358	3.28569
TOTAL	(MT)	18.17822	19.05956	20.43565	22.55312	23.87434

SOURCE : AUTHOR.

TABLE [4.3.2] CONSUMPTION OF PETROLEUM PRODUCTS: NET CARBON BURNT.

Sectors (3)		1980-81	1981-82	1982-83	1983-84	1984-85
1.TRANSPORT	(MT)	10.26775	10.71103	11.59248	12.39740	13.30587
F.O.		0.29571	0.27403	0.27490	0.33474	0.30959
H.S.D		7.67606	8.06198	8.82365	9.37158	10.04164
L.D.O		0.07194	0.08408	0.08581	0.08841	0.08235
MOGAS		1.27205	1.33640	1.43920	1.58045	1.74175
A.T.F		0.95199	0.95453	0.96891	1.02223	1.13054
2.AGRICULTURE	(MT)	0.17170	0.34397	0.26925	0.25702	0.26378
F.O.		0.17170	0.15002	0.14916	0.13355	0.13008
H.S.D.		N.A.	0.16794	0.09669	0.10093	0.10857
L.D.O.		N.A.	0.02600	0.02340	0.02254	0.02514
3.POWER	(MT)	1.94505	1.83502	2.13412	2.24232	2.48349
F.O.		1.80810	1.53060	1.75520	1.92951	2.16278
H.S.D.		N.A.	0.15013	0.19169	0.12299	0.11875
L.D.O.		0.13695	0.15429	0.18723	0.18983	0.20196
4.INDUSTRY	(MT)	8.49272	8.52272	8.66504	8.94051	9.70056
F.O.		4.20502	4.27527	4.15299	4.15646	4.28567
H.S.D.		1.09840	0.89229	1.07634	1.09161	1.34776
L.D.O.		0.76365	0.63363	0.62843	0.65010	0.72898
NAPHTHA		0.38932	0.49615	0.49532	0.46953	0.52328
LUBRICANTS		0.24824	0.24783	0.25327	0.25829	0.27797
BITUMEN		0.00000	0.00000	0.00000	0.00000	0.00000
PETROLEUM COKE		0.11470	0.14568	0.08624	0.09545	0.19592
L.P.G.		0.06335	0.05523	0.05766	0.06984	0.08040
OTHERS		0.46719	0.45044	0.45965	0.52914	0.55845
REFINERY-FUEL		1.14285	1.32620	1.45514	1.62008	1.70213
5.DOMESTIC	(MT)	3.85335	4.32672	4.85491	5.22355	5.75023
LPG		0.26557	0.34434	0.43043	0.53601	0.69356
KEROSENE		3.58779	3.98237	4.42448	4.68754	5.05667
TOTAL	(MT)	24.73058	25.73945	27.51581	29.06080	31.50394

SOURCE : AUTHOR.

TABLE [4.3.2] CONSUMPTION OF PETROLEUM PRODUCTS: NET CARBON BURNT.

Sectors (4)		1985-86	1986-87	1987-88	1988-89	1989-90
1.TRANSPORT	(MT)	14.38503	15.71991	17.22542	18.75408	20.48790
F.O.		0.25496	0.31392	0.36162	0.40238	0.40671
H.S.D		10.92460	11.88135	13.02810	14.26814	15.55653
L.D.O		0.07454	0.07454	0.08755	0.08321	0.08495
MOGAS		1.90138	2.09361	2.34852	2.55078	2.91768
A.T.F		1.22955	1.35648	1.39964	1.44956	1.50203
2.AGRICULTURE	(MT)	0.29634	0.29883	0.32182	0.33100	0.43886
F.O.		0.14395	0.14136	0.14395	0.17431	0.17777
H.S.D.		0.12638	0.13147	0.15013	0.12723	0.22901
L.D.O.		0.02600	0.02600	0.02774	0.02947	0.03207
3.POWER	(MT)	2.37731	2.28189	2.38505	2.30929	2.40221
F.O.		2.02056	1.90869	1.99021	1.89742	2.01362
H.S.D.		0.13571	0.13656	0.17727	0.11196	0.10687
L.D.O.		0.22103	0.23664	0.21757	0.29991	0.28171
4.INDUSTRY	(MT)	10.23323	10.53879	10.88292	11.71613	12.29356
F.O.		4.43136	4.52762	4.56578	4.85889	5.05054
H.S.D.		1.43937	1.42919	1.62088	1.43428	1.67007
L.D.O.		0.65183	0.66484	0.74631	0.83299	0.88414
NAPHTHA		0.52010	0.54405	0.47757	0.56330	0.56096
LUBRICANTS		0.29304	0.31606	0.33113	0.35458	0.38765
BITUMEN		0.00000	0.00000	0.00000	0.00000	0.00000
PETROLEUM COKE		0.13647	0.17415	0.20596	0.26457	0.32067
L.P.G.		0.11451	0.12750	0.22009	0.30049	0.37196
OTHERS		0.56096	0.56849	0.60366	0.77111	0.80041
REFINERY-FUEL		2.08559	2.18690	2.11154	2.33593	2.24718
5.DOMESTIC	(MT)	6.17913	6.72787	7.28523	7.85327	8.46139
LPG		0.89335	1.08907	1.14917	1.29291	1.46996
KEROSENE		5.28579	5.63880	6.13606	6.56035	6.99143
TOTAL	(MT)	33.47104	35.58729	38.10044	40.96377	44.06392

SOURCE : AUTHOR.

TABLE [4.3.3] CONSUMPTION OF PETROLEUM PRODUCTS: CARBONDIOXIDE EMISSIONS.

Sectors (1)		1970-71	1971-72	1972-73	1973-74	1974-75
1.TRANSPORT	(MT)	7.33731	10.67770	19.90020	21.08571	22.91934
F.O.		1.40583	1.39438	1.13969	1.10678	0.89501
H.S.D		N.A.	2.92216	11.96015	13.52270	16.06489
L.D.O		N.A.	0.03290	0.13087	0.12729	0.13873
MOGAS		4.00745	4.21154	4.39081	4.15638	3.48617
A.T.F		1.92404	2.11672	2.27868	2.17257	2.33453
2.AGRICULTURE	(MT)	0.52441	0.55232	0.53443	0.59953	0.45072
F.O.		0.52441	0.55232	0.53443	0.59953	0.45072
H.S.D.		N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.		N.A.	N.A.	N.A.	N.A.	N.A.
3.POWER	(MT)	3.53640	3.95559	4.85904	5.19816	5.34272
F.O.		3.53640	3.85333	4.43927	4.77052	5.02593
H.S.D.		N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.		N.A.	0.10226	0.41977	0.42764	0.31679
4.INDUSTRY	(MT)	14.16173	16.83509	21.39914	22.35773	20.81600
F.O.		8.07440	8.84635	10.04256	10.33661	10.02539
H.S.D.		N.A.	0.17074	0.95236	1.72349	1.57724
L.D.O.		N.A.	0.85527	3.38462	3.15364	2.61946
NAPHTHA		0.49954	0.64321	0.71670	0.84767	0.94658
LUBRICANTS		0.75290	0.50009	0.84131	0.84546	0.65619
BITUMEN		0.00000	0.00000	0.00000	0.00000	0.00000
PETROLEUM COKE		0.29563	0.51943	0.38957	0.38405	0.24590
L.P.G.		0.09648	0.11122	0.13467	0.14606	0.15879
OTHERS		1.06373	1.79590	1.45054	1.52513	1.27923
REFINERY-FUEL		3.37906	3.39287	3.48681	3.39563	3.30722
5.DOMESTIC	(MT)	9.56593	10.30294	10.36580	9.79506	8.54371
LPG		0.37253	0.45427	0.51993	0.57085	0.62445
KEROSENE		9.19340	9.84868	9.84588	9.22421	7.91926
TOTAL	(MT)	35.12578	42.32364	57.05862	59.03619	58.07250

SOURCE : AUTHOR.

TABLE [4.3.3] CONSUMPTION OF PETROLEUM PRODUCTS: CARBONDIOXIDE EMISSIONS.

Sectors (2)		1975-76	1976-77	1977-78	1978-79	1979-80
1.TRANSPORT	(MT)	24.34959	25.58040	27.58498	30.01697	32.87706
F.O.		1.04954	1.08102	1.07888	0.89572	0.94724
H.S.D		17.12991	18.12006	19.55385	21.53555	24.36254
L.D.O		0.14874	0.08009	0.20881	0.22884	0.26316
MOGAS		3.51651	3.62959	3.83645	4.13432	4.10949
A.T.F		2.50488	2.66963	2.90700	3.22255	3.19463
2.AGRICULTURE	(MT)	0.34699	0.40637	0.39778	0.38061	0.41209
F.O.		0.34699	0.40637	0.39778	0.38061	0.41209
H.S.D.		N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.		N.A.	N.A.	N.A.	N.A.	N.A.
3.POWER	(MT)	5.25906	4.76180	5.49157	6.44742	6.31004
F.O.		5.02450	4.45430	5.24843	6.27007	6.10695
H.S.D.		N.A.	N.A.	N.A.	N.A.	N.A.
L.D.O.		0.23456	0.30750	0.24314	0.17735	0.20309
4.INDUSTRY	(MT)	20.66162	22.14722	22.94011	25.62906	27.45358
F.O.		10.08620	10.38597	9.98461	11.53687	12.79484
H.S.D.		1.50586	1.72979	2.09925	2.64226	3.07051
L.D.O.		2.18395	2.52148	2.87760	3.07211	3.15507
NAPHTHA		1.01455	1.21348	1.26542	1.38975	1.33339
LUBRICANTS		0.60922	0.62718	0.66034	0.75152	0.78191
BITUMEN		0.00000	0.00000	0.00000	0.00000	0.00000
PETROLEUM COKE		0.41720	0.48351	0.40339	0.42825	0.51114
L.P.G.		0.18358	0.18492	0.20100	0.20904	0.20904
OTHERS		1.27371	1.41185	1.43948	1.51685	1.61907
REFINERY-FUEL		3.38735	3.58904	4.00900	4.08360	3.97861
5.DOMESTIC	(MT)	9.37087	10.00077	11.02320	11.95122	11.73256
LPG		0.67872	0.69815	0.84689	0.88441	0.88977
KEROSENE		8.69215	9.30262	10.17631	11.06681	10.84278
TOTAL	(MT)	59.98812	62.89656	67.43764	74.42529	78.78533

SOURCE : AUTHOR.

TABLE [4.3.3] CONSUMPTION OF PETROLEUM PRODUCTS: CARBONDIOXIDE EMISSIONS.

Sectors (3)		1980-81	1981-82	1982-83	1983-84	1984-85
1.TRANSPORT	(MT)	33.88359	35.34639	38.25519	40.91143	43.90937
F.O.		0.97585	0.90431	0.90717	1.10463	1.02164
H.S.D		25.33100	26.60455	29.11805	30.92621	33.13743
L.D.O		0.23742	0.27746	0.28318	0.29176	0.27174
MOGAS		4.19775	4.41012	4.74936	5.21547	5.74777
A.T.F		3.14157	3.14995	3.19742	3.37336	3.73079
2.AGRICULTURE	(MT)	0.56662	1.13510	0.88854	0.84816	0.87049
F.O.		0.56662	0.49508	0.49222	0.44071	0.42926
H.S.D.		N.A.	0.55420	0.31909	0.33308	0.35827
L.D.O.		N.A.	0.08581	0.07723	0.07437	0.08295
3.POWER	(MT)	6.41868	6.05555	7.04259	7.39968	8.19552
F.O.		5.96673	5.05097	5.79216	6.36737	7.13718
H.S.D.		N.A.	0.49542	0.63258	0.40586	0.39186
L.D.O.		0.45195	0.50916	0.61786	0.62644	0.66648
4.INDUSTRY	(MT)	28.02597	28.12497	28.59464	29.50367	32.01183
F.O.		13.87658	14.10838	13.70487	13.71632	14.14272
H.S.D.		3.62471	2.94455	3.55194	3.60232	4.44762
L.D.O.		2.52005	2.09098	2.07382	2.14533	2.40563
NAPHTHA		1.28476	1.63731	1.63455	1.54945	1.72683
LUBRICANTS		0.81921	0.81783	0.83578	0.85236	0.91729
BITUMEN		0.00000	0.00000	0.00000	0.00000	0.00000
PETROLEUM COKE		0.37852	0.48075	0.28458	0.31497	0.64652
L.P.G.		0.20904	0.18224	0.19028	0.23048	0.26532
OTHERS		1.54171	1.48645	1.51685	1.74617	1.84287
REFINERY-FUEL		3.77139	4.37647	4.80196	5.34626	5.61703
5.DOMESTIC	(MT)	12.71606	14.27817	16.02121	17.23771	18.97577
LPG		0.87637	1.13634	1.42042	1.76882	2.28875
KEROSENE		11.83969	13.14183	14.60079	15.46889	16.68702
TOTAL	(MT)	81.61093	84.94018	90.80217	95.90063	103.96299

SOURCE : AUTHOR.

TABLE [4.3.3] CONSUMPTION OF PETROLEUM PRODUCTS: CARBONDIOXIDE EMISSIONS.

Sectors (4)		1985-86	1986-87	1987-88	1988-89	1989-90
1.TRANSPORT	(MT)	47.47061	51.87572	56.84390	61.88845	67.54409
F.O.		0.84135	1.03595	1.19335	1.32785	1.34216
H.S.D		36.05119	39.20847	42.99273	47.08487	51.33656
L.D.O		0.24600	0.24600	0.28890	0.27460	0.28032
MOGAS		6.27456	6.90891	7.75012	8.41757	9.62835
A.T.F		4.05751	4.47638	4.61880	4.78356	4.95670
2.AGRICULTURE	(MT)	0.97791	0.98612	1.06201	1.09232	1.44822
F.O.		0.47505	0.46646	0.47506	0.57521	0.58666
H.S.D.		0.41705	0.43385	0.49542	0.41985	0.75573
L.D.O.		0.08581	0.08581	0.09153	0.09725	0.10584
3.POWER	(MT)	7.84511	7.53023	7.87066	7.62067	7.92728
F.O.		6.66785	6.29869	6.56769	6.26149	6.64496
H.S.D.		0.44784	0.45064	0.58499	0.36947	0.35267
L.D.O.		0.72941	0.78090	0.71797	0.98971	0.92964
4.INDUSTRY	(MT)	33.76966	34.77802	35.91365	38.66324	40.56876
F.O.		14.62349	14.94115	15.06706	16.03433	16.66677
H.S.D.		4.74991	4.71632	5.34890	4.73312	5.51124
L.D.O.		2.15105	2.19396	2.46284	2.74888	2.91765
NAPHTHA		1.71633	1.79535	1.57597	1.85890	1.85116
LUBRICANTS		0.96702	1.04300	1.09274	1.17010	1.27923
BITUMEN		0.00000	0.00000	0.00000	0.00000	0.00000
PETROLEUM COKE		0.45036	0.57469	0.67968	0.87308	1.05820
L.P.G.		0.37789	0.42077	0.72629	0.99161	1.22746
OTHERS		1.85116	1.87603	1.99207	2.54465	2.64136
REFINERY-FUEL		6.88245	7.21676	6.96810	7.70856	7.41569
5.DOMESTIC	(MT)	20.39115	22.20196	24.04126	25.91578	27.92259
LPG		2.94804	3.59393	3.79225	4.26662	4.85087
KEROSENE		17.44310	18.60803	20.24901	21.64916	23.07172
TOTAL	(MT)	110.45444	117.37205	125.73147	135.18045	145.41094

SOURCE : AUTHOR.

TABLE [4.4.1]

SECTOR-WISE CONSUMPTION OF ELECTRICITY FROM UTILITIES IN INDIA

Sectors (1)		1970-71	1971-72	1972-73	1973-74	1974-75
1.TRANSPORT	(GWH)	1364.00	1633.00	1831.00	1531.00	1531.00
a) TRACTION & RAILWAYS		1364.00	1633.00	1831.00	1531.00	1531.00
2.AGRICULTURE	(GWH)	4470.00	5006.00	5918.00	6310.00	7763.00
3.INDUSTRY	(GWH)	34050.00	36327.00	37030.00	37760.00	38165.00
a) INDUSTRY		29579.00	31637.00	32244.00	32481.00	32690.00
b) COMMERCIAL		2573.00	2953.00	2782.00	2988.00	3082.00
c) OTHERS		1898.00	1737.00	2004.00	2291.00	2393.00
4.DOMESTIC	(GWH)	3840.00	4107.00	4309.00	4645.00	5173.00
TOTAL	(GWH)	43724.00	47073.00	49088.00	50246.00	52632.00

SOURCE : COMPILED BY THE AUTHOR.

TABLE [4.4.1] SECTOR-WISE CONSUMPTION OF ELECTRICITY FROM UTILITIES IN INDIA

Sectors (2)		1975-76	1976-77	1977-78	1978-79	1979-80
1.TRANSPORT	(GWH)	1855.00	2168.00	2297.00	2186.00	2301.00
a) TRACTION & RAILWAYS		1855.00	2168.00	2297.00	2186.00	2301.00
2.AGRICULTURE	(GWH)	8721.00	9621.00	10107.00	12027.00	13452.00
3.INDUSTRY	(GWH)	43849.00	48513.00	50030.00	55504.00	53929.00
a) INDUSTRY		37568.00	41606.00	42635.00	47728.00	45955.00
b) COMMERCIAL		3507.00	4142.00	4428.00	4331.00	4657.00
c) OTHERS		2774.00	2765.00	2967.00	3445.00	3317.00
4.DOMESTIC	(GWH)	5821.00	6337.00	6821.00	7576.00	8402.00
TOTAL	(GWH)	60246.00	66639.00	69255.00	77293.00	78084.00

SOURCE : COMPILED BY THE AUTHOR.

TABLE [4.4.1] SECTOR-WISE CONSUMPTION OF ELECTRICITY FROM UTILITIES IN INDIA

Sectors (3)		1980-81	1981-82	1982-83	1983-84	1984-85
1.TRANSPORT	(GWH)	2266.00	2505.00	2633.00	2710.00	2880.00
a) TRACTION & RAILWAYS		2266.00	2505.00	2633.00	2710.00	2880.00
2.AGRICULTURE	(GWH)	14489.00	15202.00	17817.00	18233.00	20960.00
3.INDUSTRY	(GWH)	56366.00	62099.00	63047.00	68186.00	74722.00
a) INDUSTRY		48069.00	53064.00	52967.00	57094.00	63019.00
b) COMMERCIAL		4682.00	5194.00	5846.00	6581.00	6937.00
c) OTHERS		3615.00	3841.00	4234.00	4511.00	4766.00
4.DOMESTIC	(GWH)	9246.00	10439.00	12092.00	13235.00	15506.00
TOTAL	(GWH)	82367.00	90245.00	95589.00	102344.00	114068.00

SOURCE : COMPILED BY THE AUTHOR.

TABLE [4.4.1] SECTOR-WISE CONSUMPTION OF ELECTRICITY FROM UTILITIES IN INDIA

Sectors (4)		1985-86	1986-87	1987-88	1988-89	1989-90
1.TRANSPORT	(GWH)	3182.00	3229.00	3616.00	4037.00	4150.00
a) TRACTION & RAILWAYS		3182.00	3229.00	3616.00	4037.00	4150.00
2.AGRICULTURE	(GWH)	23422.00	29444.00	35267.00	38847.00	43643.00
3.INDUSTRY	(GWH)	79237.00	83956.00	84610.00	93848.00	98851.00
a) INDUSTRY		66980.00	70297.00	69180.00	76819.00	80878.00
b) COMMERCIAL		7290.00	7772.00	8841.00	10064.00	10227.00
c) OTHERS		4967.00	5887.00	6589.00	6965.00	7746.00
4.DOMESTIC	(GWH)	17258.00	19323.00	22120.00	24609.00	28174.00
TOTAL	(GWH)	123099.00	135952.00	145613.00	161341.00	174818.00

SOURCE : COMPILED BY THE AUTHOR.

TABLE [4.4.3] ENERGY CONTENT OF NATURAL GAS FOR CARBONDIOXIDE EMISSIONS.

Sectors (1)	1970-71	1971-72	1972-73	1973-74	1974-75
1).NET-ENERGY USE i.e. less LPG (10^6 MJ)	14203.73	16703.87	18370.64	18189.47	20037.40
a) AGRICULTURE	543.51	688.45	724.68	797.15	1050.79
b) POWER	9457.07	11341.24	12283.33	11703.58	12826.84
c) INDUSTRY	4203.14	4674.19	5362.63	5688.74	5942.38
d) DOMESTIC	N.A.	N.A.	N.A.	N.A.	217.40
2) NON-ENERGY (10^6 MJ)	4539.76	4758.25	4879.63	4345.54	7720.02
a) INDUSTRY	4539.76	4758.25	4879.63	4345.54	7720.02
FERTILIZERS	4539.76	4758.25	4879.63	4345.54	7720.02
PETRO-CHEMICALS	N.A.	N.A.	N.A.	N.A.	N.A.
OTHERS	N.A.	N.A.	N.A.	N.A.	N.A.
TOTAL (1+2) (10^6 MJ)	18743.49	21462.12	23250.27	22535.01	27757.42
3) GAS-FLARED (10^6 MJ)	27889.20	28108.80	23899.80	30597.60	34806.60
GRAND TOTAL (1+2+3) (10^6 MJ)	46632.69	49570.92	47150.07	53132.61	62564.02

SOURCE : AUTHOR.

TABLE [4.4.3] ENERGY CONTENT OF NATURAL GAS FOR CARBONDIOXIDE EMISSIONS.

Sectors (2)	1975-76	1976-77	1977-78	1978-79	1979-80
1).NET-ENERGY USE i.e. less LPG (10^6 MJ)	20109.87	20001.17	21341.83	28661.09	26160.95
a) AGRICULTURE	1195.72	1376.89	1413.13	1558.06	1413.13
b) POWER	13261.64	12464.50	13479.05	20291.04	18624.28
c) INDUSTRY	5181.46	5616.27	5978.61	6340.95	5652.50
d) DOMESTIC	471.04	543.51	471.04	471.04	471.04
2) NON-ENERGY (10^6 MJ)	11288.70	16678.15	16848.09	18061.92	18935.89
a) INDUSTRY	11288.70	16678.15	16848.09	18061.92	18935.89
FERTILIZERS	11240.15	16095.51	16338.27	17503.56	18328.97
PETRO-CHEMICALS	N.A.	N.A.	218.49	121.38	169.94
OTHERS	48.55	582.64	291.32	436.98	436.98
TOTAL (1+2) (10^6 MJ)	31398.57	36679.32	38189.91	46723.02	45096.84
3) GAS-FLARED (10^6 MJ)	39601.20	31366.20	43590.60	34879.80	35282.40
GRAND TOTAL (1+2+3) (10^6 MJ)	70999.77	68045.52	81780.51	81602.82	80379.24

SOURCE : AUTHOR.

TABLE [4.4.3] ENERGY CONTENT OF NATURAL GAS FOR CARBONDIOXIDE EMISSIONS.

Sectors (3)	1980-81	1981-82	1982-83	1983-84	1984-85
1).NET-ENERGY USE i.e. less LPG (10^6 MJ)	25871.08	30436.56	46198.35	54749.57	64641.46
a) AGRICULTURE	1630.53	1703.00	1847.93	2029.10	2246.51
b) POWER	17827.13	22175.21	37139.85	43806.91	52684.24
c) INDUSTRY	5906.14	6014.84	6703.29	8333.82	9058.50
d) DOMESTIC	507.28	543.51	507.28	579.74	652.21
2) NON-ENERGY (10^6 MJ)	15342.92	24713.76	28719.43	31948.24	39716.81
a) INDUSTRY	15342.92	24713.76	28719.43	31948.24	39716.81
FERTILIZERS	14833.11	24058.29	28039.68	31147.11	38915.68
PETRO-CHEMICALS	121.38	194.21	169.94	242.77	267.04
OTHERS	388.43	461.26	509.81	558.37	534.09
TOTAL (1+2) (10^6 MJ)	41214.00	55150.32	74917.78	86697.82	104358.27
3) GAS-FLARED (10^6 MJ)	28145.40	55595.40	69100.80	92122.20	111703.20
GRAND TOTAL (1+2+3) (10^6 MJ)	69359.40	110745.72	144018.58	178820.02	216061.47

SOURCE : AUTHOR.

TABLE [4.4.3] ENERGY CONTENT OF NATURAL GAS FOR CARBONDIOXIDE EMISSIONS.

Sectors (4)	1985-86	1986-87	1987-88	1988-89	1989-90
1).NET-ENERGY USE i.e. less LPG (10^6 MJ)	58735.31	87541.34	113593.59	89787.85	107035.24
a) AGRICULTURE	2826.25	3369.76	3587.17	3152.36	2826.25
b) POWER	47067.97	73953.59	98592.71	66054.58	77540.76
c) INDUSTRY	8080.18	9312.14	10181.75	19059.08	25182.63
d) DOMESTIC	760.91	905.85	1231.96	1621.83	1485.59
2) NON-ENERGY (10^6 MJ)	61517.36	81594.26	85454.27	132138.51	162460.21
a) INDUSTRY	61517.36	81594.26	85454.27	132138.51	162460.21
FERTILIZERS	60691.95	80963.06	84725.96	129492.34	159692.66
PETRO-CHEMICALS	242.77	0.00	0.00	509.81	704.03
OTHERS	582.64	631.20	728.30	2136.36	2063.53
TOTAL (1+2) (10^6 MJ)	120252.67	169135.60	199047.86	221926.37	269495.45
3) GAS-FLARED (10^6 MJ)	114118.80	99478.80	126087.00	142117.80	209388.60
GRAND TOTAL (1+2+3) (10^6 MJ)	234371.47	268614.40	325134.86	364044.17	478884.05

SOURCE : AUTHOR.

TABLE [4.4.4]   NATURAL GAS: NET CARBON BURNT FOR CARBONDIOXIDE EMISSIONS.

Sectors (1)	1970-71	1971-72	1972-73	1973-74	1974-75
1).NET-ENERGY USE i.e.less LPG (10^6 g of C)	194022.92	228174.92	250942.92	248468.13	273710.91
a) AGRICULTURE	7424.35	9404.17	9899.13	10889.04	14353.74
b) POWER	129183.63	154921.37	167790.23	159870.93	175214.58
c) INDUSTRY	57414.95	63849.38	73253.55	77708.16	81172.86
d) DOMESTIC	N.A.	N.A.	N.A.	N.A.	2969.74
2) NON-ENERGY(10^6 g of C)	62013.09	64997.68	66655.78	59360.13	105455.42
a) INDUSTRY	62013.09	64997.68	66655.78	59360.13	105455.42
FERTILIZERS	62013.09	64997.68	66655.78	59360.13	105455.42
PETRO-CHEMICALS	N.A.	N.A.	N.A.	N.A.	N.A.
OTHERS	N.A.	N.A.	N.A.	N.A.	N.A.
TOTAL (1+2) (10^6 g of C)	256036.02	293172.60	317598.70	307828.26	379166.33
3) GAS-FLARED(10^6 g of C)	380966.47	383966.21	326471.27	417963.22	475458.16
GRAND TOTAL (1+2+3) (10^6 g of C)	637002.49	677138.81	644069.97	725791.47	854624.49

SOURCE ; AUTHOR.

TABLE [4.4.4] NATURAL GAS: NET CARBON BURNT FOR CARBONDIOXIDE EMISSIONS.

Sectors (2)	1975-76	1976-77	1977-78	1978-79	1979-80
1).NET-ENERGY USE i.e.less LPG (10^6 g of C)	274700.82	273215.95	291529.34	391510.54	357358.55
a) AGRICULTURE	16333.56	18808.34	19303.30	21283.13	19303.30
b) POWER	181154.06	170265.02	184123.80	277175.61	254407.61
c) INDUSTRY	70778.77	76718.25	81667.81	86617.38	77213.20
d) DOMESTIC	6434.43	7424.35	6434.43	6434.43	6434.43
2) NON-ENERGY(10^6 g of C)	154203.68	227823.50	230144.85	246725.89	258664.24
a) INDUSTRY	154203.68	227823.50	230144.85	246725.89	258664.24
FERTILIZERS	153540.44	219864.60	223180.81	239098.61	250373.72
PETRO-CHEMICALS	N.A.	N.A.	2984.59	1658.10	2321.35
OTHERS	663.24	7958.90	3979.45	5969.17	5969.17
TOTAL (1+2) (10^6 g of C)	428904.50	501039.45	521674.19	638236.43	616022.79
3) GAS-FLARED(10^6 g of C)	540952.39	428462.29	595447.60	476458.07	481957.58
GRAND TOTAL (1+2+3) (10^6 g of C)	969856.90	929501.75	1117121.78	1114694.50	1097980.37

SOURCE ; AUTHOR.

TABLE [4.4.4] NATURAL GAS: NET CARBON BURNT FOR CARBONDIOXIDE EMISSIONS.

Sectors (3)	1980-81	1981-82	1982-83	1983-84	1984-85
1).NET-ENERGY USE i.e.less LPG (10^6 g of C)	353398.90	415763.41	631069.46	747879.18	883002.29
a) AGRICULTURE	22273.04	23262.95	25242.78	27717.56	30687.30
b) POWER	243518.57	302913.34	507330.35	598402.34	719666.66
c) INDUSTRY	80677.90	82162.77	91566.94	113839.98	123739.11
d) DOMESTIC	6929.39	7424.35	6929.39	7919.30	8909.22
2) NON-ENERGY(10^6 g of C)	209584.35	337589.99	392307.42	436412.99	542531.65
a) INDUSTRY	209584.35	337589.99	392307.42	436412.99	542531.65
FERTILIZERS	202620.32	328636.23	383022.04	425469.51	531588.17
PETRO-CHEMICALS	1658.10	2652.97	2321.35	3316.21	3647.83
OTHERS	5305.93	6300.80	6964.04	7627.28	7295.66
TOTAL (1+2) (10^6 g of C)	562983.25	753353.40	1023376.88	1184292.17	1425533.94
3) GAS-FLARED(10^6 g of C)	384466.16	759433.16	943916.93	1258389.25	1525865.71
GRAND TOTAL (1+2+3) (10^6 g of C)	947449.42	1512786.56	1967293.81	2442681.43	2951399.65

SOURCE ; AUTHOR.

TABLE [4.4.4] NATURAL GAS: NET CARBON BURNT FOR CARBONDIOXIDE EMISSIONS.

Sectors (4)	1985-86	1986-87	1987-88	1988-89	1989-90
1).NET-ENERGY USE i.e.less LPG (10^6 g of C)	802324.39	1195814.76	1551688.44	1226502.06	1462101.32
a) AGRICULTURE	38606.60	46030.95	49000.69	43061.21	38606.60
b) POWER	642948.42	1010206.09	1346776.47	902305.59	1059206.78
c) INDUSTRY	110375.29	127203.81	139082.76	260347.09	343994.73
d) DOMESTIC	10394.09	12373.91	16828.52	20788.17	20293.21
2) NON-ENERGY(10^6 g of C)	840327.14	1114577.56	1167305.27	1805012.09	2219206.49
a) INDUSTRY	840327.14	1114577.56	1167305.27	1805012.09	2219206.49
FERTILIZERS	829052.04	1105955.42	1157356.64	1768865.43	2181401.72
PETRO-CHEMICALS	3316.21	0.00	0.00	6964.04	9617.00
OTHERS	7958.90	8622.14	9948.62	29182.63	28187.77
TOTAL (1+2) (10^6 g of C)	1642651.53	2310392.32	2718993.71	3031514.15	3681307.82
3) GAS-FLARED(10^6 g of C)	1558862.81	1358880.41	1722348.42	1941329.15	2860248.28
GRAND TOTAL (1+2+3) (10^6 g of C)	3201514.34	3669272.73	4441342.13	4972843.30	6541556.09

SOURCE ; AUTHOR.

TABLE [4.4.5] CARBONDIOXIDE EMISSIONS FROM CONSUMPTION OF NATURAL GAS.

Sectors (1)	1970-71	1971-72	1972-73	1973-74	1974-75
1).NET-ENERGY USE i.e. less LPG (MT of CO2)	0.64028	0.75298	0.82811	0.81994	0.90325
a) AGRICULTURE	0.02450	0.03103	0.03267	0.03593	0.04737
b) POWER	0.42631	0.51124	0.55371	0.52757	0.57821
c) INDUSTRY	0.18947	0.21070	0.24174	0.25644	0.26787
d) DOMESTIC	N.A.	N.A.	N.A.	N.A.	0.00980
2) NON-ENERGY (MT of CO2)	0.20464	0.21449	0.21996	0.19589	0.34800
a) INDUSTRY	0.20464	0.21449	0.21996	0.19589	0.34800
FERTILIZERS	0.20464	0.21449	0.21996	0.19589	0.34800
PETRO-CHEMICALS	N.A.	N.A.	N.A.	N.A.	N.A.
OTHERS	N.A.	N.A.	N.A.	N.A.	N.A.
TOTAL (1+2) (MT of CO2)	0.84492	0.96747	1.04808	1.01583	1.25125
3) GAS-FLARED (MT of CO2)	1.25719	1.26709	1.07736	1.37928	1.56901
GRAND TOTAL (1+2+3) (MT of CO2)	2.10211	2.23456	2.12543	2.39511	2.82026

SOURCE : AUTHOR.

TABLE [4.4.5] CARBONDIOXIDE EMISSIONS FROM CONSUMPTION OF NATURAL GAS.

Sectors (2)	1975-76	1976-77	1977-78	1978-79	1979-80
1).NET-ENERGY USE i.e. less LPG (MT of CO2)	0.90651	0.90161	0.96205	1.29198	1.17928
a) AGRICULTURE	0.05390	0.06207	0.06370	0.07023	0.06370
b) POWER	0.59781	0.56187	0.60761	0.91468	0.83955
c) INDUSTRY	0.23357	0.25317	0.26950	0.28584	0.25480
d) DOMESTIC	0.02123	0.02450	0.02123	0.02123	0.02123
2) NON-ENERGY (MT of CO2)	0.50887	0.75182	0.75948	0.81420	0.85359
a) INDUSTRY	0.50887	0.75182	0.75948	0.81420	0.85358
FERTILIZERS	0.50668	0.72555	0.73650	0.78903	0.82623
PETRO-CHEMICALS	N.A.	N.A.	0.00985	0.00547	0.00766
OTHERS	0.00219	0.02626	0.01313	0.01970	0.01970
TOTAL (1+2) (MT of CO2)	1.41538	1.65343	1.72152	2.10618	2.03288
3) GAS-FLARED (MT of CO2)	1.78514	1.41393	1.96498	1.57231	1.59046
GRAND TOTAL (1+2+3) (MT of CO2)	3.20053	3.06736	3.68650	3.67849	3.62334

SOURCE : AUTHOR.

TABLE [4.4.5] CARBONDIOXIDE EMISSIONS FROM CONSUMPTION OF NATURAL GAS.

Sectors (3)	1980-81	1981-82	1982-83	1983-84	1984-85
1).NET-ENERGY USE i.e. less LPG (MT of CO2)	1.16622	1.37202	2.08253	2.46800	2.91391
a) AGRICULTURE	0.07350	0.07677	0.08330	0.09147	0.10127
b) POWER	0.80361	0.99961	1.67419	1.97473	2.37490
c) INDUSTRY	0.26624	0.27114	0.30217	0.37567	0.40834
d) DOMESTIC	0.02287	0.02450	0.02287	0.02613	0.02940
2) NON-ENERGY (MT of CO2)	0.69163	1.11405	1.29461	1.44016	1.79035
a) INDUSTRY	0.69163	1.11405	1.29461	1.44016	1.79035
FERTILIZERS	0.66865	1.08450	1.26397	1.40405	1.75424
PETRO-CHEMICALS	0.00547	0.00875	0.00766	0.01094	0.01204
OTHERS	0.01751	0.02079	0.02298	0.02517	0.02408
TOTAL (1+2) (MT of CO2)	1.85784	2.48607	3.37714	3.90816	4.70426
3) GAS-FLARED (MT of CO2)	1.26874	2.50613	3.11493	4.15268	5.03536
GRAND TOTAL (1+2+3) (MT of CO2)	3.12658	4.99220	6.49207	8.06085	9.73962

SOURCE : AUTHOR.

TABLE [4.4.5] CARBONDIOXIDE EMISSIONS FROM CONSUMPTION OF NATURAL GAS.

Sectors (4)	1985-86	1986-87	1987-88	1988-89	1989-90
1).NET-ENERGY USE i.e. less LPG (MT of CO2)	2.64767	3.94619	5.12057	4.04746	4.82493
a) AGRICULTURE	0.12740	0.15190	0.16170	0.14210	0.12740
b) POWER	2.12173	3.33368	4.44438	2.97761	3.49538
c) INDUSTRY	0.36424	0.41977	0.45897	0.85915	1.13518
d) DOMESTIC	0.03430	0.04083	0.05553	0.06860	0.06697
2) NON-ENERGY (MT of CO2)	2.77308	3.67811	3.85211	5.95654	7.32338
a) INDUSTRY	2.77308	3.67811	3.85211	5.95654	7.32338
FERTILIZERS	2.73587	3.64965	3.81928	5.83726	7.19863
PETRO-CHEMICALS	0.01094	0.00000	0.00000	0.02298	0.03174
OTHERS	0.02626	0.02845	0.03283	0.09630	0.09302
TOTAL (1+2) (MT of CO2)	5.42075	7.62429	8.97268	10.00400	12.14832
3) GAS-FLARED (MT of CO2)	5.14425	4.48431	5.68375	6.40639	9.43882
GRAND TOTAL (1+2+3) (MT of CO2)	10.56500	12.10860	14.65643	16.41038	21.58714

SOURCE : AUTHOR.

TABLE [4.4.6]   NATURAL GAS : EMISSIONS OF CARBONDIOXIDE.

YEAR	AGRICULTURE	POWER	INDUSTRY	DOMESTIC	GAS-FLARED	TOTAL
1970-71	0.02450	0.42631	0.39411	0.00000	1.25719	2.10211
1971-72	0.03103	0.51124	0.42520	0.00000	1.26709	2.23456
1972-73	0.03267	0.55371	0.46170	0.00000	1.07736	2.12543
1973-74	0.03593	0.52757	0.45233	0.00000	1.37928	2.39511
1974-75	0.04737	0.57821	0.61587	0.00980	1.56901	2.82026
1975-76	0.05390	0.59781	0.74244	0.02123	1.78514	3.20053
1976-77	0.06207	0.56187	1.00499	0.02450	1.41393	3.06736
1977-78	0.06370	0.60761	1.02898	0.02123	1.96498	3.68650
1978-79	0.07023	0.91468	1.10003	0.02123	1.57231	3.67849
1979-80	0.06370	0.83955	1.10840	0.02123	1.59046	3.62334
1980-81	0.07350	0.80361	0.95787	0.02287	1.26874	3.12658
1981-82	0.07677	0.99961	1.38518	0.02450	2.50613	4.99220
1982-83	0.08330	1.67419	1.59679	0.02287	3.11493	6.49207
1983-84	0.09147	1.97473	1.81583	0.02613	4.15268	8.06085
1984-85	0.10127	2.37490	2.19869	0.02940	5.03536	9.73962
1985-86	0.12740	2.12173	3.13732	0.03430	5.14425	10.56500
1986-87	0.15190	3.33368	4.09788	0.04083	4.48431	12.10860
1987-88	0.16170	4.44436	4.31108	0.05553	5.68375	14.65643
1988-89	0.14210	2.97761	6.81569	0.06860	6.40639	16.41038
1989-90	0.12740	3.49538	8.45856	0.06697	9.43882	21.58714

SOURCE : AUTHOR.

Chapter 5

Sectoral Allocation of CO_2 Emissions Resulting from Gross Generation of Electricity (Methodology-II)

[5.1.] Electricity presents an interesting and a challenging case when we are dealing with CO_2 emissions through energy consumption. This is so because it has the distinction of causing emissions in its production phase and not in the consumption phase, unlike other commercial fuels with which we are concerned here. For these other fuels, emissions result in their consumption phase. Again, the particular sectoral classification so chosen makes the electricity case even more interesting for within the classification, which includes electricity (-Power) itself, all the sectors excluding electricity consume not only the fossil fuels but also electricity. So, when we are allocating CO_2 emissions to the individual sectors, we are missing out the vital fact that CO_2 emissions allocated to the power sector has to be finally distributed amongst the other sectors within our classification,[1] because of the fact that power produced is only for consumption by the other sectors and so the CO_2 emissions associated with it have to be distributed amongst its eventual consumers. This fact is important and it needs to be successfully tackled for if this is not done then our entire exercise will lose its meaning, as what we are attempting here is a sectoral generation of CO_2 emissions through the energy consumption and power is an important element, here. Power (-electricity) provides the cleanest possible form of commercial energy made available, solely for consumption and thus it has no value, in terms of polluting emissions, of its own. Infact, it cannot even be stored. Hence, we cannot blame power for the ensuing CO_2 emission due to its production, but in turn we have to allocate the emissions to the final, end-consumers of power - namely all the other sectors in our classification i.e. Transport, Agriculture, Industry and Domestic.

Now, generation of electricity involves two methods.

(a) Generation through utilities :In this case, the electricity produced is eventually commercially consumed by all the remaining sectors in our sectoral classification (excluding the power sector, of course). Further here, the produced electricity is of three kinds (because of their different sources of production) -

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1 *As our classification is such that it not only represents the Indian economy in its totality but also power in toto.*

1. Hydro electricity,
2. Nuclear electricity, and
3. Thermal electricity.

So, except thermal electricity, none of the other two forms give rise to any type of polluting emissions, for as the name suggests, they are solely hydro and nuclear produced respectively and hence no question of any sort of combustion resulting in pollutants emissions arises. It is only in the production of thermal electricity that we have such emissions and in line with our work here, CO_2 emissions garner a major share in this. By thermal electricity we mean electricity produced by the combustion (consumption) of coal, oil (petroleum products) and natural gas. This is what we have got in our sectoral classification, under the heading Power, in each of the cases for CO_2 emissions due to the consumption of fossil fuels.

(b) Generation through non-utilities : Here, the electricity generated is, basically, by the captive power plants and is for use within the industry of its origin. Mainly such generation takes place within the Transport sector (specifically Railway industry) and within the Industry sector. Further, the entire generation of this kind is taken to be not only thermal, but also only coal based.[2] So, the coal required for its generation is included, in our sectoral classification for coal consumption, within the coal consumption of that particular sector in which this electricity generation takes place. This is an important concept to keep in mind for we will require its use in not only allocation of CO_2 emissions resulting in the production of electricity, but also when we calculate the sectoral consumption of energy due to fossil fuel consumption as well as electricity consumption (Chapter 6).

Thus, in the allocation of CO_2 emissions due to power production, one has to tackle both the generation types separately and then add up the resulting share of CO_2 emissions, sectorally, across generation types so as to arrive at a perfect picture of a sectoral classification of CO_2 emission, through energy consumption, for the Indian economy. And so, the data needed here is broadly of the following three type -

1. Gross generation of electricity in utilities and non- utilities in India.
2. Electricity generated, distributed and sold to ultimate consumers from utilities in India.
3. Consumption of electricity from utilities by sectors in India.

These have been obtained and are shown in the Tables (5.1.1) to (5.1.3).

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2 *Discussion with Prof. R.P. Sengupta resulted in this assumption being incorporated into our work here.*

[5.2] Sectoral Allocation of Gross Generation of Thermal Electricity

1. From Utilities

The data required for this case is present in the Tables (5.1.2) and (5.1.3). What we have to do here is, since the CO_2 emissions are only obtained from the gross generation of thermal electricity and as the overall and sectoral end-consumption figures, which we have got from both the above mentioned tables, are inclusive of all the three kinds of electricity, we have to disaggregate the sectoral consumption data in such a manner so as to arrive at a sectoral end-consumption of electricity in terms of only thermal gross-generation. Then using this data, we can adroitly allocate the CO_2 emissions from power generation (in utilities) sectorally. So how do we tackle this problem? What we have done is as follows.

The first stage is to trace the steps necessary to convert the overall end-consumption figures [Table (5.1.2)] into figures representing gross generation of electricity from utilities [Table (5.1.2)]. This is required because using the same technique, we will convert the sectoral end consumption figures [Table (5.1.3)] into the corresponding gross generation figures. Then only will we be able to disaggregate these figures and get to the sectorally allocated gross generation of thermal electricity. For getting to the necessary conversion technique, we have used Table (5.2.1)

Table [5.2.1]

Parameters used in the Conversion of End Consumption to the Corresponding Gross-Generation

Variable	Alias
Gross electricity generation (utilities)	G
Auxiliary Consumption	A
Net electricity generation (utilities)	N
Purchases from non-utilities and imported	P
Net electricity available for Supply	S
Sold to final Consumers	C
Transmission and distribution losses	L

Source: Author

So, from the Table (5.1.2) and (5.2.1), we get :

C = G-A+P-L - (1)

This equation (1) can now be further broken up into the following equations :

C = S-L - (2)

S = G-A+P = G-(A-P) - (3)

Additionally what we need is to define some more parameters and these we define as the following :

b = L/S - (4)

and, a = (A-P)/G - (5)

Now, from equation (2) we have :

C/S = (1-L/S)

or, C/S = (1-b)

Thus, S = C/(1-b) - (6)

Similarly, from equation (3) we have :

S/G = [1-(A-P)/G]

or, S/G = (1-a)

Thus, G = S/(1-a) - (7)

But, what we want is to get (G) in terms of (C). So, using equation (6) and (7) we get :

G = C/[(1-b) * (1-a)] - (8)

Thus, we can convert the end-consumption of electricity into the corresponding gross generation terms by applying equation (8) to the end consumption figures and for this, what we need besides Tables (5.1.2), (5.1.3) and (5.2.4) is the values for (b) and (a), for the entire period of the study. This information is calculated in Table (5.2.2).

Now, using equation (8) along with the information given in Table (5.2.2) onto Table (5.1.3) will give me the sectoral allocation of gross-generation of electricity-Table (5.2.3). The next step is, now, to arrive at a sectoral allocation of electricity in terms of gross thermal (for it is this which gives rise to CO_2 emissions). For this what we have done is that we have calculated the percentage share of thermal electricity in the gross generation of electricity using Table (5.1.2), for each of the years undertaken in the study, and this is as shown in Table (5.2.4). Then assuming this percentage shares of thermal to be the same across the sectors,[3] for each of the years, we have used these percentages (varying according to the respective years) onto the sectoral allocation of gross generation of electricity, i.e., Table (5.2.3), so as to find the corresponding sectoral allocation of gross thermal generation of electricity - Table (5.2.5.).

With obtaining the Table (5.2.5.), a major part of our work (-to get an allocation of CO_2 emissions due to generation of power into its - power's - consuming sectors) is done. What remains furthers in terms of getting a correct sectoral distribution of thermal electricity (-gross generation), is obtaining the counter-part of the above exercise (dealing in utilities) with regard to generation of electricity from non- utilities.

2. From Non-Utilities

This case, in contrast to the case above, is not at all complicated. Rather, it is extremely straight forward. For, in Table (5.1.1) we straight away get the figures for sectoral gross generation of electricity from non-utilities. And when we put to use the assumption that this sectoral gross generation of electricity from non-utilities is wholly thermal, then our problem in solved. What is now left is only compiling this sectoral allocation of thermal gross generation of electricity from non-utilities, with Table (5.2.5) (i.e. sectoral allocation of gross

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3 *Result of a discussion with Prof. Ram Prasad Sengupta.*

thermal from utilities) to get the complete sectoral allocation of gross thermal electricity. This is simply done by adding up the appropriate sectors and we get our Table (5.2.6). So, what remains to be done is the allocation of CO_2 emissions as a result of the gross generation of thermal electricity, to its (-electricity's) consuming sectors.

[5.3] Although this task is certainly complex, it can nonetheless be achieved with the additional help of some active imagination. Imagination for appreciating and willing to go ahead with the concept earlier introduced, which says that gross- generation of electricity from non-utilities is essentially thermal and that too, solely coal based.For, among its (-the concept's) many implications, we do get a lucid treatment for allocating CO_2 emissions from generation of electricity through non-utilities. As these emissions are already accounted for in the emissions of CO_2 from the combustion of coal consumed by the self-generating sector, to prevent the occurrence of double counting when calculating sectorally the CO_2 emissions from energy consumption, we do not need to add these emissions, again, to the concerned electricity consuming sector, for we need to add to any particular sector only those CO_2 emission which occur as a result of the concerned sector's consumption of thermal electricity produced from utilities (in terms of gross generation). So what is only required is to understand, and explicity state, that sectoral allocation of CO_2 emissions for electricity generation, through non-utilities, is already taken care of while one is sectorally allocating the CO_2 emission as a result of the conusmption of coal. This allocation is included within the concerned sector's share of CO_2 emissions as a result of its consumption of coal. But, this does not mean that now one does not have to get at the concerned sectors generation of electricity (-in terms of gross of thermal generation) from non- utilities, as we do no longer have to distribute, sectorally, the resulting CO_2 emissions. This, infact, is required for our calculation exercise needed to generate a corresponding (- to this CO_2 emissions) sectoral consumption of energy, in terms of energy units. So we tackle the emissions from the production of electricity through utilities and non-utilities, separately.

(a) **Sectoral Allocation of CO_2 Emissions from Generation of Electricity Through Utilities** : These emission have already been accounted for and are attributed to the power sector in the allocation of CO_2 emissions from the combustion of individual fossil fuels. So, to begin with we formulate a Table in which we show the sectoral allocation of CO_2 emissions, for the power sector, across the individual fossil fuels. This is obtained simply by adding up the allocated CO_2 emissions, across the individual fossil fuels, for the sector concerned. This is presented in Table (5.3.1). The next step required is to allocate the CO_2 emissions in the power sector, to its consuming sectors. For this we take recourse to Table (5.2.5), as it is only in the production of thermal electricity that CO_2 emissions take place. In Table (5.2.5), we have the sectoral distribution of consumption of electricity in terms of gross-generation of thermal electricity. From this Table, we calculate for each year of the study, the share of each sector in the consumption of overall electricity in terms of gross-generation of thermal electricity. This is shown in Table (5.3.2).

Now taking this percentage denoting consumption share, we distribute the CO_2 emissions from the power sector (5.3.1), for each year, to each of the consuming sectors of electricity (in terms of gross generation of thermal electricity). This distribution is shown in Table (5.3.3).

In this manner we are able to successfully allocate the CO_2 emission resulting from the gross generation of thermal electricity (-utilities). But what about the corresponding CO2 emissions from the generation of electricity through non- utilities?

(b) **Sectoral Allocation of CO_2 Emissions from Generation of Electricity Through Non- Utilities** : Here, the resultant CO_2 emissions are already included within the concerned sector's allocated CO_2 emissions as a result of its consumption of coal. So, in effect, we do nothing more, as our task, here, has been implicitly, already, done in the course of our earlier calculations (-sectoral allocation of CO_2 emission from the consumption of coal; Chapter 4).

Therefore, Table (5.3.3) gives us the complete profile regarding the sectoral classification of CO_2 emissions due to electricity generation for the Indian economy, for a period spanning twenty years. Here, what one could have additionally done was to deduct the resulting CO_2 emission from those emission due to consumption of coal, within the concerned sector's allocation. But then we would have had to add these back to that sector's, within its emission as a result of its consumption of power and this would have given us the ditto sectoral picture as not doing this would give. So we do not bother to carry out this unnecessary exercise which give us no new insights.

Hence, this completes our exercise of generating data for a sectoral allocation of CO_2 emission, through energy consumption, for the Indian economy. Now, in order to impart a meaning to our entire doing, what is essential and yet left to be done, is to calculate the corresponding commercial energy consumption in terms of energy units, as a result of consuming these commercial energy constituents, for an effective counter-measure to all the CO_2 thus emitted. Moreover, knowing that we have calculated the CO_2 emissions from energy consumption, it should be an effective goal for us to go and calculate the energy consumption, responsible for the CO_2 emissions, in terms of energy units. This is what we will now do.

Tables to Chapter 5

TABLE [5.1.1] GROSS GENERATION OF ELECTRICITY IN GIGA-WATT HOURS (UTILS. & NON-UTILS.)

	UTILITIES				(NON-UTILITIES)			
YEAR	THERMAL	HYDRO	NUCLEAR	TOTAL (UTILITIES)	TRANSPORT (RAILWAYS)	SELF-GENR. INDUSTRIES	TOTAL (NON-UTILS.)	GROSS TOTAL
1	2	3	4	5	6	7	8	9
1970-71	28162.00	25248.00	2418.00	55828.00	37.00	5347.00	5384.00	61212.00
1971-72	31712.00	28024.00	1190.00	60926.00	43.00	5415.00	5458.00	66384.00
1972-73	36217.00	27196.00	1133.00	64546.00	38.00	5932.00	5970.00	70516.00
1973-74	35321.00	28972.00	2396.00	66689.00	40.00	6067.00	6107.00	72796.00
1974-75	40109.00	27875.00	2206.00	70190.00	36.00	6452.00	6488.00	76678.00
1975-76	43303.00	33302.00	2626.00	79231.00	38.00	6857.00	6895.00	85926.00
1976-77	50245.00	34836.00	3252.00	88333.00	41.00	7241.00	7282.00	95615.00
1977-78	51090.00	38007.00	2272.00	91369.00	39.00	7520.00	7559.00	98928.00
1978-79	52594.00	47159.00	2770.00	102523.00	34.00	7573.00	7607.00	110130.00
1979-80	56273.00	45477.00	2877.00	104627.00	36.00	8157.00	8193.00	112820.00
1980-81	61301.00	46542.00	3001.00	110844.00	42.00	8374.00	8416.00	119260.00
1981-82	69515.00	49565.00	3021.00	122101.00	45.00	8979.00	9024.00	131125.00
1982-83	79868.00	48374.00	2022.00	130264.00	47.00	9989.00	10036.00	140300.00
1983-84	86677.00	49954.00	3546.00	140177.00	48.00	10769.00	10817.00	150994.00
1984-85	98836.00	53948.00	4075.00	156859.00	43.00	12303.00	12346.00	169205.00
1985-86	114347.00	51021.00	4982.00	170350.00	43.00	12997.00	13040.00	183390.00
1986-87	128851.00	53840.00	5022.00	187713.00	37.00	13528.00	13565.00	201278.00
1987-88	149614.00	47444.00	5035.00	202093.00	35.00	16855.00	16890.00	218983.00
1988-89	157692.00	57873.00	5817.00	221382.00	36.00	18934.00	18970.00	240352.00
1989-90(*)	178723.00	62054.00	4625.00	245402.00	37.00	20763.00	20800.00	266202.00

SOURCE : ENERGY STATISTICS -1989-90, CSO, GOI.

TABLE [5.1.2] ELECTRICITY GENERATED, DISTRIBUTED AND SOLD TO ULTIMATE CONSUMERS FROM UTILITIES IN INDIA IN GIGA-WATT HOURS.

UTILITIES

YEAR	THERMAL	HYDRO	NUCLEAR	GROSS TOTAL	AUXILLARY CONSN.	NET ELEC. GENERATED	PURCHASES & IMPORTS	NET ELEC. SUPPLY	FINAL CONSN.	LOSES
1	2	3	4	5	6	7	8	9	10	11
1970-71	28162.00	25248.00	2418.00	55828.00	2863.00	52965.00	66.00	53031.00	43724.00	9307.00
1971-72	31712.00	28024.00	1190.00	60926.00	3130.00	57796.00	129.00	57925.00	47073.00	10852.00
1972-73	36217.00	27196.00	1133.00	64546.00	3398.00	61148.00	178.00	61326.00	49088.00	12238.00
1973-74	35321.00	28972.00	2396.00	66689.00	3615.00	63074.00	115.00	63189.00	50246.00	12943.00
1974-75	40109.00	27875.00	2206.00	70190.00	4130.00	66060.00	139.00	66199.00	52632.00	13567.00
1975-76	43303.00	33302.00	2626.00	79231.00	4556.00	74675.00	121.00	74796.00	60246.00	14550.00
1976-77	50245.00	34836.00	3252.00	88333.00	5334.00	82999.00	88.00	83087.00	66639.00	16448.00
1977-78	51090.00	38007.00	2272.00	91369.00	5620.00	85749.00	69.00	85818.00	69255.00	16563.00
1978-79	52594.00	47159.00	2770.00	102523.00	5893.00	96630.00	73.00	96703.00	77293.00	19410.00
1979-80	56273.00	45477.00	2877.00	104627.00	6495.00	98132.00	68.00	98200.00	78084.00	20116.00
1980-81	61301.00	46542.00	3001.00	110844.00	7230.00	103614.00	120.00	103734.00	82367.00	21367.00
1981-82	69515.00	49565.00	3021.00	122101.00	8287.00	113814.00	114.00	113928.00	90245.00	23683.00
1982-83	79868.00	48374.00	2022.00	130264.00	9029.00	121235.00	70.00	121305.00	95589.00	25716.00
1983-84	86677.00	49954.00	3546.00	140177.00	10142.00	130035.00	87.00	130122.00	102344.00	27778.00
1984-85	98836.00	53948.00	4075.00	156859.00	11650.00	145209.00	184.00	145393.00	114068.00	31325.00
1985-86	114347.00	51021.00	4982.00	170350.00	13157.00	157193.00	107.00	157300.00	123099.00	34201.00
1986-87	128851.00	53840.00	5022.00	187713.00	14704.00	173009.00	316.00	173325.00	135952.00	37373.00
1987-88	149614.00	47444.00	5035.00	202093.00	16317.00	185776.00	2097.00	187873.00	145613.00	42260.00
1988-89	157692.00	57873.00	5817.00	221382.00	17185.00	204197.00	1745.00	205942.00	161341.00	44601.00
1989-90(*)	178723.00	62054.00	4625.00	245402.00	20002.00	225400.00	1723.00	227123.00	174818.00	52305.00

NOTES:
*:Provisional.
(Source: Energy statistics -1989/90, CSO, GOI).

TABLE [5.1.3] SECTORAL CONSUMPTION OF ELECTRICITY (UTILITIES)

Sectors (1)		1970-71	1971-72	1972-73	1973-74	1974-75
1.TRANSPORT	(GWH)	1364.00	1633.00	1831.00	1531.00	1531.00
a) TRACTION & RAILWAYS		1364.00	1633.00	1831.00	1531.00	1531.00
2.AGRICULTURE	(GWH)	4470.00	5006.00	5918.00	6310.00	7763.00
3.INDUSTRY	(GWH)	34050.00	36327.00	37030.00	37760.00	38165.00
a) INDUSTRY		29579.00	31637.00	32244.00	32481.00	32690.00
b) COMMERCIAL		2573.00	2953.00	2782.00	2988.00	3082.00
c) OTHERS		1898.00	1737.00	2004.00	2291.00	2393.00
4.DOMESTIC	(GWH)	3840.00	4107.00	4309.00	4645.00	5173.00
TOTAL	(GWH)	43724.00	47073.00	49088.00	50246.00	52632.00

SOURCE : ENERGY STATISTIC -1989-90, CSO, GOI.

TABLE [5.1.3] SECTORAL CONSUMPTION OF ELECTRICITY (UTILITIES)

Sectors (2)		1975-76	1976-77	1977-78	1978-79	1979-80
1.TRANSPORT	(GWH)	1855.00	2168.00	2297.00	2186.00	2301.00
a) TRACTION & RAILWAYS		1855.00	2168.00	2297.00	2186.00	2301.00
2.AGRICULTURE	(GWH)	8721.00	9621.00	10107.00	12027.00	13452.00
3.INDUSTRY	(GWH)	43849.00	48513.00	50030.00	55504.00	53929.00
a) INDUSTRY		37568.00	41606.00	42635.00	47728.00	45955.00
b) COMMERCIAL		3507.00	4142.00	4428.00	4331.00	4657.00
c) OTHERS		2774.00	2765.00	2967.00	3445.00	3317.00
4.DOMESTIC	(GWH)	5821.00	6337.00	6821.00	7576.00	8402.00
TOTAL	(GWH)	60246.00	66639.00	69255.00	77293.00	78084.00

SOURCE : ENERGY STATISTIC -1989-90, CSO, GOI.

TABLE [5.1.3] SECTORAL CONSUMPTION OF ELECTRICITY (UTILITIES)

Sectors (3)		1980-81	1981-82	1982-83	1983-84	1984-85
1.TRANSPORT	(GWH)	2266.00	2505.00	2633.00	2710.00	2880.00
a) TRACTION & RAILWAYS		2266.00	2505.00	2633.00	2710.00	2880.00
2.AGRICULTURE	(GWH)	14489.00	15202.00	17817.00	18233.00	20960.00
3.INDUSTRY	(GWH)	56366.00	62099.00	63047.00	68166.00	74722.00
a) INDUSTRY		48069.00	53064.00	52967.00	57094.00	63019.00
b) COMMERCIAL		4682.00	5194.00	5846.00	6561.00	6937.00
c) OTHERS		3615.00	3841.00	4234.00	4511.00	4766.00
4.DOMESTIC	(GWH)	9246.00	10439.00	12092.00	13235.00	15506.00
TOTAL	(GWH)	82367.00	90245.00	95589.00	102344.00	114068.00

SOURCE : ENERGY STATISTIC -1989-90, CSO, GOI.

TABLE [5.1.3] SECTORAL CONSUMPTION OF ELECTRICITY (UTILITIES)

Sectors (4)		1985-86	1986-87	1987-88	1988-89	1989-90
1.TRANSPORT	(GWH)	3182.00	3229.00	3616.00	4037.00	4150.00
a) TRACTION & RAILWAYS		3182.00	3229.00	3616.00	4037.00	4150.00
2.AGRICULTURE	(GWH)	23422.00	29444.00	35267.00	38847.00	43643.00
3.INDUSTRY	(GWH)	79237.00	83956.00	84610.00	93848.00	98851.00
a) INDUSTRY		66980.00	70297.00	69180.00	76819.00	80878.00
b) COMMERCIAL		7290.00	7772.00	8841.00	10064.00	10227.00
c) OTHERS		4967.00	5887.00	6589.00	6965.00	7746.00
4.DOMESTIC	(GWH)	17258.00	19323.00	22120.00	24609.00	28174.00
TOTAL	(GWH)	123099.00	135952.00	145613.00	161341.00	174818.00

SOURCE : ENERGY STATISTIC -1989-90, CSO, GOI.

TABLE [5.2.2] COMPUTATION OF PARAMETERS REQUIRED IN PURSUIT OF CONVERSION FROM END-CONSUMPTION TO GROSS GENERATION OF ELECTRICITY (UTILITIES) IN GIGA-WATT HOURS.

(1)

YEAR	GROSS TOTAL (G)	AUXILLARY CONSUMPTION (A)	NET ELEC. GENERATED (N)	PURCHASES & IMPORTED (P)	NET ELEC. FOR SUPPLY (S)	FINAL CONSUMPTION (C)	LOSES (L)
1	2	3	4	5	6	7	8
1970-71	55828.00	2863.00	52965.00	66.00	53031.00	43724.00	9307.00
1971-72	60926.00	3130.00	57796.00	129.00	57925.00	47073.00	10852.00
1972-73	64546.00	3398.00	61148.00	178.00	61326.00	49088.00	12238.00
1973-74	66689.00	3615.00	63074.00	115.00	63189.00	50246.00	12943.00
1974-75	70190.00	4130.00	66060.00	139.00	66199.00	52632.00	13567.00
1975-76	79231.00	4556.00	74675.00	121.00	74796.00	60246.00	14550.00
1976-77	88333.00	5334.00	82999.00	88.00	83087.00	66639.00	16448.00
1977-78	91369.00	5620.00	85749.00	69.00	85818.00	69255.00	16563.00
1978-79	102523.00	5893.00	96630.00	73.00	96703.00	77293.00	19410.00
1979-80	104627.00	6495.00	98132.00	68.00	98200.00	78084.00	20116.00
1980-81	110844.00	7230.00	103614.00	120.00	103734.00	82367.00	21367.00
1981-82	122101.00	8287.00	113814.00	114.00	113928.00	90245.00	23683.00
1982-83	130264.00	9029.00	121235.00	70.00	121305.00	95589.00	25716.00
1983-84	140177.00	10142.00	130035.00	87.00	130122.00	102344.00	27778.00
1984-85	156859.00	11650.00	145209.00	184.00	145393.00	114068.00	31325.00
1985-86	170350.00	13157.00	157193.00	107.00	157300.00	123099.00	34201.00
1986-87	187713.00	14704.00	173009.00	316.00	173325.00	135952.00	37373.00
1987-88	202093.00	16317.00	185776.00	2097.00	187873.00	145613.00	42260.00
1988-89	221382.00	17185.00	204197.00	1745.00	205942.00	161341.00	44601.00
1989-90(*)	245402.00	20002.00	225400.00	1723.00	227123.00	174818.00	52305.00

SOURCE : AUTHOR (In particular, see Chapter-4 and Table [5.2.1]).

'ABLE [5.2.2] (2)

COMPUTATION OF PARAMETERS REQUIRED IN PURSUIT OF CONVERSION FROM END-CONSUMPTION TO GROSS GENERATION OF ELECTRICITY (UTILITIES) IN GIGA-WATT HOURS.

YEAR	b=(L/S)	(1-b)	a=[(A-P)/G]	(1-a)	G = C/(1-b)*(1-a)
1	9	10	11	12	13
1970-71	0.18	0.82	0.05	0.95	55828.00
1971-72	0.19	0.81	0.05	0.95	60926.00
1972-73	0.20	0.80	0.05	0.95	64546.00
1973-74	0.20	0.80	0.05	0.95	66689.00
1974-75	0.20	0.80	0.06	0.94	70190.00
1975-76	0.19	0.81	0.06	0.94	79231.00
1976-77	0.20	0.80	0.06	0.94	88333.00
1977-78	0.19	0.81	0.06	0.94	91369.00
1978-79	0.20	0.80	0.06	0.94	102523.00
1979-80	0.20	0.80	0.06	0.94	104627.00
1980-81	0.21	0.79	0.06	0.94	110844.00
1981-82	0.21	0.79	0.07	0.93	122101.00
1982-83	0.21	0.79	0.07	0.93	130264.00
1983-84	0.21	0.79	0.07	0.93	140177.00
1984-85	0.22	0.78	0.07	0.93	156859.00
1985-86	0.22	0.78	0.08	0.92	170350.00
1986-87	0.22	0.78	0.08	0.92	187713.00
1987-88	0.22	0.78	0.07	0.93	202093.00
1988-89	0.22	0.78	0.07	0.93	221382.00
1989-90(*)	0.23	0.77	0.07	0.93	245402.00

SOURCE : AUTHOR (In particular, see Chapter-4 and Table [5.2.1]).

TABLE [5.2.3]

SECTORAL CONSUMPTION OF ELECTRICITY IN GROSS GENERATION TERMS IN GIGA-WATT HOURS (UTILITIES).

YEARS	TRANSPORT	AGRICULTURE	INDUSTRY	DOMESTIC	TOTAL
1	2	3	4	5	6
1970-71	1741.59	5707.42	43475.97	4903.02	55828.00
1971-72	2113.57	6479.20	47017.59	5315.64	60926.00
1972-73	2407.59	7781.60	48690.89	5665.92	64546.00
1973-74	2032.02	8374.95	50116.96	6165.08	66689.00
1974-75	2041.74	10352.73	50896.82	6898.71	70190.00
1975-76	2439.56	11469.20	57666.90	7655.34	79231.00
1976-77	2873.78	12753.07	64306.17	8399.98	88333.00
1977-78	3030.46	13334.29	66005.21	8999.03	91369.00
1978-79	2899.55	15952.86	73621.63	10048.96	102523.00
1979-80	3083.18	18024.72	72261.02	11258.08	104627.00
1980-81	3049.43	19498.33	75853.59	12442.65	110844.00
1981-82	3389.25	20568.22	84019.61	14123.91	122101.00
1982-83	3588.12	24280.13	85917.38	16478.38	130264.00
1983-84	3711.79	24973.10	93364.59	18127.52	140177.00
1984-85	3960.39	28822.85	102752.90	21322.86	156859.00
1985-86	4403.40	32412.43	109651.77	23882.41	170350.00
1986-87	4458.38	40654.21	115920.56	26679.85	187713.00
1987-88	5018.56	48946.27	117428.31	30699.85	202093.00
1988-89	5539.32	53303.42	128772.34	33766.93	221382.00
1989-90	5825.59	61264.17	138762.79	39549.45	245402.00

SOURCE : AUTHOR.

TABLE [5.2.4] SHARE OF THERMAL, HYDRO AND NUCLEAR IN THE GROSS GENERATION OF ELECTRICITY (UTILITIES) IN GIGA-WATT HOURS.

YEAR	THERMAL	(%)	HYDRO	(%)	NUCLEAR	(%)	GROSS TOTAL
1	2		3		4		5
1970-71	28162.00	50.44	25248.00	45.22	2418.00	4.33	55828.00
1971-72	31712.00	52.05	28024.00	46.00	1190.00	1.95	60926.00
1972-73	36217.00	56.11	27196.00	42.13	1133.00	1.76	64546.00
1973-74	35321.00	52.96	28972.00	43.44	2396.00	3.59	66689.00
1974-75	40109.00	57.14	27875.00	39.71	2206.00	3.14	70190.00
1975-76	43303.00	54.65	33302.00	42.03	2626.00	3.31	79231.00
1976-77	50245.00	56.88	34836.00	39.44	3252.00	3.68	88333.00
1977-78	51090.00	55.92	38007.00	41.60	2272.00	2.49	91369.00
1978-79	52594.00	51.30	47159.00	46.00	2770.00	2.70	102523.00
1979-80	56273.00	53.78	45477.00	43.47	2877.00	2.75	104627.00
1980-81	61301.00	55.30	46542.00	41.99	3001.00	2.71	110844.00
1981-82	69515.00	56.93	49565.00	40.59	3021.90	2.47	122101.00
1982-83	79868.00	61.31	48374.00	37.14	2022.00	1.55	130264.00
1983-84	86677.00	61.83	49954.00	35.64	3546.00	2.53	140177.00
1984-85	98836.00	63.01	53948.00	34.39	4075.00	2.60	156859.00
1985-86	114347.00	67.12	51021.00	29.95	4982.00	2.92	170350.00
1986-87	128851.00	68.64	53840.00	28.68	5022.00	2.68	187713.00
1987-88	149614.00	74.03	47444.00	23.48	5035.00	2.49	202093.00
1988-89	157692.00	71.23	57873.00	26.14	5817.00	2.63	221382.00
1989-90(*)	178723.00	72.83	62054.00	25.29	4625.00	1.88	245402.00

SOURCE: COMPILED BY THE AUTHOR.

TABLE [5.2.5] SECTORAL CONSUMPTION IN TERMS OF GROSS THERMAL (UTILITIES).

YEARS	TRANSPORT	AGRICULTURE	INDUSTRY	DOMESTIC	TOTAL
1	2	3	4	5	6
1970-71	878.53	2879.06	21931.12	2473.29	28162.00
1971-72	1100.11	3372.43	24472.67	2766.79	31712.00
1972-73	1350.91	4366.29	27320.64	3179.17	36217.00
1973-74	1076.23	4435.69	26543.82	3265.26	35321.00
1974-75	1166.72	5915.91	29084.21	3942.16	40109.00
1975-76	1333.32	6268.39	31517.33	4183.96	43303.00
1976-77	1634.65	7254.12	36578.22	4778.02	50245.00
1977-78	1694.52	7456.02	36907.55	5031.91	51090.00
1978-79	1487.46	8183.77	37767.68	5155.09	52594.00
1979-80	1658.27	9694.49	38865.15	6055.09	56273.00
1980-81	1686.45	10783.33	41949.96	6881.26	61301.00
1981-82	1929.58	11709.98	47834.36	8041.08	69515.00
1982-83	2199.96	14886.74	52678.00	10103.29	79868.00
1983-84	2295.15	15441.86	57731.03	11208.96	86677.00
1984-85	2495.42	18161.12	64744.04	13435.42	98836.00
1985-86	2955.77	21756.76	73603.47	16031.00	114347.00
1986-87	3060.34	27906.09	79570.84	18313.73	128851.00
1987-88	3715.36	36236.03	86934.82	22727.79	149614.00
1988-89	3945.70	37968.41	91725.47	24052.43	157692.00
1989-90	4242.70	44617.88	101059.09	28803.34	178723.00

SOURCE : AUTHOR.

TABLE [5.2.6]

SECTORAL CONSUMPTION OF ELECTRICITY IN TERMS OF GROSS THERMAL (UTILITIES & NON-UTILITIES).

Sectors (1)		1970-71	1971-72	1972-73	1973-74	1974-75
1.TRANSPORT	(GWH)	915.53	1143.11	1388.91	1116.23	1202.72
TRANS. (Utils., GWH)		878.53	1100.11	1350.91	1076.23	1166.72
TRANS. (Non-Utils., GWH)		37.00	43.00	38.00	40.00	36.00
2.AGRICULTURE	(GWH)	2879.06	3372.43	4366.29	4435.69	5915.91
3.INDUSTRY	(GWH)	27278.12	29887.67	33252.64	32610.82	35536.21
INDUS. (Utils., GWH)		21931.12	24472.67	27320.64	26543.82	29084.21
INDUS. (Non-Utils., GWH)		5347.00	5415.00	5932.00	6067.00	6452.00
4.DOMESTIC	(GWH)	2473.29	2766.79	3179.17	3265.26	3942.16
TOTAL	(GWH)	33546.00	37170.00	42187.00	41428.00	46597.00

SOURCE : AUTHOR.

TABLE [5.2.6] SECTORAL CONSUMPTION OF ELECTRICITY IN TERMS OF GROSS THERMAL (UTILITIES & NON-UTILITIES).

Sectors (2)		1975-76	1976-77	1977-78	1978-79	1979-80
1.TRANSPORT	(GWH)	1371.32	1675.65	1733.52	1521.46	1694.27
TRANS. (Utils., GWH)		1333.32	1634.65	1694.52	1487.46	1658.27
TRANS. (Non-Utils., GWH)		38.00	41.00	39.00	34.00	36.00
2.AGRICULTURE	(GWH)	6268.39	7254.12	7456.02	8183.77	9694.49
3.INDUSTRY	(GWH)	38174.33	43819.22	44427.55	45340.68	47022.15
INDUS. (Utils., GWH)		31517.33	36578.22	36907.55	37767.68	38865.15
INDUS. (Non-Utils., GWH)		6657.00	7241.00	7520.00	7573.00	8157.00
4.DOMESTIC	(GWH)	4183.96	4778.02	5031.91	5155.09	6055.09
TOTAL	(GWH)	49998.00	57527.00	58649.00	60201.00	64466.00

SOURCE : AUTHOR.

TABLE [5.2.6] SECTORAL CONSUMPTION OF ELECTRICITY IN TERMS OF GROSS THERMAL (UTILITIES & NON-UTILITIES).

Sectors (3)		1980-81	1981-82	1982-83	1983-84	1984-85
1.TRANSPORT	(GWH)	1728.45	1974.58	2246.96	2343.15	2538.42
TRANS. (Utils., GWH)		1686.45	1929.58	2199.96	2295.15	2495.42
TRANS. (Non-Utils., GWH)		42.00	45.00	47.00	48.00	43.00
2.AGRICULTURE	(GWH)	10783.33	11709.98	14886.74	15441.88	18161.12
3.INDUSTRY	(GWH)	50323.96	56813.36	62667.00	68500.03	77047.04
INDUS. (Utils., GWH)		41949.96	47834.36	52678.00	57731.03	64744.04
INDUS. (Non-Utils., GWH)		8374.00	8979.00	9989.00	10769.00	12303.00
4.DOMESTIC	(GWH)	6881.26	8041.08	10103.29	11208.96	13435.42
TOTAL	(GWH)	69717.00	78539.00	89904.00	97494.00	111182.00

SOURCE : AUTHOR.

TABLE [5.2.6] SECTORAL CONSUMPTION OF ELECTRICITY IN TERMS OF GROSS THERMAL (UTILITIES & NON-UTILITIES).

Sectors (4)	1985-86	1986-87	1987-88	1988-89	1989-90
1.TRANSPORT (GWH)	2998.77	3097.34	3750.36	3981.70	4279.70
TRANS. (Utils., GWH)	2955.77	3060.34	3715.36	3945.70	4242.70
TRANS. (Non-Utils., GWH)	43.00	37.00	35.00	36.00	37.00
2.AGRICULTURE (GWH)	21756.76	27906.09	36236.03	37968.41	44617.88
3.INDUSTRY (GWH)	86600.47	93098.84	103789.82	110659.47	121822.09
INDUS. (Utils., GWH)	73603.47	79570.84	86934.82	91725.47	101059.09
INDUS. (Non-Utils., GWH)	12997.00	13528.00	16855.00	18934.00	20763.00
4.DOMESTIC (GWH)	16031.00	18313.73	22727.79	24052.43	28803.34
TOTAL (GWH)	127387.00	142416.00	166504.00	176662.00	199523.00

SOURCE : AUTHOR.

TABLE [5.3.1] — CO_2 EMISSIONS FROM GENERATION OF POWER (ACROSS FOSSIL FUELS - UTILITIES).

YEAR	COAL (MLN.TONNES)	PETROLEUM (MLN.TONNES)	NATURAL GAS (MLN.TONNES)	TOTAL (MLN.TONNES)
1970-71	17.73	3.54	1.68	22.95
1971-72	19.57	3.96	1.78	25.30
1972-73	22.34	4.86	1.63	28.83
1973-74	22.33	5.20	1.91	29.44
1974-75	27.24	5.34	2.15	34.73
1975-76	30.92	5.26	2.38	38.56
1976-77	36.03	4.76	1.98	42.77
1977-78	34.42	5.49	2.57	42.49
1978-79	33.28	6.45	2.49	42.22
1979-80	40.30	6.31	2.43	49.04
1980-81	51.20	6.42	2.07	59.69
1981-82	59.61	6.06	3.51	69.17
1982-83	66.46	7.04	4.79	78.29
1983-84	74.92	7.40	6.13	88.45
1984-85	77.38	8.20	7.41	92.99
1985-86	92.12	7.85	7.27	107.23
1986-87	105.46	7.53	7.82	120.80
1987-88	123.21	7.87	10.13	141.21
1988-89	130.47	7.62	9.38	147.48
1989-90	145.37	7.93	12.93	166.23

SOURCE : AUTHOR.

(Note: 1 Million tonne = 1 Tera gram = 10^{12} grams.)

TABLE [5.3.2] SECTORAL SHARE IN CONSUMPTION IN TERMS OF GROSS THERMAL (UTILITIES).

YEARS	TRANSPORT	(%)	AGRI.	(%)	INDUSTRY	(%)	DOMESTIC	(%)	TOTAL
1	2	3	4	5	6	7	8	9	10
1970-71	878.53	3.12	2879.06	10.22	21931.12	77.87	2473.29	8.78	28162.00
1971-72	1100.11	3.47	3372.43	10.63	24472.67	77.17	2766.79	8.72	31712.00
1972-73	1350.91	3.73	4366.29	12.06	27320.64	75.44	3179.17	8.78	36217.00
1973-74	1076.23	3.05	4435.69	12.56	26543.82	75.15	3265.26	9.24	35321.00
1974-75	1166.72	2.91	5915.91	14.75	29084.21	72.51	3942.16	9.83	40109.00
1975-76	1333.32	3.08	6268.39	14.48	31517.33	72.78	4183.96	9.66	43303.00
1976-77	1634.65	3.25	7254.12	14.44	36578.22	72.80	4778.02	9.51	50245.00
1977-78	1694.52	3.32	7456.02	14.59	36907.55	72.24	5031.91	9.85	51090.00
1978-79	1487.46	2.83	8183.77	15.56	37767.68	71.81	5155.09	9.80	52594.00
1979-80	1658.27	2.95	9694.49	17.23	38865.15	69.07	6055.09	10.76	56273.00
1980-81	1686.45	2.75	10783.33	17.59	41949.96	68.43	6881.26	11.23	61301.00
1981-82	1929.58	2.78	11709.98	16.85	47834.36	68.81	8041.08	11.57	69515.00
1982-83	2199.96	2.75	14886.74	18.64	52678.00	65.96	10103.29	12.65	79868.00
1983-84	2295.15	2.65	15441.86	17.82	57731.03	66.60	11208.96	12.93	86677.00
1984-85	2495.42	2.52	18161.12	18.38	64744.04	65.51	13435.42	13.59	98836.00
1985-86	2955.77	2.58	21756.76	19.03	73603.47	64.37	16031.00	14.02	114347.00
1986-87	3060.34	2.38	27906.09	21.66	79570.84	61.75	18313.73	14.21	128851.00
1987-88	3715.36	2.48	36236.03	24.22	86934.82	58.11	22727.79	15.19	149614.00
1988-89	3945.70	2.50	37968.41	24.08	91725.47	58.17	24052.43	15.25	157692.00
1989-90	4242.70	2.37	44617.88	24.96	101059.09	56.55	28803.34	16.12	178723.00

SOURCE : AUTHOR.

TABLE [5.3.3]

SECTORAL ALLOCATION OF CARBONDIOXIDE EMISSIONS RESULTING IN THE GENERATION OF POWER (UTILITIES).
(TERA GRAMS \ MILLION TONNES)

YEAR	TRANSPORT	AGRICULTURE	INDUSTRY	DOMESTIC	TOTAL
1970-71	0.72	2.35	17.97	2.02	22.95
1971-72	0.88	2.69	19.52	2.21	25.30
1972-73	1.08	3.48	21.75	2.53	28.83
1973-74	0.90	3.70	22.12	2.72	29.44
1974-75	1.01	5.12	25.19	3.41	34.73
1975-76	1.19	5.58	28.07	3.73	38.56
1976-77	1.39	6.18	31.14	4.07	42.77
1977-78	1.41	6.20	30.69	4.18	42.49
1978-79	1.19	6.57	30.32	4.14	42.22
1979-80	1.45	8.45	33.87	5.28	49.04
1980-81	1.64	10.50	40.95	6.70	59.69
1981-82	1.92	11.65	47.60	8.00	69.17
1982-83	2.16	14.59	51.64	9.90	78.29
1983-84	2.34	15.76	58.91	11.44	88.45
1984-85	2.35	17.09	60.91	12.64	92.99
1985-86	2.77	20.04	69.02	15.03	107.23
1986-87	2.87	26.16	74.60	17.17	120.80
1987-88	3.51	34.20	82.05	21.45	141.21
1988-89	3.69	35.51	85.78	22.49	147.48
1989-90	3.95	41.50	93.99	26.79	166.23

SOURCE: AUTHOR.

Chapter 6

Fuel Consumption in Energy Units (Methodology-III)

[6.1] In this last and concluding chapter, of the trilogy of the methodology series, we will talk about how do we go about converting our physical consumption of commercial energy constituents (fossil fuels and electricity) into energy units. The earlier two chapters of this series tells us how to generate carbondioxide emission, for the Indian economy, out of consumption of fossil fuels and electricity i.e. commercial energy constituents. In addition, the sectoral allocation of these emissions so obtained is also presented in these two chapters. So the remaining task of calculating the corresponding energy consumption in energy units, to these CO_2 emissions is left to done here, in this chapter. Once we do this, we will be ready to explicate our results and also this will enable us to try our hand at some projections for the Indian economy. Since a major part of our ground work (creation of the necessary framework for our exercise) has already been taken care of in the earlier chapters, we will keep this chapter very brief and concise.

To start with, the first thing which we do is re-arrange our data on fossil fuel (i.e. coal, petroleum products and natural gas) consumption (-physical) on a sectoral basis. So, for each of the sectors in our classification, we obtain the physical quantities of the fossil fuel consumed for the entire period of our study. But this is not enough, as the calorific value (- needed for conversion of physical units to energy units) of the fuels consumed differ not only sectorally, but, at times, also intra sectorally (consumption of coal by the Industry sector). Tables (4.1.4), (4.1.5) and (4.1.6) have given us the disaggregated, sectoral consumption for each of the fossil fuels. So, all that we so is to rearrange these tables, for each sector, across the various fuels types. Hence, what we get is Tables (6.1.1), to (6.1.5)-where the level of disaggregation is within fuel types, intrasectorally. This really simplifies our task of conversion, atleast for almost all of the sectors. For it is only in the case of the power sector that we encounter some technical complexities as it enters our calculation twice. Hence, what we do is evaluate the energy consumption for rest of the sectors and power separately, and then aggregate them in the end.

[6.2.] In this section, we will describe the conversion of fossil fuel consumption from physical units to energy units. Here, what we do once we have obtained the Tables (6.1.1.) to (6.1.5.) is to simply use the appropriate conversion Tables, given below, for the concerned fuel type, for each of the sectors taken into consideration. Really, the conversion at this stage is effectively so simple. The only problem is that it is not complete. Not complete in the sense that all the sectors, excluding power, consume not only the fossil fuels but also power. Hence a true profile of energy consumption, for these sectors, will have to include energy consumed as a result of its consumption of power. How this is done is shown in the next section.

The conversion Tables for coal have already been given earlier, and these are Tables (4.2.3) and (4.2.4). For, here, we use the same technique of getting at a calorific value of coal consumed, as was done while generating the CO_2 emissions (Chapter 4). For natural gas and petroleum products, we use the conversion Table given below - Table (6.2.1).

Table [6.2.1]

Conversion table for Natural Gas and Petroleum Products

Fuel Type	**Multiplying Factor**
Natural Gas	8.7 Mega Cal/Cubic Meter
Petroleum Product	
Fuel Oil (FO + Refinery Fuel)	10.44 Tera Cal/Mln tonnes
HSD	10*1.035 Tera Cal/Mln tonnes
LDO	10*1.035 Tera Cal/Mln tonnes
Mogas	10*1.070 Tera Cal/Mln tonnes
ATF	10*1.070 Tera Cal/Mln tonnes
Naphtha	10*1.075 Tera Cal/Mln tonnes
Residual Fuel Oils (Others)	10*1.985 Tera Cal/Mln tonnes
Misc.(Lubricants,Bitumen & Petroleum Coke)	10*1.960 Tera Cal/Mln tonnes
LPG	10*1.130 Tera Cal/Mln tonnes
Kerosene	10*1.045 Tera Cal/Mln tonnes

Source: Complied from, (1) R.P.Sengupta (1993), and (2) Volumes of Petroleum & Natural Gas Statistics.

In Table (6.2.1), the conversion factors for petroleum products have been obtained by taking 10,000 Tera Calories to be the energy content of one million tonnes of oil equivalent [- obtained from volumes of (P & NGS)].

So, applying these factor straight away to our disaggregated Tables (6.1.1), to (6.1.5) we get the consumption of fossil fuels in energy units. These have been done and are shown in Tables (6.2.2) to (6.2.6). Once, these are obtained, then simply aggregating the energy units for each fuel- type, for each of the sectors, for the entire period of our study, would give us the necessary data on sectoral energy consumption out of fossil fuels. But this we only do after completing the sectoral profile.

Here, it is important to note that the power sector's energy consumption is only that amount which is used to generate thermal electricity. The amount of energy needed for the generation of hydro and nuclear electricity have not been calculated as what we want is a level of correspondence between CO_2 emissions and energy consumption, and CO_2 emissions in the power sector is only due to the gross generation of thermal electricity. But, when we are allocating electricity (in gross generation terms) sectorally, then we calculate the energy consumption out of power from all the three types (i.e., thermal, hydro and nuclear) of gross generation. How this is done is explained in the following section.

[6.3] In chapter 5, for the allocation of CO_2 emissions due to gross generation of thermal electricity, we had sectorally distributed the gross thermal generation (utilities) - Table (5.2.5). Now, using similar techniques, we sectorally distribute the gross generation of hydro and nuclear electricity too. To re-iterate in brief, what we do is first of all we transform the sectoral end-consumption of electricity to sectorally consumption in gross generation terms -Table (5.2.3). Then for each year, we use the percentage share of hydro nuclear and thermal in the overall gross generation for that year -Table (5.2.4), to break up the sectoral consumption, in gross generation terms, into consumption of hydro, nuclear and thermal for each sector. The percentage used and the disaggregated consumption in terms of gross generation for each of the consuming sectors, is shown in the Table (6.3.1) and (6.3.2) respectively. So using the Table (6.3.2) we can now finally calculate the energy consumption, for each sector, when consuming powers. The conversion, used is given in Table (6.3.3).

Table [6.3.3]

Conversions for the Power Sectors

Type	Multiplying Factor
Hydro	860 KCAL/KWH
Nuclear	2986 KCAL/KWH
Thermal	860 KCAL/KWH

Source: Compiled from - R.P.Sengupta (1993).

But, before we convert, we have to do one more task and this is, to add to each of the concerned sector, its consumption of electricity from non-utilities (for, so far, in this chapter, our entire work has been with utilities). This we add to the thermal part in the concerned sectors consumption [Table (6.3.2.)]. Once this is done, we get our Table (6.3.4.), on which we use our conversion factors [Table (6.3.3)] to give us the correct description of sectoral consumption of energy, from the consumption of power, for the entire period of our study. Finally what is left to be done is to add up these consumption data, in energy units, across hydro, nuclear and thermal consumption, for each of the sectors, so as to get a factually correct, concise and compact scenario for sectoral energy consumption due to consumption of power. This is shown in Table (6.3.5).

[6.4.] Now all that is left to do is to merge the relevant sectors, year-wise, of Table (6.3.5) with each of the concerned sectors depicted by Tables (6.2.2) to (6.2.5) -excluding Table (6.2.6) which shows the energy consumption during gross generation of thermal electricity. This is done and shown in Tables (6.4.1) to (6.4.4.). So, Tables (6.4.1) to (6.4.4), along with Table (6.2.6) gives us our data on sectoral energy consumption (in energy units) from consumption of commercial energy for the entire period of our study. Thus we are now ready for not only have we generated sectoral CO_2 emissions, but also we have generated sectoral energy consumption, and that too both out of consumption of fossil fuels - to now go and describe and analyse the results which we have obtained, as a part of our task in addressing the question of global warning from a country specific model. For we have already built an inventory of CO_2 emissions as well as the resulting energy consumption for the Indian economy, as a whole, as well as sectorally (for adding up sectoral figures will give us our holistic profile), and now we can analyse the results and its implications. Once this is done, we can then go into some important projections, for the Indian economy, using the same data generated in these methodology trilogy and thus conclude our work. This, we will do in the closing chapter - Chapter 8. For in the next chapter we will discuss a paper by Jyoti Parikh and Subir Gokarn (1993), in which they have presented an alternative methodology for generation of CO_2 emissions.

Tables to Chapter 6

TABLE [6.1.1] FOSSIL FUEL CONSUMPTION IN THE AGRICULTURE SECTOR.

YEAR	COAL (000' Tonnes)	PETROLEUM (000' Tonnes)	NATURAL GAS (Mln. cubic meters)
1970-71	1450.00	183.25	15.00
1971-72	1640.00	193.00	19.00
1972-73	1830.00	186.75	20.00
1973-74	1780.00	209.50	22.00
1974-75	2040.00	157.50	29.00
1975-76	2230.00	121.25	33.00
1976-77	2410.00	142.00	38.00
1977-78	2500.00	139.00	39.00
1978-79	2340.00	133.00	43.00
1979-80	1990.00	144.00	39.00
1980-81	1970.00	198.00	45.00
1981-82	2370.00	401.00	47.00
1982-83	2840.00	313.00	51.00
1983-84	2560.00	299.00	56.00
1984-85	2570.00	307.00	62.00
1985-86	2360.00	345.00	78.00
1986-87	2440.00	348.00	93.00
1987-88	2540.00	375.00	99.00
1988-89	2970.00	385.00	87.00
1989-90	2700.00	512.00	78.00

SOURCE: Compiled by the AUTHOR.

TABLE [6.1.2]

FOSSIL FUEL CONSUMPTION IN THE DOMESTIC SECTOR.

YEAR	COAL (000' Tonnes)	PETROLEUM (000' Tonnes)	NATURAL GAS (Mln. cubic meters)
1970-71	N.A.	3422.00	N.A.
1971-72	N.A.	3686.50	N.A.
1972-73	N.A.	3710.00	N.A.
1973-74	N.A.	3507.00	N.A.
1974-75	3720.00	3061.00	6.00
1975-76	3640.00	3357.25	13.00
1976-77	4290.00	3582.50	15.00
1977-78	3380.00	3950.00	13.00
1978-79	3030.00	4282.00	13.00
1979-80	2260.00	4204.00	13.00
1980-81	2740.00	4555.00	14.00
1981-82	2290.00	5117.00	15.00
1982-83	2040.00	5744.00	14.00
1983-84	1600.00	6184.00	16.00
1984-85	1740.00	6813.00	18.00
1985-86	1300.00	7329.00	21.00
1986-87	1270.00	7986.00	25.00
1987-88	970.00	8646.00	34.00
1988-89	630.00	9323.00	42.00
1989-90	570.00	10049.00	41.00

SOURCE: Compiled by the AUTHOR.

TABLE [6.1.3] FOSSIL FUEL CONSUMPTION IN THE INDUSTRY SECTOR.

YEAR	COAL (000' Tonnes)	PETROLEUM (000' Tonnes)	NATURAL GAS (Mln. cubic meters)
1970-71	40990.00	6798.50	184.00
1971-72	41920.00	8095.75	190.00
1972-73	44410.00	10026.00	211.00
1973-74	45340.00	10516.75	238.00
1974-75	45400.00	9877.75	244.00
1975-76	49010.00	9699.50	247.00
1976-77	53430.00	10714.75	297.00
1977-78	59320.00	11114.00	336.00
1978-79	57890.00	12311.00	351.00
1979-80	59960.00	13008.00	330.00
1980-81	54750.00	13145.00	339.00
1981-82	60680.00	13924.00	530.00
1982-83	64720.00	14186.00	684.00
1983-84	66400.00	14068.00	802.00
1984-85	70110.00	15129.00	971.00
1985-86	73640.00	15956.00	1018.00
1986-87	76440.00	16642.00	1552.00
1987-88	76679.00	16819.00	1594.00
1988-89	84955.00	18361.00	1855.00
1989-90	86404.00	19265.00	2216.00

SOURCE: Compiled by the AUTHOR.

TABLE [6.1.4] FOSSIL FUEL CONSUMPTION IN THE TRANSPORT SECTOR.

YEAR	COAL (000' Tonnes)	PETROLEUM (000' Tonnes)
1970-71	15580.00	2633.25
1971-72	15920.00	3827.75
1972-73	15320.00	7125.00
1973-74	13920.00	7547.50
1974-75	14140.00	8200.75
1975-76	14300.00	8710.75
1976-77	13170.00	9151.50
1977-78	12930.00	9868.00
1978-79	12130.00	10740.00
1979-80	11360.00	11761.00
1980-81	11810.00	12121.00
1981-82	11260.00	12645.00
1982-83	10950.00	13686.00
1983-84	10700.00	14836.00
1984-85	9460.00	15711.00
1985-86	9610.00	16988.00
1986-87	8120.00	18564.00
1987-88	7550.00	20342.00
1988-89	6740.00	22147.00
1989-90	5800.00	24174.00

SOURCE: Compiled by the AUTHOR.

TABLE [6.1.5]

FOSSIL FUEL CONSUMPTION IN THE POWER SECTOR (IN UTILITIES GENERATION).

YEAR	COAL (000' Tonnes)	PETROLEUM (000' Tonnes)	NATURAL GAS (Mln. cubic meters)
1970-71	13210.00	1235.75	1023.00
1971-72	14580.00	1382.25	1081.00
1972-73	16650.00	1698.00	992.00
1973-74	16640.00	1816.50	1159.00
1974-75	20300.00	1867.00	1305.00
1975-76	23040.00	1837.75	1448.00
1976-77	26850.00	1664.00	1201.00
1977-78	25650.00	1919.00	1563.00
1978-79	24800.00	2253.00	1613.00
1979-80	30030.00	2205.00	1478.00
1980-81	38150.00	2243.00	1281.00
1981-82	44420.00	2120.00	2131.00
1982-83	49520.00	2466.00	2913.00
1983-84	55830.00	2589.00	3726.00
1984-85	57660.00	2867.00	4506.00
1985-86	68640.00	2745.00	4417.00
1986-87	78580.00	2635.00	4759.00
1987-88	91810.00	2755.00	6166.00
1988-89	97220.00	2666.00	5706.00
1989-90	108320.00	2773.00	7861.00

SOURCE: Compiled by the AUTHOR.

TABLE [6.2.2]

FOSSIL FUEL CONSUMPTION IN THE AGRI. SECTOR IN ENERGY UNITS (Tera Cals.).

YEAR	COAL	PETROLEUM	NATURAL GAS	TOTAL
1970-71	8990.00	1913.13	130.50	11033.63
1971-72	10168.00	2014.92	165.30	12348.22
1972-73	11346.00	1949.67	174.00	13469.67
1973-74	11036.00	2187.18	191.40	13414.58
1974-75	12648.00	1644.30	252.30	14544.6
1975-76	13826.00	1265.85	287.10	15378.95
1976-77	14942.00	1482.48	330.60	16755.08
1977-78	15500.00	1451.16	339.30	17290.46
1978-79	14508.00	1388.52	374.10	16270.62
1979-80	12338.00	1503.36	339.30	14180.66
1980-81	12214.00	2067.12	391.50	14672.62
1981-82	14694.00	4165.92	408.90	19268.82
1982-83	18228.00	3255.03	443.70	21926.73
1983-84	15872.00	3108.51	487.20	19467.71
1984-85	15934.00	3190.95	539.40	19664.35
1985-86	14632.00	3585.69	678.60	18896.29
1986-87	15128.00	3616.47	809.10	19553.57
1987-88	15748.00	3896.19	861.30	20505.49
1988-89	18414.00	4002.84	756.90	23173.74
1989-90	16740.00	5317.65	678.60	22736.25

SOURCE: Compiled by the AUTHOR.

TABLE [6.2.3]

FOSSIL FUEL CONSUMPTION IN THE DOMS. SECTOR IN ENERGY UNITS (Tera Cals.).

YEAR	COAL	PETROLEUM	NATURAL GAS	TOTAL
1970-71	N.A.	35878.05	N.A.	35878.05
1971-72	N.A.	38668.00	N.A.	38668.00
1972-73	N.A.	38934.40	N.A.	38934.40
1973-74	N.A.	36829.20	N.A.	36829.20
1974-75	18600.00	32185.50	52.20	50837.70
1975-76	18200.00	35298.53	113.10	53611.63
1976-77	21450.00	37658.55	130.50	59239.05
1977-78	16900.00	41546.10	113.10	58559.20
1978-79	15150.00	45027.40	113.10	60290.50
1979-80	11300.00	44214.00	113.10	55627.10
1980-81	13700.00	47877.70	121.80	61699.50
1981-82	11450.00	53833.05	130.50	65413.55
1982-83	10200.00	60475.30	121.80	70797.10
1983-84	9000.00	65183.80	139.20	74323.00
1984-85	8700.00	71921.75	156.60	80778.35
1985-86	6500.00	77523.05	182.70	84205.75
1986-87	6350.00	84593.55	217.50	91161.05
1987-88	4850.00	91553.45	295.80	96699.25
1988-89	3150.00	98778.55	365.40	102293.95
1989-90	2850.00	106550.55	356.70	109757.25

SOURCE: Computed by the AUTHOR.

TABLE [6.2.4]

FOSSIL FUEL CONSUMPTION IN THE INDUSTRY. SECTOR IN ENERGY UNITS (Tera Cals.).

YEAR	COAL	PETROLEUM	NATURAL GAS	TOTAL
1970-71	219184.00	69860.03	1600.80	290644.83
1971-72	223762.00	83189.02	1653.00	308604.02
1972-73	236340.00	103108.30	1835.70	341284.00
1973-74	241210.00	108310.68	2070.60	351591.28
1974-75	243792.00	102070.47	2122.80	347985.27
1975-76	264818.00	100424.85	2148.90	367391.75
1976-77	296991.94	110896.41	2583.90	410472.25
1977-78	329172.04	115052.25	2923.20	447147.49
1978-79	320720.13	127488.76	3053.70	451262.59
1979-80	331621.33	134546.09	2871.00	469038.42
1980-81	304479.68	135989.61	2949.30	443418.59
1981-82	332654.89	144136.96	4611.00	481402.85
1982-83	354292.89	146823.43	5950.80	507067.12
1983-84	364638.89	145760.87	6977.40	517377.16
1984-85	384016.44	156848.70	8447.70	549312.84
1985-86	386871.47	165378.29	8856.60	561106.36
1986-87	399891.51	172354.92	13502.40	585748.83
1987-88	404010.76	174003.23	13867.80	591881.79
1988-89	447707.13	190032.57	16138.50	653878.20
1989-90	455791.97	199202.57	19279.20	674273.74

SOURCE: AUTHOR.

TABLE [6.2.5]

FOSSIL FUEL CONSUMPTION IN THE TRANS. SECTOR IN ENERGY UNITS (Tera Cals.).

YEAR	COAL	PETROLEUM	TOTAL
1970-71	84911.00	28048.05	112959.05
1971-72	86764.00	40460.82	127224.82
1972-73	83494.00	74622.39	158116.39
1973-74	75864.00	78951.18	154815.18
1974-75	77063.00	85640.91	162703.91
1975-76	77935.00	90949.47	168884.47
1976-77	71776.50	95547.22	167323.72
1977-78	70468.50	103018.93	173487.43
1978-79	66108.50	112115.72	178224.22
1979-80	61912.00	122678.04	184590.04
1980-81	64364.50	126409.49	190773.99
1981-82	61367.00	131858.64	193225.64
1982-83	59677.50	142682.08	202359.58
1983-84	58315.00	152601.99	210916.99
1984-85	51557.00	163837.98	215394.98
1985-86	52374.50	177157.06	229531.56
1986-87	44254.00	193607.78	237861.78
1987-88	41147.50	212139.63	253287.13
1988-89	36733.00	230930.96	267663.96
1989-90	31610.00	252086.21	283696.21

SOURCE: AUTHOR.

TABLE [6.2.6]

FOSSIL FUEL CONSUMPTION IN THE POWER SECTOR IN ENERGY UNITS - Tera Cals. (IN UTILITIES GENERATION).

YEAR	COAL	PETROLEUM	NATURAL GAS	TOTAL
1970-71	52840.00	12901.23	8900.10	74641.33
1971-72	58320.00	14427.47	9404.70	82152.17
1972-73	66600.00	17713.91	8630.40	92944.31
1973-74	66560.00	18950.81	10083.30	95594.11
1974-75	81200.00	19481.51	11353.50	112035.01
1975-76	92160.00	19178.73	12597.60	123936.33
1976-77	107400.00	17362.49	10448.70	135211.19
1977-78	102600.00	20026.71	13598.10	136224.81
1978-79	99200.00	23515.74	13163.10	135878.84
1979-80	120120.00	23013.81	12858.60	155992.41
1980-81	152600.00	23402.70	10970.70	186973.40
1981-82	177680.00	22100.85	18539.70	218320.55
1982-83	198080.00	25705.26	25343.10	249128.36
1983-84	223320.00	26996.40	32416.20	282732.60
1984-85	230640.00	29897.91	39202.20	299740.11
1985-86	274560.00	28620.45	38427.90	341608.35
1986-87	314320.00	27470.34	41403.30	383193.64
1987-88	367240.00	28720.80	53644.20	449605.00
1988-89	388880.00	27790.02	49642.20	466312.22
1989-90	433280.00	28909.53	68390.70	530580.23

SOURCE: Computed by the AUTHOR.

TABLE [6.3.2] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES).

(1)

Sectors	1970-71	1971-72	1972-73	1973-74	1974-75
THERMAL (Gwh)	28162.00	31712.00	36217.00	35321.00	40109.00
1. Transport	878.53	1100.11	1350.91	1076.23	1166.72
2. Agriculture	2879.06	3372.43	4366.29	4435.69	5915.91
3. Industry	21931.12	24472.67	27320.64	26543.82	29084.21
4. Domestic	2473.29	2766.79	3179.17	3265.26	3942.16
HYDRO (Gwh)	25248.00	28024.00	27196.00	28972.00	27875.00
1. Transport	787.63	972.17	1014.42	882.78	810.85
2. Agriculture	2581.16	2980.23	3278.72	3638.37	4111.45
3. Industry	19661.84	21626.58	20515.56	21772.53	20212.98
4. Domestic	2217.37	2445.02	2387.30	2678.32	2739.73
NUCLEAR (Gwh)	2418.00	1190.00	1133.00	2396.00	2206.00
1. Transport	75.43	41.28	42.26	73.01	64.17
2. Agriculture	247.20	126.55	136.59	300.89	326.38
3. Industry	1883.01	918.34	854.69	1800.60	1599.64
4. Domestic	212.36	103.82	99.46	221.50	216.82
TOTAL (GWH)	55828.00	60926.00	64546.00	66689.00	70190.00
Transport (Gwh)	1741.59	2113.57	2407.59	2032.02	2041.74
Agriculture (Gwh)	5707.42	6479.20	7781.60	8374.95	10352.73
Industry (Gwh)	43475.97	47017.59	48690.89	50116.96	50896.82
Domestic (Gwh)	4903.02	5315.64	5665.92	6165.08	6898.71
TOTAL (Gwh)	55828.00	60926.00	64546.00	66689.00	70190.00

SOURCE: Computed by the AUTHOR.

TABLE [6.3.2] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES).

(2)

Sectors	1975-76	1976-77	1977-78	1978-79	1979-80
THERMAL (Gwh)	43303.00	50245.00	51090.00	52594.00	56273.00
1. Transport	1333.32	1634.65	1694.52	1487.46	1658.27
2. Agriculture	6268.39	7254.12	7456.02	8183.77	9694.49
3. Industry	31517.33	36578.22	36907.55	37767.68	38865.15
4. Domestic	4183.96	4778.02	5031.91	5155.09	6055.09
HYDRO (Gwh)	33302.00	34836.00	38007.00	47159.00	45477.00
1. Transport	1025.38	1133.34	1260.59	1333.75	1340.13
2. Agriculture	4820.68	5029.44	5546.70	7338.07	7834.60
3. Industry	24238.28	25360.51	27456.36	33864.81	31408.86
4. Domestic	3217.66	3312.71	3743.35	4622.37	4893.42
NUCLEAR (Gwh)	2626.00	3252.00	2272.00	2770.00	2877.00
1. Transport	80.86	105.80	75.36	78.34	84.78
2. Agriculture	380.13	469.51	331.57	431.02	495.64
3. Industry	1911.29	2367.45	1641.30	1989.13	1987.01
4. Domestic	253.73	309.25	223.77	271.51	309.57
TOTAL (GWH)	79231.00	88333.00	91369.00	102523.00	104627.00
Transport (Gwh)	2439.56	2873.78	3030.46	2899.55	3083.18
Agriculture (Gwh)	11469.20	12753.07	13334.29	15952.86	18024.72
Industry (Gwh)	57666.90	64306.17	66005.21	73621.63	72261.02
Domestic (Gwh)	7655.34	8399.98	8999.03	10048.96	11258.08
TOTAL (Gwh)	79231.00	88333.00	91369.00	102523.00	104627.00

SOURCE: Computed by the AUTHOR.

TABLE [6.3.2] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES).

(3)

Sectors	1980-81	1981-82	1982-83	1983-84	1984-85
THERMAL (Gwh)	61301.00	69515.00	79868.00	86677.00	98836.00
1. Transport	1686.45	1929.58	2199.96	2295.16	2495.42
2. Agriculture	10783.33	11709.98	14886.74	15441.86	18161.12
3. Industry	41949.96	47834.36	52678.00	57731.03	64744.04
4. Domestic	6881.26	8041.08	10103.29	11208.96	13435.42
HYDRO (Gwh)	46542.00	49565.00	48374.00	49954.00	53948.00
1. Transport	1280.42	1375.81	1332.46	1322.75	1362.08
2. Agriculture	8187.10	8349.35	9016.51	8899.51	9912.95
3. Industry	31849.97	34106.45	31905.72	33271.75	35339.47
4. Domestic	5224.51	5733.38	6119.31	6459.99	7333.50
NUCLEAR (Gwh)	3001.00	3021.00	2022.00	3546.00	4075.00
1. Transport	82.56	83.86	55.70	93.90	102.89
2. Agriculture	527.90	508.90	376.88	631.73	748.78
3. Industry	2053.67	2078.80	1333.64	2361.81	2669.39
4. Domestic	336.87	349.45	255.78	458.56	553.94
TOTAL (GWH)	110844.00	122101.00	130264.00	140177.00	156859.00
Transport (Gwh)	3049.43	3389.25	3588.12	3711.79	3960.39
Agriculture (Gwh)	19498.33	20568.22	24280.13	24973.10	28822.86
Industry (Gwh)	75853.59	84019.61	85917.36	93364.59	102752.90
Domestic (Gwh)	12442.85	14123.91	16478.38	18127.52	21322.86
TOTAL (Gwh)	110844.00	122101.00	130264.00	140177.00	156859.00

SOURCE: Computed by the AUTHOR.

TABLE [6.3.2] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES).

(4)

Sectors	1985-86	1986-87	1987-88	1988-89	1989-90
THERMAL (Gwh)	114347.00	128851.00	149614.00	157692.00	178723.00
1. Transport	2955.77	3060.34	3715.36	3945.70	4242.70
2. Agriculture	21756.76	27906.09	36236.03	37968.41	44617.88
3. Industry	73603.47	79570.84	86934.82	91725.47	101059.09
4. Domestic	16031.00	18313.73	22727.79	24052.43	28803.34
HYDRO (Gwh)	51021.00	53840.00	47444.00	57873.00	62054.00
1. Transport	1318.85	1278.76	1178.17	1448.07	1473.10
2. Agriculture	9707.75	11660.48	11490.78	13934.41	15491.67
3. Industry	32841.46	33248.43	27567.85	33663.27	35088.49
4. Domestic	7152.95	7652.34	7207.19	8827.25	10000.74
NUCLEAR (Gwh)	4982.00	5022.00	5035.00	5817.00	4625.00
1. Transport	128.78	119.28	125.03	145.55	109.79
2. Agriculture	947.92	1087.65	1219.46	1400.59	1154.62
3. Industry	3206.84	3101.29	2925.64	3383.60	2615.21
4. Domestic	698.46	713.78	764.86	887.25	745.37
TOTAL (GWH)	170350.00	187713.00	202093.00	221382.00	245402.00
Transport (Gwh)	4403.40	4458.38	5018.56	5539.32	5825.59
Agriculture (Gwh)	32412.43	40654.21	48946.27	53303.42	61264.17
Industry (Gwh)	109651.77	115920.56	117428.31	128772.34	138762.79
Domestic (Gwh)	23882.41	26679.85	30699.85	33766.93	39549.45
TOTAL (Gwh)	170350.00	187713.00	202093.00	221382.00	245402.00

SOURCE: Computed by the AUTHOR.

TABLE [6.3.4] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES & NON-UTILITIES).

(1)

Sectors	1970-71	1971-72	1972-73	1973-74	1974-75
THERMAL (Gwh)	33546.00	37170.00	42187.00	41428.00	46597.00
1. Transport	915.53	1143.11	1388.91	1116.23	1202.72
--Utils.	878.53	1100.11	1350.91	1076.23	1166.72
--Non-Utils.	37.00	43.00	38.00	40.00	36.00
2. Agriculture	2879.06	3372.43	4366.29	4435.69	5915.91
3. Industry	27278.12	29887.67	33252.64	32610.82	35536.21
--Utils.	21931.12	24472.67	27320.64	26543.82	29084.21
--Non-Utils.	5347.00	5415.00	5932.00	6067.00	6452.00
4. Domestic	2473.29	2766.79	3179.17	3265.26	3942.16
HYDRO (Gwh)	25248.00	28024.00	27196.00	28972.00	27875.00
1. Transport	787.63	972.17	1014.42	882.78	810.85
2. Agriculture	2581.16	2980.23	3278.72	3638.37	4111.45
3. Industry	19661.84	21626.58	20515.56	21772.53	20212.98
4. Domestic	2217.37	2445.02	2387.30	2678.32	2739.73
NUCLEAR (Gwh)	2418.00	1190.00	1133.00	2396.00	2206.00
1. Transport	75.43	41.28	42.26	73.01	64.17
2. Agriculture	247.20	126.55	136.59	300.89	325.38
3. Industry	1883.01	918.34	854.69	1800.60	1599.64
4. Domestic	212.36	103.82	99.46	221.50	216.82
TOTAL (GWH)	61212.00	66384.00	70516.00	72796.00	76678.00
Transport (Gwh)	1778.59	2156.57	2445.59	2072.02	2077.74
Agriculture (Gwh)	5707.42	6479.20	7781.60	8374.95	10352.73
Industry (Gwh)	48822.97	52432.59	54622.89	56183.96	57348.82
Domestic (Gwh)	4903.02	5315.64	5665.92	6165.08	6898.71
TOTAL (Gwh)	61212.00	66384.00	70516.00	72796.00	76678.00

SOURCE: Computed by the AUTHOR.

TABLE [6.3.4] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES & NON-UTILITIES).

(2)

Sectors	1975-76	1976-77	1977-78	1978-79	1979-80
THERMAL (Gwh)	49998.00	57527.00	58649.00	60201.00	64466.00
1. Transport	1371.32	1675.65	1733.52	1521.46	1694.27
--Utils.	1333.32	1634.65	1694.52	1487.46	1658.27
--Non-Utils.	38.00	41.00	39.00	34.00	36.00
2. Agriculture	6268.39	7254.12	7456.02	8183.77	9694.49
3. Industry	38174.33	43819.22	44427.55	45340.68	47022.15
--Utils.	31517.33	36578.22	36907.55	37767.68	38865.15
--Non-Utils.	6657.00	7241.00	7520.00	7573.00	8157.00
4. Domestic	4183.96	4778.02	5031.91	5155.09	6055.09
HYDRO (Gwh)	33302.00	34836.00	38007.00	47159.00	45477.00
1. Transport	1025.38	1133.34	1260.59	1333.75	1340.13
2. Agriculture	4820.68	5029.44	5546.70	7338.07	7834.60
3. Industry	24238.28	25360.51	27456.36	33864.81	31408.86
4. Domestic	3217.66	3312.71	3743.35	4622.37	4893.42
NUCLEAR (Gwh)	2626.00	3252.00	2272.00	2770.00	2877.00
1. Transport	80.86	105.80	75.36	78.34	84.78
2. Agriculture	380.13	469.51	331.57	431.02	495.64
3. Industry	1911.29	2367.45	1641.30	1989.13	1987.01
4. Domestic	253.73	309.25	223.77	271.51	309.57
TOTAL (GWH)	85926.00	95615.00	98928.00	110130.00	112820.00
Transport (Gwh)	2477.56	2914.78	3069.46	2933.55	3119.18
Agriculture (Gwh)	11469.20	12753.07	13334.29	15952.86	18024.72
Industry (Gwh)	64323.90	71547.17	73525.21	81194.63	80418.02
Domestic (Gwh)	7655.34	8399.98	8999.03	10048.96	11258.08
TOTAL (Gwh)	85926.00	95615.00	98928.00	110130.00	112820.00

SOURCE: Computed by the AUTHOR.

TABLE [6.3.4] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES & NON-UTILITIES).

(3)

Sectors	1980-81	1981-82	1982-83	1983-84	1984-85
THERMAL (Gwh)	69717.00	78539.00	89904.00	97494.00	111182.00
1. Transport	1728.45	1974.58	2246.96	2343.15	2538.42
--Utils.	1686.45	1929.58	2199.96	2295.15	2495.42
--Non-Utils.	42.00	45.00	47.00	48.00	43.00
2. Agriculture	10783.33	11709.98	14886.74	15441.86	18161.12
3. Industry	50323.96	56813.36	62667.00	68500.03	77047.04
--Utils.	41949.96	47834.36	52678.00	57731.03	64744.04
--Non-Utils.	8374.00	8979.00	9989.00	10769.00	12303.00
4. Domestic	6881.26	8041.08	10103.29	11208.96	13436.42
HYDRO (Gwh)	46542.00	49565.00	48374.00	49954.00	53948.00
1. Transport	1280.42	1375.81	1332.46	1322.75	1362.08
2. Agriculture	8187.10	8349.35	9016.51	8899.51	9912.95
3. Industry	31849.97	34106.45	31905.72	33271.75	35339.47
4. Domestic	5224.51	5733.38	6119.31	6459.99	7333.50
NUCLEAR (Gwh)	3001.00	3021.00	2022.00	3546.00	4075.00
1. Transport	82.56	83.86	55.70	93.90	102.89
2. Agriculture	527.90	508.90	376.88	631.73	748.78
3. Industry	2053.67	2078.80	1333.64	2361.81	2669.39
4. Domestic	336.87	349.45	255.78	458.56	553.94
TOTAL (GWH)	119260.00	131125.00	140300.00	150994.00	169205.00
Transport (Gwh)	3091.43	3434.25	3635.12	3759.79	4003.39
Agriculture (Gwh)	19498.33	20568.22	24280.13	24973.10	28822.85
Industry (Gwh)	84227.59	92998.61	95906.36	104133.59	115055.90
Domestic (Gwh)	12442.65	14123.91	16478.38	18127.52	21322.86
TOTAL (Gwh)	119260.00	131125.00	140300.00	150994.00	169205.00

SOURCE: Computed by the AUTHOR.

TABLE [6.3.4] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES & NON-UTILITIES).

(4)

Sectors	1985-86	1986-87	1987-88	1988-89	1989-90
THERMAL (Gwh)	127387.00	142416.00	166504.00	176662.00	199523.00
1. Transport	2998.77	3097.34	3750.36	3981.70	4279.70
--Utils.	2955.77	3060.34	3715.36	3945.70	4242.70
--Non-Utils.	43.00	37.00	35.00	36.00	37.00
2. Agriculture	21756.76	27906.09	36236.03	37968.41	44617.88
3. Industry	86600.47	93098.84	103789.82	110659.47	121822.09
--Utils.	73603.47	79570.84	86934.82	91725.47	101059.09
--Non-Utils.	12997.00	13528.00	16855.00	18934.00	20763.00
4. Domestic	16031.00	18313.73	22727.79	24052.43	28803.34
HYDRO (Gwh)	51021.00	53840.00	47444.00	57873.00	62054.00
1. Transport	1318.85	1278.76	1178.17	1448.07	1473.10
2. Agriculture	9707.75	11660.48	11490.78	13934.41	15491.67
3. Industry	32841.46	33248.43	27567.85	33663.27	35088.49
4. Domestic	7152.95	7652.34	7207.19	8827.25	10000.74
NUCLEAR (Gwh)	4982.00	5022.00	5035.00	5817.00	4625.00
1. Transport	128.78	119.28	125.03	145.55	109.79
2. Agriculture	947.92	1087.65	1219.46	1400.59	1154.62
3. Industry	3206.84	3101.29	2925.64	3383.60	2615.21
4. Domestic	698.46	713.78	764.86	887.25	745.37
TOTAL (GWH)	183390.00	201278.00	218983.00	240352.00	266202.00
Transport (Gwh)	4446.40	4495.38	5053.56	5575.32	5862.59
Agriculture (Gwh)	32412.43	40654.21	48946.27	53303.42	61264.17
Industry (Gwh)	122648.77	129448.56	134283.31	147706.34	159525.79
Domestic (Gwh)	23882.41	26679.85	30699.85	33766.93	39549.45
TOTAL (Gwh)	183390.00	201278.00	218983.00	240352.00	266202.00

SOURCE: Computed by the AUTHOR.

TABLE [6.3.5] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES & NON-UTILITIES), IN ENERGY UNITS.

(1)

Sectors	1970-71	1971-72	1972-73	1973-74	1974-75
THERMAL (Tera Cals.)	28849.56	31966.20	36280.82	35628.08	40073.42
1. Transport	787.36	983.08	1194.46	959.96	1034.34
--Utils.	755.54	946.10	1161.78	925.56	1003.38
--Non-Utils.	31.82	36.98	32.68	34.40	30.96
2. Agriculture	2475.99	2900.29	3755.01	3814.69	5087.68
3. Industry	23459.18	25703.39	28597.27	28045.31	30561.14
--Utils.	18860.76	21046.49	23495.75	22827.69	25012.42
--Non-Utils.	4598.42	4656.90	5101.52	5217.62	5548.72
4. Domestic	2127.03	2379.44	2734.09	2808.12	3390.26
HYDRO (Tera Cals.)	21713.28	24100.64	23388.56	24915.92	23972.50
1. Transport	677.36	836.07	872.40	759.19	697.33
2. Agriculture	2219.80	2562.99	2819.70	3128.99	3535.84
3. Industry	16909.18	18598.86	17643.38	18724.38	17383.16
4. Domestic	1906.94	2102.72	2053.07	2303.36	2356.17
NUCLEAR (Tera Cals.)	7220.15	3553.34	3383.14	7154.46	6587.12
1. Transport	225.24	123.27	126.19	218.00	191.61
2. Agriculture	738.13	377.88	407.87	898.47	971.57
3. Industry	5622.68	2742.17	2552.10	5376.59	4776.51
4. Domestic	634.10	310.02	296.98	661.39	647.42
TOTAL (Tera Cals.)	57782.99	59620.18	63052.52	67698.46	70633.04
Transport (Tera Cals.)	1689.96	1942.42	2193.05	1937.15	1923.28
Agriculture (Tera Cals.)	5433.92	5841.16	6982.57	7842.16	9595.10
Industry (Tera Cals.)	45991.04	47044.42	48792.75	52146.28	52720.81
Domestic (Tera Cals.)	4668.07	4792.18	5084.14	5772.87	6393.85
TOTAL (Tera Cals.)	57782.99	59620.18	63052.52	67698.46	70633.04

SOURCE: Computed by the AUTHOR.

TABLE [6.3.5]

SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES & NON-UTILITIES), IN ENERGY UNITS.

(2)

Sectors	1975-76	1976-77	1977-78	1978-79	1979-80
THERMAL (Tera Cals.)	42998.28	49473.22	50438.14	51772.86	55440.76
1. Transport	1179.33	1441.06	1490.82	1308.46	1457.07
--Utils.	1146.65	1405.80	1457.28	1279.22	1426.11
--Non-Utils.	32.68	35.26	33.54	29.24	30.96
2. Agriculture	5390.82	6238.54	6412.18	7038.04	8337.26
3. Industry	32829.93	37684.53	38207.70	38992.99	40439.05
--Utils.	27104.91	31457.27	31740.50	32480.21	33424.03
--Non-Utils.	5725.02	6227.26	6467.20	6512.78	7015.02
4. Domestic	3598.20	4109.10	4327.44	4433.37	5207.38
HYDRO (Tera Cals.)	28639.72	29958.96	32686.02	40556.74	39110.22
1. Transport	881.83	974.67	1084.11	1147.03	1152.51
2. Agriculture	4145.79	4325.32	4770.16	6310.74	6737.75
3. Industry	20844.92	21810.04	23612.47	29123.74	27011.62
4. Domestic	2767.18	2848.93	3219.28	3975.24	4208.34
NUCLEAR (Tera Cals.)	7841.24	9710.47	6784.19	8271.22	8590.72
1. Transport	241.43	315.92	225.01	233.93	253.15
2. Agriculture	1135.07	1401.95	990.08	1287.02	1479.98
3. Industry	5707.11	7069.20	4900.92	5939.55	5933.21
4. Domestic	757.62	923.41	668.18	810.72	924.38
TOTAL (Tera Cals.)	79479.24	89142.65	89908.35	100600.82	103141.70
Transport (Tera Cals.)	2302.60	2731.64	2799.94	2689.41	2862.73
Agriculture (Tera Cals.)	10671.67	11965.81	12172.42	14635.80	16554.99
Industry (Tera Cals.)	59381.95	66563.76	66721.09	74056.28	73383.88
Domestic (Tera Cals.)	7123.01	7881.44	8214.91	9219.33	10340.10
TOTAL (Tera Cals.)	79479.24	89142.65	89908.35	100600.82	103141.70

SOURCE: Computed by the AUTHOR.

TABLE [6.3.5] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES & NON-UTILITIES), IN ENERGY UNITS.

(3)

Sectors	1980-81	1981-82	1982-83	1983-84	1984-85
THERMAL (Tera Cals.)	59956.62	67543.54	77317.44	83844.84	95616.52
1. Transport	1486.47	1698.14	1932.39	2015.11	2183.04
--Utils.	1450.35	1659.44	1891.97	1973.83	2146.06
--Non-Utils.	36.12	38.70	40.42	41.28	36.98
2. Agriculture	9273.66	10070.58	12802.59	13280.00	15618.56
3. Industry	43278.60	48859.49	53893.62	58910.02	66260.46
--Utils.	36076.96	41137.55	45303.08	49648.68	55679.88
--Non-Utils.	7201.64	7721.94	8590.54	9261.34	10580.58
4. Domestic	5917.89	6915.33	8888.83	9639.71	11554.46
HYDRO (Tera Cals.)	40026.12	42625.90	41601.64	42960.44	46395.28
1. Transport	1101.16	1183.20	1145.92	1137.56	1171.39
2. Agriculture	7040.91	7180.44	7754.20	7653.58	8525.13
3. Industry	27390.97	29331.55	27438.92	28613.71	30391.94
4. Domestic	4493.08	4930.71	5262.60	5555.59	6306.81
NUCLEAR (Tera Cals.)	8960.99	9020.71	6037.69	10588.86	12167.95
1. Transport	246.53	250.39	166.31	280.37	307.22
2. Agriculture	1576.31	1519.56	1125.38	1886.36	2235.86
3. Industry	6132.25	6207.29	3982.24	7052.35	7970.80
4. Domestic	1005.90	1043.46	763.77	1369.27	1654.07
TOTAL (Tera Cals.)	108943.73	119190.15	124956.77	137393.64	154179.75
Transport (Tera Cals.)	2834.15	3131.73	3244.62	3433.04	3661.65
Agriculture (Tera Cals.)	17890.88	18770.58	21682.17	22819.94	26379.56
Industry (Tera Cals.)	76801.83	84398.33	85314.78	94576.08	104623.20
Domestic (Tera Cals.)	11416.87	12889.50	14715.20	16564.57	19515.34
TOTAL (Tera Cals.)	108943.73	119190.15	124956.77	137393.64	154179.75

SOURCE: Computed by the AUTHOR.

TABLE [6.3.5] SECTORAL CONSUMPTION OF GROSS GENERATION OF ELECTRICITY (UTILITIES & NON-UTILITIES), IN ENERGY UNITS.

(4)

Sectors	1985-86	1986-87	1987-88	1988-89	1989-90
THERMAL (Tera Cals.)	109552.82	122477.76	143193.44	151929.32	171589.78
1. Transport	2578.94	2663.72	3225.31	3424.26	3680.54
--Utils.	2541.96	2631.90	3195.21	3393.30	3648.72
--Non-Utils.	36.98	31.82	30.10	30.96	31.82
2. Agriculture	18710.81	23999.24	31162.99	32652.83	38371.37
3. Industry	74476.40	80065.00	89259.25	95167.14	104766.99
--Utils.	63298.98	68430.92	74763.95	78883.90	86910.81
--Non-Utils.	11177.42	11634.08	14495.30	16283.24	17856.18
4. Domestic	13786.66	15749.81	19545.90	20685.09	24770.87
HYDRO (Tera Cals.)	43878.06	46302.40	40801.84	49770.78	53366.44
1. Transport	1134.21	1099.73	1013.23	1245.34	1266.86
2. Agriculture	8348.66	10028.01	9882.07	11983.60	13322.84
3. Industry	28243.66	28593.65	23708.35	28950.41	30176.10
4. Domestic	6151.53	6581.01	6198.19	7591.43	8600.64
NUCLEAR (Tera Cals.)	14876.25	14995.69	15034.51	17369.56	13810.25
1. Transport	384.54	356.16	373.35	434.61	327.84
2. Agriculture	2830.50	3247.71	3641.31	4182.17	3447.70
3. Industry	9575.62	9260.46	8735.96	10163.44	7809.02
4. Domestic	2085.59	2131.35	2283.89	2649.34	2225.69
TOTAL (Tera Cals.)	168307.13	183775.85	199029.79	219069.66	238766.47
Transport (Tera Cals.)	4097.69	4119.61	4611.89	5104.21	5275.25
Agriculture (Tera Cals.)	29889.97	37274.96	44686.37	48818.60	55141.91
Industry (Tera Cals.)	112295.68	117919.12	121703.56	134220.99	142752.12
Domestic (Tera Cals.)	22023.79	24462.17	28027.97	30925.86	35597.19
TOTAL (Tera Cals.)	168307.13	183775.85	199029.79	219069.66	238766.47

SOURCE: Computed by the AUTHOR.

TABLE [6.4.1] ENERGY CONSUMPTION IN THE AGRICULTURE SECTOR

(Tera Cals.)

YEAR	COAL	PETROLEUM	NATURAL GAS	POWER	TOTAL
1970-71	8990.00	1913.13	130.50	6433.92	16467.55
1971-72	10168.00	2014.92	165.30	5841.16	18189.38
1972-73	11346.00	1949.67	174.00	6982.57	20452.24
1973-74	11036.00	2187.18	191.40	7842.16	21256.74
1974-75	12648.00	1644.30	252.30	9595.10	24139.70
1975-76	13826.00	1265.85	287.10	10671.67	26050.62
1976-77	14942.00	1482.48	330.60	11965.81	28720.89
1977-78	15500.00	1451.16	339.30	12172.42	29462.88
1978-79	14508.00	1388.52	374.10	14635.80	30906.42
1979-80	12338.00	1503.36	339.30	16554.99	30735.65
1980-81	12214.00	2067.12	391.50	17890.88	32563.50
1981-82	14694.00	4165.92	408.90	18770.58	38039.40
1982-83	18228.00	3255.03	443.70	21682.17	43608.90
1983-84	15872.00	3108.51	487.20	22819.94	42287.65
1984-85	15934.00	3190.95	539.40	26379.56	46043.91
1985-86	14632.00	3585.69	678.60	29889.97	48786.26
1986-87	15128.00	3616.47	809.10	37274.96	56828.53
1987-88	15748.00	3896.19	861.30	44686.37	65191.86
1988-89	18414.00	4002.84	756.90	48818.60	71992.34
1989-90	16740.00	5317.65	678.60	55141.91	77878.16

SOURCE: Compiled by the AUTHOR.

TABLE [6.4.2] ENERGY CONSUMPTION IN THE DOMESTIC SECTOR
(Tera Cals.)

YEAR	COAL	PETROLEUM	NATURAL GAS	POWER	TOTAL
1970-71	N.A.	35878.05	N.A.	4668.07	40546.12
1971-72	N.A.	38668.00	N.A.	4792.18	43460.18
1972-73	N.A.	38934.40	N.A.	5084.14	44018.54
1973-74	N.A.	36829.20	N.A.	5772.87	42602.07
1974-75	18600.00	32185.50	52.20	6393.85	57231.55
1975-76	18200.00	35298.53	113.10	7123.01	60734.64
1976-77	21450.00	37658.55	130.50	7881.44	67120.49
1977-78	16900.00	41546.10	113.10	8214.91	66774.11
1978-79	15150.00	45027.40	113.10	9219.33	69509.83
1979-80	11300.00	44214.00	113.10	10340.10	65967.20
1980-81	13700.00	47877.70	121.80	11416.87	73116.37
1981-82	11450.00	53833.05	130.50	12889.50	78303.05
1982-83	10200.00	60475.30	121.80	14715.20	85512.30
1983-84	9000.00	65183.80	139.20	16564.57	90887.57
1984-85	8700.00	71921.75	156.60	19515.34	100293.69
1985-86	6500.00	77523.05	182.70	22023.79	106229.54
1986-87	6350.00	84593.55	217.50	24462.17	115623.22
1987-88	4850.00	91553.45	295.80	28027.97	124727.22
1988-89	3150.00	98778.55	365.40	30925.86	133219.81
1989-90	2850.00	106550.55	356.70	35597.19	145354.44

SOURCE: Computed by the AUTHOR.

TABLE [6.4.3] ENERGY CONSUMPTION IN THE INDUSTRY SECTOR

(Tera Cals.)

YEAR	COAL	PETROLEUM	NATURAL GAS	POWER	TOTAL
1970-71	219184.00	69860.03	1600.80	45991.04	336635.87
1971-72	223762.00	83189.02	1653.00	47044.42	355648.44
1972-73	236340.00	103108.30	1835.70	48792.75	390076.75
1973-74	241210.00	108310.68	2070.60	52146.28	403737.56
1974-75	243792.00	102070.47	2122.80	52720.81	400706.08
1975-76	264818.00	100424.85	2148.90	59381.95	426773.70
1976-77	296991.94	110896.41	2583.90	66563.76	477036.00
1977-78	329172.04	115052.25	2923.20	66721.09	513868.58
1978-79	320720.13	127488.76	3053.70	74056.28	525318.87
1979-80	331621.33	134546.09	2871.00	73383.88	542422.30
1980-81	304479.68	135989.61	2949.30	76801.83	520220.41
1981-82	332654.89	144136.96	4611.00	84398.33	565801.18
1982-83	354292.89	146823.43	5950.80	85314.78	592381.90
1983-84	364638.89	145760.87	6977.40	94576.08	611953.24
1984-85	384016.44	156848.70	8447.70	104623.20	653936.05
1985-86	386871.47	165376.29	8856.60	112295.68	673402.04
1986-87	399891.61	172354.92	13502.40	117919.12	703667.94
1987-88	404010.76	174003.23	13867.80	121703.56	713585.35
1988-89	447707.13	190032.57	16138.50	134220.99	788099.19
1989-90	455791.97	199202.57	19279.20	142752.12	817025.86

SOURCE: AUTHOR.

TABLE [6.4.4] ENERGY CONSUMPTION IN THE TRANSPORT SECTOR

(Tera Cals.)

YEAR	COAL	PETROLEUM	POWER	TOTAL
1970-71	84911.00	28048.05	1689.96	114649.01
1971-72	86764.00	40460.82	1942.42	129167.23
1972-73	83494.00	74622.39	2193.05	160309.45
1973-74	75864.00	78951.18	1937.15	156752.33
1974-75	77063.00	85640.91	1923.28	164627.19
1975-76	77935.00	90949.47	2302.60	171187.07
1976-77	71776.50	95547.22	2731.64	170055.36
1977-78	70468.50	103018.93	2799.94	176287.37
1978-79	66108.50	112115.72	2689.41	180913.63
1979-80	61912.00	122678.04	2862.73	187452.77
1980-81	64364.50	126409.49	2834.15	193608.14
1981-82	61367.00	131858.64	3131.73	196357.37
1982-83	59677.50	142682.08	3244.62	205604.20
1983-84	58315.00	152601.99	3433.04	214350.03
1984-85	51557.00	163837.98	3661.65	219056.63
1985-86	52374.50	177157.06	4097.69	233629.25
1986-87	44254.00	193607.78	4119.61	241981.39
1987-88	41147.50	212139.63	4611.89	257899.02
1988-89	36733.00	230930.96	5104.21	272768.17
1989-90	31610.00	252086.21	5275.25	288971.46

SOURCE: AUTHOR.

Chapter 7

Alternative-Methodology

[7.1] In the previous chapters, we have attempted to generate a database with respect to CO_2 emissions, for the entire Indian economy and, moreover, we have managed to allocate these emissions sectorally. This exercise had been targeted so as to not only enable us to have an important database regarding CO_2 emissions, (the prime causal factor leading to greenhouse effect and in turn global warming), but also because it would lead us to many an important policy decisions and projections needed for a holistic growth and a healthy development of the entire Indian economy and society as such. Infact, some such over ambitious attempts have been valiantly tried at here. In doing so, the methodology adopted is in tune with the conventional approaches of looking at the energy supply structure and at the end uses of energy. this is an important method and our stance for sticking to it has been ably enumerated in the earlier chapters. But this is not the only way. Another important method for an analysis of CO_2 emissions in the Indian economy, along with an examination of the accompanying important policy decisions, is through an examination of the flows of energy in the economy of India through a 60-sector input-output model.

So how does the methodology work out? Jyoti Parikh and Subir Gokarn (1993) have carried out an exercise involving generation of CO_2 emission, for the Indian economy, for 1983/84, using this methodology, involving energy flows in the Indian economy through a 60-sector input-output model for 1983/84. In this paper, they have given a brief review of the methodology adopted. Due to lack of time, what we are going to do is to give an exposition of their above mentioned work, although running through the entire exercise in actuality, for the same span of twenty years (taken in our worked out generation exercise, using the energy consumption approach), would have proved to be extremely insightful and infact would have ably rounded up our entire exercise. For, the methodology adopted generates a database for CO_2 from the consumption angle, and this input-output method would have generated a database for us from the production angle, thus drawing the full circle and giving us a range, a zone for CO_2 emissions, and in this manner, stemming any chances of leakages of any kind. But time constraint, primarily, has constricted our work to the consumption sphere. Hence, what we can atleast do within the time constraint sphere, is to try to theoretically paint the circle complete and in the process raise a few questions, which we would like

picture

to pursue, along with the exercise, at a latter stage. Thus, theoretically, how we can achieve generation of CO_2 emissions using the input-output methodology is as follows.

[7.2] The entire exercise, of generation of CO_2 emissions using an input-output model, is dependent on developing an input-output model which directly incorporates carbon emissions arising from the energy usage pattern of each activity of the model - a 60-sector (commodity * commodity) transaction matrix of the Indian economy. This matrix, for each of the years for which the exercise is carried out, is obtained from (-rather published by) the Central Statistical Organization, Department of Statistics, Ministry of Planning, Government of India. To serve as a model, the commodity-flow matrix for 1989/90 is given in Table (7.2.1).

Before we embark upon our exposition of the required methodology, it is pertinent to mention here that the entire exercise has to be carried out separately for each of the years for which we want to generate and analyse the CO_2 emissions, as not only is the relevant commodity-flow matrix different for each year, but the required parameters also are different year-wise. Also we would like to re-iterate, here, that our entire exposition, along with its assumptions and 'facts and figures', is based on Jyoti Parikh and Subir Gokarn's (1993), 'Climate Change and India's Policy Options: New Perspectives on Sectoral CO_2 Emissions and Incremental Costs', September 1993 - a working paper of IGIDR, Bombay.

Now, the entire exercise uses the sectoral energy transactions (in value terms) reported in the commodity-flow matrix as the starting point. Then comes conversion of these values into physical quantities of fossil (carbon-emanating) fuels and the, finally, converting these physical fuel quantities into their carbon emission equivalents. These carbon equivalents replace the original values of energy transactions in the 60-sector matrix, and it is this modified transaction matrix which is used to compute a technology co-efficient matrix, which is in turn used as the base for the generation exercise as well as the basis of analysis of various demand, production and conservation scenarios. So, before the actual working of this method is explained, we think it best to describe each stage of the transformation of sectoral energy value transactions into carbon emissions, as is done in the above mentioned paper by Jyoti Parikh and Subir Gokarn.

[7.2.1] Stage I: Conversion of Sectoral Energy Transactions from Value Units to Physical Units

The original matrix provides information on fossil-fuel usage by each of the 60-sectors in terms of the Rupees values (for the year concerned) of coal and lignite [Sector 15-Table (7.2.1)], crude petroleum and natural gas [Sector 16-Table (7.2.1)] and petroleum products [Sector 34-Table (7.2.1)] used by each sector during the particular year concerned. The coal classification includes all varieties of coal, including coking coal. Crude petroleum and natural gas are almost entirely shown as input into the petroleum products activity, as expected, with small values feeding into several other sectors. We interpret these flows as the amount of natural gas being directly consumed. But here, Jyoti Parikh and Subir Gokarn (1993) have to say, ' as they are relatively insignificant, and as the price of natural gas is difficult to obtain, we ignored these values. Thus, we have to attribute zero carbon emissions from natural gas usage (both combustion and flaring)', in stark contrast to our adopted methodology using energy consumption, for which we have generated CO_2 emission for a period of twenty years. The petroleum products classification, again, is an aggregated one and is inclusive of all refinery products. Therefore, the conversion exercise thus concentrates on coal and petroleum products.

(1) **Coal:** From coal production data, it is possible to obtain the proportions of coking coal and non-coking coal consumed in the country (India), in the year concerned. No further disaggregation is available form the same source. So, the first task is to make a distinction between fuel and non-fuel uses of coal. Since obtaining the exact data on the complete sectoral consumption of various types of coal is not possible, as we have, ourselves, found in the course of our generation exercise, the assumption that coking coal is used pre-dominantly by the iron and steel activity [Sector 42-Table (7.2.1)], is made. This sector is assumed to use an amount of non-coking coal as well (e.g. for captive power generation). In

this activity, coking coal would represent the non-fuel component of coal usage, whereas non-coking coal represents the fuel component. In the coal tar production activity [Sector 35-Table (7.2.1)], a similar distinction has to be made. In the iron and steel case, coking coal is first decomposed into coke and volatile matter; the coke fed into the blast durance, in which it is oxidised and emerges as a mixture of carbon oxides. This mix (comprising some other gaseous emissions as well) is termed blast furnace gas', and is used as a fuel gas by the rest of the iron and steel making activity. The volatile matter extracted form coal is fractionally distillated into a number of products, the most important being coke-oven gas, which is also used as a fuel gas throughout the plant. Thus, even coking coal is, atleast indirectly, used as a fuel. Therefore, its best to avoid any distinction between fuel and non fuel uses of coal in the iron and steel sector, as Jyoti Parikh and Subir Gokarn (1993) have done. The same reasoning is also used for the coal tar sector and, 'treat the entire coal usage by this sector as fuel, although, in reality, the bulk of the energy requirement in the coal tar sector is met by the gaseous fraction remaining after the condensation of tar' (Jyoti Parikh and Subir Gokarn, 1993).

The next step is relatively simple; using the proportion of coking and non-coking coal production as weights, a weighted average price per tonne of coal for the year concerned is obtained. This price is assumed to be uniform for all coal-producing sectors. This is the price which is used to convert the Rupees value of coal usages into physical units (tonnes). The same formula is also applied to the components of final demand for coal.

(2) **Petroleum Products:** The conversion exercise for petroleum products involves an additional step. Here, a distinction is made between categories of distillate (light, middle and heavy), since each of these have somewhat different carbon emission implications. Now, the demand for fuels by the production activities (intermediate demand) in the system is seen to consist of furnace oil, LSHS (-both heavy distillates), HSD and LDO (-both middle distillates). Also the sector fertilizers [Sector 36 - Table (7.2.1)], is to be treated as using petroleum products for feedstock (i.e. non-fuel) purposes, and the final demand component for petroleum products is assumed to consist of LDO (-middle distillate), motorspirit and kerosene (-light distillates) (Jyoti Parikh and Subir Gokarn, 1993).

So, for all production sectors other than fertilizers, the following procedure is to be used. The relevant volumes of the document 'Indian Petroleum and Natural Gas Statistics' (P&NGS) provides some idea of the usage patterns of refinery products by some of the production sectors. The prices of various distillates can also be obtained from the same source (on a Rs/kl basis which, then , is converted to a Rs/tonnes basis, using specific gravities for various distillates). What Jyoti Parikh and Subir Gokarn have done is to represent all middle distillate usage as HSD and all heavy distillate usage as furnace oil, since the calorific values, carbon emissions and prices, within each distillate category, are quite close to each other. This is, again, quite different from our adopted technique, enumerated in the earlier chapters, and seems odd to us. Now, the value of petroleum product usage provided by the input-output matrix is decomposed into HSD and FD components, using the value distributions obtained from the (P&NG) statistics. But, as it is not possible obtain this value decomposition for all sectors separately, making some judgments about usage patterns is necessary here. 'The final result, therefore , is a combination of (P&NGS) distributions applied to as many sectors as possible and our own judgements for the rest of the sectors' (Jyoti Parikh and Subir Gokarn, 1993). The Rupees value for HSD and FO, thus so obtained, is converted to physical units (tonnes) using the price information described above.

In the fertilizer activity, petroleum products are used as feedstock as well as fuel. Based on technical norms available for various (nitrogenous) fertilizer processes, the ratio of feedstock to fuel can be taken as 80:20 (Jyoti Parikh and Subir Gokarn, 1993). Further, no carbon emissions is to be attributed to the feedstock component, because technical descriptions of the processes indicate that, ideally, all CO_2 generated in the process of hydrogen production is recycled as an input into the area production process. So, only the fuel component of petroleum usage is deemed to emit carbon. Thus, 20% of the total Rupees value of petroleum product usage shown by the fertilizer activity is taken as fuel, and converted into HSD and FO components, and thence to physical components by the process described above.

Jyoti Parikh and Subir Gokarn have made an assumption here that all of the fertilizer produced in the country is nitrogenous. But in reality, while its has the largest share in output, there is significant production of phosphatic fertilizers as well. We are of the opinion that this fact should be taken into account.

Finally, for the final demand component of petroleum products, as well as for imports, the value shares provided in the (P&NGS) are used to convert the matrix information on aggregate values into product-wise values, and then to physical quantities, using price information form the same source.

[7.2.2] Stage II: Conversion from Physical Units of Fossil Fuels (tonnes) to Carbon Emissions (tonnes)

Information on carbon emissions in tonnes/Gigajoules (GJ) for various fuels can be obtained from 'Estimation of Greenhouse Gas Emission and Sinks', OECD, August 1991. Jyoti Parikh and Subir Gokarn have done the same. Multiplying these parameters by the calorific values of the various fuels considered gives the carbon emissions in tonnes of carbon/tonne of fuel. The calorific values (GJ/tonne of fuel) can be assumed to be 21, 44 and 38 for coal, HSD and FO respectively (Jyoti Parikh and Subir Gokarn, 1993). For coal, this carbon emission parameters is applied to the physical quantities of coal usage, computed for each sector and for each component of final demand in Stage I, to derive total carbon emissions from coal usage in each activity. For petroleum products, the carbon emissions from the usage of HSD and FO are separately calculated for each sector (for the final demand components, MS, HSD and Kerosene are taken into consideration), and these are aggregated to derive a figure for total carbon emissions from petroleum product usage by each activity, as well as by each component of final demand.

Then, Jyoti Parikh and Subir Gokarn (1993) have inserted these carbon emission figures back into the original 60-sector matrix, simply replacing the two rows containing the value transactions for coal and petroleum with their respective derived carbon equivalents. After this transformation, the validity of the conventional economic interpretation of the transformed matrix as well as of its various computational transformations, become difficult to interpret.[1] Nevertheless, they have created a matrix containing all the original 60 sectors,

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[1] *Discussion with Prof.Anjan Mukherji was very helpful, here, at this point in our exercise.*

but two of the rows are entirely denominated in terms of tonnes of carbon. This transformed commodity-flow matrix for the Indian economy generates a technology co-efficient matrix simply by dividing each column, representing all inputs into a given activity, by the level of output of that activity. It is mentioned that 'although these co-efficient are conventionally expressed in terms of value of input/unit value of output, for coal and petroleum refining activities, in the present exercise, all inputs other than coal and petroleum products are interpreted as value of input/tonne of carbon equivalent. In the case of coal and petroleum product inputs into these activities, the co-efficient are interpreted as tonnes of carbon equivalent/tonnes. Similarly, coal and petroleum product inputs into all other activities are interpreted as tonnes of carbon equivalent/unit value of output' (Jyoti Parikh and Subir Gokarn, 1993). Nonetheless, in this manner we are now ready to calculate the carbon emissions - fuel-wise as well as sector-wise. Once these carbon emission are calculated, then calculating the CO_2 emissions is just one step away - use of Table (4.1.7) on these carbon emissions.

[7.3] The conventional solution to any input-output system is represented by: $X = [I-A]^{-1} F$-(1); where x is a (60 x 1) vector representing levels of output of each activity, A is a (60x60) matrix containing input usage co-efficient for each activity, and F is the sum of vectors C, I, G, and (E-M), representing private consumption, gross investment (gross fixed capital formation and change in stocks), Government consumption and net exports (exports-imports) respectively.

So, for any row (i = 1 to 60) of the $(I\text{-}A)^{-1}$ matrix, the j^{the} element represents the combined direct and indirect requirement of commodity i to satisfy one unit of final demand for commodity j. Here, we will have two rows in the $(I\text{-}A)^{-1}$ matrix [i=15, 34 -Table (7.2.1)] denominated in terms of tonnes of carbon emissions. Representing these rows as CE^c and CE^p (carbon emissions from coal and petroleum products, respectively), we derive the following measure of total carbon emissions (direct and indirect arising from satisfaction of each component of the final demand vector F:

$TCE_i = TCE^c_i + TCE^p_i$

$= \Sigma_i \, [CE^c_i F_i) + (CE^p_i F_i)]$ - (2),

where TCE_i is the total carbon emissions attributed to the i^{th} element of the final demand F, TCE^c_i is total carbon emissions attributed to the i^{th} element of F from direct and indirect coal usage, TCE^p_i is total carbon emissions attributed to the i^{th} element F from direct and indirect petroleum product usage, CE^c_i is the i^{th} element of the coal row of the $(I\text{-}A)^{-1}$ matrix, CE^p_i is the i^{th} element of the petroleum products row of the $(I\text{-}A)^{-1}$ matrix, and F_i is the i^{th} element of the final demand vector F. Thus,

$\Sigma_i \, CE^c_i F_i = X^c$ = total carbon emissions from coal, and

$\Sigma_i \, CE^p_i F_i = X^p$ = total carbon emission from petroleum.

Further,

$PCE_i = TCE_i/\Sigma_i TCE_i$

where PCE_i is the share of the i^{th} sector in total carbon emissions.

Thus, in this manner, our exercise of generating carbon emissions, for the Indian economy for any particular year, can be accomplished, successfully completing the production side of the whole story consisting of the production and consumption spheres. We have already, as of the earlier chapters, generated sectoral CO_2 emission from energy consumption (consumption side) and by the method just given, we can now also, generate CO_2 emissions from the production phase, as applying Table (4.1.7) onto the total carbon emission generated, here, will give us the needed CO_2 emissions.

[7.4] So, now we can, effectively round-up our study - generation and analysis of CO_2 emission from energy consumption and its sectoral allocation, for India, over a period spanning from 1970/71 to 1989/90 - undertaken here. For not only have we traversed the full path, starting from why have we chose to work with environment and so why inturn environmental economics, to why CO_2, and generation and analysis of its emissions from energy consumption, to a detailed description of the methodology involved, but, we have also given a theoretical exposition of the other half of the story, by enumerating the alternative methodology and raising some problems involved, in the process, to the same problem taken at hand, which could easily have bene incorporated within the folds of our study, but due to lack of time, its empirical outcome was left undone. Thus, what is now left (and will follow in the forthcoming, concluding chapter) is to analyse our results obtained and use these results to draw some projections for the Indian Economy and thus, finally, attempt to provide some policy implications emerging from our work. In this manner we will complete our case study of India with respect to carbon emissions.

But, before we delve into the concluding chapter, we think that it is appropriate for us to mention here that in the empirical exercise, based on the alternative methodology and conducted in IGIDR, Bombay, India, by Jyoti Parikh and Subir Gokarn, titled 'Climatic change ad India's Energy Policy Options: New Perspectives on Sectoral CO_2 Emissions and Incremental Costs', September 1993, they have shown that for the year 1983/84, for India, the direct emissions of CO_2 are highest in the electricity sector (33%), followed by iron and steel (9.8%), road and air transport, and coal tar. If a similar analysis by final demand is carried out, incorporating both direct and indirect emissions, the highest emitting sector in construction (22%), followed by food crops (8.6%), road and air transport, and so on. This indicates that, in addition to energy efficiency, improving the construction efficiency would also lead to CO_2 savings (by using less energy intensive materials or by making optimal use of them). It is also shown, by generating alternative energy policy scenarios, that if India saves energy from coal rather than from imported oil to reduce CO_2 emissions, then savings foregone are more than Rs. 5634 million for only 10% of energy saving. Sectoral priorities also change. To save coal, the power-sector, iron and steel, coal tar, etc., will require attention. Similar arguments are made for substitution of coal by oil and gas. Infact, additional costs of Rs.10 billion would be incurred for 10% substitution of coal by oil and gas, compared to the current policy of substituting oil and gas with coal. Finally, the working paper also offers another interpretation of the notion of the 'incremental costs' through comparison of alternative development strategies.

Tables to Chapter 7

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (1)

SN	COMMODITY SECTOR	1	2	3	4
1	PADDY	38368.60	35.80	0.00	44.50
2	WHEAT	10.60	23812.40	0.00	7.60
3	OTHER CEREALS	19.60	13.90	1394.40	0.60
4	PULSES	105.50	654.80	0.00	13569.20
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	0.00	0.00
11	OTHER CROPS	227.70	67.20	0.00	639.00
12	ANIMAL HUSBANDRY	26511.00	10313.40	13023.10	6028.70
13	FORESTRY & LOGGING	3.60	0.70	0.00	1.00
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	163.40	356.70	0.00	1.70
16	CRUDE PETROLEUM & N.GAS	0.00	0.00	0.00	0.00
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	0.00	0.00	0.00	0.00
20	SUGAR	0.00	0.00	0.00	0.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	0.20	0.10	0.00	0.00
23	OTH.FOOD & BEVERAGE IND.	0.80	5.00	0.00	9.40
24	COTTON TEXTILES	31.90	1.50	0.00	3.60
25	WOOLLEN TEXTILE	0.00	0.00	0.00	0.00
26	ART SILK & SYNTH.FIBRE	0.00	0.00	0.00	0.00
27	JUTE,HEMP,MESTA TEXTILES	435.20	116.90	0.00	51.90
28	OTHER TEXTILE	19.70	9.90	0.20	1.70
29	WOOD & WOOD PRODUCTS	2.20	0.90	0.00	2.70
30	PAPER & PAPER PRODUCTS	32.90	23.70	1.80	13.30
31	LEATHER & LEATHER PROD.	0.00	0.00	0.00	0.00
32	RUBBER PRODUCTS	5.80	4.30	0.50	0.50
33	PLASTIC PRODUCTS	12.50	4.40	0.00	15.60
34	PETROLEUM PRODUCTS	4815.80	2611.10	1377.10	857.60
35	COAL TAR PRODUCTS	0.00	0.00	0.00	0.00
36	FERTILIZERS	18838.80	12485.60	3740.10	1024.20
37	PESTICIDES	1291.90	424.30	38.80	434.10
38	SYNTH.FIBRE & RESIN	0.00	0.00	0.00	0.00
39	OTHER CHEMICALS	0.20	0.10	0.00	11.20
40	CEMENT	0.00	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	0.00	0.00	0.00	0.60
42	IRON & STEEL	0.00	0.00	0.00	0.00
43	NON FERROUS METALS	0.00	0.00	0.00	0.00
44	TRACTORS & OTH.AGRI.MACH	1688.90	880.90	876.80	584.40
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	189.20	385.60	2.00	11.80
47	ELECTRICAL MACHINERY	9.20	6.80	0.80	0.80
48	COMMUNICATIONS EQUIPMENT	0.00	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	0.00	0.00	0.00	0.00
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	14.40	10.80	1.30	1.20
52	OTH.TRANSPORT EQUIP.	268.60	205.40	271.20	135.80
53	OTH. MANUFACTURING	176.50	57.20	0.60	28.00
54	CONSTRUCTION	8780.70	4696.70	4293.60	2864.10
55	ELECTRICITY ETC.	2916.50	6110.30	313.80	374.10
56	RAIL TRANSPORT SERVICE	1735.50	1310.50	285.20	174.80
57	OTHER TRANSPORT SERVICE	2630.50	1361.30	455.80	371.60
58	COMMUNICATION	142.30	101.90	7.00	21.70
59	TRADE	7822.20	4179.90	1071.10	1151.40
60	OTHER SERVICES	4011.30	1692.40	995.70	608.80
61	TOTAL	121334.20	71942.40	28151.00	29047.30
62	INDIRECT TAX	-12596.70	-9754.70	-1739.50	-586.10
63	GROSS VALUE ADDED	235286.00	120899.00	78390.00	66233.00
64	GROSS OUTPUT	344023.50	183086.70	104801.50	94694.20

SOURCE: 'Input/output flows 1989-90', CSO, N. Delhi (on floppy).

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (2)

SN	COMMODITY SECTOR	5	6	7	8
1	PADDY	0.00	0.00	0.00	0.00
2	WHEAT	0.00	0.00	0.00	0.00
3	OTHER CEREALS	0.00	0.00	0.00	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	3530.90	0.00	0.00	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	1184.20	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	0.00	0.00
11	OTHER CROPS	0.00	0.00	0.00	0.00
12	ANIMAL HUSBANDRY	1727.40	893.20	7801.60	945.70
13	FORESTRY & LOGGING	0.00	0.00	0.00	0.00
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	0.00	0.00	0.00	0.00
16	CRUDE PETROLEUM & N.GAS	0.00	0.00	0.00	0.00
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	0.00	0.00	0.00	0.00
20	SUGAR	0.00	0.00	0.00	0.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	0.00	0.00	0.00	0.00
23	OTH.FOOD & BEVERAGE IND.	0.00	0.00	0.00	0.00
24	COTTON TEXTILES	0.00	0.00	0.00	0.00
25	WOOLLEN TEXTILE	0.00	0.00	0.00	0.00
26	ART SILK & SYNTH.FIBRE	0.00	0.00	0.00	0.00
27	JUTE,HEMP,MESTA TEXTILES	0.00	0.00	0.00	0.00
28	OTHER TEXTILE	0.20	0.00	0.40	0.00
29	WOOD & WOOD PRODUCTS	0.00	0.00	0.00	0.00
30	PAPER & PAPER PRODUCTS	3.00	0.00	4.30	0.00
31	LEATHER & LEATHER PROD.	0.00	0.00	0.00	0.00
32	RUBBER PRODUCTS	0.00	0.00	1.30	0.00
33	PLASTIC PRODUCTS	0.00	0.00	0.00	0.00
34	PETROLEUM PRODUCTS	655.10	0.00	1296.20	0.00
35	COAL TAR PRODUCTS	0.00	0.00	0.00	0.00
36	FERTILIZERS	4664.40	229.50	7211.40	424.40
37	PESTICIDES	51.70	15.20	4627.20	88.60
38	SYNTH.FIBRE & RESIN	0.00	0.00	0.00	0.00
39	OTHER CHEMICALS	0.00	0.00	0.00	0.00
40	CEMENT	0.00	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	0.00	0.00	0.00	0.00
42	IRON & STEEL	0.00	0.00	0.00	0.00
43	NON FERROUS METALS	0.00	0.00	0.00	0.00
44	TRACTORS & OTH.AGRI.MACH	233.80	19.80	528.60	0.00
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	3.40	0.00	4.80	0.00
47	ELECTRICAL MACHINERY	1.40	0.00	2.00	0.00
48	COMMUNICATIONS EQUIPMENT	0.00	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	0.00	0.00	0.00	0.00
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	2.20	0.00	3.20	0.00
52	OTH.TRANSPORT EQUIP.	60.10	5.90	146.20	0.00
53	OTH. MANUFACTURING	0.90	0.00	1.40	0.00
54	CONSTRUCTION	1221.80	93.60	2682.20	0.00
55	ELECTRICITY ETC.	839.50	0.00	1001.50	0.00
56	RAIL TRANSPORT SERVICE	335.90	14.70	504.50	28.70
57	OTHER TRANSPORT SERVICE	398.70	38.80	891.10	104.80
58	COMMUNICATION	11.80	0.00	18.90	0.00
59	TRADE	1826.70	55.90	1977.80	159.90
60	OTHER SERVICES	962.80	111.10	727.70	306.70
61	TOTAL	16531.80	1469.80	30614.60	2058.90
62	INDIRECT TAX	-2558.20	-135.30	-4113.50	-255.00
63	GROSS VALUE ADDED	58894.00	5954.00	36796.00	18211.00
64	GROSS OUTPUT	72867.60	7288.50	63297.00	20014.90

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (3)

SN	COMMODITY SECTOR	9	10	11	12
1	PADDY	0.00	0.00	48.20	2353.90
2	WHEAT	0.00	0.00	326.20	4201.30
3	OTHER CEREALS	0.00	0.00	179.00	5107.90
4	PULSES	0.00	0.00	99.20	9696.00
5	SUGARCANE	0.00	0.00	0.00	657.30
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	0.00	0.00
11	OTHER CROPS	0.00	0.00	19725.00	138920.00
12	ANIMAL HUSBANDRY	300.00	0.00	27115.80	166.30
13	FORESTRY & LOGGING	0.00	0.00	0.30	0.00
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	0.00	0.00	193.20	0.00
16	CRUDE PETROLEUM & N.GAS	0.00	0.00	0.00	0.00
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	0.00	0.00	0.00	0.00
20	SUGAR	0.00	0.00	0.00	0.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	0.00	0.00	0.10	0.00
23	OTH.FOOD & BERERAGE IND.	0.00	0.00	0.30	11819.00
24	COTTON TEXTILES	0.00	0.00	30.50	2071.10
25	WOOLLEN TEXTILE	0.00	0.00	0.00	0.00
26	ART SILK & SYNTH.FIBRE	0.00	0.00	0.00	0.00
27	JUTE,HEMP,MESTA TEXTILES	0.00	0.00	32.60	0.00
28	OTHER TEXTILE	0.00	0.00	20.90	0.00
29	WOOD & WOOD PRODUCTS	0.00	0.00	1.10	0.00
30	PAPER & PAPER PRODUCTS	0.00	0.00	16.60	0.00
31	LEATHER & LEATHER PROD.	0.00	0.00	0.00	0.00
32	RUBBER PRODUCTS	0.00	0.00	3.50	0.00
33	PLASTIC PRODUCTS	0.00	0.00	7.80	0.00
34	PETROLEUM PRODUCTS	0.00	0.00	4082.10	0.00
35	COAL TAR PRODUCTS	0.00	0.00	0.20	0.00
36	FERTILIZERS	0.00	412.00	15310.30	0.00
37	PESTICIDES	100.30	253.50	1793.20	0.00
38	SYNTH.FIBRE & RESIN	0.00	0.00	0.00	0.00
39	OTHER CHEMICALS	0.00	0.00	0.40	1160.60
40	CEMENT	0.00	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	0.00	0.00	0.00	0.00
42	IRON & STEEL	0.00	0.00	0.00	0.00
43	NON FERROUS METALS	0.00	0.00	0.00	0.00
44	TRACTORS & OTH.AGRI.MACH	73.90	0.00	1718.20	0.00
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	0.00	0.00	52.00	0.00
47	ELECTRICAL MACHINERY	0.00	0.00	5.50	0.00
48	COMMUNICATIONS EQUIPMENT	0.00	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	0.00	0.00	0.00	0.00
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	0.00	0.00	0.70	0.00
52	OTH.TRANSPORT EQUIP.	15.60	0.00	567.00	0.00
53	OTH. MANUFACTURING	0.00	0.00	15.20	600.20
54	CONSTRUCTION	327.30	0.00	8569.60	415.60
55	ELECTRICITY ETC.	0.00	0.00	1752.60	0.00
56	RAIL TRANSPORT SERVICE	0.90	25.00	1234.00	599.20
57	OTHER TRANSPORT SERVICE	28.20	34.00	2258.30	3646.70
58	COMMUNICATION	0.00	0.00	54.00	0.00
59	TRADE	44.50	81.20	6377.10	26112.20
60	OTHER SERVICES	28.50	63.40	4649.50	1289.60
61	TOTAL	920.20	870.00	97675.20	209617.10
62	INDIRECT TAX	2.00	-260.00	-7677.40	1732.50
63	GROSS VALUE ADDED	1703.00	3461.00	270378.00	225756.00
64	GROSS OUTPUT	2626.00	4071.00	359775.80	437105.60

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (4)

SN	COMMODITY SECTOR	13	14	15	16
1	PADDY	0.00	0.00	0.00	0.00
2	WHEAT	0.00	0.00	0.00	0.00
3	OTHER CEREALS	0.00	0.00	0.00	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	0.00	0.00
11	OTHER CROPS	0.50	0.00	0.00	0.00
12	ANIMAL HUSBANDRY	0.00	0.00	0.00	0.00
13	FORESTRY & LOGGING	107.70	0.00	0.00	0.00
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	0.00	0.00	690.20	0.00
16	CRUDE PETROLEUM & N.GAS	0.00	0.00	0.00	0.00
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	0.00	0.00	453.40	0.00
20	SUGAR	0.00	0.00	0.00	0.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	0.00	0.00	0.00	0.00
23	OTH.FOOD & BEVERAGE IND.	0.00	30.80	0.00	0.00
24	COTTON TEXTILES	1.10	0.00	0.00	0.00
25	WOOLLEN TEXTILE	0.10	0.00	0.00	0.00
26	ART SILK & SYNTH.FIBRE	0.00	0.00	0.00	0.00
27	JUTE,HEMP,MESTA TEXTILES	2.10	0.00	1.10	0.00
28	OTHER TEXTILE	79.00	894.90	0.00	0.00
29	WOOD & WOOD PRODUCTS	13.20	2.80	54.80	0.00
30	PAPER & PAPER PRODUCTS	173.70	0.00	567.20	0.00
31	LEATHER & LEATHER PROD.	0.00	0.00	0.00	0.00
32	RUBBER PRODUCTS	166.00	0.00	18.30	0.00
33	PLASTIC PRODUCTS	5.20	0.00	0.60	0.00
34	PETROLEUM PRODUCTS	422.50	387.50	1691.30	884.90
35	COAL TAR PRODUCTS	0.00	0.00	0.00	0.00
36	FERTILIZERS	1.80	0.00	0.00	0.00
37	PESTICIDES	1.80	0.00	0.00	0.00
38	SYNTH.FIBRE & RESIN	0.00	0.00	0.00	0.00
39	OTHER CHEMICALS	0.10	10.50	1924.50	23.10
40	CEMENT	0.00	0.00	0.00	229.80
41	OTH.NON MET.MINERAL PROD	0.30	0.00	0.00	280.90
42	IRON & STEEL	10.30	10.50	0.20	0.00
43	NON FERROUS METALS	0.00	2.50	0.00	0.00
44	TRACTORS & OTH.AGRI.MACH	0.00	0.00	0.00	0.00
45	MACHINE TOOLS	3.50	0.00	146.40	0.00
46	OTH.NON ELECTRICAL MACH.	14.80	0.00	6352.40	1076.00
47	ELECTRICAL MACHINERY	35.40	0.00	0.00	0.00
48	COMMUNICATIONS EQUIPMENT	0.20	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	1.70	0.00	0.00	0.00
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	265.00	0.00	600.30	0.00
52	OTH.TRANSPORT EQUIP.	10.90	293.70	0.00	0.00
53	OTH. MANUFACTURING	249.50	0.60	1913.30	0.00
54	CONSTRUCTION	201.70	0.00	425.90	1839.40
55	ELECTRICITY ETC.	33.40	0.00	6067.30	185.40
56	RAIL TRANSPORT SERVICE	206.20	13.60	1836.80	67.50
57	OTHER TRANSPORT SERVICE	2588.70	58.70	870.80	80.40
58	COMMUNICATION	137.50	0.00	111.30	0.00
59	TRADE	135.30	99.20	1433.90	227.70
60	OTHER SERVICES	1214.50	74.00	3148.50	2476.60
61	TOTAL	6121.80	1879.40	28417.40	7371.60
62	INDIRECT TAX	383.20	322.60	2551.50	606.30
63	GROSS VALUE ADDED	74260.00	36350.00	32554.00	37194.00
64	GROSS OUTPUT	80765.00	38552.00	63524.90	45171.90

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (5)

SN	COMMODITY SECTOR	17	18	19	20
1	PADDY	0.00	0.00	0.00	0.00
2	WHEAT	0.00	0.00	0.00	0.00
3	OTHER CEREALS	0.00	0.00	0.00	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	0.00	0.00	0.00	24501.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	0.00	0.00
11	OTHER CROPS	0.00	0.00	0.00	12.40
12	ANIMAL HUSBANDRY	0.00	0.00	0.00	0.00
13	FORESTRY & LOGGING	0.00	0.00	0.00	310.80
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	2.00	4.20	1.30	145.60
16	CRUDE PETROLEUM & N.GAS	0.00	0.00	0.00	2.10
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	0.00	0.00	0.00	635.10
20	SUGAR	0.00	0.00	0.00	80.60
21	KHANDSARI BOORA	0.00	0.00	0.00	97.20
22	HYDROGENATED OIL	0.00	0.00	0.00	0.00
23	OTH.FOOD & BEVERAGE IND.	0.00	0.00	0.00	3.30
24	COTTON TEXTILES	0.00	0.00	0.00	15.60
25	WOOLLEN TEXTILE	0.00	0.00	0.00	0.00
26	ART SILK & SYNTH.FIBRE	0.00	0.00	0.00	0.00
27	JUTE,HEMP,MESTA TEXTILES	0.00	0.00	4.60	2060.90
28	OTHER TEXTILE	0.00	1.00	0.00	30.20
29	WOOD & WOOD PRODUCTS	0.40	46.40	4.90	5.10
30	PAPER & PAPER PRODUCTS	3.20	4.50	9.10	57.00
31	LEATHER & LEATHER PROD.	0.00	0.00	0.00	0.00
32	RUBBER PRODUCTS	0.50	1.80	0.40	0.00
33	PLASTIC PRODUCTS	0.00	0.00	2.40	23.80
34	PETROLEUM PRODUCTS	334.60	107.10	382.70	537.30
35	COAL TAR PRODUCTS	12.00	3.00	27.80	160.70
36	FERTILIZERS	0.00	0.00	0.00	0.00
37	PESTICIDES	0.00	0.00	0.00	0.00
38	SYNTH.FIBRE & RESIN	0.00	0.00	0.00	0.10
39	OTHER CHEMICALS	106.70	107.40	156.00	344.90
40	CEMENT	0.00	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	0.00	0.00	0.00	146.80
42	IRON & STEEL	0.00	0.00	1.00	0.00
43	NON FERROUS METALS	0.00	0.00	0.00	0.00
44	TRACTORS & OTH.AGRI.MACH	0.00	0.00	0.00	0.00
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	51.20	184.60	173.90	230.20
47	ELECTRICAL MACHINERY	0.20	0.70	0.10	0.00
48	COMMUNICATIONS EQUIPMENT	0.00	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	0.00	0.00	0.00	0.00
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	1.30	4.50	0.90	0.00
52	OTH.TRANSPORT EQUIP.	0.00	0.00	0.00	0.00
53	OTH. MANUFACTURING	0.40	90.50	210.10	702.50
54	CONSTRUCTION	30.10	28.90	0.70	731.60
55	ELECTRICITY ETC.	369.20	640.20	209.70	311.60
56	RAIL TRANSPORT SERVICE	10.90	26.20	16.30	274.20
57	OTHER TRANSPORT SERVICE	27.20	140.40	142.90	2740.30
58	COMMUNICATION	30.00	0.00	2.20	125.60
59	TRADE	53.80	70.40	103.10	7404.20
60	OTHER SERVICES	155.30	197.90	131.90	6514.20
61	TOTAL	1225.10	1760.60	1682.00	40280.80
62	INDIRECT TAX	140.90	152.30	190.00	740.60
63	GROSS VALUE ADDED	2916.00	4477.00	9406.00	9675.00
64	GROSS OUTPUT	4282.00	6390.00	11186.10	50704.50

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (6)

SN	COMMODITY SECTOR	21	22	23	24
1	PADDY	0.20	0.00	1462.30	13.00
2	WHEAT	0.00	0.00	3850.60	23.90
3	OTHER CEREALS	0.00	0.00	887.00	0.40
4	PULSES	0.00	743.40	792.70	15.60
5	SUGARCANE	7682.20	0.00	7.60	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	368.60	60614.30
8	TEA	0.00	0.00	20015.00	0.00
9	COFFEE	0.00	0.00	597.00	0.00
10	RUBBER	0.00	0.00	0.00	0.00
11	OTHER CROPS	3.50	272.80	65033.30	37.90
12	ANIMAL HUSBANDRY	0.00	0.00	17723.80	0.50
13	FORESTRY & LOGGING	208.50	15.80	340.00	163.90
14	FISHING	0.00	0.00	2268.60	0.00
15	COAL & LIGNITE	219.20	232.20	1152.80	2296.80
16	CRUDE PETROLEUM & N.GAS	0.00	0.00	33.90	0.00
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	340.00	0.00	18.30	19.70
20	SUGAR	746.40	0.00	1485.50	0.00
21	KHANDSARI BOORA	1760.00	0.00	20233.00	0.00
22	HYDROGENATED OIL	0.20	0.00	625.70	0.20
23	OTH.FOOD & BEVERAGE IND.	28.00	7214.20	13148.50	425.00
24	COTTON TEXTILES	18.10	333.80	198.70	37844.30
25	WOOLLEN TEXTILE	0.00	0.00	2.20	63.90
26	ART SILK & SYNTH.FIBRE	0.00	0.00	0.60	2361.10
27	JUTE,HEMP,MESTA TEXTILES	373.20	31.10	726.40	3349.00
28	OTHER TEXTILE	0.10	0.00	51.40	796.20
29	WOOD & WOOD PRODUCTS	6.70	4.40	495.90	140.40
30	PAPER & PAPER PRODUCTS	26.40	60.60	2576.80	1092.00
31	LEATHER & LEATHER PROD.	0.00	0.00	0.70	74.00
32	RUBBER PRODUCTS	0.00	0.00	0.00	0.10
33	PLASTIC PRODUCTS	42.00	102.10	805.00	321.30
34	PETROLEUM PRODUCTS	1207.80	93.90	1796.40	3618.30
35	COAL TAR PRODUCTS	2.60	3.30	36.40	207.90
36	FERTILIZERS	0.00	0.00	0.00	0.00
37	PESTICIDES	0.00	0.00	0.00	0.00
38	SYNTH.FIBRE & RESIN	0.00	0.30	4.80	1278.60
39	OTHER CHEMICALS	157.20	3437.70	1562.90	5751.80
40	CEMENT	0.00	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	54.80	2.50	612.30	0.80
42	IRON & STEEL	0.00	190.10	79.90	184.60
43	NON FERROUS METALS	0.00	0.00	122.80	9.50
44	TRACTORS & OTH.AGRI.MACH	0.00	0.00	0.00	0.00
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	127.10	24.30	749.30	1750.30
47	ELECTRICAL MACHINERY	0.00	0.00	0.00	0.00
48	COMMUNICATIONS EQUIPMENT	0.00	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	0.00	0.00	0.00	0.00
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	0.00	0.00	0.00	0.00
52	OTH.TRANSPORT EQUIP.	0.00	0.00	0.00	0.00
53	OTH. MANUFACTURING	169.80	1296.30	4453.00	2168.00
54	CONSTRUCTION	82.60	30.10	1304.00	762.70
55	ELECTRICITY ETC.	686.90	465.40	2292.90	10862.10
56	RAIL TRANSPORT SERVICE	181.70	153.00	779.90	874.90
57	OTHER TRANSPORT SERVICE	488.50	455.10	5949.40	8394.40
58	COMMUNICATION	39.80	56.30	332.90	464.10
59	TRADE	2722.30	2119.90	17516.30	21491.70
60	OTHER SERVICES	1540.10	512.00	8209.80	14500.50
61	TOTAL	18809.20	17840.80	200742.30	181972.60
62	INDIRECT TAX	797.20	3154.80	9350.60	5824.10
63	GROSS VALUE ADDED	7385.00	1692.00	43617.00	75061.00
64	Gross output	26991.40	22687.60	253709.80	262857.70

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (7)

SN	COMMODITY SECTOR	25	26	27	28
1	PADDY	7.80	0.00	0.00	73.40
2	WHEAT	0.40	1.80	0.00	2.50
3	OTHER CEREALS	0.00	0.00	0.00	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	80.40	306.70	5947.50	247.70
7	COTTON	0.00	0.00	0.00	67.50
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	0.00	42.90
11	OTHER CROPS	0.00	5.50	133.60	49.90
12	ANIMAL HUSBANDRY	1534.80	4448.30	0.00	188.90
13	FORESTRY & LOGGING	19.10	64.40	2.80	16.70
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	171.20	636.10	221.70	556.10
16	CRUDE PETROLEUM & N.GAS	2.10	0.00	0.00	0.30
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	0.00	0.00	0.00	9.30
20	SUGAR	0.00	0.00	0.00	0.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	0.00	0.00	0.00	0.00
23	OTH.FOOD & BEVERAGE IND.	1.40	35.20	44.90	3.00
24	COTTON TEXTILES	66.30	7213.80	34.00	17371.00
25	WOOLLEN TEXTILE	3681.60	20.00	0.00	2103.80
26	ART SILK & SYNTH.FIBRE	687.00	47706.00	45.40	6103.40
27	JUTE,HEMP,MESTA-TEXTILES	369.00	1637.50	6780.80	1906.60
28	OTHER TEXTILE	45.30	1857.80	1082.60	22528.40
29	WOOD & WOOD PRODUCTS	19.30	191.60	1.50	1062.40
30	PAPER & PAPER PRODUCTS	25.10	1696.00	91.90	859.30
31	LEATHER & LEATHER PROD.	0.00	0.00	0.00	7.10
32	RUBBER PRODUCTS	0.00	0.10	0.00	68.70
33	PLASTIC PRODUCTS	26.60	332.70	62.00	1118.40
34	PETROLEUM PRODUCTS	201.10	1918.40	608.20	983.80
35	COAL TAR PRODUCTS	5.00	401.20	8.50	1.50
36	FERTILIZERS	0.00	0.00	0.00	0.00
37	PESTICIDES	0.00	0.00	0.00	0.00
38	SYNTH.FIBRE & RESIN	300.90	12815.50	64.00	647.30
39	OTHER CHEMICALS	446.80	3461.90	467.10	471.10
40	CEMENT	0.00	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	0.00	0.00	0.00	5.00
42	IRON & STEEL	2.70	11.60	153.90	40.40
43	NON FERROUS METALS	14.50	151.40	0.00	715.70
44	TRACTORS & OTH.AGRI.MACH	0.00	0.00	0.00	0.00
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	65.50	449.40	102.20	642.30
47	ELECTRICAL MACHINERY	0.00	0.00	0.00	0.00
48	COMMUNICATIONS EQUIPMENT	0.00	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	0.00	0.00	0.00	0.40
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	0.00	0.00	0.00	0.00
52	OTH.TRANSPORT EQUIP.	0.00	0.00	0.00	0.00
53	OTH. MANUFACTURING	284.40	1502.80	367.10	1377.10
54	CONSTRUCTION	56.60	353.50	108.60	1181.20
55	ELECTRICITY ETC.	427.70	14821.90	1324.10	2437.70
56	RAIL TRANSPORT SERVICE	62.00	314.80	165.10	257.50
57	OTHER TRANSPORT SERVICE	733.40	5203.50	1797.90	3897.90
58	COMMUNICATION	65.90	325.40	75.30	325.70
59	TRADE	1312.70	8810.70	2953.80	7670.40
60	OTHER SERVICES	2544.60	10203.30	1649.50	10478.90
61	TOTAL	13101.40	126899.20	23294.00	85611.30
62	INDIRECT TAX	586.70	12149.60	1009.40	4475.70
63	GROSS VALUE ADDED	5475.00	29774.00	7961.00	98509.00
64	GROSS OUTPUT	19163.10	168822.80	32264.40	188596.00

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (8)

SN	COMMODITY SECTOR	29	30	31	32
1	PADDY	0.00	0.00	0.00	0.00
2	WHEAT	0.00	4.60	0.00	0.00
3	OTHER CEREALS	0.00	0.00	0.00	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	1.70	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	364.10	4270.00
11	OTHER CROPS	13.00	142.90	3.80	0.00
12	ANIMAL HUSBANDRY	0.00	1.40	4575.40	0.00
13	FORESTRY & LOGGING	16422.70	1982.00	647.90	21.20
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	39.20	1779.20	72.00	107.50
16	CRUDE PETROLEUM & N.GAS	0.20	2.20	0.00	0.00
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	2.20	687.20	0.00	193.70
20	SUGAR	0.00	0.00	0.00	0.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	0.00	0.00	0.00	0.00
23	OTH.FOOD & BEVERAGE IND.	2.30	135.40	202.50	0.00
24	COTTON TEXTILES	15.50	144.90	75.00	240.50
25	WOOLLEN TEXTILE	0.10	1.70	8.00	0.30
26	ART SILK & SYNTH.FIBRE	2.80	22.10	65.80	1611.80
27	JUTE,HEMP,MESTA TEXTILES	0.20	389.00	127.00	85.40
28	OTHER TEXTILE	44.20	325.50	768.20	623.20
29	WOOD & WOOD PRODUCTS	1231.70	46.00	102.20	27.40
30	PAPER & PAPER PRODUCTS	26.40	30760.10	265.50	197.30
31	LEATHER & LEATHER PROD.	6.60	11.10	6826.30	19.30
32	RUBBER PRODUCTS	10.10	19.50	2020.60	5010.70
33	PLASTIC PRODUCTS	64.80	191.80	94.30	83.80
34	PETROLEUM PRODUCTS	86.40	925.10	173.40	509.00
35	COAL TAR PRODUCTS	13.20	10.20	0.70	6.00
36	FERTILIZERS	0.00	0.00	0.00	9.00
37	PESTICIDES	0.00	0.00	0.00	0.00
38	SYNTH.FIBRE & RESIN	29.60	71.40	50.60	548.30
39	OTHER CHEMICALS	88.80	3361.20	1576.80	6460.90
40	CEMENT	0.00	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	6.10	45.10	30.70	72.40
42	IRON & STEEL	35.00	75.20	2.30	180.30
43	NON FERROUS METALS	5.00	1391.00	13.10	62.80
44	TRACTORS & OTH.AGRI.MACH	0.00	0.00	0.00	0.00
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	61.20	463.50	74.70	58.20
47	ELECTRICAL MACHINERY	0.00	0.00	0.00	0.00
48	COMMUNICATIONS EQUIPMENT	0.00	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	0.00	0.00	0.00	0.00
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	0.00	0.00	0.00	0.00
52	OTH.TRANSPORT EQUIP.	0.00	0.00	0.00	0.00
53	OTH. MANUFACTURING	183.30	1213.40	351.00	808.30
54	CONSTRUCTION	131.00	278.50	206.60	275.70
55	ELECTRICITY ETC.	254.10	3663.20	346.30	441.90
56	RAIL TRANSPORT SERVICE	135.00	759.80	60.50	84.90
57	OTHER TRANSPORT SERVICE	844.00	1761.20	1424.10	1089.70
58	COMMUNICATION	35.10	436.60	107.10	194.00
59	TRADE	2237.50	4069.10	4100.30	4193.70
60	OTHER SERVICES	700.70	5816.20	2189.00	1730.40
61	TOTAL	22730.90	60987.30	26926.00	29217.60
62	INDIRECT TAX	895.60	4199.30	1458.80	4670.70
63	GROSS VALUE ADDED	7734.00	22304.00	10140.00	12176.00
64	GROSS OUTPUT	31360.60	87490.60	38524.80	46064.30

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (9)

SN	COMMODITY SECTOR	33	34	35	36
1	PADDY	0.00	0.00	0.00	0.00
2	WHEAT	0.00	0.00	0.00	0.00
3	OTHER CEREALS	0.00	0.00	0.00	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	4.20	0.00	0.00	0.00
11	OTHER CROPS	0.00	0.00	0.00	0.00
12	ANIMAL HUSBANDRY	0.00	0.00	0.00	0.00
13	FORESTRY & LOGGING	2.60	86.10	35.90	25.50
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	11.50	3.20	9903.30	1554.10
16	CRUDE PETROLEUM & N.GAS	0.00	84419.70	0.00	848.20
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	0.00	0.30	58.10	4057.10
20	SUGAR	0.00	0.00	0.00	0.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	0.00	16.30	0.00	0.00
23	OTH.FOOD & BERERAGE IND.	0.20	0.00	0.00	13.00
24	COTTON TEXTILES	73.20	53.50	3.30	11.50
25	WOOLLEN TEXTILE	0.00	0.40	0.00	0.00
26	ART SILK & SYNTH.FIBRE	51.80	0.30	0.00	0.00
27	JUTE,HEMP,MESTA TEXTILES	22.70	94.40	38.30	1969.30
28	OTHER TEXTILE	59.80	2.20	0.10	0.00
29	WOOD & WOOD PRODUCTS	24.60	40.40	2.80	8.80
30	PAPER & PAPER PRODUCTS	148.40	179.10	24.60	81.60
31	LEATHER & LEATHER PROD.	1.00	0.00	0.00	0.00
32	RUBBER PRODUCTS	40.70	0.00	0.00	0.00
33	PLASTIC PRODUCTS	1016.00	231.00	14.40	269.00
34	PETROLEUM PRODUCTS	227.20	17169.00	474.80	8574.70
35	COAL TAR PRODUCTS	0.60	0.30	2333.70	40.20
36	FERTILIZERS	0.00	0.00	0.00	6870.50
37	PESTICIDES	0.00	0.00	0.00	2.60
38	SYNTH.FIBRE & RESIN	2402.00	1.70	0.00	0.40
39	OTHER CHEMICALS	706.40	3106.70	526.80	8276.80
40	CEMENT	0.00	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	61.80	0.00	5.20	1.00
42	IRON & STEEL	51.30	0.00	5.00	0.00
43	NON FERROUS METALS	138.10	4.70	0.00	27.40
44	TRACTORS & OTH.AGRI.MACH	0.00	0.00	0.00	0.00
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	37.40	55.40	36.60	220.20
47	ELECTRICAL MACHINERY	0.00	0.00	0.00	0.00
48	COMMUNICATIONS EQUIPMENT	0.00	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	0.00	0.00	0.00	0.00
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	0.00	0.00	0.00	0.00
52	OTH.TRANSPORT EQUIP.	0.00	0.00	0.00	0.00
53	OTH. MANUFACTURING	262.10	1604.10	276.50	570.00
54	CONSTRUCTION	106.60	277.50	127.10	268.60
55	ELECTRICITY ETC.	660.00	847.20	1044.50	5601.10
56	RAIL TRANSPORT SERVICE	20.00	562.90	2600.60	1128.40
57	OTHER TRANSPORT SERVICE	728.80	1982.40	1433.90	1816.70
58	COMMUNICATION	100.30	88.00	18.30	117.00
59	TRADE	1013.40	7709.30	2969.80	5339.80
60	OTHER SERVICES	1158.70	3430.80	1178.00	3666.80
61	TOTAL	9160.40	122177.80	23121.60	51476.20
62	INDIRECT TAX	4469.30	45143.20	560.20	783.00
63	GROSS VALUE ADDED	4598.00	9336.00	1089.00	11484.00
64	GROSS OUTPUT	18227.70	176657.00	24770.70	63733.10

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (10)

SN	COMMODITY SECTOR	37	38	39	40
1	PADDY	0.00	0.00	2272.10	0.00
2	WHEAT	0.00	0.00	44.40	0.00
3	OTHER CEREALS	0.00	0.00	3.30	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	22.60	0.00	0.00
11	OTHER CROPS	0.00	0.00	3778.20	0.00
12	ANIMAL HUSBANDRY	0.00	0.00	110.00	0.00
13	FORESTRY & LOGGING	1.00	353.40	1148.90	2.50
14	FISHING	0.00	0.00	0.20	0.00
15	COAL & LIGNITE	1.40	430.80	646.70	1856.60
16	CRUDE PETROLEUM & N.GAS	0.00	1.50	22.40	0.00
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	15.00	0.00
19	NON MET.& MINOR MINERALS	141.00	268.70	2172.40	3039.20
20	SUGAR	0.00	17.60	216.70	0.00
21	KHANDSARI BOORA	0.00	0.00	40.90	0.00
22	HYDROGENATED OIL	0.00	0.00	124.10	0.00
23	OTH.FOOD & BEREAGE IND.	0.00	260.30	2874.70	0.00
24	COTTON TEXTILES	0.20	22.10	2775.50	0.70
25	WOOLLEN TEXTILE	0.00	0.00	0.00	0.00
26	ART SILK & SYNTH.FIBRE	0.00	0.00	31.10	0.00
27	JUTE,HEMP,MESTA TEXTILES	87.70	91.30	843.80	2304.40
28	OTHER TEXTILE	0.20	7.70	87.80	0.00
29	WOOD & WOOD PRODUCTS	17.80	30.30	573.60	2.90
30	PAPER & PAPER PRODUCTS	90.40	2030.80	4545.50	2.40
31	LEATHER & LEATHER PROD.	0.00	0.00	2.40	0.00
32	RUBBER PRODUCTS	0.00	2.30	94.90	0.00
33	PLASTIC PRODUCTS	82.40	173.90	1440.20	7.70
34	PETROLEUM PRODUCTS	104.70	1520.60	6110.90	317.00
35	COAL TAR PRODUCTS	0.00	0.90	1438.60	28.30
36	FERTILIZERS	0.00	0.00	0.00	0.00
37	PESTICIDES	1082.00	0.00	0.20	0.00
38	SYNTH.FIBRE & RESIN	0.00	1707.30	236.10	0.00
39	OTHER CHEMICALS	1556.60	5629.60	42608.20	9.00
40	CEMENT	0.00	0.00	32.30	4.60
41	OTH.NON MET.MINERAL PROD	42.20	0.10	1167.90	106.20
42	IRON & STEEL	0.60	6.80	144.30	357.20
43	NON FERROUS METALS	34.50	28.80	2354.60	23.70
44	TRACTORS & OTH.AGRI.MACH	0.00	0.00	0.00	0.00
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	21.80	107.80	661.00	180.60
47	ELECTRICAL MACHINERY	0.00	0.00	0.00	0.00
48	COMMUNICATIONS EQUIPMENT	0.00	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	0.00	0.00	0.00	0.00
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	0.00	0.00	0.00	0.00
52	OTH.TRANSPORT EQUIP.	0.00	0.00	0.00	0.00
53	OTH. MANUFACTURING	1247.80	664.00	6030.30	484.80
54	CONSTRUCTION	41.80	118.30	720.50	172.60
55	ELECTRICITY ETC.	192.80	1685.20	7076.40	2061.20
56	RAIL TRANSPORT SERVICE	21.70	202.40	819.10	776.60
57	OTHER TRANSPORT SERVICE	253.20	853.90	5368.10	406.50
58	COMMUNICATION	47.00	124.00	814.90	40.50
59	TRADE	507.90	1609.80	12367.40	1678.00
60	OTHER SERVICES	1103.40	1284.60	9734.70	1303.50
61	TOTAL	6789.20	19966.70	121639.50	15257.40
62	INDIRECT TAX	603.80	4578.70	17706.80	1028.50
63	GROSS VALUE ADDED	2852.00	7382.00	46668.00	10086.00
64	GROSS OUTPUT	10245.00	31927.30	185904.30	26371.90

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (II)

SN	COMMODITY SECTOR	41	42	43	44
1	PADDY	54.40	0.00	0.00	0.00
2	WHEAT	20.50	0.00	0.00	0.00
3	OTHER CEREALS	0.10	0.00	0.00	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	7.20	0.00	0.00	0.00
11	OTHER CROPS	11.80	0.00	0.00	0.00
12	ANIMAL HUSBANDRY	10.70	0.00	0.00	0.00
13	FORESTRY & LOGGING	714.50	277.00	24.20	12.50
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	4280.40	6590.80	190.20	104.70
16	CRUDE PETROLEUM & N.GAS	45.20	30.10	12.40	0.00
17	IRON ORE	0.10	1448.80	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	424.50	4758.40	0.00
19	NON MET.& MINOR MINERALS	8112.70	3265.80	94.00	0.00
20	SUGAR	19.90	0.00	0.00	0.00
21	KHANDSARI BOORA	0.10	0.00	0.00	0.00
22	HYDROGENATED OIL	0.00	0.00	0.00	0.00
23	OTH.FOOD & BEVERAGE IND.	2.10	0.00	0.00	0.00
24	COTTON TEXTILES	75.10	6.10	2.20	2.60
25	WOOLLEN TEXTILE	0.00	0.00	0.00	0.00
26	ART SILK & SYNTH.FIBRE	0.50	0.00	0.20	0.00
27	JUTE,HEMP,MESTA TEXTILES	264.50	147.00	33.40	3.00
28	OTHER TEXTILE	20.80	0.40	0.00	0.00
29	WOOD & WOOD PRODUCTS	157.00	26.00	18.10	19.00
30	PAPER & PAPER PRODUCTS	527.80	20.80	14.70	15.20
31	LEATHER & LEATHER PROD.	0.30	0.00	0.30	2.40
32	RUBBER PRODUCTS	54.80	0.10	0.80	519.50
33	PLASTIC PRODUCTS	162.20	27.00	23.50	11.30
34	PETROLEUM PRODUCTS	5100.40	4240.10	2036.60	228.80
35	COAL TAR PRODUCTS	338.70	5940.80	50.40	66.80
36	FERTILIZERS	0.00	0.00	0.00	0.00
37	PESTICIDES	0.00	0.00	0.00	0.00
38	SYNTH.FIBRE & RESIN	61.60	0.00	0.20	1.40
39	OTHER CHEMICALS	1442.30	1151.60	930.50	429.00
40	CEMENT	3338.70	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	2314.60	471.20	3.60	0.20
42	IRON & STEEL	1591.80	41285.00	979.20	3959.80
43	NON FERROUS METALS	502.50	6821.80	6406.00	246.30
44	TRACTORS & OTH.AGRI.MACH	0.00	0.00	0.00	4399.20
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	313.00	593.10	41.90	554.80
47	ELECTRICAL MACHINERY	44.50	112.00	204.80	69.80
48	COMMUNICATIONS EQUIPMENT	0.00	0.00	0.00	0.00
49	ELECTRONIC EQUIPMENT	0.00	0.00	0.00	58.40
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	0.00	0.00	0.00	270.40
52	OTH.TRANSPORT EQUIP.	0.00	0.00	0.00	33.20
53	OTH. MANUFACTURING	1162.00	15281.00	631.00	307.00
54	CONSTRUCTION	792.40	1966.10	178.10	103.40
55	ELECTRICITY ETC.	2215.60	8582.10	4686.90	279.30
56	RAIL TRANSPORT SERVICE	2199.10	4274.00	292.00	166.90
57	OTHER TRANSPORT SERVICE	3716.60	3933.40	915.80	430.00
58	COMMUNICATION	310.10	410.30	88.30	63.40
59	TRADE	6645.10	10888.40	1641.60	1010.00
60	OTHER SERVICES	3334.90	7345.20	2082.80	1214.00
61	TOTAL	60044.50	125479.00	26422.00	14582.50
62	INDIRECT TAX	6119.10	15486.30	3785.40	1110.20
63	GROSS VALUE ADDED	27996.00	46961.00	5732.00	6737.00
64	GROSS OUTPUT	84159.60	187926.30	35930.40	22429.80

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (12)

SN	COMMODITY SECTOR	45	46	47	48
1	PADDY	0.00	0.00	0.00	0.00
2	WHEAT	0.00	0.00	0.00	0.00
3	OTHER CEREALS	0.00	0.00	0.00	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	0.00	0.00
11	OTHER CROPS	0.00	0.00	0.00	0.00
12	ANIMAL HUSBANDRY	0.00	0.00	0.10	0.00
13	FORESTRY & LOGGING	29.60	485.20	22.80	14.70
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	8.40	106.40	75.60	2.00
16	CRUDE PETROLEUM & N.GAS	0.00	3.80	5.60	3.10
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.20	0.00	0.00
19	NON MET.& MINOR MINERALS	0.00	6.70	0.00	0.00
20	SUGAR	0.00	0.00	0.00	0.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	0.00	0.00	0.00	0.00
23	OTH.FOOD & BERERAGE IND.	0.00	0.00	0.00	0.00
24	COTTON TEXTILES	1.60	40.60	44.10	5.60
25	WOOLLEN TEXTILE	0.00	0.00	0.00	0.00
26	ART SILK & SYNTH.FIBRE	0.00	11.10	1.10	0.00
27	JUTE,HEMP,MESTA TEXTILES	4.50	66.70	69.80	6.50
28	OTHER TEXTILE	0.00	2.30	9.80	0.10
29	WOOD & WOOD PRODUCTS	19.40	237.90	379.30	82.00
30	PAPER & PAPER PRODUCTS	20.10	206.00	1061.80	214.20
31	LEATHER & LEATHER PROD.	2.60	4.80	0.20	0.00
32	RUBBER PRODUCTS	1.20	225.90	200.80	5.40
33	PLASTIC PRODUCTS	9.00	80.60	194.90	115.80
34	PETROLEUM PRODUCTS	85.00	846.20	1054.00	88.30
35	COAL TAR PRODUCTS	27.50	265.00	36.60	22.00
36	FERTILIZERS	0.00	0.00	0.00	0.00
37	PESTICIDES	0.00	0.00	0.00	0.00
38	SYNTH.FIBRE & RESIN	0.40	30.30	928.60	60.40
39	OTHER CHEMICALS	46.60	609.40	1991.30	135.00
40	CEMENT	0.00	0.00	2.30	0.00
41	OTH.NON MET.MINERAL PROD	4.30	25.70	281.70	54.80
42	IRON & STEEL	2318.50	19682.10	9783.40	671.70
43	NON FERROUS METALS	304.10	3307.60	13495.20	491.60
44	TRACTORS & OTH.AGRI.MACH	0.00	200.70	5.60	0.00
45	MACHINE TOOLS	150.30	6.60	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	179.40	14718.10	358.40	1.80
47	ELECTRICAL MACHINERY	369.00	2333.30	13524.70	3896.50
48	COMMUNICATIONS EQUIPMENT	0.00	63.80	323.00	3619.40
49	ELECTRONIC EQUIPMENT	0.30	41.20	420.90	170.80
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	0.00	170.20	42.70	0.00
52	OTH.TRANSPORT EQUIP.	0.00	0.80	0.20	0.00
53	OTH. MANUFACTURING	708.90	4052.70	5097.60	877.00
54	CONSTRUCTION	85.90	791.50	579.60	187.20
55	ELECTRICITY ETC.	251.30	1695.80	1436.20	254.50
56	RAIL TRANSPORT SERVICE	81.10	813.20	552.00	41.80
57	OTHER TRANSPORT SERVICE	187.40	1824.20	1857.40	359.80
58	COMMUNICATION	79.70	750.50	485.50	149.50
59	TRADE	356.50	4161.30	4293.90	860.60
60	OTHER SERVICES	886.10	11562.80	6301.50	1523.30
61	TOTAL	6158.10	69430.30	64927.40	13924.70
62	INDIRECT TAX	854.80	8672.50	14963.10	2579.20
63	GROSS VALUE ADDED	5336.00	30850.00	40444.00	10362.00
64	GROSS OUTPUT	12349.90	108952.80	120334.60	26865.90

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (13)

SN	COMMODITY SECTOR	49	50	51	52
1	PADDY	0.00	0.00	0.00	0.00
2	WHEAT	0.00	0.00	0.00	0.00
3	OTHER CEREALS	0.00	0.00	0.00	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	0.00	0.00
11	OTHER CROPS	0.00	0.00	0.00	0.00
12	ANIMAL HUSBANDRY	0.00	0.00	0.00	0.00
13	FORESTRY & LOGGING	0.10	200.10	81.00	79.80
14	FISHING	0.00	0.00	0.00	0.00
15	COAL & LIGNITE	1.30	50.60	5.20	89.90
16	CRUDE PETROLEUM & N.GAS	0.10	1.30	0.00	0.10
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	7.90	0.00	0.00	0.00
20	SUGAR	0.00	0.00	0.00	0.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	0.00	0.00	0.00	0.00
23	OTH.FOOD & BERERAGE IND.	0.00	0.00	9.60	0.00
24	COTTON TEXTILES	2.30	1.40	11.10	4.60
25	WOOLLEN TEXTILE	0.00	0.00	1.20	0.00
26	ART SILK & SYNTH.FIBRE	0.00	0.00	0.00	1.20
27	JUTE,HEMP,MESTA TEXTILES	3.60	18.90	20.90	13.70
28	OTHER TEXTILE	0.00	0.00	68.20	35.00
29	WOOD & WOOD PRODUCTS	5.60	10.10	56.70	55.00
30	PAPER & PAPER PRODUCTS	53.60	4.10	621.60	64.50
31	LEATHER & LEATHER PROD.	0.70	0.00	18.30	15.80
32	RUBBER PRODUCTS	0.30	52.90	3140.50	1133.60
33	PLASTIC PRODUCTS	14.00	8.50	170.70	65.80
34	PETROLEUM PRODUCTS	24.20	289.60	976.90	423.80
35	COAL TAR PRODUCTS	0.30	121.00	0.00	10.70
36	FERTILIZERS	0.00	0.00	0.00	0.00
37	PESTICIDES	0.00	0.00	0.00	0.00
38	SYNTH.FIBRE & RESIN	6.60	0.10	57.20	8.40
39	OTHER CHEMICALS	41.00	629.30	545.40	628.30
40	CEMENT	0.00	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	15.00	0.00	183.90	8.60
42	IRON & STEEL	72.60	2068.10	14872.90	3298.80
43	NON FERROUS METALS	105.20	939.60	2382.90	442.00
44	TRACTORS & OTH.AGRI.MACH	0.00	36.60	0.00	13.20
45	MACHINE TOOLS	0.00	0.00	66.20	80.40
46	OTH.NON ELECTRICAL MACH.	0.10	134.10	1583.70	208.90
47	ELECTRICAL MACHINERY	2950.50	643.50	1031.30	258.20
48	COMMUNICATIONS EQUIPMENT	2319.60	19.20	0.00	7.30
49	ELECTRONIC EQUIPMENT	403.50	159.90	0.00	0.00
50	RAIL EQUIPMENT	0.00	4038.80	0.00	1.80
51	MOTOR VEHICLES	0.00	18.00	7632.40	299.70
52	OTH.TRANSPORT EQUIP.	0.00	0.00	62.80	7856.70
53	OTH. MANUFACTURING	369.80	611.50	3454.40	744.20
54	CONSTRUCTION	35.80	58.50	760.80	127.40
55	ELECTRICITY ETC.	67.10	410.80	1334.30	496.30
56	RAIL TRANSPORT SERVICE	13.80	104.30	477.20	192.70
57	OTHER TRANSPORT SERVICE	101.30	238.20	1367.70	427.90
58	COMMUNICATION	68.50	27.80	319.70	122.70
59	TRADE	310.90	580.50	3494.90	1237.60
60	OTHER SERVICES	625.20	493.40	4759.00	2881.00
61	TOTAL	7619.50	11870.70	49569.80	21317.90
62	INDIRECT TAX	1080.70	1463.20	9209.20	3575.80
63	GROSS VALUE ADDED	7596.00	10233.00	20519.00	24464.00
64	GROSS OUTPUT	16296.20	23566.90	79298.10	49357.70

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (14)

SN	COMMODITY SECTOR	53	54	55	56
1	PADDY	1.70	0.00	0.00	0.00
2	WHEAT	1.40	0.00	0.00	0.00
3	OTHER CEREALS	0.60	0.00	0.00	0.00
4	PULSES	0.00	0.00	0.00	0.00
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.30	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	0.00	0.00
11	OTHER CROPS	68.70	4144.70	0.00	0.00
12	ANIMAL HUSBANDRY	138.20	425.40	183.70	0.00
13	FORESTRY & LOGGING	327.90	13642.80	0.00	16.40
14	FISHING	7.70	0.00	0.00	0.00
15	COAL & LIGNITE	834.70	0.00	25696.80	2405.30
16	CRUDE PETROLEUM & N.GAS	0.60	0.00	237.60	0.00
17	IRON ORE	23.20	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	86.80	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	25.30	30034.80	0.00	0.00
20	SUGAR	0.00	0.00	0.00	0.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	1.10	0.00	0.00	0.00
23	OTH.FOOD & BEVERAGE IND.	24.00	0.00	0.00	0.00
24	COTTON TEXTILES	131.90	0.00	0.00	79.10
25	WOOLLEN TEXTILE	5.50	0.00	0.00	0.00
26	ART SILK & SYNTH.FIBRE	5.80	0.00	0.00	0.00
27	JUTE,HEMP,MESTA TEXTILES	495.50	1120.40	0.00	0.00
28	OTHER TEXTILE	114.10	26.40	61.10	21.60
29	WOOD & WOOD PRODUCTS	510.80	15306.10	260.70	72.40
30	PAPER & PAPER PRODUCTS	1297.90	941.60	287.10	298.20
31	LEATHER & LEATHER PROD.	55.20	0.00	0.00	0.00
32	RUBBER PRODUCTS	301.50	213.80	20.10	4.90
33	PLASTIC PRODUCTS	222.60	0.00	0.00	79.70
34	PETROLEUM PRODUCTS	1386.40	571.30	3143.00	5470.30
35	COAL TAR PRODUCTS	76.70	10700.60	0.00	0.00
36	FERTILIZERS	20.50	524.20	0.00	0.00
37	PESTICIDES	0.00	287.80	0.00	1.20
38	SYNTH.FIBRE & RESIN	49.80	0.00	0.00	0.00
39	OTHER CHEMICALS	2630.80	8498.80	294.80	14.30
40	CEMENT	0.00	22729.30	0.00	0.00
41	OTH.NON MET.MINERAL PROD	660.00	13788.20	214.30	228.70
42	IRON & STEEL	21987.00	66589.60	622.80	1206.60
43	NON FERROUS METALS	9300.80	0.00	23.20	0.00
44	TRACTORS & OTH.AGRI.MACH	5.40	0.00	0.00	0.00
45	MACHINE TOOLS	0.60	0.00	5.80	97.00
46	OTH.NON ELECTRICAL MACH.	310.70	845.60	2331.80	156.90
47	ELECTRICAL MACHINERY	1572.40	20811.40	5265.70	1821.50
48	COMMUNICATIONS EQUIPMENT	1028.10	0.00	16.50	328.30
49	ELECTRONIC EQUIPMENT	42.70	0.00	0.60	13.00
50	RAIL EQUIPMENT	1653.40	0.00	0.00	23021.70
51	MOTOR VEHICLES	29.30	515.30	63.40	36.90
52	OTH.TRANSPORT EQUIP.	727.70	0.00	0.20	1.50
53	OTH. MANUFACTURING	11978.90	1076.50	2868.30	2548.10
54	CONSTRUCTION	672.60	71.60	4139.40	9644.60
55	ELECTRICITY ETC.	3431.20	9735.70	53342.50	4044.60
56	RAIL TRANSPORT SERVICE	1208.20	8036.80	6855.00	980.40
57	OTHER TRANSPORT SERVICE	2507.20	15044.10	2735.90	1517.60
58	COMMUNICATION	1445.90	1232.20	549.80	197.00
59	TRADE	5217.20	43602.00	7080.40	1692.70
60	OTHER SERVICES	8992.60	15902.00	1996.00	5835.20
61	TOTAL	81598.50	305619.20	118206.30	62729.10
62	INDIRECT TAX	16958.70	36163.80	5703.60	4001.60
63	GROSS VALUE ADDED	70472.00	220180.00	86610.00	56540.00
64	GROSS OUTPUT	169029.30	561963.00	210520.00	123270.70

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (15)

SN	COMMODITY SECTOR	57	58	59	60
1	PADDY	48.60	0.00	0.00	8291.80
2	WHEAT	86.70	0.00	0.00	4969.30
3	OTHER CEREALS	1.20	0.00	0.00	0.00
4	PULSES	431.90	0.00	0.00	2847.70
5	SUGARCANE	0.00	0.00	0.00	0.00
6	JUTE	0.00	0.00	0.00	0.00
7	COTTON	0.00	0.00	0.00	0.00
8	TEA	0.00	0.00	0.00	0.00
9	COFFEE	0.00	0.00	0.00	0.00
10	RUBBER	0.00	0.00	0.00	0.00
11	OTHER CROPS	93.10	0.00	0.00	6934.40
12	ANIMAL HUSBANDRY	0.00	0.00	0.00	9676.10
13	FORESTRY & LOGGING	0.00	0.00	0.00	298.30
14	FISHING	0.00	0.00	0.00	2553.50
15	COAL & LIGNITE	179.60	0.00	0.00	2687.90
16	CRUDE PETROLEUM & N.GAS	0.00	0.00	0.00	0.00
17	IRON ORE	0.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	0.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	0.00	0.00	0.00	0.00
20	SUGAR	0.00	0.00	0.00	1152.00
21	KHANDSARI BOORA	0.00	0.00	0.00	0.00
22	HYDROGENATED OIL	15.20	0.00	0.00	735.80
23	OTH.FOOD & BERERAGE IND.	485.70	0.00	0.00	4854.70
24	COTTON TEXTILES	43.70	0.00	0.00	167.90
25	WOOLLEN TEXTILE	48.10	0.00	0.00	0.00
26	ART SILK & SYNTH.FIBRE	0.00	0.00	0.00	0.00
27	JUTE,HEMP,MESTA TEXTILES	0.00	0.00	1349.60	27.10
28	OTHER TEXTILE	329.40	11.30	0.00	765.30
29	WOOD & WOOD PRODUCTS	4.50	2.20	1283.00	874.60
30	PAPER & PAPER PRODUCTS	2409.50	743.90	3474.90	14210.00
31	LEATHER & LEATHER PROD.	20.30	0.00	0.00	0.00
32	RUBBER PRODUCTS	6147.20	5.20	9.40	50.40
33	PLASTIC PRODUCTS	129.20	0.00	698.90	20.90
34	PETROLEUM PRODUCTS	35899.40	80.10	339.00	954.90
35	COAL TAR PRODUCTS	0.00	0.00	0.00	0.00
36	FERTILIZERS	0.10	0.00	0.00	0.00
37	PESTICIDES	0.20	0.00	0.00	22.90
38	SYNTH.FIBRE & RESIN	0.00	0.00	0.00	0.00
39	OTHER CHEMICALS	109.90	0.30	0.00	25706.80
40	CEMENT	0.00	0.00	0.00	3.00
41	OTH.NON MET.MINERAL PROD	23.40	0.00	0.00	285.20
42	IRON & STEEL	22.70	0.00	283.60	3.00
43	NON FERROUS METALS	0.00	0.00	0.00	0.00
44	TRACTORS & OTH.AGRI.MACH	0.00	0.00	0.00	0.00
45	MACHINE TOOLS	0.00	0.00	0.00	0.00
46	OTH.NON ELECTRICAL MACH.	616.10	19.70	32.10	558.90
47	ELECTRICAL MACHINERY	1318.50	3.80	3.50	471.50
48	COMMUNICATIONS EQUIPMENT	187.60	1160.80	0.00	661.40
49	ELECTRONIC EQUIPMENT	19.20	0.60	0.00	28.00
50	RAIL EQUIPMENT	0.00	0.00	0.00	0.00
51	MOTOR VEHICLES	12344.60	13.00	23.60	255.20
52	OTH.TRANSPORT EQUIP.	2657.40	0.00	0.00	1225.00
53	OTH. MANUFACTURING	2224.60	12.90	2598.40	16233.50
54	CONSTRUCTION	1915.80	1087.20	2252.00	32349.40
55	ELECTRICITY ETC.	2346.80	302.30	4933.50	6774.90
56	RAIL TRANSPORT SERVICE	1795.80	211.20	1723.10	1596.40
57	OTHER TRANSPORT SERVICE	24129.50	494.10	50381.50	8677.00
58	COMMUNICATION	2026.80	0.00	3521.00	7472.90
59	TRADE	6283.30	122.90	7413.90	14059.70
60	OTHER SERVICES	16859.40	450.40	41408.10	32204.40
61	TOTAL	120456.20	4642.50	121721.20	210662.10
62	INDIRECT TAX	20348.30	258.50	3280.10	16019.50
63	GROSS VALUE ADDED	176230.00	41400.00	477060.00	833710.00
64	GROSS OUTPUT	317034.60	46301.00	602061.20	1060391.50

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (16)

SN	COMMODITY SECTOR	I.USE	PVT CONS	PUB CONS	G.F.INV
1	PADDY	53076.60	248374.40	299.00	0.00
2	WHEAT	37373.10	111860.50	299.30	0.00
3	OTHER CEREALS	7608.00	67795.00	0.00	0.00
4	PULSES	28956.00	63441.80	151.20	0.00
5	SUGARCANE	36279.00	31528.00	0.00	0.00
6	JUTE	6584.00	0.00	0.00	0.00
7	COTTON	62235.00	0.00	0.00	0.00
8	TEA	20015.00	0.00	0.00	0.00
9	COFFEE	597.00	0.00	0.00	0.00
10	RUBBER	4711.00	0.00	0.00	0.00
11	OTHER CROPS	240327.10	207798.40	236.50	0.00
12	ANIMAL HUSBANDRY	133851.80	271103.60	282.20	33268.40
13	FORESTRY & LOGGING	38213.20	46108.20	121.60	0.00
14	FISHING	4850.10	28219.90	3.00	0.00
15	COAL & LIGNITE	66768.00	2073.50	72.40	0.00
16	CRUDE PETROLEUM & N.GAS	85673.60	0.00	0.00	0.00
17	IRON ORE	1472.00	0.00	0.00	0.00
18	OTHER METALLIC MINERALS	5285.00	0.00	0.00	0.00
19	NON MET.& MINOR MINERALS	53643.00	0.00	0.00	0.00
20	SUGAR	3717.70	53147.30	0.00	0.00
21	KHANDSARI BOORA	-22131.20	6029.80	0.00	0.00
22	HYDROGENATED OIL	1519.00	16616.00	0.00	0.00
23	OTH.FOOD & BEVERAGE IND.	41733.60	196308.50	195.90	0.00
24	COTTON TEXTILES	70080.20	145126.20	68.50	0.00
25	WOOLLEN TEXTILE	6027.10	12696.90	0.00	0.00
26	ART SILK & SYNTH.FIBRE	58709.40	104039.60	0.00	0.00
27	JUTE,HEMP,MESTA TEXTILES	26575.60	0.00	10.40	0.00
28	OTHER TEXTILE	30804.60	65894.90	662.60	19822.80
29	WOOD & WOOD PRODUCTS	23546.10	1999.10	300.20	2114.60
30	PAPER & PAPER PRODUCTS	72989.20	12238.60	7976.10	0.00
31	LEATHER & LEATHER PROD.	7069.60	12006.40	6.90	0.00
32	RUBBER PRODUCTS	19509.00	10095.80	466.80	9247.40
33	PLASTIC PRODUCTS	8567.30	2521.30	1.30	0.00
34	PETROLEUM PRODUCTS	130507.00	42136.50	9966.30	0.00
35	COAL TAR PRODUCTS	22407.00	0.00	0.00	0.00
36	FERTILIZERS	71767.70	0.00	612.30	0.00
37	PESTICIDES	10517.60	0.00	6.40	0.00
38	SYNTH.FIBRE & RESIN	21371.00	0.00	0.00	0.00
39	OTHER CHEMICALS	139344.10	64303.20	1599.50	0.00
40	CEMENT	26340.00	0.00	0.00	0.00
41	OTH.NON MET.MINERAL PROD	21224.40	12864.60	0.80	243.20
42	IRON & STEEL	192814.40	0.00	0.00	11989.40
43	NON FERROUS METALS	49949.00	0.00	0.00	0.00
44	TRACTORS & OTH.AGRI.MACH	11266.10	0.00	138.70	10540.20
45	MACHINE TOOLS	556.70	0.00	0.00	7451.30
46	OTH.NON ELECTRICAL MACH.	38179.20	1093.70	3791.60	134416.50
47	ELECTRICAL MACHINERY	55909.40	5075.30	478.00	70171.40
48	COMMUNICATIONS EQUIPMENT	9727.10	1393.30	444.00	17864.50
49	ELECTRONIC EQUIPMENT	1361.50	11581.80	30.30	6115.30
50	RAIL EQUIPMENT	29615.70	0.00	0.00	17839.30
51	MOTOR VEHICLES	22628.80	3659.30	2545.60	47326.30
52	OTH.TRANSPORT EQUIP.	14544.20	8336.00	43.40	23091.40
53	OTH. MANUFACTURING	102019.00	33673.00	21828.80	29718.20
54	CONSTRUCTION	101607.20	0.00	46616.90	413738.80
55	ELECTRICITY ETC.	185080.50	17140.60	12962.80	0.00
56	RAIL TRANSPORT SERVICE	50389.20	34361.80	6565.60	1707.50
57	OTHER TRANSPORT SERVICE	184699.30	138122.80	6612.40	3901.30
58	COMMUNICATION	23910.00	18441.00	4706.00	0.00
59	TRADE	293855.10	241285.50	5564.60	35547.50
60	OTHER SERVICES	279036.70	481090.30	376229.80	0.00
61	TOTAL	3371045.80	2831571.20	511891.80	895317.40
62	INDIRECT TAX	261971.50	110218.30	18778.20	74102.60
63	GROSS VALUE ADDED	3951430.00	0.00	0.00	0.00
64	GROSS OUTPUT	7584447.00	2950789.50	530670.00	969420.10

TABLE [7.2.1]

INPUT/OUTPUT FLOWS 1989-90 (17)

SN	COMMODITY SECTOR	CH.IN STK	EXPORTS	IMPORTS	G.OUTPUT
1	PADDY	2516.00	3836.00	2829.00	305273.00
2	WHEAT	4457.00	19.00	214.00	153795.00
3	OTHER CEREALS	811.00	19.00	235.00	75998.00
4	PULSES	569.00	0.00	2279.00	90839.00
5	SUGARCANE	11.00	0.00	0.00	67818.00
6	JUTE	95.00	0.00	73.00	6606.00
7	COTTON	13.00	937.00	1099.00	62086.00
8	TEA	0.00	0.00	0.00	20015.00
9	COFFEE	0.00	2029.00	0.00	2626.00
10	RUBBER	16.00	0.00	656.00	4071.00
11	OTHER CROPS	1730.00	15713.00	1863.00	463934.00
12	ANIMAL HUSBANDRY	1025.00	940.00	3033.00	437430.00
13	FORESTRY & LOGGING	296.00	0.00	3972.00	80765.00
14	FISHING	4.00	5499.00	24.00	38552.00
15	COAL & LIGNITE	142.00	89.00	5620.00	63525.00
16	CRUDE PETROLEUM & N.GAS	394.00	0.00	40896.00	45171.60
17	IRON ORE	72.00	2738.00	0.00	4282.00
18	OTHER METALLIC MINERALS	207.00	1604.00	706.00	6390.00
19	NON MET.& MINOR MINERALS	5080.00	557.00	47876.00	11404.00
20	SUGAR	104.00	266.00	971.00	56264.00
21	KHANDSARI BOORA	15.00	0.00	0.00	28176.00
22	HYDROGENATED OIL	444.00	0.00	106.00	18473.00
23	OTH.FOOD & BERERAGE IND.	115.00	10648.00	3984.00	245017.00
24	COTTON TEXTILES	190.00	13010.00	397.00	228078.00
25	WOOLLEN TEXTILE	230.00	248.00	590.00	18611.00
26	ART SILK & SYNTH.FIBRE	14518.00	4809.00	2075.00	180001.00
27	JUTE,HEMP,MESTA TEXTILES	24.00	2623.00	56.00	29177.00
28	OTHER TEXTILE	1587.00	35286.00	1098.00	152960.00
29	WOOD & WOOD PRODUCTS	1.00	141.00	351.00	27751.00
30	PAPER & PAPER PRODUCTS	623.00	248.00	8153.00	85922.00
31	LEATHER & LEATHER PROD.	226.00	17213.00	314.00	36282.00
32	RUBBER PRODUCTS	287.00	6765.00	629.00	45742.00
33	PLASTIC PRODUCTS	5097.00	1262.00	630.00	16819.00
34	PETROLEUM PRODUCTS	792.00	5303.00	15323.00	173381.80
35	COAL TAR PRODUCTS	161.00	7.00	555.00	22020.00
36	FERTILIZERS	2178.00	15.00	12279.00	62293.90
37	PESTICIDES	524.00	646.00	925.00	10769.00
38	SYNTH.FIBRE & RESIN	20013.00	636.00	11359.00	30661.00
39	OTHER CHEMICALS	1107.00	14740.00	31093.00	190000.90
40	CEMENT	0.00	0.00	32.00	26308.00
41	OTH.NON MET.MINERAL PROD	669.00	48373.00	1680.00	81695.00
42	IRON & STEEL	705.00	2258.00	30619.00	177157.90
43	NON FERROUS METALS	538.00	906.00	14059.00	37334.00
44	TRACTORS & OTH.AGRI.MACH	183.00	184.00	66.00	22246.00
45	MACHINE TOOLS	288.00	2340.00	3194.00	7442.00
46	OTH.NON ELECTRICAL MACH.	5361.00	10509.00	87334.00	106017.00
47	ELECTRICAL MACHINERY	2012.00	5023.00	13427.00	125242.00
48	COMMUNICATIONS EQUIPMENT	4080.00	306.00	3838.00	29977.00
49	ELECTRONIC EQUIPMENT	5875.00	4731.00	16229.00	13466.00
50	RAIL EQUIPMENT	136.00	247.00	1468.00	45570.00
51	MOTOR VEHICLES	86.00	3701.00	3880.00	76067.00
52	OTH.TRANSPORT EQUIP.	6957.00	3265.00	16056.00	40181.00
53	OTH. MANUFACTURING	3026.00	8419.00	28655.00	170028.90
54	CONSTRUCTION	0.00	0.00	0.00	561863.00
55	ELECTRICITY ETC.	0.00	67.00	0.00	215170.90
56	RAIL TRANSPORT SERVICE	0.00	7777.00	0.00	100801.00
57	OTHER TRANSPORT SERVICE	0.00	23183.00	39484.00	317034.90
58	COMMUNICATION	0.00	842.00	1598.00	46301.00
59	TRADE	0.00	38434.00	0.00	614686.80
60	OTHER SERVICES	0.00	59650.00	25148.00	1170858.90
61	TOTAL	95590.00	368061.00	489030.00	7584449.00
62	INDIRECT TAX	0.00	2189.00	0.00	476260.00
63	GROSS VALUE ADDED	0.00	0.00	0.00	3951430.00
64	GROSS OUTPUT	95590.00	370250.00	489030.00	

Chapter 8

Results, Projections and Some Implications

'Unfortunately, there was no direct equivalent for global warming of the dramatic discovery of the 'ozone hole' over Antarctic. The fact that seven of the ten years in the 1980's were amongst the warmest since records began, and that there were unexpected droughts in the USA and severe storms around the world in 1988, lent warnings about global warning a popular credibility that they had previously lacked'.

- *Owen Greene, 1991*[1]

'We must think globally but act locally'.

- *Gro Harlem Brundtland, May 1990.*[2]

[8.1] In the previous chapters, we have generated sectoral data on carbondioxide emissions, for the Indian economy, from consumption of fossil fuels which in turn has been converted into energy units. The data so obtained is within the framework of individual fuels despite its being sectorally allocated. Besides this, nothing more is'said and done', except accomplishing the essence of the exercise undertaken at hand. What is now really needed is

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1 *Obtained from Philip Sarre and Paul Smith (1991), One World for One Earth: Saving the Environment, Earthscan, London, in association with The Open University, 1991.*

2 *Ibid.*

to allocate these emissions, as well as the calorific consumption of the concerned fuels, across the fossil fuels for each of the sectors in our classification. This will complete our exercise in the strict sense But this in turn is not enough to impart any great signficiance to our generation exercise if it is not accompanied by some implications along with some general projections to highlight its signficance, as absolute figures per se have no meaning. What we will do in this chapter is precisely the above mentioned, so that we can purposefully conclude our undertaken task of exploring a specific aspect of the energy-environment interaction, through a case study of carbondioxide emissions (for the Indian economy). All this is 'good' and understood. But still one may ask inspite of the elaborate enumeration in the initial chapters, 'where does economics play a hand in this entire story'? Before we get down to our results and its projections, we would like to take up this issue once and for all, for on this point, atleast, we hope not to leave any scope for any kind of doubts, and again this would logically lead us into the implications of our generation exercise.

[8.2] The role of economics in our entire exercise is very basic and extremely subtle. Economics can be, simplisticly, taken to be the history of demand and supply meeting each other through the price mechanism and cascading into the concept of development. This entire logistics includes not only the factors of production, but it also includes variants of technology as well as the political economy of the concerned nation, amongst many other parameters. Again, this economics is not, therefore, the sole right of any one generation. Further, it is through this economics only that not only various generations, but also various nation-states are inter-linked and inter-dependent. So, what we have is not only conventional economics, say of firms and their profit maximization, or of the development parameters of any nation (isolated, as well as vis-a-vis other nation-states), but in turn we also have economics of each and every related aspect of concern. All this eventually boils down into a strong case for development (as already mentioned) and moresoever, increasingly as of today, of sustainable development. It is in this understanding that we have 'economics of energy' and 'economics of environment', which with the passage of time have become an integral part of mainstream economics.

Energy plays a very vital role in developing the fate of a nation, of the economy. Infact, 'the mere pervasiveness of energy use in economic activity reflects its great importance in development process'.[3] Production, transport, consumption, etc. all require energy and so increase in the level of activity of any of these would express itself in the form of an increase in energy consumption. So, developing countries along the path of development require increasing energy to achieve target growth. W.S.Chern (1985) has shown that 'GDP elasticities of aggregate energy demand are high and price elasticities

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3 *Sambit Basu (1994), Demand for Electricity: Aggregative and Sectoral Analysis for India, Dissertation Submitted to Jawaharlal Nehru University, New Delhi, in partial fulfilment of the requirements for the award of the degree of Master of Philosophy, CESP, 1994.*

low for less developed countries'.[4] Thus, there is a strong co-relation between industrialization and energy use. To quote, E.F. Schumacher (1992), 'it might be said that energy is for the mechanical world what consciousness is for the human world. If energy fails, everything fails'.[5]

The industrialised world consumes the lion's share of energy resources. A particularly quotable quote is that 'the United States has consumed more fossil fuels and minerals in the past 50 years than the rest of humanity in the whole of recorded history' (Sandy Irvine, 'No Growth in a Finite World', New Statesman, 23 November 1990).[6] The industrialised world also has tools at hand to increase the efficiency and decrease the use of fossil fuels. On the other hand, the less developed (ala developing) countries energy consumption is small, but it is inefficient and rapidly growing in the pursuit to seek material benefits associated with economic growth and development. An inevitable outcome of all such central activities, to any economy and a 'part and parcel' of every economic activity stemming from energy consumption, is the generation and in turn emission of gases resulting in global warming. And in this respect Figures (8.2.1) and (8.2.2) shows the contribution to global warming attributed too different gases, and contribution of different activities

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4 *W.S.Chern (1985), 'An Assessment of Future Energy Demand in Developing Country', Natural Resources Forum, vol.9, 1985.*

5 *E.F.Schumacher (1992), Small is Beautiful, Abacus books, London, 1992.*

6 *Philip Sarre and Paul Smith, op.cit.*

respectively. From the figures it is crystal clear that the main culprit is carbondioxide released from burning of fossil fuels (-energy consumption). So, because of this, global warming can be said to be the ultimate pollution issue, bringing together natural and social processes and symbolising the urgent need to review society's use of and impacts upon natural systems and this in turn constitutes the basic tenat of energy - enviornment interaction.

Now, one of the immediate implications which arises out of this interaction is the fact that, although prevention of such a gas is perfect in ideal it is impossible to implement (atleast in the near future), becaue of its typical generation aspect (- from energy consumption). Hence a plausible plan of action, to tackle this problem, could be to stabilise (i.e., arresting the rate of growth) emissions of GHGs while ensuring sustainable development of the world economy. In this process the immedite steps would be to first of all identify the causal factors and show that they are likely to grow; and the second - to put a time-scale on the change in global temperature, would be to predict the likely change in emissions of carbondioxide and other greeenhouse gases, and both of these would at once take us out of the realm of science and into that of economics and of economic forcasting. And it is on this front that we have developed our present work, taking the particular case of India. In this context, the opening quotes to this chapter become very relevant.

[8.3.] In Tables (4.2.7), (4.3.2), (4.4.6) and (5.3.3) we have the sectoral carbondioxide emissions from consumption of coal, petroleum products, natural gas and the sectoral allocation of CO_2 resulting from generation of power. From these tables, what we do is to aggregate the CO_2 emissions across the fossil fuels and to these we add their respective shares in the resulting CO_2 from gross generation of power. Hence the result is Table (8.3.1) to (8.3.5) and we get our sectoral generation of CO_2 emissions. Further, in Tables (6.4.1) to (6.4.4.) and Table (6.2.6) we have already got our energy consumption out of consumption of 'commercial fuels' in energy units. So, only what is left to be done is to obtain the total picture for the entire economy and this is simply obtained by adding up, for each of the concerned years, across the sectors in both these cases and doing so we obtain our Tables (8.3.6) and (8.3.7) respectively. Once we have obtained our data in our required framework we can now go ahead into the implications of our exercise. But for this we we have to undertake some econometric exercises, to be specific - some regressions and projections for each of the sectors in our study, as well as for the total depicting the entire economy. So, before we go into each of the concerned sectors, what we will do is to outline the methodology accepted and on whose basis we have managed our projections.

[8.4] To carry out our projections, for each of the concerned sectors, we first of all carried out a number of regressions, based on the standard OLS model and in the process we used the TSP-6 computer package. the specific models and their regressions which we incorporated were selected on the basis of the purpose for which we needed them, and thus so was also selected the independent variable. So, if we needed the regressions for projection purposes or to show us some economic implications, we used a log-linear (- double-log) model. And if we wanted to see the trend i.e., growth, of the dependent variable over time, we used a semi-log model. This is precisely because of the fact that the co-efficient of the independent variable, in a double-log model and a semi-log model gives us the elasticity factor and the growth rate of the dependent variable respectively. Finally, in deciding whether our regression suffered from autocorrelation or not, we took recourse to checking the Durbin-Watson test statistic obtained in lieu of our regressions. The Durbin-Watson test statistic is computed from the vector of OLS residuals:

$$e_t = y - X\beta \tag{1}$$

It is denoted in the literature as d or DW and is defined as:[7]

$$d = \frac{\Sigma^n_{t=2} (e_t - e_{t-1})^2}{\Sigma^n_{t=1} e^2_t} \tag{2}$$

The Durbin-Watson Statistic is closely related to the sample first-order autocorrelation of the e's, for expanding equation (1), we get:

$$d = \frac{\Sigma^n_{t=2} e^2_t + \Sigma^n_{t=2} e^2_{t-1} - 2\,\Sigma^n_{t=2} e_t\, e_{t-1}}{\Sigma^n_{t=1} e^2_t} \tag{3}$$

[7] *J.Johnston (1988), Econometric Methods, Mc-Graw Hill, 1988 edition, pp.314-317.*

For large n, the different ranges of summation in numerator and denominator have a diminishing effect and,

$$d = 2(1-r) \qquad (4)$$

where $r = \Sigma(e_t\ e_{t-1})/\Sigma e^2_t$ is the co-efficient in the OLS regression of e_t on e_{t-1}. Thus formula/equation (4) shows heuristically that the range of d is from 0 to 4 :

$d<2$ for positive autocorrelation of the e's,

$d>2$ for negative autocorrelation of the e's,

$d=2$ for zero autocorrelation of the e's.

But, the hypothesis under test is about the properties of the unobservable u's, which will not be replaced by the OLS residuals. Nonetheless, the above indictors are valid in that d will tend to be less (greater) than 2 for positive (negative) autocorrelation of the u's.

Durbin and Watson established upper (d_U) and lower (d_L) bounds for the critical values of d. These bounds are to test the hypothesis of zero autocorrelation against the alternative of positive first-order autocorrelation. The testing procedure is as follows:[8]

(1) If $d<d_L$, reject hypothesis of non autocorrelated u in favor of the hypothesis of positive first order autocorrelation.

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8 *Ibid.*

(2) If $d>d_L$, do not reject the null hypothesis.

(3) If $d_L<d<d_U$, the test is inconclusive.

If the sample value of d exceeds 2, we wish to test the null hypothesis against the alternative hypothesis of negative first-order autocorrelation. The appropriate procedure is to compute (4-d) and compare this statistic with the tabulated values of d_L and d_U, as if one were testing for positive autocorrelation. Inspite of everything, the inconclusive range provides us with an awkward problem. 'A conservative practical procedure is to use d_U as if it were a conventional critical value and simply reject the null hypothesis if $d<d_U$. The consequences of accepting H_0 when autocorrelation is present are almost certainly more serious than the consequences of incorrectly assuming it to be absent, which is one of the reason for the procedure' (J. Johnston, 1988).

Finally, there are two important qualifications to the use of the Durbin-Watson test. First, it is necessary to have included a constant term in the regression. Second, it is strictly valid only for a non-stochastic X.

Thus, on these principles we checked our regression and whereever necessary we performed the AR(1) so as to take care of the autocorrelation. As it turned out, after our doing this, all our regressions were generically accepted at 1% level of significance as checked from the Savin-White tables for Durbin-Watson test statistic at 1% level of significance.

So, from these regressions, we selected our model for projections and these (- projections) we carried out based on the standard compound rate of growth principles. The projections were carried out for the terminal years of the 8^{th}, 9^{th} and the 10^{th} plan periods i.e., for the years 1996/97, 2001/02 and 2006/07. For these, the prime necessity was to obtain target percentage growth rates for our dependent variable (% growth rate of the independent variable multiplied by the concerned elasticity factor will give us the % growth rate of the dependent variable i.e., $dY/Y = ßdX/X$; ß is the elasticity factor, and dX/X is the growth rate of the independent variable). Then using this % growth rate, and the terminal year values of our dependent variable (i.e., 1989/90 for our case) would give us the needed/projected values of our dependent variable, for the year concerned. In cases were the target terminal year percentage growth rates of the independent variable is not available, we regress our independent variable with some key macro-economic indicators, such as GDPfc (Gross Domestic Product at factor cost, at 80-81 prices), or PFCE (Private Final Consumption Expenditure), or, say, Population whose target terminal year values can easily be obtained from the 8^{th} (FYP) plan documents of the Government of India. In this case, these key indicators become the independent variable, and our erstwhile independent variable become the dependent variable. From here, target terminal year growth rates (%) are obtained for our present dependent variables, and using this we carry out our projections.

We have carried out projections for each of the concerned sector as well as for the total economy using two models - one direct and one indirect, and in all the cases we have obtained very close results. Hence the sensitivity of our projection, for a set of consistent assumptions, is quite stable. But what we have not done is that checked the accuracy of our projections. This we have not been able to do largely because of the time constraint within which we had to perform our entire exercise. But, we feel, that this would not impart a great deviation to our results obtained. So, what we have not been able to do is to check the robustness of the model using the AAE (- average absolute error) test, or check the sensitivity of our model to change in assumptions, or incorporate in the auto-correlation factor in our projections. Given time, we would have certainly gone through all these exercises, but with the time constraint and the basic purpose of our exercise (- to be generation of CO_2 emissions and its implications), we had to bypass these issues, and be satisfied with obtaining the basic objectives of our work. The sectoral projections carried out and the implications of our work is as follows.

[8.4.1] **AGRICULTURE SECTOR**: In the Tables (6.4.1) and (8.3.1), we have the agriculture sector's energy consumption in calorific values and its emissions of CO_2. Figure (8.4.1.1) and (8.4.1.2) depict these two graphically. From these tables and figures it is seen that it is largely the consumption of power and the corresponding emissions of CO_2 which have really shown a remarkable growth over time. The other fuels consumption have grown but at a decreasing rate. And so is the case with their emissions of CO_2. Infact its in the case of consumption of coal that CO_2 emissions, although have increased over time from their 1970-71 values, have decreased as a % of emissions from the consumption of coal across our sectoral classification. This may be largely attributed to the increasing substitution of coal consumption by consumption of power and petroleum products as deduced from the increase in consumption of coal which show the lowest percentage rate of growth. This definitely is a positive sign. A similar case is seen with natural gas also.

The regressions undertaken for the agriculture sector are shown in Table (8.4.1.1). For the regressions in the agriculture sector, we have taken a 3 year moving-average for all the parameters concerned, so as to smoothen out the fluctuations. And whereever the Durbin-Watson Statistic shows an inconsistent value, we have applied moving-average of the first order [MA (1)], unlike in other sectors where auto-regressive process of the first order [AR(1)], is applied.

For our independent variables we have taken Gross Value Added in Agriculture and Allied Activities (GVAAGR), from various volumes of National Account Statistics, and Agricultural Production Index (AGRPDNX), from H.L. Chandok's 'India Database'. From the regressions we see that our dependent variables (i.e., AGRCAL - calorific consumption of energy in the agriculture sector, and AGRCO2 - CO_2 emissions in the agriculture sector) and the independent variables show a highly elastic relationship, which is generally over 2. So this means that for a corresponding increase in our independent variables, our dependent variables grows more than proportionately. Hence, if we want to reduce any of these dependent variables in value terms or in percentage growth terms, then we are faced with the problem of inducing either GVAAGR, or AGRPDNX to decrease more than proportionately. And this will conflict with our surge towards development and growth. Not only this, the elasticity factor in the relationship between GVAAGR and GDPfc is also 0.633. This imparts a substantial effect of increase in GVAAGR on the nation's GDPfc. And, finally the relationship between AGRCO2 and AGRCAL shows an elasticity factor of 1.415. Thus it definitely seems improbable to hope for an across the board absolute reduction in CO_2 in the agriculture sector as even our GDPfc would then suffer a setback, and this would backtrack us from our path of (sustainable) development. Hence, the most rational and logical insight would be to opt for a case of fuel substitution keeping the environmental factor (- emission of CO_2) as an important parameter, and trying to stabilize this rate of growth of the CO_2 emissions by finding a more fuel efficient consumption order.

The projections carried out for this sector is on the basis of GVAAGR, and are shown in Tables (8.4.1.2) and (8.4.1.3). As earlier mentioned, both the models show a similar rate of growth (%) for energy consumption and CO_2 emissions. And this in absolute terms, increases almost 8 times from 1990-91 to 2006-07 (similar to their increase from 1970-71 to 1989-90) - an ominious picture definitely. This can partly be attributed to the consistent high elasticity factor in our models. Thus what is clear is we have to do something about the question of CO_2 emissions and on this a middle path has to be compromised at, for we sure cannot afford the much needed absolute cut in these emissions.

This is the story for not only the rest of the sectors to follow, but also for the picture drawn for the entire economy. Hence we provide a detailed description for the agriculture sector. In the rest of the sectors we will just give the necessary data and informations, along with the regressions carried out, and only point out their peculiarities 'if and when' they came, for we will not linger on the obvious interpretation and implication as we are afraid that if we do so, then we would end up being only repetative.

[8.4.2] **DOMESTIC SECTOR**: In the Tables (6.4.3) and (8.3.2), we have the domestic sector's energy consumption in calorific units, as well as its CO_2 emissions. Figures (8.4.2.1) and (8.4.2.2) give us this information graphically. From these tables and figures we find that coal consumption in absolute terms have decreased significantly, and the immediate effect of this is on the CO_2 emissions which have decreased markedly. On the other hand, consumption of power and natural gas has explicitly increased. Consumption of petroluem products have also increased, but the ensuing CO_2 emissions as a percent of the overall emissions of CO_2 from the petroluem consumption across sectors, have decreased. Overall, both the energy consumption and CO_2 emissions have increased through the time concerned and this is to be expected.

For the regression exercise shown in Table (8.4.2.1), Private Final Consumption Expenditure (PFCE) and Per-Capita PFCE (PCYPFCE) are taken as the independent variables, and calorific consumption of fuels (DOMCAL) and the CO_2 emitted from the consumption of these fuels (DOMCO2) is taken to be the dependent variables. All the regressions show an elasticity factor of more than 1.5. The elasticity factor for DOMCO2 and DOMCAL is also 1.227. And, finally this factor for PFCE and GDPfc is 0.761. Thus, again, we reach the same policy conclusion that an across the board absolute reduction in CO_2 is not feasible and for energy consumption, not at all advisable. As this would eventually result in a significant decrease in the rate of growth of the economy as such, leave aside the setback which the particular sector would receive. So, once again we come to a juncture where stabilization of such emissions in terms of reducing the rate of growth, through efficient fuel consumption and fuel substitution (involving a different fuel consumption order) is required.

The regressions involving per-capita DOMCAL (PDOMCAL) and per-capita DOMCO2 (PDOMCO2) with PCYGDP (per-capita GDPfc), further strengthens this point, for here the elasticity factor is 1.661 and 1.387 respectively and in these models we can assume PCYGDP to be an indicator of the development of an economy, as it may be associated with the standard of living of an individual. So, what the regression signifies is that, as the standard of living improves (in the process of economic development of an economy), proportionately more energy is consumed and CO_2 is emitted. Thus, reducing these emissions from an 'outsider's perspective' would lead to a more than proportionate decrease in a parameter (PCYGDP) which would not be accepted at a macro level.

The projections undertaken [Tables (8.4.2.2) and (8.4.2.3)], using PFCE and GDPfc further show, atleast, a 3-fold increase in both fuel consumption (in energy units) and in CO_2 emissions, from 1970-71 to 2006-07 as against the 4-fold increase from 1970-71 to 1989-90, and this amount of emissions we cannot afford. Moreover, both our models of models of projections show very similar results and this in itself lends credibility to our work. So looking on to a policy of stabilization of the CO_2 emissions growth rate seems to be the only way out.

[8.4.3] **INDUSTRY SECTOR**: The Tables (6.4.3), (8.3.3), (8.4.3.1) to (8.4.3.3), and the Figure (8.4.3.1) and (8.4.3.2) provide us with the entire profile of the industry sector. Here a very interesting case which we find is that, although calorific consumption of energy and CO_2 emisssions increase over the entire time period, CO_2 emissions as a percent of the overall emission from the individual fuel (across sectors) have decreased for all fuels except for Natural Gas, whose growth in consumption is the maximum. But this decrease is least seen in terms of coal consumption. Hence, this is one aspect which should be looked into when one wants to delve into notions of energy-efficiency and fuel-substitution in order to reduce CO_2 emissions.

The regressions undertaken and the projections carried out have been based on the independent variable Gross Value Added in Industry (GVAIND). This has been obtained from the various volumes of 'National Accounts Statistics', and is calculated by summing over the gross value added of the following sectors - Mining and Quarring; Manufacturing Registered; Manufacturing Unregistered; Banking and Insurance; Trade, Hotels, Restaurants, etc.; Ownership of Dwellings, Rents, etc; Other Services. This has been done because of our particular classification.

Now these regressions all show on elasticity factor of around 1. So, in this case also if we want to present a strong case for absolute reduction of CO_2 emissions, we falter. For here too, the highly elastic relationship between dependent and independent variables present us with a macro-economic problem leading to a reduction in key macro parameters such as GDPfc (with whom, GVAIND has an elasticity factor of 1.178). So, here also we have a problem of finding a compromise for the ensuing CO_2 problem, as the projections show that CO_2 emissions increase from around 300 Tera grams (or, million tonnes) in 1970-71 to 800 Tera grams in 2006-07. Hence, once again whole onus boils down upon the question of choosing a proper consumption basket of energy fuels, and going in for energy efficiency with this important environmental parameter in concern.

[8.4.4] **POWER SECTOR**: Here also, the Tables (6.2.6), (8.3.4), (8.4.4.1) to (8.4.4.3) and Figures (8.4.4.1) and (8.4.4.2) present us the entire story of the power sector. Power sector has always presented us with a problem, in the sense that power comes into play, in our exercise, in two ways - through the consumption angle and through the generation angle. CO_2 emissions resulting in this sector is because of its generation aspect. This is particularly taken into account in all our regressions undertaken, and in the projection which we have done. Further, it should be taken into account that in reaching the total CO_2 emissions from the power sector, we have added CO_2 emissions due to flaring of Gas to the CO_2 emissions due to the consumption of natural gas. This was done as per our discussions with Prof. R.P. Sengupta.

From the tables and figures (- above mentioned) we find that in the generation of power, it is only coal consumption which shows a dramatic increase in not only consumption, but also in its emissions of CO_2 (- for the percent increase in its growth, as a percent of the overall emissions from the entire coal consumption across sectors, shows a phenomenal increase from around 14% to 47%). This clearly shows that using of coal to generate power (i.e., generation of thermal electricity) has increased over time and shows an increasing growth rate. This is not a good sign. Hence, an important policy decision can be made here.

The regressions carried out have a number of variables and all of these regressions gives us a highly elastic picture of the power sector. Infact, the elasticity of POWCO2 with GDPfc, ELECAL and POWCAL (- where POWCO2 is the CO_2 emissions from the generation of power; ELECAL is the calorific value of consumption of electricity, and POWCAL is the calorific value embedded in the generation of power) is seen to be 2.461, 1.353 and 1.007. This simply gives us the high proportionate co-rrelation between these variables. Infact, the elasticity of 2.461 between POWCO2 and GDPfc is the most ominous for it tells us of the high importance accorded to emissions of CO_2. So, a case of reduction of CO_2 is out of question. And what follows is simply a repetition of our earlier analysis of the other sectors: we have to go in for better energy efficiency and opt for a pattern of power generation which takes in this environmental factor as an important parameter. This becomes all the more important for the power sector as our projections show.

Some further important policy implicatioons which we also obtain from our regresssions are that the GDPfc intensity of POWCO2 and THRCAL (- calorific value of consumption of thermal electricity) show a sufficiently high elasticity factor (- of 0.638); the GDPfc intensity of ELECAL, POWCAL, POWCO2 and THRCAL have grown at a rate of 3.3%, 6.11%, 6.3% and 4.9% respectively. Both these points say, and rightly so, that CO_2 emissions and thermal electricity go hand in hand (- and may be herein also lies one of the ways to actually reduce CO_2 emissions), and that as growth and development takes place in an economy, the GDPfc intensity of certain key variables such as ELECAL, POWCAL, THRCAL is bound to grow for the indirect causation, if we take here, implies a sign of surge towards achieving the standards of the developed nations. And if these factors grow, then POWCO2 is bound to grow too. So, one again, in as important a sector as power, the question of a head on absolute CO_2 emission reduction is very difficult to tackle and the only solution may be through the policies already mentioned.

The projections in the power sector have been carried out using two models - one for power generation (direct), and one for power consumption (indirect). The direct projection has been carried out using POWCAL, whereas the indirect has been carried out using ELECAL and THRCAL. But, once again both these projections show a fairly similar picture and in fact the range of CO_2 emissions so obtained, in the power sector, is pretty close. In 2006-07 this range is (1440.61 mln tonnes to 1195.85 mln tonnes). CO_2 emissions due to generation of power grew almost 7 - fold in both the periods of our study i.e., from 1970-71 to 1989-90 and 1990-91 to 2006-07. From these projections and of the other sectors already, seen, and also pre-empting the case of the transport sector, we can see that projected CO_2 emissions show the greatest growth rate, as well as the largest value in absolute terms, in the power sector. Thus, what we can directly infer is that in tackling the CO_2 problem, power sector will have to play a major role.

Finally, it has to be said that our entire analysis of the power sector is made for power out of utilities.

[8.4.5] **TRANSPORT-SECTOR**: Here too, Tables (6.4.4), (8.3.5), (8.4.5.1) to (8.4.5.3), and Figures (8.4.5.1) and (8.4.5.2) present the portfolio of the transport sector. From these information, what we infer straight away is the fact that coal consumption in absolute terms as well as its associated CO_2 emissions have significantly decreased over time. Petroleum products and power consumption has on the other hand, increased, with a substantial increase in the consumption of the Petroleum products. This is the case with the CO_2 emissions also and infact this aspect should be encouraged.

The regressions of the transport sector shows a reasonable elasticity factor with TRPAX (- total passenger traffic in billion km., obtained from various volumes of CMIE documents). With GDPfc and population, this does not show good results. Again elasticity of TRPAX with population is extremely high (3.712), showing a logical relationship. Therefore, a major implication here is the fact that to get any kind of reduction in the transport sector, one must start of with reducing the rate of growth in the population. And this is what we actually need in the economy also, with India having the second largest population in the world. Thus in this sector, the question of CO_2 reduction can be, and infact should be, tackled on concrete fronts for this policy would be complementary to our surge towards development.

The projections of CO_2 emissions show the least increase over the period 1970-71 to 2006-07, being less than double. Thus, in transport sector, a hard policy can be effectively implemented. And this should be not only oriented towards energy efficiency by substituting in place of coal, petroleum products and power, but also by a policy of population reduction.

[8.4.6] **TOTAL ECONOMY**: An aggregation of the already mentioned sectors would give us a nation wide picture of the economy as a whole. This is presented to us in the Tables (8.3.6), (8.3.7), (8.4.6.1) to (8.4.6.3), and the Figures (8.4.6.1) and (8.4.6.2). From these, what we find is that it is only in the transport sector and in the industry sector where CO_2 emissions as a percent of the total emissions for that year have decreased and this is a very good sign. This can be largely attributed to the policies of energy efficiency, fuel substitution leading to a change in consumption preference, and incorporating in the environmental factor for such policy decisions. This aspect should be encouraged in other sectors as well, so as to approach the environmental problem with an integrated, economic approach. And this is the need of the day, today.

The regressions carried out over the aggregative totals also give us the afore-mentioned scenerio; of obtaining an elasticity of more than 1 with key macro parameters such as GPDfc and PCYGDP. This fact in isolation would surely imply a no-case scenerio for CO_2 reduction in absolute terms, but when we look at the elasticity factor obtained from the relationship between GDPfc intensity of TOTCAL and TOTCO2 (- total calorific content and total CO_2 emissions in the whole economy) with PCYGDP, then we happily find a negative elasticity in the range of -0.5 to -0.8. This tells us that, although CO_2

reduction policies (in absolute sense) in the individual sectors may not work, but a stabilization policy (i.e., reducing the rate of growth of CO_2 emissions) coupled with an efficient energy consumption and a proper selection of energy consumption bundles in each individual sector, may add upto an overall reduction from the macro-view point. We suggest a follow-up on this line for a successful policy implementation, incorporating the environmental factor as an important parameter.

The projections carried out for the total economy as such and the added projections, of all the constituting sectors, show a very alike case [Table (8.4.6.4)]. Infact, we would hope that this maybe the range of future CO_2 emissions if, ceteris paribus, consumption of energy and the resulting CO_2 emissions keep taking place at the prevalent rate, under the prevalent conditions.

[8.4.7] Throughout this chapter, and in most of our policy implications, we have voted for a substitution of coal. The grounds on which we have made this suggestion is given in Table [8.4.7.1], where we have shown that, in our exercise, coal has the highest calorific intensity of CO_2 emissions. Hence, we have favoured a policy favouring substitution of coal. But, from the view point of economics , this may not be a good suggestion as in consuming other fuels, petroleum products to a large extent are importables by LDCS, and hence such a substitution policy will adversely affect the BOP (Balance of Payment) of these economies. In electricity, it would mean opting more for a hydro and nuclear based generation. Nevertheless, this discrepency we have to consider whenever we want to incorporate in an environmental factor in our policy framework.

Thus, what we have done in our entire exercise is to generate a sectoral database on CO_2 emissions from the calorific consumption in India, and used this database to draw some projections and policy implications. The reason for taking up CO_2 emissions for our case study has also been enumerated above. From the work, many policy implications have emerged and these have been mentioned as and when they have been found to be important. A complete list of the policy suggestions which we suggest is as follows:

(1) Environmental policy and energy policy should be considered within the formulation of economic policies, locally as well as globally.

(2) For CO_2 emissions, we have to opt for a strategy which leads us to a reduction in its rate of growth, as absolute reduction does not seem to be a good policy. This is because then not only will key macro-economic variables be affected, but also because the country's (- India's) development programme may suffer a setback.

(3) Efficient energy consumption (through a proper energy consumption basket and inturn implying adoption of better technologies). This could mean, say, substituting petroleum products in place of coal, or going in for more gas-based technologies. Here, we hve to realise that these

changes come with great economic costs, and means of financing this costs have to be found. This aspect is of particular importance to a developing economy like India's.

(4) Opting for a more explicit program of development of renewable energy (- for here, there is no question of 'environmental pollution'), and that too on a more explicit and commercial basis.

(5) Incorporating the use of market-based instruments such as 'Polluter Pays Principle', or carbon-taxes, or carbon-charges (i.e., Pigovian and Marshallian mehtods), so as to internalize this 'bad' externality (- environmental i.e., CO_2 emissions). Although avowed environmentalists may ostracize this idea, but in reality these are important economic measures for,

(a) The levy may be so hefty that it may not be remunerative to pollute at all;

(b) The revenue earned may, infact, be used to finance other projects such as providing an alternative consumption basket to these consumers;

(c) The revenue earned may be used for reducing CO_2 emissions by developing/purchasing new technologies; or

(d) Be used to subsidise our exportables/importables; or

(e) Even be used to purchase pollution rights across countries by way of tradable environmental permits.

Again, such measures become warranted, for environemntal pollution/global warming (i.e., CO_2 emissions) does lead us towards a question of shouldering the onus of responsibility. Intra-nation, this question implies which economic activity, and which category of end-consumers are to be summoned and once they are, then how are they to be penalised so that in future, they may correct themselves. And inter-nation, this assymetry is magnified and the bone of contention emerges from the basic paradigm that 'North' not only has a higher level of per-capita emissions, but it also has a lower level of emissions per unit of GDP, as compared to the 'South' (V.Bhasker, working paper No.4, CDS, DSE). And this picks up the hue of a conflict between efficiency and equity in the distribution of emission entitlements. This brings us to the question of a system of tradable emission entitlements, or a uniform global tax on emissions. Tradable emission permits control the quantitites, but allow the value of abatement at the margin to be market-determined. Emission taxes provide the correct incentives to decision makers, and allow the market to determine the quantities. Both these instruments are traditional market based instruments.

In the case of CO_2 emissions, within the system of market based instruments, the main variants can be categorized as:

(i) <u>Carbon Tax</u>: The most appropriate and efficient way to define the tax base would be to levy the tax directly on actual emissions (in line with the 'Polluter Pays Principle'), to apply the same tax rate to each emission unit and to locate the tax at the point where the technical possibilities for emission reduction exist. Under these circumstances, each individual 'polluter' will tend to reduce emissions of CO_2 upto the point where the marginal cost of reducing emissions by an additional unit would equal the level of the tax rate on this pollution unit. As there is a direct linear reltionship between fossil fuel input and CO_2 emissions, this tax seems very rational.

(ii) Carbon Charges: Instead of a carbon tax, a carbon charge could be envisaged. The revenue obtained could be earmarked to finance measures to reduce emissions. Hence, for reducing emissions while a carbon tax is normally the incentive effect, the purpose of a carbon charge in mainly revenue raising.

(iii) Fiscal Incentives: These can take the form of either tax incentives (eg., reduced tax rates, tax exemptions, etc) or fiscal incentives in the form of direct financial transfers.

Besides these instruments, we also could have traditional regulatory instruments and voluntary agreements and regulatory/institutional reform to enhance or install the market mechanism (as already mentioned above). Amongst these, the chief measures again are via the double pronged approach of ensuring efficiency standards and emission standards.

Thus, whatever be the case, it is agreed upon that, 'Of all the issues which impinge upon the welfare of future generations, global warming is perhaps the one issue which explicitly requires a treatment of intra-generational distributional issues... The global environment is a global public good, and greenhouse gases, which contribute to global warming, are an archetypal public bad. Consequently, we must define, in global terms, the responsibility of current generations the world over to future generations. In doing so, we confront, inevitably, the division of the burden of this responsibility within the current generation'.[9] And, if we fail here, then in the near future we may reach such a situation where:

> *"... another angel approached me.*
>
> *This one was quietly but appropriately dressed in cellophane, synthetic rubber and stainless steel,*
>
> *But his mask was the blind mask of Ares, snouted for gasmasks,*
>
> *He was neither soldier, sailor, farmer, dictator nor munitons-manfuacturer.*
>
> *Nor did he have much conversation except to say,*
> *'You will not be saved by General Motors or the pre- fabricated house.*
> *You will not be saved by dialectic materialism or the Lambeth Conference.*
> *You will not be saved by Vitamin D or the expanding universe.*
> *Infact, you will not be saved'."*
>
> **- "Nightmare, with Angels" by Stephen Vincent Benet, and obtained from Thomas N. Scortia and Frank M. Robinson (1976), Prometheus Crisis, Bantam books Inc., 1976.**

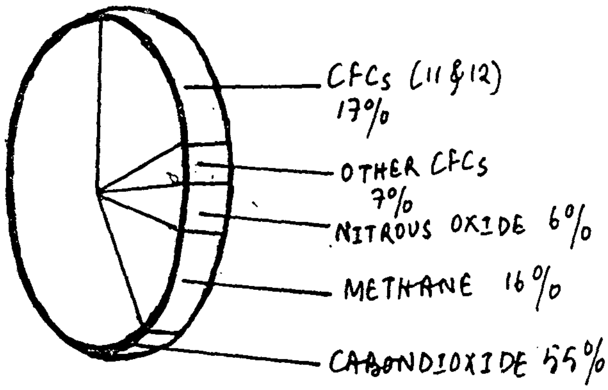
So to save overselves, it is impertinent to save the environment.

---

[9] *V.Bhasker, Distributive Justice and Control of Global Warming, Working paper No.4, Centre for Development Studies, Delhi School of Economics.*

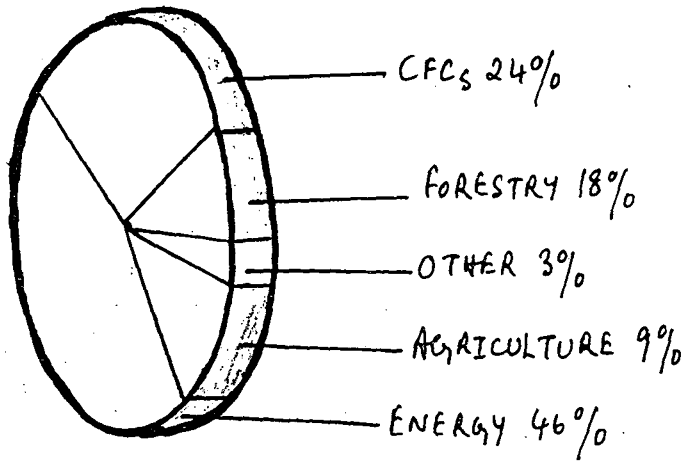
Figures & Tables to Chapter 8

FIGURE [8.2.1] Estimated contribution of each greenhouse gas to global warmings in the 1980s.



SOURCE: Philip Sarre and Paul Smith (1991).

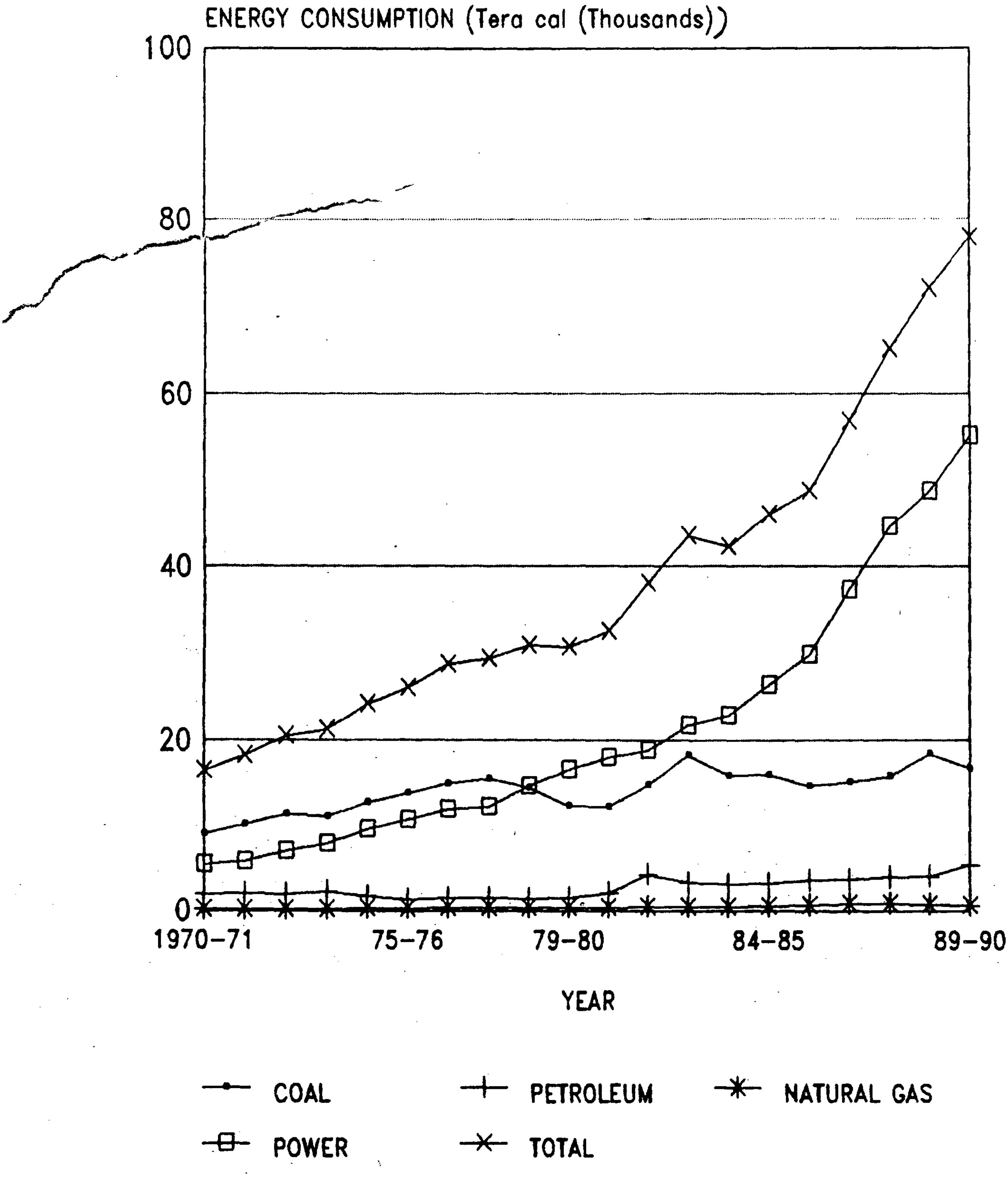
FIGURE [8.2.2] Estimated contribution of different human activities to global warming in the 1980s.



SOURCE: Philip Sarre and Paul Smith (1991).

FIGURE [8.4-1.1]

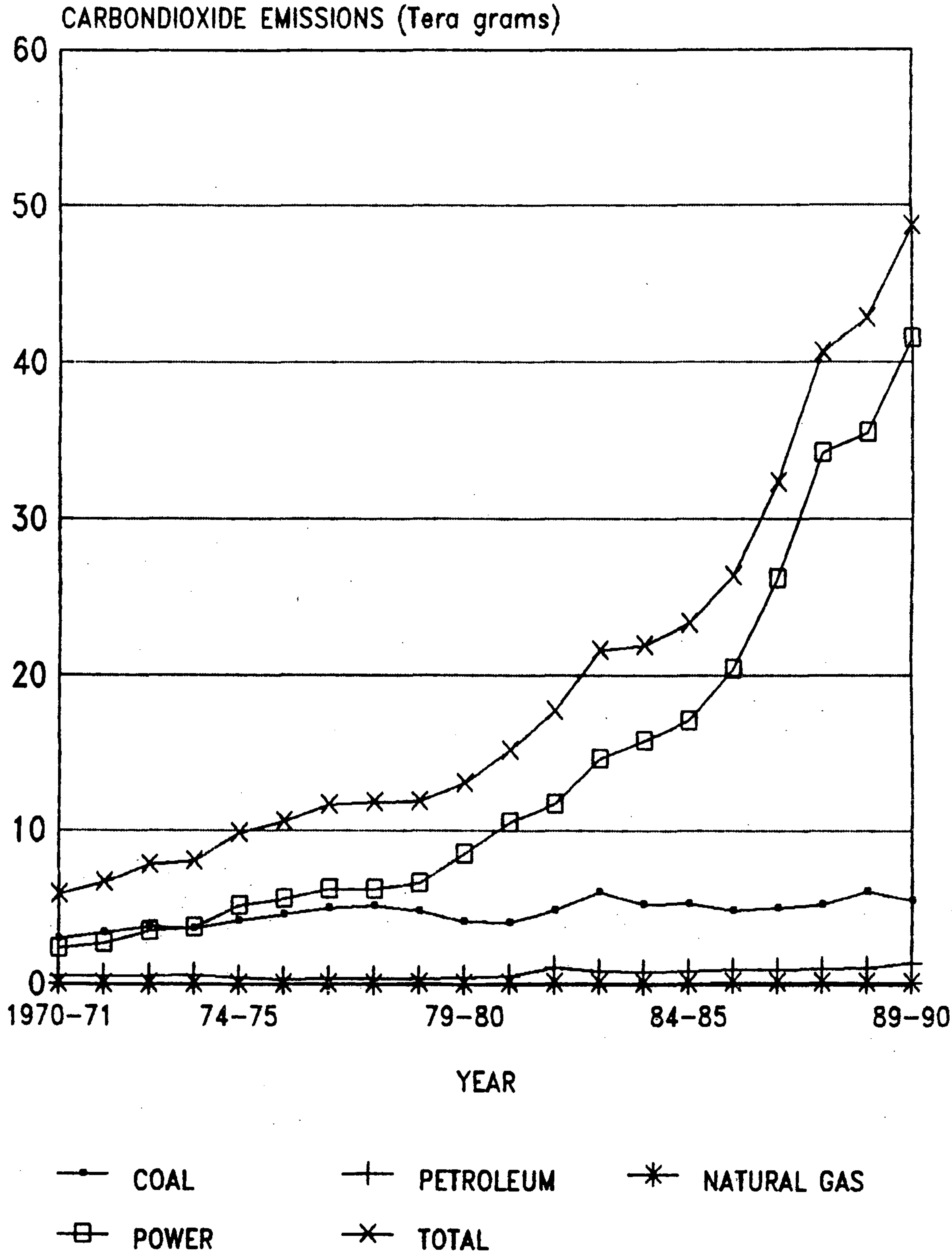
ENERGY CONSUMPTION IN THE AGRICULTURE SECTOR (Tera cals)



SOURCE: AUTHOR

FIGURE [8.4.1.2]

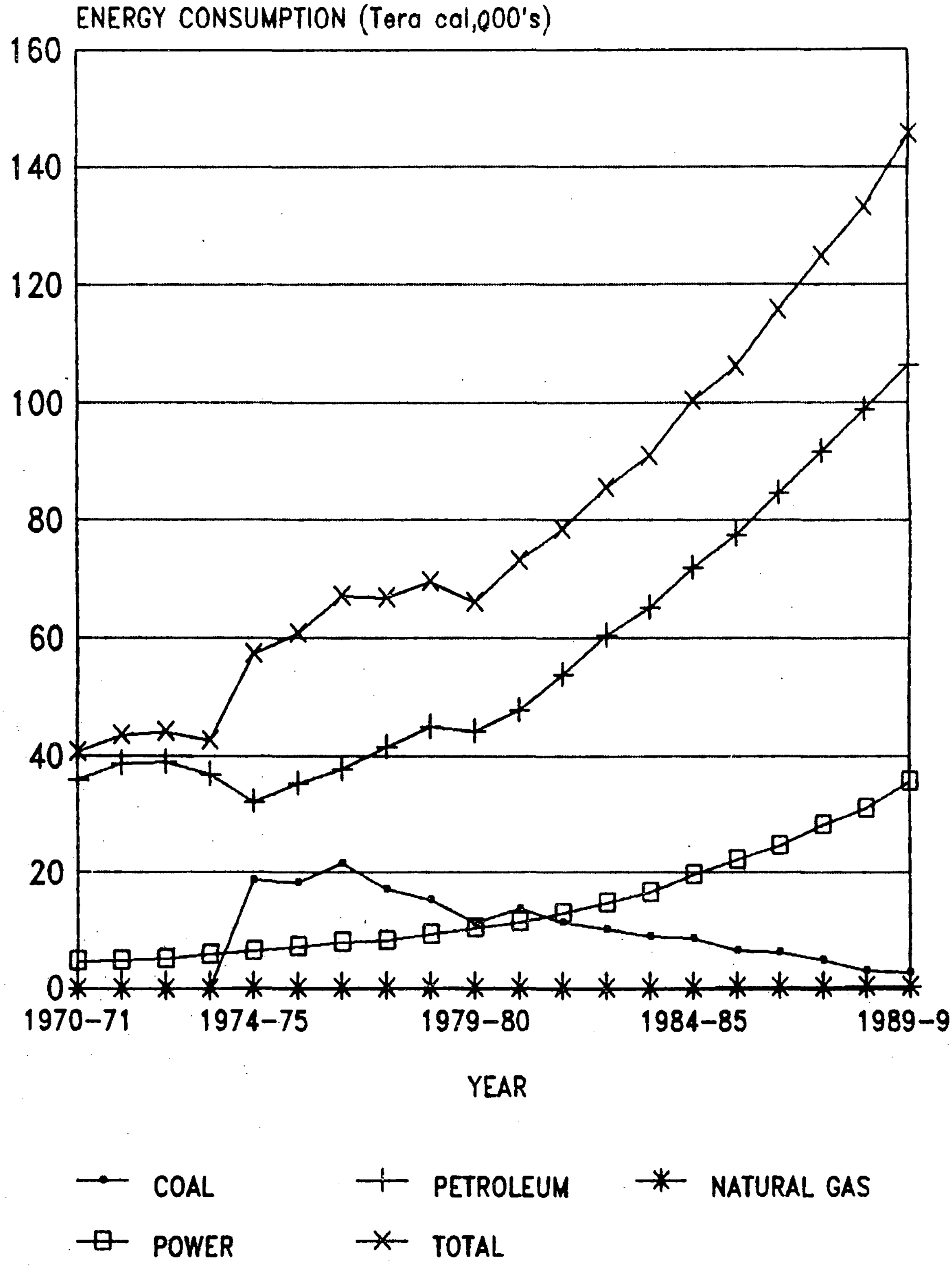
CARBONDIOXIDE EMISSIONS IN THE AGRICULTURE SECTOR (Tera grams)



SOURCE: AUTHOR

FIGURE [8.4.2.1]

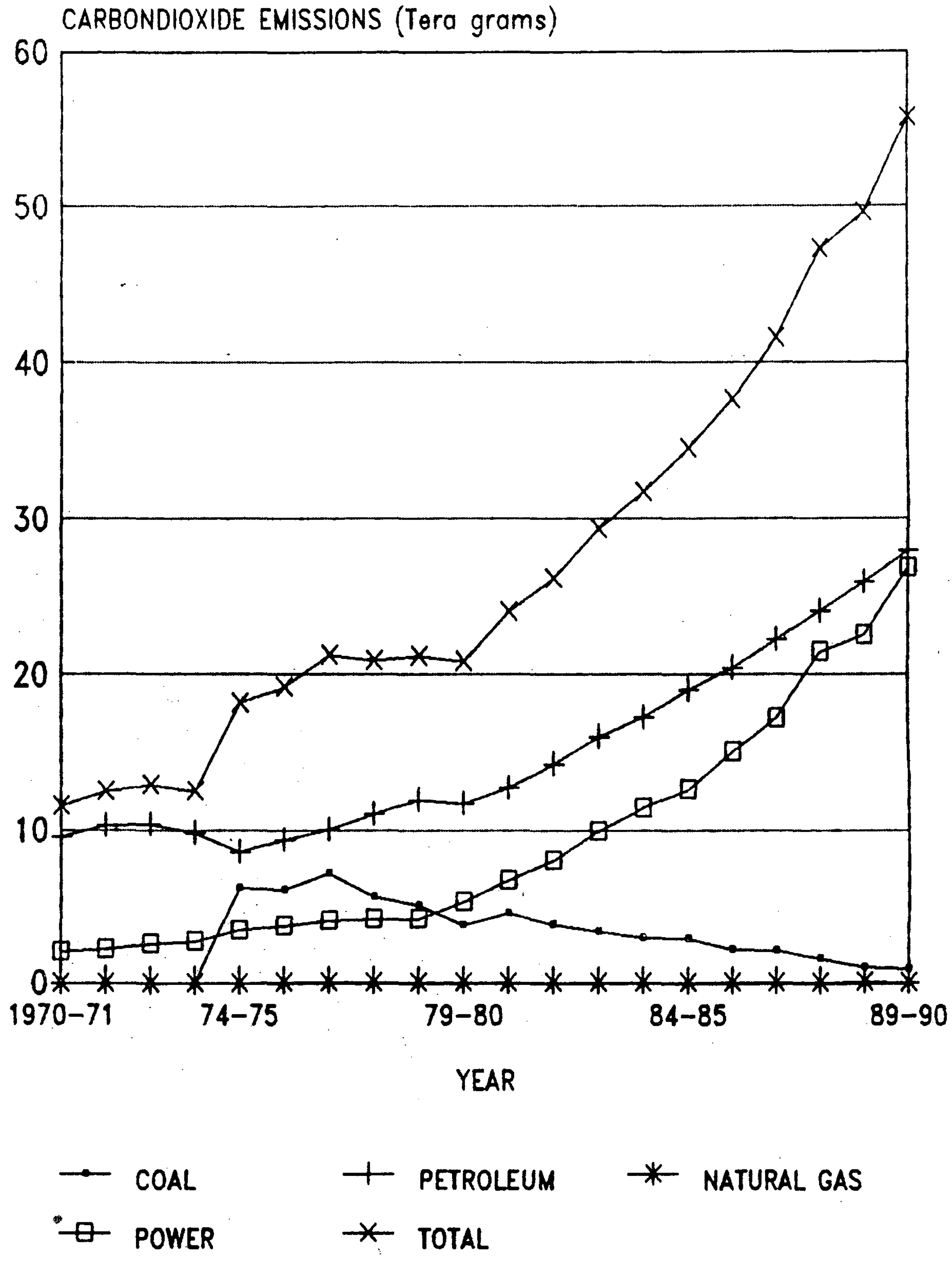
ENERGY CONSUMPTION IN THE DOMESTIC SECTOR (Tera cals)



SOURCE: AUTHOR

FIGURE [8.4.2.2]

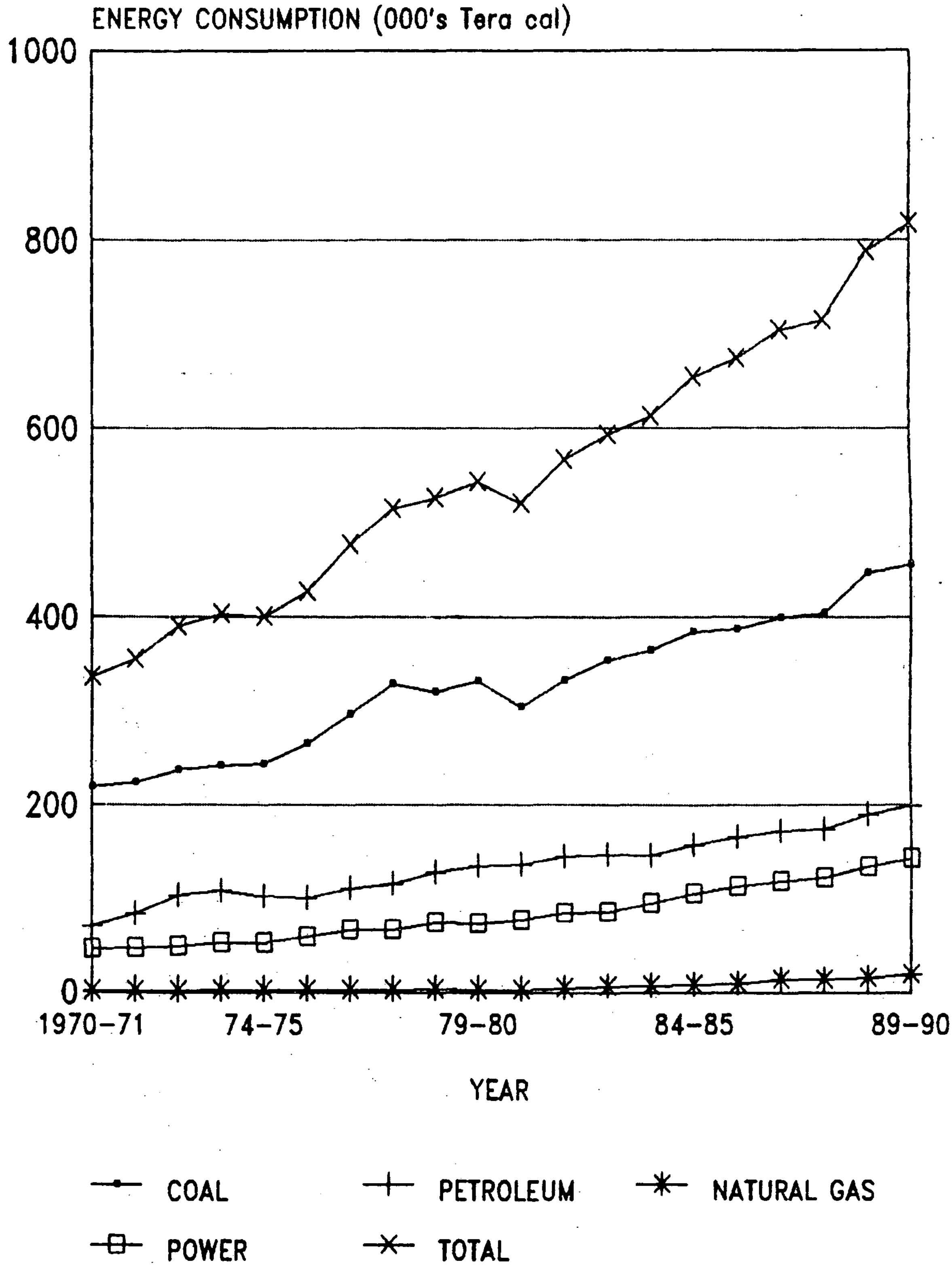
CARBONDIOXIDE EMISSIONS IN THE DOMESTIC SECTOR (Tera grams)



SOURCE: AUTHOR

FIGURE [8.4.3.1]

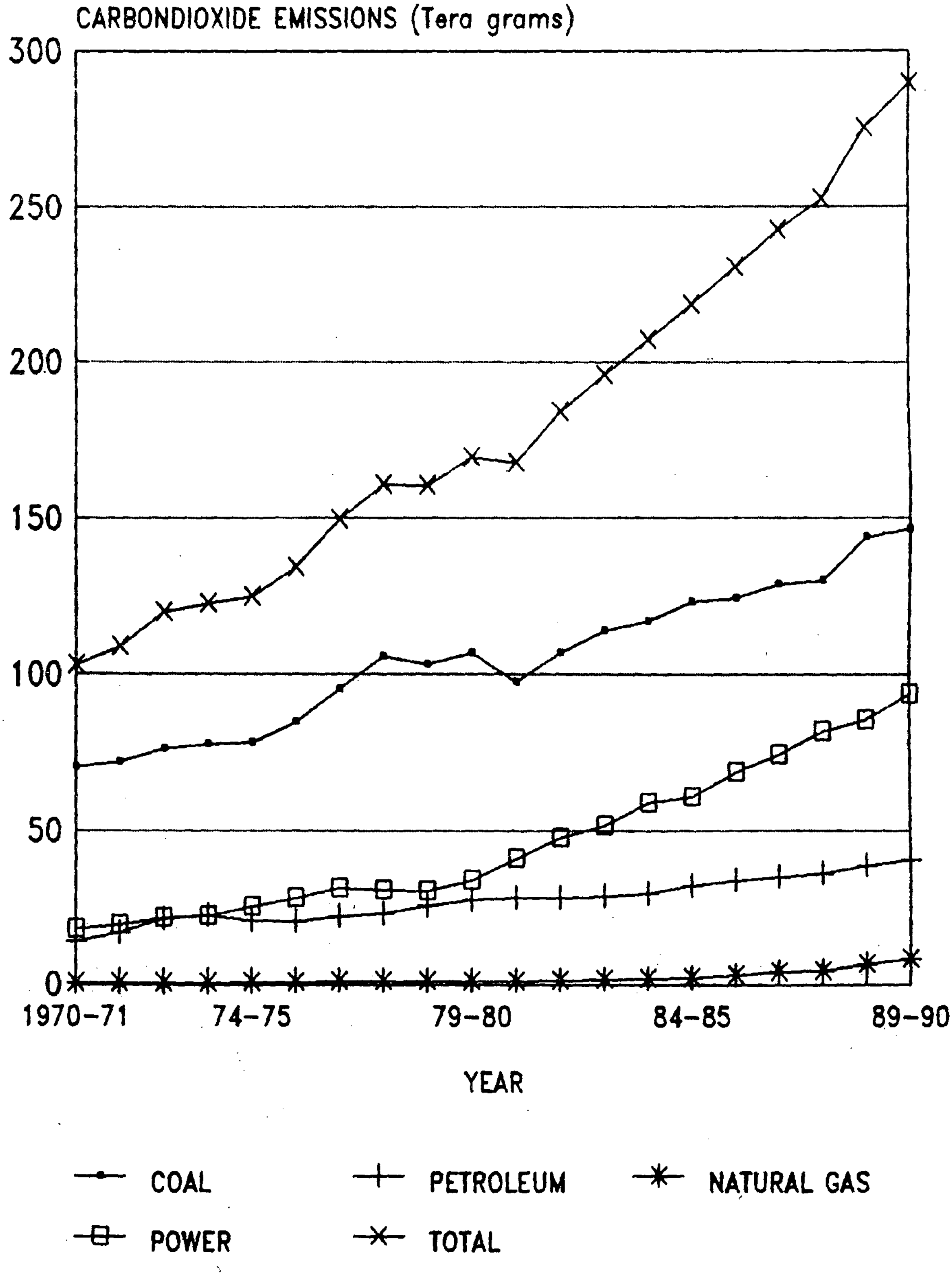
ENERGY CONSUMPTION IN THE INDUSTRY SECTOR (Tera cals)



SOURCE: AUTHOR

FIGURE [8.4.3.2]

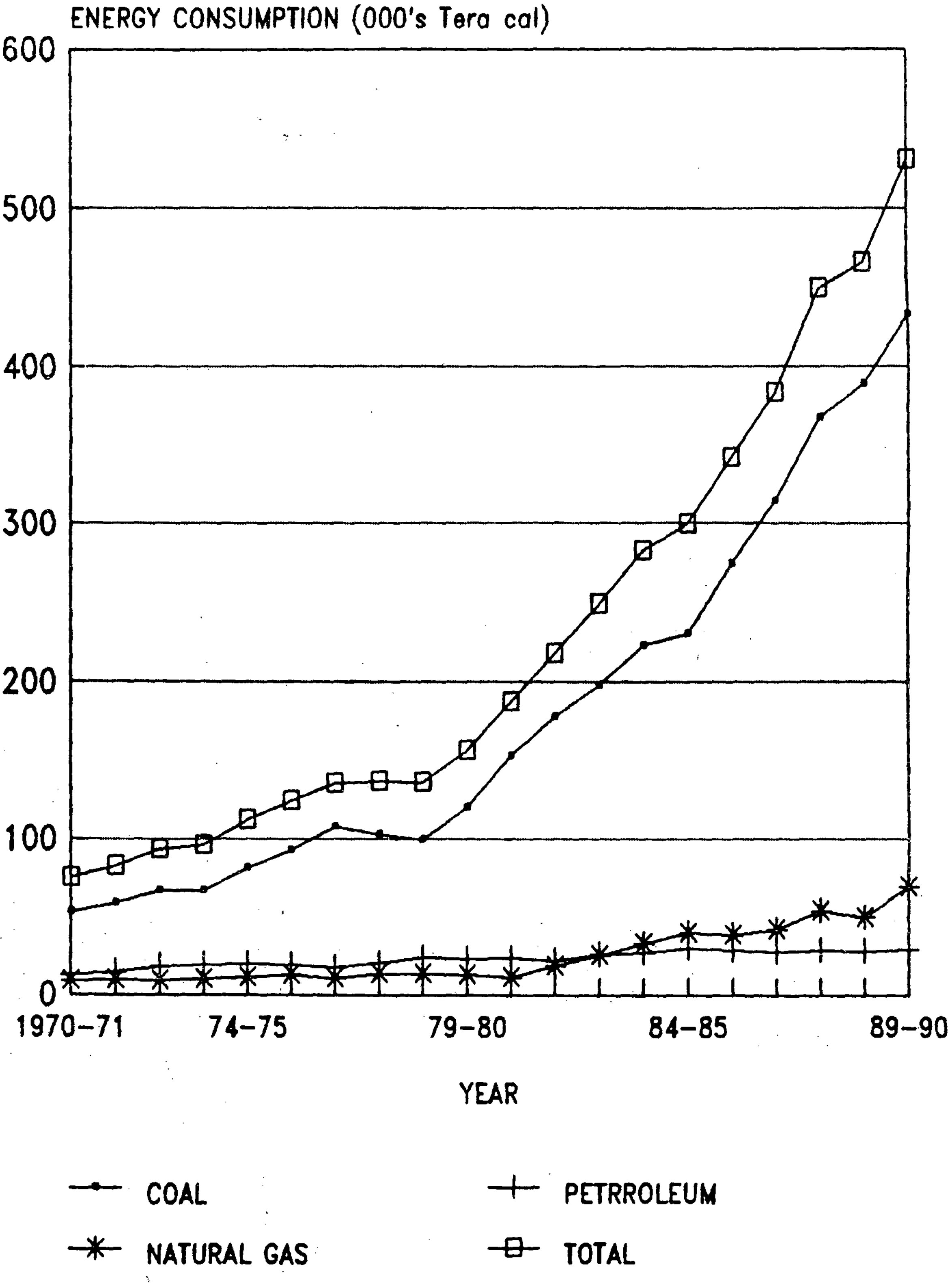
CARBONDIOXIDE EMISSIONS IN THE INDUSTRY SECTOR



SOURCE: AUTHOR

FIGURE [8.4.4.1]

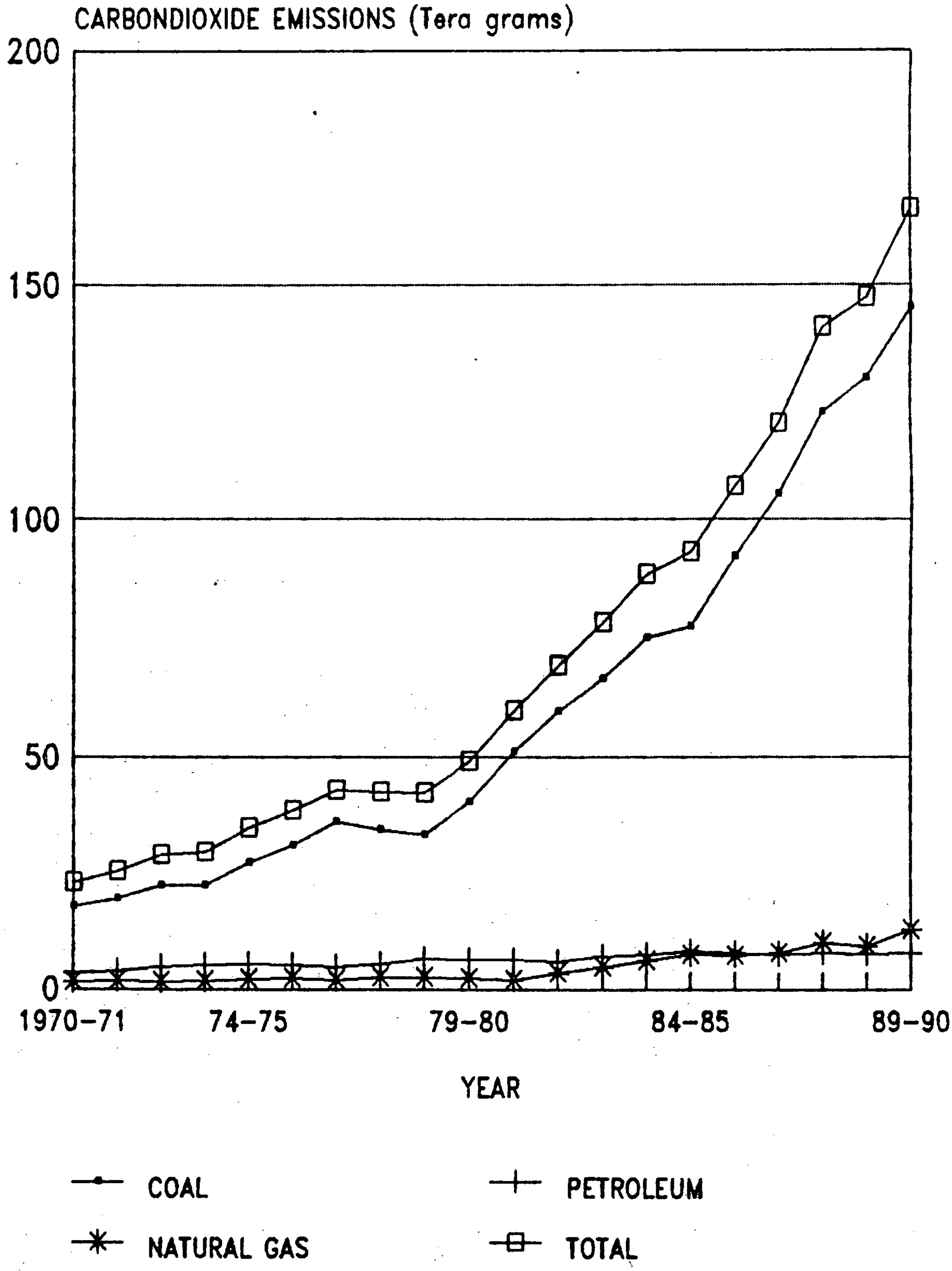
ENERGY CONSUMPTION IN THE GROSS GENERATION OF POWER (Tera cals)



SOURCE: AUTHOR

FIGURE [8.4.4.2]

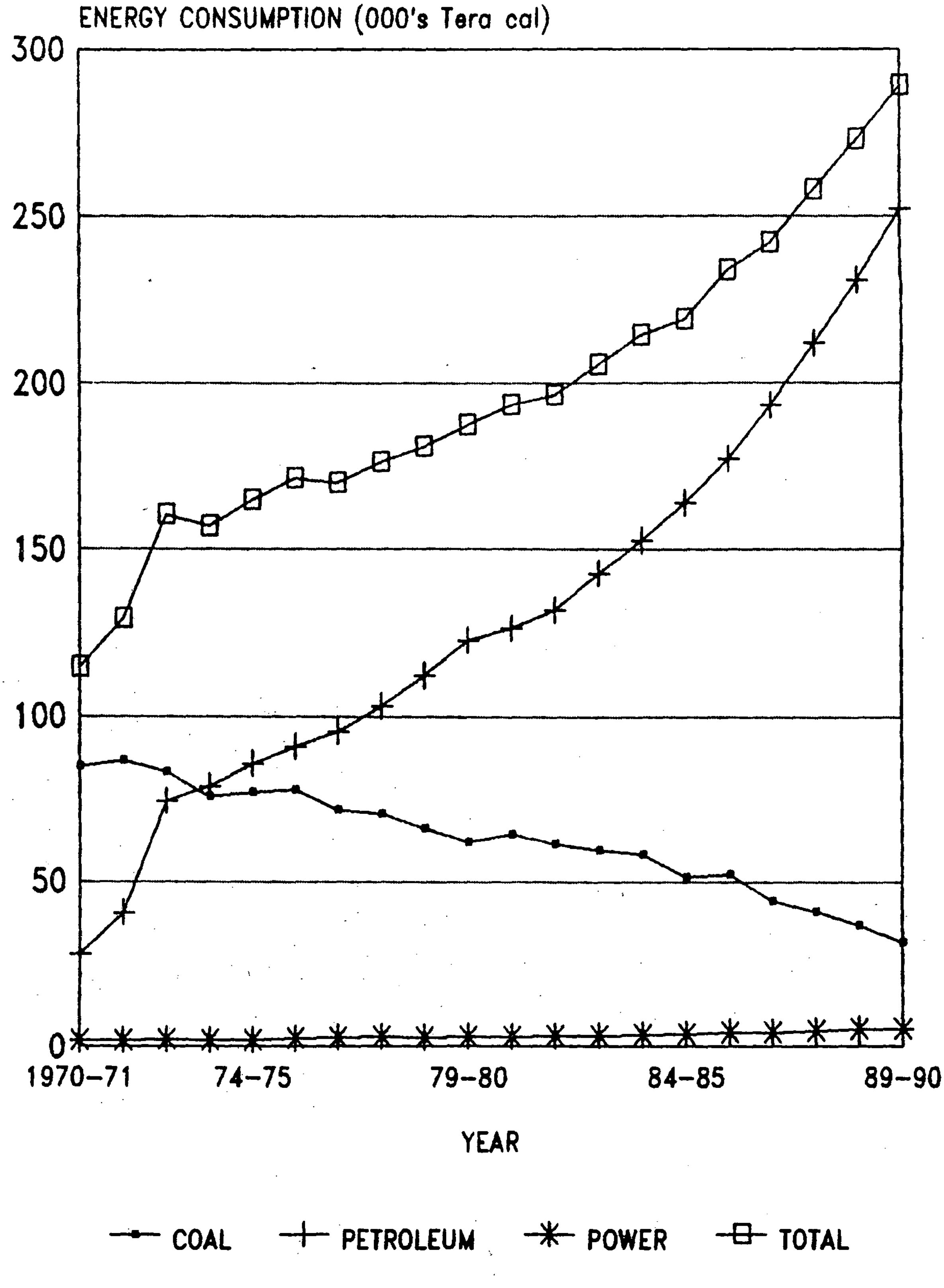
CARBONDIOXIDE EMISSIONS IN THE GROSS GENERATION OF POWER (Tera grams)



SOURCE: AUTHOR

FIGURE [8.4.5.1]

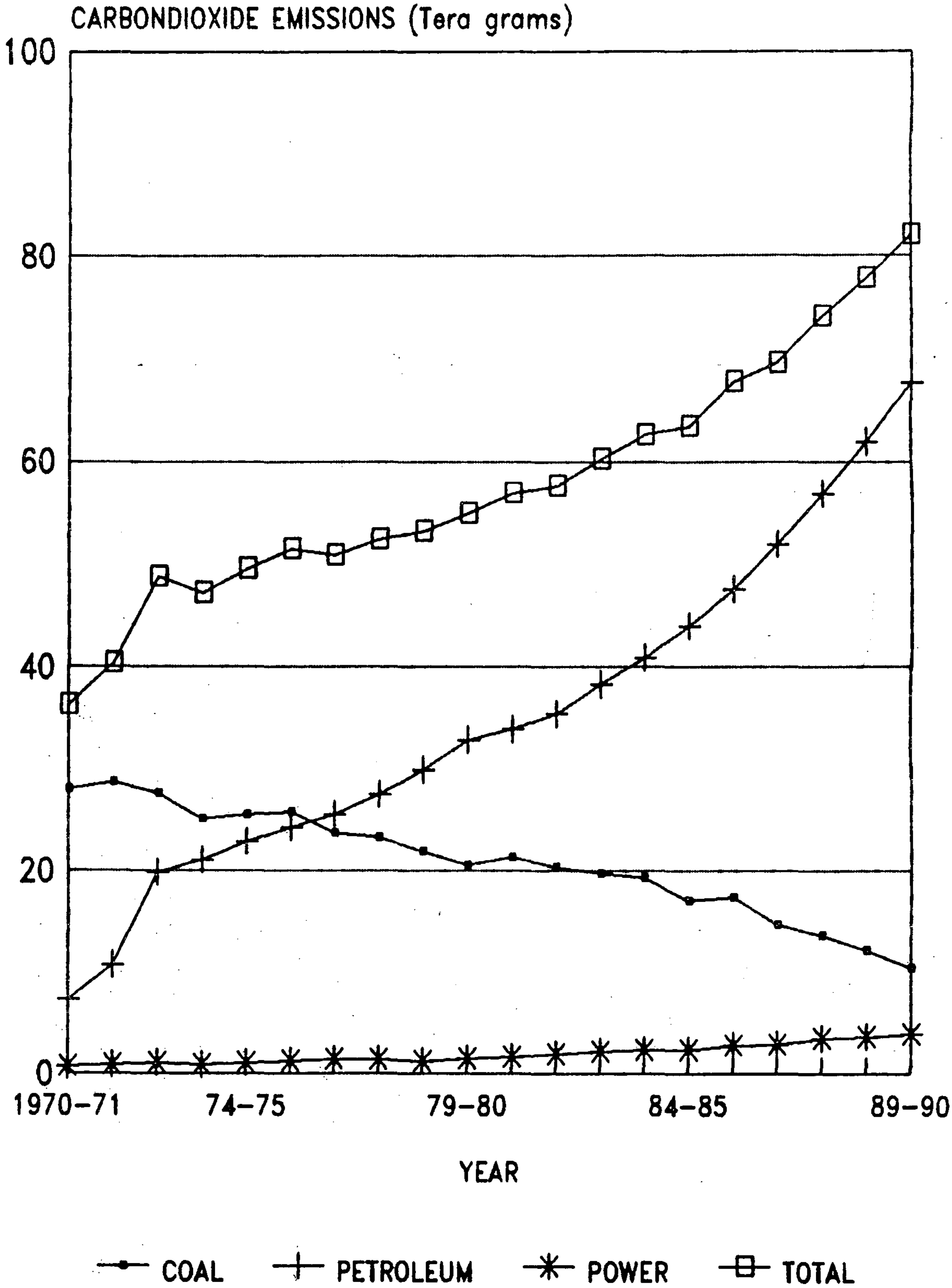
ENERGY CONSUMPTION IN THE TRANSPORT SECTOR (Tera cals)



SOURCE: AUTHOR

FIGURE [8.4.5.2]

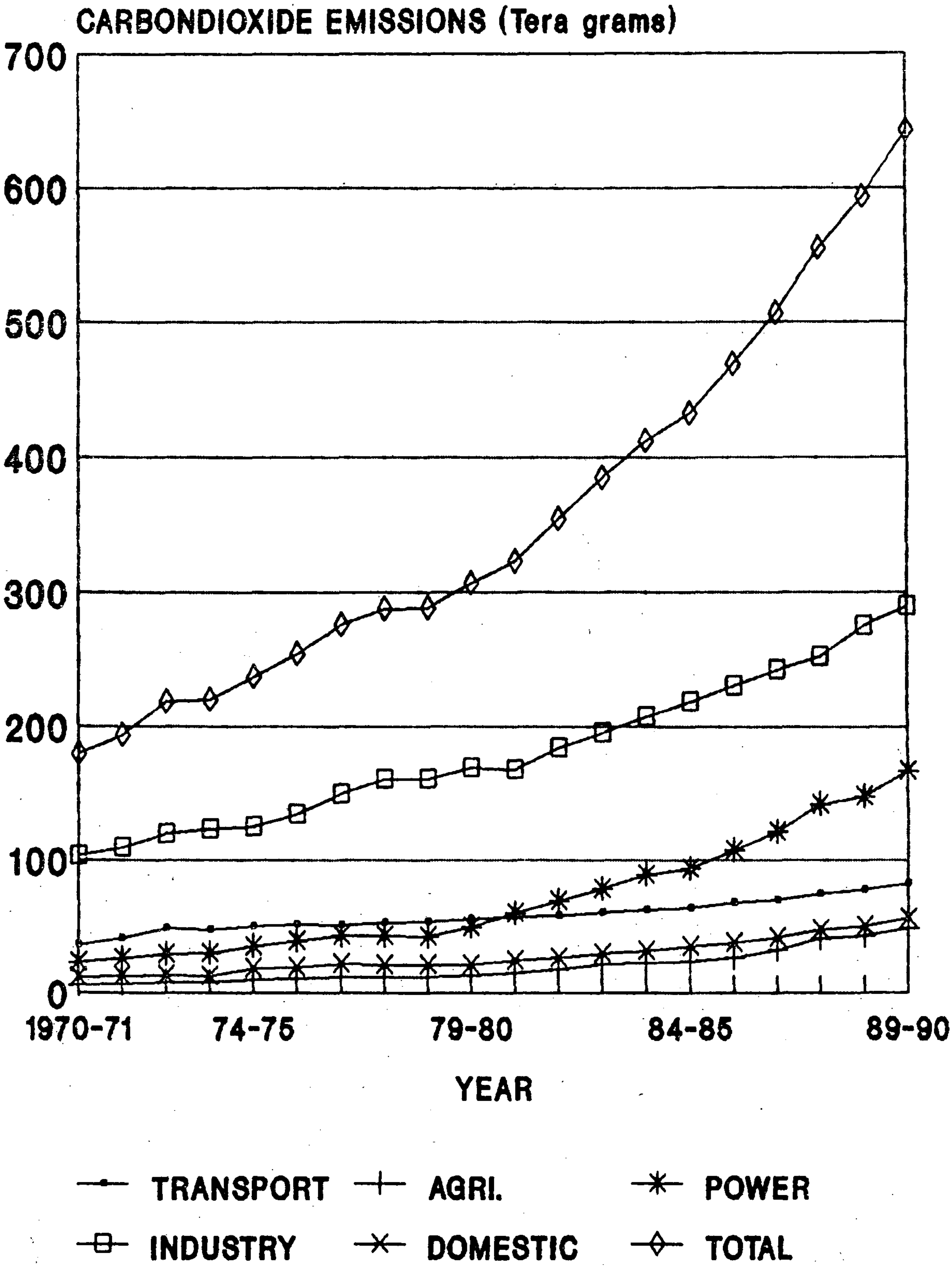
CARBONDIOXIDE EMISSIONS IN THE TRANSPORT SECTOR (Tera grams)



SOURCE AUTHOR

FIGURE [8.4.6.1]

CARBONDIOXIDE EMISSIONS IN THE INDIAN ECONOMY (Tera grams)



SOURCE: AUTHOR

FIGURE [8.4.6.2]

SECTORAL ENERGY CONSUMPTION IN THE INDIAN ECONOMY (Tera cals.)

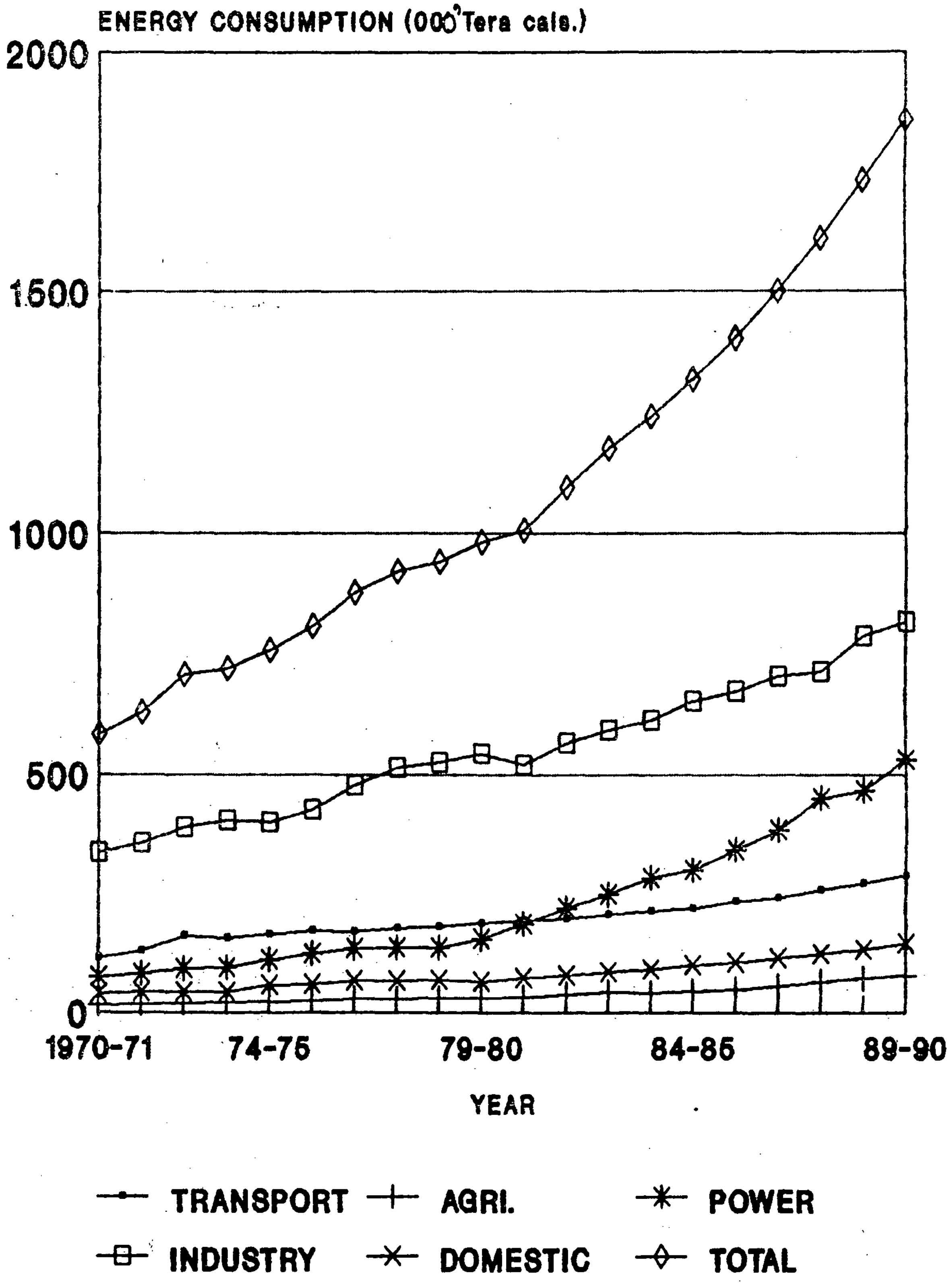


TABLE [8.3.1] CARBONDIOXIDE EMISSIONS IN THE AGRICULTURE SECTOR (Tera grams\Million tonnes).

YEAR	COAL	(As a % of tot.emissions in Coal)	PETROLEUM	(As a % of tot.emissions in Petroleum)	NATURAL GAS	(As a % of tot.emissions in Nat. Gas)	POWER	(As a % of tot.emissions in Power)	TOTAL
1970-71	2.97	2.49	0.52	1.49	0.02	1.17	2.35	10.22	5.87
1971-72	3.36	2.72	0.55	1.30	0.03	1.39	2.69	10.63	6.64
1972-73	3.75	2.88	0.53	0.94	0.03	1.54	3.48	12.06	7.80
1973-74	3.65	2.83	0.60	1.02	0.04	1.50	3.70	12.56	7.98
1974-75	4.18	2.96	0.45	0.78	0.05	1.68	5.12	14.75	9.80
1975-76	4.57	3.00	0.35	0.58	0.05	1.68	5.58	14.48	10.56
1976-77	4.94	2.96	0.41	0.65	0.06	2.02	6.18	14.44	11.59
1977-78	5.13	2.94	0.40	0.59	0.06	1.73	6.20	14.59	11.79
1978-79	4.80	2.85	0.38	0.51	0.07	1.91	6.57	15.56	11.82
1979-80	4.08	2.33	0.41	0.52	0.06	1.76	8.45	17.23	13.01
1980-81	4.04	2.26	0.57	0.69	0.07	2.35	10.50	17.59	15.18
1981-82	4.86	2.49	1.14	1.34	0.08	1.54	11.65	16.85	17.73
1982-83	6.03	2.88	0.89	0.98	0.08	1.28	14.59	18.64	21.59
1983-84	5.25	2.39	0.85	0.88	0.09	1.13	15.76	17.82	21.95
1984-85	5.27	2.33	0.87	0.84	0.10	1.04	17.09	18.38	23.33
1985-86	4.84	2.01	0.98	0.89	0.13	1.21	20.40	19.03	26.35
1986-87	5.00	1.95	0.99	0.84	0.15	1.25	26.16	21.66	32.31
1987-88	5.21	1.90	1.06	0.84	0.16	1.10	34.20	24.22	40.63
1988-89	6.09	2.07	1.09	0.81	0.14	0.87	35.51	24.08	42.83
1989-90	5.54	1.79	1.45	1.00	0.13	0.59	41.50	24.96	48.61

SOURCE: AUTHOR.

TABLE [8.3.2] CARBONDIOXIDE EMISSIONS IN THE DOMESTIC SECTOR (Tera grams\Million tonnes).

YEAR	COAL	(As a % of tot.emissions in Coal)	PETROLEUM	(As a % of tot.emissions in Petroleum)	NATURAL GAS	(As a % of tot.emissions in Nat. Gas)	POWER	(As a % of tot.emissions in Power)	TOTAL
1970-71	N.A.	N.A.	9.57	27.23	N.A.	N.A.	2.02	8.78	11.58
1971-72	N.A.	N.A.	10.30	24.34	N.A.	N.A.	2.21	8.72	12.51
1972-73	N.A.	N.A.	10.37	18.17	N.A.	N.A.	2.53	8.78	12.90
1973-74	N.A.	N.A.	9.80	16.59	N.A.	N.A.	2.72	9.24	12.52
1974-75	6.19	4.37	8.54	14.71	0.01	0.35	3.41	9.83	18.16
1975-76	6.06	3.98	9.37	15.62	0.02	0.66	3.73	9.66	19.17
1976-77	7.14	4.27	10.00	15.90	0.02	0.80	4.07	9.51	21.23
1977-78	5.62	3.23	11.02	16.35	0.02	0.58	4.18	9.85	20.85
1978-79	5.04	3.00	11.95	16.06	0.02	0.58	4.14	9.80	21.15
1979-80	3.76	2.14	11.73	14.89	0.02	0.59	5.28	10.76	20.79
1980-81	4.56	2.55	12.72	15.58	0.02	0.73	6.70	11.23	24.00
1981-82	3.81	1.95	14.28	16.81	0.02	0.49	8.00	11.57	26.11
1982-83	3.39	1.62	16.02	17.64	0.02	0.35	9.90	12.65	29.34
1983-84	2.99	1.36	17.24	17.97	0.03	0.32	11.44	12.93	31.70
1984-85	2.89	1.28	18.98	18.25	0.03	0.30	12.64	13.59	34.54
1985-86	2.16	0.90	20.39	18.46	0.03	0.32	15.03	14.02	37.62
1986-87	2.11	0.82	22.20	18.92	0.04	0.34	17.17	14.21	41.53
1987-88	1.61	0.59	24.04	19.12	0.06	0.38	21.45	15.19	47.16
1988-89	1.05	0.36	25.92	19.17	0.07	0.42	22.49	15.25	49.53
1989-90	0.95	0.31	27.92	19.20	0.07	0.31	26.79	16.12	55.73

SOURCE: AUTHOR.

TABLE [8.3.3] CARBONDIOXIDE EMISSIONS IN THE INDUSTRY SECTOR (Tera grams\Million tonnes).

YEAR	COAL	(As a % of tot.emissions in Coal)	PETROLEUM	(As a % of tot.emissions in Petroleum)	NATURAL GAS	(As a % of tot.emissions in Nat. Gas)	POWER	(As a % of tot.emissions in Power)	TOTAL
1970-71	70.58	59.08	14.16	40.32	0.39	18.75	17.87	77.87	103.01
1971-72	72.11	58.23	16.84	39.78	0.43	19.03	19.52	77.17	108.90
1972-73	76.29	58.64	21.40	37.50	0.46	21.72	21.75	75.44	119.90
1973-74	77.87	60.35	22.36	37.87	0.45	18.89	22.12	75.15	122.80
1974-75	78.36	55.35	20.82	35.84	0.62	21.84	25.19	72.51	124.97
1975-76	84.84	55.72	20.66	34.44	0.74	23.20	28.07	72.78	134.31
1976-77	95.21	56.96	22.15	35.21	1.00	32.76	31.14	72.80	149.50
1977-78	105.69	60.65	22.94	34.02	1.03	27.91	30.69	72.24	160.36
1978-79	103.10	61.31	25.63	34.44	1.10	29.90	30.32	71.81	160.15
1979-80	106.79	60.85	27.45	34.85	1.11	30.59	33.87	69.07	169.22
1980-81	97.58	54.59	28.03	34.34	0.96	30.64	40.85	68.43	167.41
1981-82	106.81	54.64	28.12	33.11	1.39	27.75	47.60	68.81	183.92
1982-83	113.87	54.34	28.59	31.49	1.60	24.60	51.64	65.96	195.69
1983-84	116.95	53.29	29.50	30.76	1.82	22.53	58.91	66.60	207.18
1984-85	123.37	54.58	32.01	30.79	2.20	22.57	60.91	65.51	218.50
1985-86	124.51	51.66	33.77	30.57	3.14	29.70	69.02	64.37	230.44
1986-87	128.95	50.33	34.78	29.63	4.10	33.84	74.60	61.75	242.43
1987-88	129.89	47.48	35.91	28.56	4.31	29.41	82.05	58.11	252.17
1988-89	143.91	49.00	38.66	28.60	6.82	41.53	85.78	58.17	275.17
1989-90	146.45	47.43	40.57	27.90	8.46	39.18	93.99	56.55	289.47

SOURCE: AUTHOR.

TABLE (8.3.4) CARBONDIOXIDE EMISSIONS IN THE GROSS GENERATION OF POWER (UTILITIES - Tera grams\Million tonnes).

YEAR	COAL	(As a % of tot.emissions in Coal)	PETROLEUM	(As a % of tot.emissions in Petroleum)	NATURAL GAS	(As a % of tot.emissions in Nat. Gas)	TOTAL
1970-71	17.73	14.84	3.54	10.07	1.68	80.09	22.95
1971-72	19.57	15.80	3.96	9.35	1.78	79.58	25.30
1972-73	22.34	17.17	4.86	8.52	1.63	76.74	28.83
1973-74	22.33	17.31	5.20	8.81	1.91	78.61	29.44
1974-75	27.24	19.25	5.34	9.20	2.15	76.14	34.73
1975-76	30.92	20.31	5.26	8.77	2.38	74.45	38.56
1976-77	36.03	21.56	4.76	7.57	1.98	64.41	42.77
1977-78	34.42	19.75	5.49	8.14	2.57	69.78	42.49
1978-79	33.28	19.79	6.45	8.66	2.49	67.61	42.22
1979-80	40.30	22.97	6.31	8.01	2.43	67.07	49.04
1980-81	51.20	28.64	6.42	7.86	2.07	66.28	59.69
1981-82	59.61	30.50	6.06	7.13	3.51	70.22	69.17
1982-83	66.46	31.71	7.04	7.76	4.79	73.77	78.29
1983-84	74.92	34.14	7.40	7.72	6.13	76.01	88.45
1984-85	77.38	34.23	8.20	7.88	7.41	76.08	92.99
1985-86	92.12	38.22	7.85	7.10	7.27	68.77	107.23
1986-87	105.46	41.16	7.53	6.42	7.82	64.57	120.80
1987-88	123.21	45.04	7.87	6.26	10.13	69.10	141.21
1988-89	130.47	44.42	7.62	5.64	9.38	57.18	147.48
1989-90	145.37	47.08	7.93	5.45	12.93	59.92	166.23

SOURCE: AUTHOR.

TABLE (8.3.5)   CARBONDIOXIDE EMISSIONS IN THE TRANSPORT (Tera grams\Million tonnes).

YEAR	COAL	(As a % of tot.emissions in Coal)	PETROLEUM	(As a % of tot.emissions in Petroleum)	POWER	(As a % of tot.emissions in Power)	TOTAL
1970-71	28.19	23.59	7.34	20.89	0.72	3.12	36.24
1971-72	28.80	23.26	10.68	25.23	0.88	3.47	40.36
1972-73	27.72	21.30	19.90	34.88	1.08	3.73	48.69
1973-74	25.18	19.52	21.09	35.72	0.90	3.05	47.17
1974-75	25.58	18.07	22.92	39.47	1.01	2.91	49.51
1975-76	25.87	16.99	24.35	40.59	1.19	3.08	51.41
1976-77	23.83	14.26	25.58	40.67	1.39	3.25	50.80
1977-78	23.39	13.42	27.58	40.90	1.41	3.32	52.39
1978-79	21.95	13.05	30.02	40.33	1.19	2.83	53.16
1979-80	20.55	11.71	32.88	41.73	1.45	2.95	54.88
1980-81	21.37	11.95	33.88	41.52	1.64	2.75	56.89
1981-82	20.37	10.42	35.35	41.61	1.92	2.78	57.64
1982-83	19.81	9.45	38.26	42.13	2.16	2.75	60.22
1983-84	19.36	8.82	40.91	42.66	2.34	2.65	62.61
1984-85	17.12	7.57	43.91	42.24	2.35	2.52	63.37
1985-86	17.39	7.21	47.47	42.98	2.77	2.58	67.63
1986-87	14.69	5.73	51.88	44.20	2.87	2.38	69.44
1987-88	13.66	4.99	56.84	45.21	3.51	2.48	74.01
1988-89	12.19	4.15	61.89	45.78	3.69	2.50	77.77
1989-90	10.49	3.40	67.54	46.45	3.95	2.37	81.98

SOURCE: AUTHOR.

TABLE [8.3.6]

CARBONDIXIDE EMISSIONS IN THE INDIAN ECONOMY
(Tera Cals.)

YEARS	TRANSPORT	(%)	AGRI.	(%)	POWER	(%)	INDUSTRY	(%)	DOMESTIC	(%)	TOTAL
1970-71	36.24	20.17	5.87	3.27	22.95	12.77	103.01	57.34	11.58	6.45	179.65
1971-72	40.36	20.83	6.64	3.43	25.30	13.06	108.90	56.22	12.51	6.46	193.71
1972-73	48.69	22.32	7.80	3.57	28.83	13.22	119.90	54.97	12.90	5.91	218.12
1973-74	47.17	21.45	7.98	3.63	29.44	13.39	122.80	55.84	12.52	5.69	219.90
1974-75	49.51	20.88	9.80	4.13	34.73	14.64	124.97	52.69	18.16	7.66	237.18
1975-76	51.41	20.24	10.56	4.16	38.56	15.18	134.31	52.88	19.17	7.55	254.01
1976-77	50.80	18.41	11.59	4.20	42.77	15.50	149.50	54.19	21.23	7.70	275.88
1977-78	52.39	18.20	11.79	4.10	42.49	14.76	160.36	55.70	20.85	7.24	287.87
1978-79	53.16	18.43	11.82	4.10	42.22	14.63	160.15	55.51	21.15	7.33	288.49
1979-80	54.88	17.88	13.01	4.24	49.04	15.98	169.22	55.13	20.79	6.77	306.94
1980-81	56.89	17.60	15.18	4.70	59.69	18.47	167.41	51.80	24.00	7.43	323.17
1981-82	57.64	16.26	17.73	5.00	69.17	19.51	183.92	51.87	26.11	7.37	354.57
1982-83	60.22	15.64	21.59	5.61	78.29	20.33	195.69	50.81	29.34	7.62	385.14
1983-84	62.61	15.20	21.95	5.33	88.45	21.47	207.18	50.30	31.70	7.70	411.89
1984-85	63.37	14.65	23.33	5.39	92.99	21.49	218.50	50.49	34.54	7.98	432.72
1985-86	67.63	14.41	26.35	5.61	107.23	22.85	230.44	49.11	37.62	8.02	469.26
1986-87	69.44	13.71	32.31	6.38	120.80	23.85	242.43	47.86	41.63	8.20	506.50
1987-88	74.01	13.33	40.63	7.32	141.21	25.43	252.17	45.42	47.18	8.49	555.19
1988-89	77.77	13.12	42.83	7.23	147.48	24.88	275.17	46.42	49.53	8.36	592.78
1989-90	81.98	12.77	48.61	7.57	166.23	25.89	289.47	45.09	55.73	8.68	642.03

SOURCE: AUTHOR.

TABLE [8.3.7]

SECTORAL ENERGY CONSUMPTION IN THE INDIAN ECONOMY
(Tera Cals.)

YEARS	TRANSPORT	(%)	AGRICULTURE	(%)	POWER	(%)	INDUSTRY	(%)	DOMESTIC	(%)	TOTAL
1970-71	114649.01	19.67	16467.55	2.82	74641.33	12.80	336635.87	57.75	40546.12	6.96	582939.88
1971-72	129167.23	20.55	18189.38	2.89	82152.17	13.07	355648.44	56.58	43460.18	6.91	628617.41
1972-73	160309.45	22.65	20452.24	2.89	92944.31	13.13	390076.75	55.11	44018.54	6.22	707801.29
1973-74	156752.33	21.77	21256.74	2.95	95594.11	13.28	403737.56	56.08	42602.07	5.92	719942.80
1974-75	164627.19	21.70	24139.70	3.18	112035.01	14.77	400706.08	52.81	57231.55	7.54	758739.53
1975-76	171187.07	21.17	26050.62	3.22	123936.33	15.33	426773.70	52.77	60734.64	7.51	808682.36
1976-77	170055.36	19.37	28720.89	3.27	135211.19	15.40	477036.00	54.32	67120.49	7.64	878143.93
1977-78	176287.37	19.11	29462.88	3.19	136224.81	14.77	513868.58	55.70	66774.11	7.24	922617.76
1978-79	180913.63	19.19	30906.42	3.28	135878.84	14.42	525318.87	55.74	69509.83	7.37	942527.59
1979-80	187452.77	19.08	30735.65	3.13	155992.41	15.88	542422.30	55.20	65967.20	6.71	982570.33
1980-81	193608.14	19.24	32563.50	3.24	186973.40	18.58	520220.41	51.69	73116.37	7.26	1006481.82
1981-82	196357.37	17.90	38039.40	3.47	218320.55	19.90	565801.18	51.59	78303.05	7.14	1096821.55
1982-83	205604.20	17.48	43608.90	3.71	249128.36	21.18	592381.90	50.36	85512.30	7.27	1176235.66
1983-84	214350.03	17.26	42287.65	3.40	282732.60	22.76	611953.24	49.26	90887.57	7.32	1242211.09
1984-85	219056.63	16.61	46043.91	3.49	299740.11	22.72	653936.05	49.58	100293.69	7.60	1319070.38
1985-86	233629.25	16.64	48786.26	3.48	341608.35	24.34	673402.04	47.97	106229.54	7.57	1403655.44
1986-87	241981.39	16.12	56828.53	3.79	383193.64	25.52	703667.94	46.87	115623.22	7.70	1501294.72
1987-88	257899.02	16.01	65191.86	4.05	449605.00	27.91	713585.35	44.29	124727.22	7.74	1611008.45
1988-89	272768.17	15.75	71992.34	4.16	466312.22	26.92	788099.19	45.49	133219.81	7.69	1732391.73
1989-90	288971.46	15.54	77878.16	4.19	530580.23	28.53	817025.86	43.93	145354.44	7.82	1859810.15

SOURCE: AUTHOR.

TABLE [8.4.1.1] REGRESSIONS: AGRICULTURE SECTOR.

DEPENDENT	INDEPENDENT	2-TAIL SIG.	CO-EFFICIENT	ADJ. R^2	DURBIN-WATSON
LNAGRCAL	LNGVAAGR	0.000	2.741	0.967	1.967
	C	0.000	-18.725		
	MA(1)	0.046	0.560		
LNAGRCO2	LNGVAAGR	0.000	3.875	0.972	1.869
	C	0.000	-38.489		
	MA(1)	0.038	0.588		
LNAGRCO2	LNAGRCAL	0.000	1.415	0.997	1.777
	C	0.000	-12.034		
	MA(1)	0.003	0.940		
LNGVAAGR	LNGDP	0.000	0.633	0.989	1.975
	C	0.000	3.218		
	MA(1)	0.027	0.630		
LNAGRCAL	LNAGRPDX	0.000	2.655	0.971	1.972
	C	0.000	-2.541		
	MA(1)	0.070	0.504		
LNAGRCO2	LNAGRPDX	0.000	3.746	0.966	1.901
	C	0.000	-15.575		
	MA(1)	0.037	0.591		

SOURCE: AUTHOR.

NOTE:

1. GVAAGR AND AGRPDNX IMPLY GROSS VALUE ADDED IN AGRICULTURE AND AGRICULTURAL PRODUCTION INDEX RESPECTIVELY.
2. AGRCAL = CALORIFIC CONTENT OF ENERGY CONSUMPTION IN THE AGRICULTURAL SECTOR
3. AGRCO2 = CO2 EMISSIONS FROM THE AGRICULTURE SECTOR
5. THE PREFIX 'L' SIGNIFIES THE LOGARITHMIC VALUE.

TABLE [8.4.1.2]		I. PROJECTION : AGRICULTURE SECTOR (INDIRECT).

YEAR	NGDP - growth rate (%)	NGVAAGR - growth rate (%): 1	NGVAAGR - Rs. Crores	NAGRCAL - growth rate (%): 2	NAGRCAL - Tera Cals.	NAGRCO2 - growth rate (%): 3	NAGRCO2 - Tera grams
(@)1990-91	5.40	3.42	59227.60	9.37	85174.79	13.26	55.06
(@)1991-92	0.90	0.57	59565.02	1.56	86504.83	2.21	56.27
(@)1992-93	4.30	2.72	61186.32	7.46	92958.72	10.56	62.21
(*)1993-94	4.30	2.72	62851.75	7.46	99894.12	10.56	68.78
(*)1994-95	5.30	3.35	64960.37	9.20	109080.16	13.01	77.73
(!)1995-96	5.50	3.48	67221.96	9.54	119489.46	13.50	88.23
(!)1996-97	5.60	3.54	69604.85	9.72	131099.41	13.75	100.36
(#)2001-02	6.05	3.83	83993.65	10.50	215950.67	14.85	200.57
(#)2006-07	6.51	4.12	102786.14	11.30	368753.90	15.98	420.95

Source: COMPUTED BY THE AUTHOR.

Note:
For the Agriculture Sector, to smoothen the associated fluctuations, we have taken a 3 year moving average for all the relevant parameters.

(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(*) - Quick estimates obtained from the 'Economic Survey - 1994/95', Ministry of Finance, GOI.
(!) - As the percentage growth rate of GDP (at factor cost, at 1980-81 prices) for 1994/95 is seen to be 5.3%, whereas the target percentage growth rate for the 8TH FYP is to be 5.6% - as obtained from the '8TH FYP', vol. 1, Planning Commission, GOI, we feel it is fairly rational and reasonable to assume that the percentage growth rate of GDP, for India, to be 5.5% and 5.6% respectively for the terminal years of the 8th plan i.e., for 1995/96 and 1996/97 respectively.
(#) - Percentage growth rates obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(0.633) * gr. rt.(%) of GDP for the year concerned).
2 - Growth rate(%) obtained as (elasticity factor(2.741) * gr. rt.(%) of GVAAGR for the year concerned).
3 - Growth rate(%) obtained as (elasticity factor(1.415) * gr. rt.(%) of AGRCAL for the year concerned).

TABLE (8.4.1.3)   II. PROJECTION : AGRICULTURE SECTOR (DIRECT).

YEAR	MGDP - growth rate (%)	MGVAAGR - growth rate (%): 1	MGVAAGR - Rs. Crores	MAGRCO2 - growth rate (%): 2	MAGRCO2 - Tera grams
(@)1990-91	5.40	3.42	59227.60	13.25	55.05
(@)1991-92	0.90	0.57	59565.02	2.21	56.27
(@)1992-93	4.30	2.72	61186.32	10.55	62.20
(*)1993-94	4.30	2.72	62851.75	10.55	68.76
(*)1994-95	5.30	3.35	64960.37	13.00	77.70
(!)1995-96	5.50	3.48	67221.96	13.49	88.18
(!)1996-97	5.60	3.54	69604.85	13.74	100.30
(#)2001-02	6.05	3.83	83993.65	14.84	200.33
(#)2006-07	6.51	4.12	102786.14	15.97	420.18

Source: COMPUTED BY THE AUTHOR.

Note:
For the Agriculture Sector, to smoothen the associated fluctuations, we have taken a 3 year moving average for all the relevant parameters.

(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(*) - Quick estimates obtained from the 'Economic Survey - 1994/95', Ministry of Finance, GOI.
(!) - As the percentage growth rate of GDP (at factor cost, at 1980-81 prices) for 1994/95 is seen to be 5.3%, whereas the target percentage growth rate for the 8TH FYP is to be 5.6% - as obtained from the '8TH FYP', vol. 1, Planning Commission, GOI, we feel it is fairly rational and reasonable to assume that the percentage growth rate of GDP, for India, to be 5.5% and 5.6% respectively for the terminal years of the 8th plan i.e., for 1995/96 and 1996/97 respectively.
(#) - Percentage growth rates obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(0.633) * gr. rt.(%) of GDP for the year concerned).
2 -Growth rate(%) obtained as (elasticity factor(3.875) * gr. rt.(%) of GVAAGR for the year concerned).

TABLE [8.4.2.1] REGRESSIONS: DOMESTIC SECTOR.

DEPENDENT	INDEPENDENT	2-TAIL SIG.	CO-EFFICIENT	ADJ. R^2	DURBIN-WATSON
LPFCE	LGDPFC	0.000	0.761	0.997	1.967
	C	0.038	2.790		
	AR(1)	0.000	0.967		
LDOMCAL	LPFCE	0.000	1.466	0.963	1.208
	C	0.002	-5.626		
	AR(1)	0.048	0.458		
LDOMCO2	LDOMCAL	0.000	1.227	0.998	2.165
	C	0.000	10.567		
LDOMCO2	LPFCE	0.000	1.808	0.959	1.248
	C	0.000	-17.582		
	AR(1)	0.078	0.415		
LPDOMCAL	LPCYPFCE	0.001	1.661	0.909	2.124
	C	0.095	-5.073		
	AR(1)	0.016	0.583		
LPDOMCO2	LPCYPFCE	0.217	1.381	0.914	2.334
	C	0.201	-10.883		
	AR(1)	0.001	0.833		

SOURCE: AUTHOR.

NOTE:

1. GDPFC = GROSS DOMESTIC PRODUCT AT FACTOR COST (AT 80-81 PRICES).
2. DOMCAL = CALORIFIC CONTENT OF ENERGY CONSUMPTION IN THE DOMESTIC SECTOR.
3. DOMCO2 = CO2 EMISSIONS FROM THE DOMESTIC SECTOR.
4. PCYPFCE = PER-CAPITA PRIVATE FINAL CONSUMPTION EXPENDITURE.
5. PREFIX 'P' AND 'L' SIGNIFY PER CAPITA VALUES AND LOGARITHMIC VALUES RESPECTIVELY
6. PFCE = PRIVATE FINAL CONSUMPTION EXPENDITURE.

TABLE [8.4.2.2] I. PROJECTION : DOMESTIC SECTOR (INDIRECT).

YEAR	GDPfc - growth rate (%)	PFCE - growth rate (%): 1	PFCE - Rs. Crores	DOMCAL - growth rate (%): 2	DOMCAL - Tera Cals.	DOMCO2 - growth rate (%): 3	DOMCO2 - Tera grams
(@)1990-91	5.40	4.11	158124.48	6.02	154111.10	7.39	59.85
(@)1991-92	0.90	0.68	159207.47	1.00	155658.48	1.23	60.58
(@)1992-93	4.30	3.27	164417.22	4.80	163125.71	5.89	64.15
(*)1993-94	4.30	3.27	169797.45	4.80	170951.16	5.89	67.93
(*)1994-95	5.30	4.03	176645.89	5.91	181059.19	7.26	72.86
(!)1995-96	5.50	4.19	184039.40	6.14	192168.88	7.53	78.34
(!)1996-97	5.60	4.26	191882.42	6.25	204174.65	7.67	84.34
(#)2001-02	6.05	4.60	240313.24	6.75	283029.57	8.28	125.56
(#)2006-07	6.51	4.95	306037.71	7.26	401861.08	8.91	192.40

Source: COMPUTED BY THE AUTHOR.

Note:
(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(*) - Quick estimates obtained from the 'Economic Survey - 1994/95', Ministry of Finance, GOI.
(!) - As the percentage growth rate of GDP (at factor cost, at 1980-81 prices) for 1994/95 is seen to be 5.3%, whereas the target percentage growth rate for the 8TH FYP is to be 5.6% - as obtained from the '8TH FYP', vol. 1, Planning Commission, GOI, we feel it is fairly rational and reasonable to assume that the percentage growth rate of GDP, for India, to be 5.5% and 5.6% respectively for the terminal years of the 8th plan i.e., for 1995/96 and 1996/97 respectively.
(#) - Percentage growth rates obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(0.761) * gr. rt.(%) of GDP for the year concerned).
2 - Growth rate(%) obtained as (elasticity factor(1.466) * gr. rt.(%) of PFCE for the year concerned).
3 - Growth rate(%) obtained as (elasticity factor(1.227) * gr. rt.(%) of DOMCAL for the year concerned).

TABLE [8.4.2.3] II. PROJECTION : DOMESTIC SECTOR (DIRECT).

YEAR	GDPfc	PFCE	PFCE	DOMCO2	DOMCO2
	- growth rate (%)	- growth rate (%): 1	- Rs. Crores	- growth rate (%): 2	- Tera grams
(@)1990-91	5.40	4.11	158124.48	7.43	59.87
(@)1991-92	0.90	0.68	159207.47	1.24	60.61
(@)1992-93	4.30	3.27	164417.22	5.92	64.20
(*)1993-94	4.30	3.27	169797.45	5.92	67.99
(*)1994-95	5.30	4.03	176645.89	7.29	72.95
(!)1995-96	5.50	4.19	184039.40	7.57	78.47
(!)1996-97	5.60	4.26	191882.42	7.70	84.52
(#)2001-02	6.05	4.60	240313.24	8.32	126.06
(#)2006-07	6.51	4.95	306037.71	8.96	193.58

Source: COMPUTED BY THE AUTHOR.

Note:
(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(*) - Quick estimates obtained from the 'Economic Survey - 1994/95', Ministry of Finance, GOI.
(!) - As the percentage growth rate of GDP (at factor cost, at 1980-81 prices) for 1994/95 is seen to be 5.3%, whereas the target percentage growth rate for the 8TH FYP is to be 5.6% - as obtained from the '8TH FYP', vol. 1, Planning Commission, GOI, we feel it is fairly rational and reasonable to assume that the percentage growth rate of GDP, for India, to be 5.5% and 5.6% respectively for the terminal years of the 8th plan i.e., for 1995/96 and 1996/97 respectively.
(#) - Percentage growth rates obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(0.761) * gr. rt.(%) of GDP for the year concerned).
2 -Growth rate(%) obtained as (elasticity factor(1.808) * gr. rt.(%) of PFCE for the year concerned).

TABLE [8.4.3.1] REGRESSIONS: INDUSTRY SECTOR.

DEPENDENT	INDEPENDENT	2-TAIL SIG.	CO-EFFICIENT	ADJ. R^2	DURBIN-WATSON
LINDCAL	LGVAIND	0.000	0.793	0.985	2.568
	C	0.000	4.431		
	AR(1)	0.004	0.555		
LINDCO2	LINDCAL	0.000	1.191	0.996	1.904
	C	0.000	-10.652		
	AR(1)	0.012	0.542		
LGVAIND	LGDPFC	0.000	1.178	0.996	2.046
	C	0.000	-2.768		
LINDCO2	LGVAIND	0.000	0.982	0.991	2.667
	C	0.000	-5.704		
	AR(1)	0.026	0.467		

SOURCE: AUTHOR.

NOTE:

1. GVAIND = GROSS VALUE ADDED IN INDUSTRIAL SECTOR.
2. INDCAL = CALORIFIC CONTENT OF ENERGY CONSUMPTION IN THE INDUSTRIAL SECTOR.
3. INDCO2 = CO2 EMISSIONS FROM THE INDUSTRIAL SECTOR.
4. GDPFC = GROSS DOMESTIC PRODUCT AT FACTOR COST (AT 80-81 PRICES).
5. THE PREFIX 'L' SIGNIFIES THE LOGARITHMIC VALUE.

TABLE [8.4.3.2] I. PROJECTION : INDUSTRY SECTOR (INDIRECT).

YEAR	GDPfc	GVAIND	GVAIND	INDCAL	INDCAL	INDCO2	INDCO2
	- growth rate (%)	- growth rate (%): 1	- Rs. Crores	- growth rate (%): 2	- Tera Cals.	- growth rate (%): 3	- Tera grams
(@)1990-91	5.40	6.36	116845.22	5.04	858240.21	6.01	306.87
(@)1991-92	0.90	1.06	118084.02	0.84	865455.77	1.00	309.94
(@)1992-93	4.30	5.07	124065.44	4.02	900219.94	4.78	324.77
(*)1993-94	4.30	5.07	130349.86	4.02	936380.53	4.78	340.30
(*)1994-95	5.30	6.24	138488.12	4.95	982740.88	5.90	360.37
(!)1995-96	5.50	6.48	147460.76	5.14	1033232.60	6.12	382.42
(!)1996-97	5.60	6.60	157188.46	5.23	1087283.71	6.23	406.25
(#)2001-02	6.05	7.13	221775.38	5.65	1431277.77	6.73	562.66
(#)2006-07	6.51	7.67	320894.52	6.08	1922732.93	7.24	798.16

Source: COMPUTED BY THE AUTHOR.

Note:
(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(*) - Quick estimates obtained from the 'Economic Survey - 1994/95', Ministry of Finance, GOI.
(!) - As the percentage growth rate of GDP (at factor cost, at 1980-81 prices) for 1994/95 is seen to be 5.3%, whereas the target percentage growth rate for the 8TH FYP is to be 5.6% - as obtained from the '8TH FYP', vol. 1, Planning Commission, GOI, we feel it is fairly rational and reasonable to assume that the percentage growth rate of GDP, for India, to be 5.5% and 5.6% respectively for the terminal years of the 8th plan i.e., for 1995/96 and 1996/97 respectively.
(#) - Percentage growth rates obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(1.178) * gr. rt.(%) of GDP for the year concerned).
2 - Growth rate(%) obtained as (elasticity factor(0.793) * gr. rt.(%) of GVAIND for the year concerned).
3 - Growth rate(%) obtained as (elasticity factor(1.191) * gr. rt.(%) of INDCAL for the year concerned).

TABLE [8.4.3.3] II. PROJECTION : INDUSTRY SECTOR (DIRECT).

YEAR	GDPfc	GVAIND	GVAIND	INDCO2	INDCO2
	- growth rate (%)	- growth rate (%): 1	- Rs. Crores	- growth rate (%): 2	- Tera grams
(@)1990-91	5.40	6.36	116845.22	6.25	307.56
(@)1991-92	0.90	1.06	118084.02	1.04	310.76
(@)1992-93	4.30	5.07	124065.44	4.97	326.22
(@)1993-94	4.30	5.07	130349.86	4.97	342.44
(*)1994-95	5.30	6.24	138488.12	6.13	363.44
(!)1995-96	5.50	6.48	147460.76	6.36	386.56
(!)1996-97	5.60	6.60	157188.46	6.48	411.60
(#)2001-02	6.05	7.13	221775.38	7.00	577.26
(#)2006-07	6.51	7.67	320894.52	7.53	829.91

Source: COMPUTED BY THE AUTHOR.

Note:
(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(*) - Quick estimates obtained from the 'Economic Survey - 1994/95', Ministry of Finance, GOI.
(!) - As the percentage growth rate of GDP (at factor cost, at 1980-81 prices) for 1994/95 is seen to be 5.3%, whereas the target percentage growth rate for the 8TH FYP is to be 5.6% - as obtained from the '8TH FYP', vol. 1, Planning Commission, GOI, we feel it is fairly rational and reasonable to assume that the percentage growth rate of GDP, for India, to be 5.5% and 5.6% respectively for the terminal years of the 8th plan i.e., for 1995/96 and 1996/97 respectively.
(#) - Percentage growth rates obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(1.178) * gr. rt.(%) of GDP for the year concerned).
2 -Growth rate(%) obtained as (elasticity factor(0.982) * gr. rt.(%) of GVAIND for the year concerned).

TABLE [8.4.4.1] REGRESSIONS: POWER SECTOR (1).

DEPENDENT	INDEPENDENT	2-TAIL SIG.	CO-EFFICIENT	ADJ. R^2	DURBIN-WATSON
LPOWCAL	LGDPFC	0.000	2.439	0.974	1.343
	C	0.000	-16.475		
LPOWCO2	LPOWCAL	0.000	1.007	0.999	1.835
	C	0.000	-8.161		
	AR(1)	0.089	0.414		
LELECAL	LGDPFC	0.000	1.770	0.989	1.539
	C	0.000	-9.167		
LTHRCAL	LELECAL	0.000	1.212	0.990	2.048
	C	0.000	-2.996		
	AR(1)	0.088	0.416		
LPOWCO2	LTHRCAL	0.000	1.040	0.994	1.490
	C	0.000	-7.422		
	AR(1)	0.001	0.800		
LPOWCO2	LGDPFC	0.000	2.461	0.973	1.353
	C	0.000	-24.812		
LPOWCO2	LELECAL	0.000	1.353	0.986	1.826
	C	0.000	-11.626		
	AR(1)	0.061	0.460		
LGELECAL	LPCYGDP	0.013	-0.616	0.972	2.611
	C	0.954	0.677		
	AR(1)	0.000	1.013		
LGPOWCO2	LPCYGDP	0.011	-1.265	0.972	1.644
	C	0.693	9.910		
	AR(1)	0.000	0.989		
LGPOWCO2	LTHRCAL	0.000	0.638	0.973	1.600
	C	0.000	-14.728		
	AR(1)	0.017	0.583		

SOURCE: AUTHOR.

NOTE:

1. GDPFC & PCYGDP = GROSS DOMESTIC PRODUCT AT FACTOR COST (AT 80-81 PRICES), AND PER-CAPITA GDP RESPECTIVELY
2. POWCAL = CALORIFIC CONTENT OF ENERGY CONSUMPTION IN THE POWER SECTOR (-GENERATION)
3. POWCO2 = CO2 EMISSIONS FROM THE POWER SECTOR (- GENERATION)
4. ELECAL = CALORIFIC CONTENT OF ELECTRICITY CONSUMPTION
5. THRCAL = CONSUMPTION OF THERMAL ELECTRICITY IN CALORIES.
6. PREFIX 'G' AND 'L' SIGNIFY GDP INTENSITY AND LOGARITHMIC VALUE RESPECTIVELY.

TABLE (8.4.4.1) REGRESSIONS: POWER SECTOR (contd. i.e., 2).

DEPENDENT	INDEPENDENT	2-TAIL SIG.	CO-EFFICIENT	ADJ. R^2	DURBIN-WATSON
LPOWCAL	LGDPFC	0.000	0.033	0.982	1.941
	C	0.000	-0.476		
LPOWCO2	LPOWCAL	0.000	0.061	0.966	1.837
	C	0.002	-0.226		
	AR(1)	0.070	0.439		
LELECAL	LGDPFC	0.000	0.063	0.966	1.226
	C	0.000	-8.319		
LTHRCAL	LELECAL	0.000	0.049	0.956	2.150
	C	0.000	-1.175		
	AR(1)	0.086	0.416		

SOURCE: AUTHOR.

NOTE:

1. GDPFC & PCYGDP = GROSS DOMESTIC PRODUCT AT FACTOR COST (AT 80-81 PRICES), AND PER-CAPITA GDP RESPECTIVELY
2. POWCAL = CALORIFIC CONTENT OF ENERGY CONSUMPTION IN THE POWER SECTOR (-GENERATION)
3. POWCO2 = CO2 EMISSIONS FROM THE POWER SECTOR (- GENERATION)
4. ELECAL = CALORIFIC CONTENT OF ELECTRICITY CONSUMPTION
5. THRCAL = CONSUMPTION OF THERMAL ELECTRICITY IN CALORIES
6. PREFIX 'G' AND 'L' SIGNIFY GDP INTENSITY AND LOGARITHMIC VALUE RESPECTIVELY.

TABLE [8.4.4.2]   I. PROJECTION : POWER SECTOR (GENERATION)

YEAR	GDPfc	POWCAL	POWCAL	POWCO2	POWCO2
	- growth rate (%)	- growth rate (%): 1	- Tera cals.	- growth rate (%): 2	- Tera grams
(@)1990-91	5.40	13.17	600460.91	13.26	188.28
(@)1991-92	0.90	2.20	613641.63	2.21	192.44
(@)1992-93	4.30	10.49	677998.52	10.56	212.76
(*)1993-94	4.30	10.49	749104.97	10.56	235.23
(*)1994-95	5.30	12.93	845939.52	13.02	265.85
(!)1995-96	5.50	13.41	959418.08	13.51	301.76
(!)1996-97	5.60	13.66	1090459.24	13.75	343.27
(#)2001-02	6.05	14.76	2170128.74	14.86	686.22
(#)2006-07	6.51	15.88	4534071.79	15.99	1440.61

Source: COMPUTED BY THE AUTHOR.

Note:
(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(*) - Quick estimates obtained from the 'Economic Survey - 1994/95', Ministry of Finance, GOI.
(!) - As the percentage growth rate of GDP (at factor cost, at 1980-81 prices) for 1994/95 is seen to be 5.3%, whereas the target percentage growth rate for the 8TH FYP is to be 5.6% - as obtained from the '8TH FYP', vol. 1, Planning Commission, GOI, we feel it is fairly rational and reasonable to assume that the percentage growth rate of GDP, for India, to be 5.5% and 5.6% respectively for the terminal years of the 8th plan i.e., for 1995/96 and 1996/97 respectively.
(#) - Percentage growth rates obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(2.439) * gr. rt.(%) of GDP for the year concerned).
2 -Growth rate(%) obtained as (elasticity factor(1.007) * gr. rt.(%) of POWCAL for the year concerned).

TABLE [8.4.4.3] II. PROJECTION : POWER SECTOR (CONSUMPTION).

YEAR	GDPfc - growth rate (%)	ELECAL - growth rate (%): 1	ELECAL - Tera Cals.	THRCAL - growth rate (%): 2	THRCAL - Tera Cals.	POWCO2 - growth rate (%): 3	POWCO2 - Tera grams
(@)1990-91	5.40	9.56	261587.80	11.58	191467.27	12.05	186.26
(@)1991-92	0.90	1.59	265754.90	1.93	195163.96	2.01	190.00
(@)1992-93	4.30	7.61	285981.50	9.22	213166.92	9.59	208.22
(*)1993-94	4.30	7.61	307747.55	9.22	232830.57	9.59	228.20
(*)1994-95	5.30	9.38	336617.35	11.37	259302.88	11.82	255.18
(!)1995-96	5.50	9.74	369387.05	11.80	289897.56	12.27	286.49
(!)1996-97	5.60	9.91	406000.69	12.01	324723.95	12.49	322.29
(#)2001-02	6.05	10.71	675198.72	12.98	597719.22	13.50	606.99
(#)2006-07	6.51	11.52	1164790.94	13.97	1149117.56	14.52	1195.83

Source: COMPUTED BY THE AUTHOR.

Note:

(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(*) - Quick estimates obtained from the 'Economic Survey - 1994/95', Ministry of Finance, GOI.
(!) - As the percentage growth rate of GDP (at factor cost, at 1980-81 prices) for 1994/95 is seen to be 5.3%, whereas the target percentage growth rate for the 8TH FYP is to be 5.6% - as obtained from the '8TH FYP', vol. 1, Planning Commission, GOI, we feel it is fairly rational and reasonable to assume that the percentage growth rate of GDP, for India, to be 5.5% and 5.6% respectively for the terminal years of the 8th plan i.e., for 1995/96 and 1996/97 respectively.
(#) - Percentage growth rates obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(1.770) * gr. rt.(%) of GDP for the year concerned).
2 - Growth rate(%) obtained as (elasticity factor(1.212) * gr. rt.(%) of ELECAL for the year concerned).
3 - Growth rate(%) obtained as (elasticity factor(1.040) * gr. rt.(%) of THRCAL for the year concerned).

TABLE [8.4.5.1]   REGRESSIONS: TRANSPORT SECTOR.

DEPENDENT	INDEPENDENT	2-TAIL SIG.	CO-EFFICIENT	ADJ. R^2	DURBIN-WATSON
LTRPAX	LPOPLN	0.000	3.712	0.990	1.675
	C	0.000	8.009		
LTRANCAL	LTRPAX	0.000	0.413	0.953	1.948
	C	0.000	9.494		
	AR(1)	0.021	0.423		
LTRANCO2	LTRANCAL	0.000	0.920	0.990	2.400
	C	0.000	-7.160		
	AR(1)	0.000	0.718		
LTRANCO2	LTRPAX	0.000	0.369	0.948	1.888
	C	0.000	1.649		
	AR(1)	0.029	0.419		
LTRANCAL	LGDPFC	0.293	0.310	0.965	2.254
	LPOPLN	0.116	0.991		
	C	0.001	4.369		
	AR(1)	0.041	0.347		
LTRANCO2	LGDPFC	0.215	0.344	0.961	2.257
	LPOPLN	0.192	0.751		
	C	0.926	0.314		
	AR(1)	0.077	0.313		

SOURCE: AUTHOR.

NOTE:

1. GDPFC & PCYGDP = GROSS DOMESTIC PRODUCT AT FACTOR COST (AT 80-81 PRICES), AND PER-CAPITA GDP RESPECTIVELY
2. TRANCAL = CALORIFIC CONTENT OF ENERGY CONSUMPTION IN THE TRANSPORT SECTOR.
3. TRANCO2 = CO2 EMISSIONS FROM THE TRANSPORT SECTOR.
4. POPLN = POPULATION OF INDIA IN BILLIONS
5. TRPAX = TOTAL PASSENGER TRAFFIC IN THE TRANSPORT SECTOR IN BILLIONS.
6. PREFIX 'L' SIGNIFIES LOGARITHMIC VALUE.
6. PFCE = PRIVATE FINAL CONSUMPTION EXPENDITURE.

TABLE (8.4.5.2)   I. PROJECTION : TRANSPORT SECTOR (INDIRECT).

YEAR	POPLN. - BILLIONS	POPLN. - growth rate (%)	TRPAX - growth rate (%): 1	TRPAX - Bln. Km	TRANSCAL - growth rate (%): 2	TRANSCAL - Tera Cals.	TRANSCO2 - growth rate (%): 3	TRANSCO2 - Tera grams
(@)1987-88	0.787	2.08	7.70	1237.61	3.18	249679.89	2.93	71.47
(@)1988-89	0.803	2.03	7.55	1330.90	3.12	257461.81	2.87	73.52
(@)1989-90	0.82	2.12	7.86	1435.49	3.25	265817.92	2.99	75.71
(@)1990-91	0.838	2.20	8.15	1552.46	3.37	274763.35	3.10	78.06
(#)1991-92	0.844	0.72	2.66	1593.72	1.10	277779.30	1.01	78.85
(#)1996-97	0.925	1.85	6.87	2221.33	2.84	319462.63	2.61	89.68
(#)2001-02	1.006	1.69	6.28	3012.76	2.60	363130.15	2.39	100.91
(#)2006-07	1.086	1.54	5.72	3979.62	2.36	408134.16	2.18	112.37

Source: COMPUTED BY THE AUTHOR.

Note:
(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(#) - Figures obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(3.712) * gr. rt.(%) of POPLN. for the year concerned).
2 - Growth rate(%) obtained as (elasticity factor(0.413) * gr. rt.(%) of TRPAX for the year concerned).
3 -Growth rate(%) obtained as (elasticity factor(0.92) * gr. rt(%) of TRANSCAL for the year concerned).

TABLE [8.4.5.3] II. PROJECTION : TRANSPORT SECTOR (DIRECT).

YEAR	POPLN. - BILLIONS	POPLN. - growth rate (%)	TRPAX - growth rate (%): 1	TRPAX - Bln. Km	TRANSCO2 - growth rate (%): 2	TRANSCO2 - Tera grams
(@)1987-88	0.787	2.08	7.70	1237.51	2.84	71.41
(@)1988-89	0.803	2.03	7.55	1330.90	2.78	73.40
(@)1989-90	0.82	2.12	7.86	1435.49	2.90	75.53
(@)1990-91	0.838	2.20	8.15	1552.46	3.01	77.80
(#)1991-92	0.844	0.72	2.66	1593.72	0.98	78.56
(#)1996-97	0.925	1.85	6.87	2221.33	2.53	89.03
(#)2001-02	1.006	1.69	6.28	3012.76	2.32	99.84
(#)2006-07	1.086	1.54	5.72	3979.62	2.11	110.84

Source: COMPUTED BY THE AUTHOR.

Note:
(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(#) - Figures obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(3.712) * gr. rt.(%) of POPLN. for the year concerned).
2 - Growth rate(%) obtained as (elasticity factor(0.369) * gr. rt.(%) of TRPAX for the year concerned).

TABLE [8.4.6.1] REGRESSIONS: TOTAL ECONOMY

DEPENDENT	INDEPENDENT	2-TAIL SIG.	CO-EFFICIENT	ADJ. R^2	DURBIN-WATSON
LTOTCAL	LGDPFC	0.000	1.345	0.978	1.326
	C	0.002	-1.943		
LTOTCO2	LTOTCAL	0.000	1.131	0.998	1.875
	C	0.000	-9.857		
	AR(1)	0.013	0.504		
LGTOTCO2	LGDPFC	0.000	1.503	0.980	1.577
	C	0.000	-11.840		
LGTOTCAL	LPCYGDP	0.001	-0.806	0.887	2.215
	C	0.003	9.221		
	AR(1)	0.000	0.966		
LGTOTCO2	LPCYGDP	0.052	-0.587	0.910	2.572
	C	0.811	-0.699		
	AR(1)	0.000	0.956		
LGTOTCAL	T	0.000	0.015	0.846	1.431
	C	0.000	1.947		
LGTOTCO2	T	0.000	0.022	0.921	1.738
	C	0.000	-6.165		

SOURCE: AUTHOR.

NOTE:

1. GDPFC = GROSS DOMESTIC PRODUCT AT FACTOR COST (AT 80-81 PRICES).
2. TOTCAL = CALORIFIC CONTENT OF ENERGY CONSUMPTION IN THE TOTAL ECONOMY
3. TOTCO2 = CO_2 EMISSIONS FROM THE TOTAL ECONOMY
4. PCYGDP = PER-CAPITA GDP.
5. PREFIX 'G' AND 'L' SIGNIFY PER GDP INTENSITY AND LOGARITHMIC VALUES RESPECTIVELY.

TABLE [8.4.6.2] I. PROJECTION : TOTAL (INDIRECT).

YEAR	GDPfc - growth rate (%)	TOTCAL - growth rate (%): 1	TOTCAL - Tera Cals.	TOTCO2 - growth rate (%): 2	TOTCO2 - Tera grams
(@)1990-91	5.40	7.26	1994888.00	8.21	694.76
(@)1991-92	0.90	1.21	2019036.12	1.37	704.28
(@)1992-93	4.30	5.78	2135807.07	6.54	750.34
(*)1993-94	4.30	5.78	2259331.48	6.54	799.43
(*)1994-95	5.30	7.13	2420387.92	8.06	863.88
(!)1995-96	5.50	7.40	2599436.12	8.37	936.15
(!)1996-97	5.60	7.53	2795225.64	8.52	1015.90
(#)2001-02	6.05	8.14	4133267.16	9.20	1577.72
(#)2006-07	6.51	8.76	6288667.15	9.90	2529.75

Source: COMPUTED BY THE AUTHOR.

Note:
(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(*) - Quick estimates obtained from the 'Economic Survey - 1994/95', Ministry of Finance, GOI.
(!) - As the percentage growth rate of GDP (at facter cost, at 1980-81 prices) for 1994/95 is seen to be 5.3%, whereas the target percentage growth rate for the 8TH FYP is to be 5.6% - as obtained from the '8TH FYP', vol. 1, Planning Commission, GOI, we feel it is fairly rational and reasonable to assume that the percentage growth rate of GDP, for India, to be 5.5% and 5.6% respectively for the terminal years of the 8th plan i.e., for 1995/96 and 1996/97 respectively.
(#) - Percentage growth rates obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(1.345) * gr. rt.(%) of GDP for the year concerned).
2 -Growth rate(%) obtained as (elasticity facter(1.131) * gr. rt.(%) of TOTCAL for the year concerned).

TABLE [8.4.5.3] II. PROJECTION : TOTAL (DIRECT).

YEAR	GDPfc	TOTCO2	TOTCO2
	- growth rate (%)	- growth rate (%): 1	- Rs. Crores
(@)1990-91	5.40	8.12	694.13
(@)1991-92	0.90	1.35	703.62
(@)1992-93	4.30	6.46	748.99
(*)1993-94	4.30	6.46	797.40
(*)1994-95	5.30	7.97	860.92
(!)1995-96	5.50	8.27	932.09
(!)1996-97	5.60	8.42	1010.54
(#)2001-02	6.05	9.09	1561.49
(#)2006-07	6.51	9.78	2490.27

Source: COMPUTED BY THE AUTHOR.

Note:
(@) - Obtained from various volumes of 'Economic Survey', Ministry of Finance, GOI.
(*) - Quick estimates obtained from the 'Economic Survey - 1994/95', Ministry of Finance, GOI.
(!) - As the percentage growth rate of GDP (at factor cost, at 1980-81 prices) for 1994/95 is seen to be 5.3%, whereas the target percentage growth rate for the 8TH FYP is to be 5.6% - as obtained from the '8TH FYP', vol. 1, Planning Commission, GOI, we feel it is fairly rational and reasonable to assume that the percentage growth rate of GDP, for India, to be 5.5% and 5.6% respectively for the terminal years of the 8th plan i.e., for 1995/96 and 1996/97 respectively.
(#) - Percentage growth rates obtained from the '8th FYP', Planning Commission, GOI.

1 - Growth rate(%) obtained as (elasticity factor(1.503) * gr. rt.(%) of GDP for the year concerned).

TABLE [8.4.6.4]

PROJECTION PROFILE FOR CARBONDIOXIDE EMISSIONS (Tera grams/mln Tonnes)

SECTOR	1996-97		2001-02		2006-07	
	DIRECT	INDIRECT	DIRECT	INDIRECT	DIRECT	INDIRECT
AGRI.	100.30	100.36	200.33	200.57	420.18	420.95
DOMS.	84.52	84.34	126.06	125.56	193.58	192.40
IND.	411.60	406.25	577.26	562.66	829.91	798.16
POWER	343.27	322.29	686.22	606.99	1440.61	1195.83
TRANS.	89.03	89.68	99.84	100.91	110.84	112.37
TOTAL	1028.72	1002.92	1689.71	1596.68	2995.12	2719.71
TOTAL ECONOMY	1010.54	1015.90	1561.49	1577.72	2490.27	2529.75

SOURCE: AUTHOR

TABLE (8.4.7.1) CALORIFIC INTENSITY OF CARBONDIOXIDE EMISSIONS (grams/cal)

	1970-71	1989-90
COAL	3.26 * 10^-4	3.26 * 10^-4
PETROLEUM PRODUCTS	2.36 * 10^-4	2.45 * 10^-4
NATURAL GAS	1.96 * 10^-4	2.43 * 10^-4
ELECTRICITY (CONSUMPTION)	2.97 * 10^-4	1.81 * 10^-4
POWER (GENERATION)	3.22 * 10^-4	3.13 * 10^-4

SOURCE : AUTHOR

NOTE: The figures vary for a particular fuel, across years, because of the fact that the consumption basket of fuels differ(intra-, as well as inter-fuels) across years, and this means that not only the calorific consumption differs, but also the corresponding emissions of carbondioxide also differs.

APPENDIX: 8A(- AGRICULTURE SECTOR)

	GMAGRCA	GMAGRCO	LGMAGRC	LGMAGRC	LMAGRCA	LMAGRCO	LMAGRPD	LMGDP	LMGVAAG	MAGRCAL	MAGRCO2	MAGRPDX	MGDP	MGVAAGR
1971	0.20200	7.44E-05	-1.5995	-9.5058	9.8185	1.9121	4.6849	11.418	10.447	18370	6.7676	108.30	90938	34453
1972	0.21579	8.08E-05	-1.5335	-9.4241	9.9018	2.0112	4.6877	11.435	10.445	19966	7.4723	108.60	92526	34386
1973	0.23306	9.06E-05	-1.4565	-9.3096	9.9965	2.1434	4.6797	11.453	10.443	21950	8.5281	107.73	94179	34307
1974	0.24100	9.56E-05	-1.4229	-9.2552	10.078	2.2458	4.7481	11.501	10.506	23816	9.4481	115.37	98819	36532
1975	0.25658	1.04E-04	-1.3603	-9.1723	10.177	2.3655	4.7593	11.538	10.519	26304	10.649	116.67	102615	37017
1976	0.25881	1.04E-04	-1.3517	-9.1687	10.243	2.4257	4.8264	11.594	10.581	28078	11.311	124.77	108489	39379
1977	0.26126	1.03E-04	-1.3422	-9.1788	10.299	2.4623	4.8603	11.641	10.606	29697	11.731	129.07	113668	40359
1978	0.26108	1.05E-04	-1.3429	-9.1623	10.321	2.5018	4.8621	11.664	10.603	30368	12.205	129.30	116320	40239
1979	0.26376	1.12E-04	-1.3327	-9.0970	10.355	2.5904	4.8675	11.687	10.602	31402	13.335	130.00	119056	40235
1980	0.27646	1.25E-04	-1.2857	-8.9852	10.428	2.7281	4.8777	11.713	10.618	33780	15.304	131.33	122184	40856
1981	0.29571	1.41E-04	-1.2184	-8.8660	10.547	2.8996	4.9273	11.766	10.673	38071	18.166	138.00	128744	43190
1982	0.30327	1.50E-04	-1.1931	-8.8054	10.629	3.0166	4.9767	11.822	10.727	41312	20.422	145.00	136223	45584
1983	0.30740	1.56E-04	-1.1796	-8.7669	10.691	3.1042	5.0039	11.871	10.759	43980	22.290	149.00	143071	47072
1984	0.30345	1.59E-04	-1.1925	-8.7497	10.730	3.1728	5.0499	11.923	10.796	45706	23.875	156.00	150621	48811
1985	0.32249	1.74E-04	-1.1317	-8.6546	10.831	3.3079	5.0413	11.962	10.790	50553	27.327	154.67	156757	48542
1986	0.34847	2.03E-04	-1.0542	-8.5045	10.950	3.4994	5.0348	12.004	10.786	56936	33.096	153.67	163386	48345
1987	0.37163	2.22E-04	-0.98985	-8.4139	11.077	3.6530	5.0876	12.067	10.838	64671	38.591	162.00	174018	50912
1988	0.38388	2.36E-04	-0.95743	-8.3527	11.180	3.7848	5.1571	12.138	10.897	71687	44.027	173.67	186745	54001

SOURCE: COMPILED AND COMPUTED BY THE AUTHOR.

APPENDIX: 8B (- DOMESTIC SECTOR)

	DOMSCAL	LDOMCAL	DOMSCO2	LDOMCO2	GDPFC	LGDPFC	PFCE	LPFCE	BPOPLN	PDOMCAL	LPDOMCA	PDOMCO2	LPDOMCO	PCYPFCE	LPCYPFCE
1970	40546	10.610	11.581	2.4494	90426	11.412	71522	11.178	0.54100	749.47	6.6194	0.21407	-1.5414	1322.0	7.1869
1971	43460	10.680	12.510	2.5266	91339	11.422	73206	11.201	0.55400	784.48	6.6650	0.22582	-1.4880	1321.4	7.1865
1972	44019	10.692	12.897	2.5570	91048	11.419	73647	11.207	0.56700	776.34	6.6546	0.22746	-1.4808	1298.9	7.1693
1973	42602	10.660	12.516	2.5270	95192	11.464	75654	11.234	0.58000	734.52	6.5992	0.21580	-1.5334	1304.4	7.1735
1974	57232	10.955	18.156	2.8990	96297	11.475	75747	11.235	0.59300	965.12	6.8723	0.30618	-1.1836	1277.4	7.1525
1975	60735	11.014	19.174	2.9536	104968	11.561	80063	11.291	0.60700	1000.6	6.9083	0.31588	-1.1524	1319.0	7.1846
1976	67120	11.114	21.230	3.0554	106280	11.574	82165	11.316	0.62000	1082.6	6.9871	0.34242	-1.0717	1325.2	7.1894
1977	66774	11.109	20.853	3.0375	114219	11.646	88706	11.393	0.63400	1053.2	6.9596	0.32890	-1.1120	1399.1	7.2436
1978	69510	11.149	21.152	3.0517	120504	11.699	94041	11.451	0.64800	1072.7	6.9779	0.32641	-1.1196	1451.2	7.2802
1979	65967	11.097	20.791	3.0345	114236	11.646	91379	11.423	0.66400	993.48	6.9012	0.31311	-1.1612	1376.2	7.2271
1980	73116	11.200	23.998	3.1780	122427	11.715	99292	11.506	0.67900	1076.8	6.9818	0.35343	-1.0401	1462.3	7.2878
1981	78303	11.268	26.114	3.2625	129889	11.774	103848	11.551	0.69400	1128.3	7.0285	0.37629	-0.97740	1496.4	7.3108
1982	85512	11.356	29.342	3.3790	133915	11.805	107071	11.581	0.70900	1206.1	7.0951	0.41385	-0.88226	1510.2	7.3200
1983	90888	11.417	31.697	3.4562	144865	11.884	115057	11.653	0.72400	1255.4	7.1352	0.43781	-0.82598	1589.2	7.3710
1984	100294	11.516	34.540	3.5421	150433	11.921	119464	11.691	0.73800	1359.0	7.2145	0.46803	-0.75923	1618.8	7.3894
1985	106230	11.573	37.621	3.6276	156566	11.961	124054	11.728	0.75400	1408.9	7.2506	0.49895	-0.69524	1645.3	7.4057
1986	115623	11.658	41.528	3.7263	163271	12.003	130262	11.777	0.77100	1499.7	7.3130	0.53860	-0.61879	1688.5	7.4322
1987	124727	11.734	47.162	3.8536	170322	12.045	135129	11.814	0.78700	1584.8	7.3682	0.59926	-0.51206	1717.0	7.4483
1988	133220	11.800	49.527	3.9025	188461	12.147	145915	11.891	0.80300	1659.0	7.4140	0.61677	-0.48326	1817.1	7.5050
1989	145354	11.887	55.728	4.0205	201453	12.213	151883	11.931	0.82000	1772.6	7.4802	0.67961	-0.38624	1852.2	7.5241

SOURCE: COMPILED AND COMPUTED BY THE AUTHOR.

APPENDIX: 8C (- INDUSTRY SECTOR)

	INDCAL	LINDCAL	INDCO2	LINDCO2	GVAIND	LGVAIND	GDPFC	LGDPFC
1970	336636	12.727	103.01	4.6348	42553	10.659	90426	11.412
1971	355648	12.782	108.90	4.6904	43792	10.687	91339	11.422
1972	390077	12.874	119.90	4.7867	45057	10.716	91048	11.419
1973	403738	12.909	122.80	4.8106	46044	10.737	95192	11.464
1974	400706	12.901	124.97	4.8281	47295	10.764	96297	11.475
1975	426774	12.964	134.31	4.9002	50136	10.822	104968	11.561
1976	477036	13.075	149.50	5.0073	53211	10.882	106280	11.574
1977	513869	13.150	160.36	5.0774	56694	10.945	114219	11.646
1978	525319	13.172	160.15	5.0761	61040	11.019	120504	11.699
1979	542422	13.204	169.22	5.1312	59831	10.999	114236	11.646
1980	520220	13.162	167.41	5.1205	62190	11.038	122427	11.715
1981	565801	13.246	183.92	5.2145	66280	11.102	129889	11.774
1982	592382	13.292	195.69	5.2766	69869	11.154	133915	11.805
1983	611953	13.324	207.18	5.3336	74730	11.222	144865	11.884
1984	653936	13.391	218.50	5.3868	78761	11.274	150433	11.921
1985	673402	13.420	230.44	5.4400	83282	11.330	156566	11.961
1986	703668	13.464	242.43	5.4907	89278	11.400	163271	12.003
1987	713585	13.478	252.17	5.5301	94220	11.453	170322	12.045
1988	788099	13.577	275.17	5.6174	102503	11.538	188461	12.147
1989	817026	13.613	289.47	5.6681	109857	11.607	201453	12.213

SOURCE: COMPILED AND COMPUTED BY THE AUTHOR.

APPENDIX: 8D (- POWER SECTOR)

	POWERCA	LPOWCAL	POWERCO	LPOWCO2	ELECAL	LELECAL	THRCAL	LTHRCAL	GDPFC	LGDPFC	GELECAL	LGELECA	PCYGDP	LPCYGDP	GPOWCO2	LGPOWCO	GPOWCAL	LGPOWCA	GTHRCAL	LGTHRCAL
1970	74641	11.220	22.948	3.1332	57783	10.964	28850	10.276	90426	11.412	0.63901	-0.44784	1671.5	7.4215	2.54E-04	-8.2791	0.82544	-0.19184	0.31904	-1.1424
1971	82152	11.316	25.301	3.2308	59620	10.996	31966	10.372	91339	11.422	0.65274	-0.42658	1648.7	7.4078	2.77E-04	-8.1915	0.89942	-0.10600	0.34997	-1.0499
1972	92944	11.440	28.835	3.3616	63053	11.052	36281	10.499	91048	11.419	0.69252	-0.36742	1605.8	7.3814	3.17E-04	-8.0576	1.0208	0.02061	0.39848	-0.92010
1973	95594	11.468	29.436	3.3822	67698	11.123	35628	10.481	95192	11.464	0.71118	-0.34083	1641.2	7.4032	3.09E-04	-8.0814	1.0042	0.00422	0.37428	-0.98276
1974	112035	11.627	34.733	3.5477	70633	11.165	40073	10.598	96297	11.475	0.73349	-0.30994	1623.9	7.3926	3.61E-04	-7.9275	1.1634	0.15137	0.41614	-0.87672
1975	123936	11.728	38.562	3.6523	79479	11.283	42998	10.669	104968	11.561	0.75718	-0.27816	1729.3	7.4555	3.67E-04	-7.9091	1.1807	0.16611	0.40963	-0.89250
1976	136211	11.815	42.771	3.7559	89143	11.398	49473	10.809	106280	11.574	0.83875	-0.17584	1714.2	7.4467	4.02E-04	-7.8180	1.2722	0.24076	0.46550	-0.76465
1977	136225	11.822	42.487	3.7492	89908	11.407	50438	10.829	114219	11.646	0.78716	-0.23933	1801.6	7.4964	3.72E-04	-7.8967	1.1927	0.17619	0.44159	-0.81737
1978	135879	11.820	42.216	3.7428	100601	11.519	51773	10.855	120504	11.699	0.83483	-0.18052	1859.6	7.5281	3.50E-04	-7.9566	1.1276	0.12008	0.42964	-0.84482
1979	155992	11.958	49.041	3.8927	103142	11.544	55441	10.923	114236	11.646	0.90288	-0.10216	1720.4	7.4503	4.29E-04	-7.7534	1.3656	0.31154	0.48532	-0.72295
1980	186973	12.139	59.689	4.0891	108944	11.599	59957	11.001	122427	11.715	0.88987	-0.11668	1803.0	7.4972	4.88E-04	-7.6261	1.5272	0.42345	0.48973	-0.71389
1981	218321	12.294	69.174	4.2366	119190	11.688	67544	11.121	129889	11.774	0.91763	-0.08596	1871.6	7.5345	5.33E-04	-7.5378	1.6808	0.51928	0.52001	-0.65391
1982	249128	12.426	78.288	4.3604	124957	11.736	77317	11.256	133915	11.805	0.93311	-0.06924	1888.8	7.5437	5.85E-04	-7.4446	1.8603	0.62076	0.57736	-0.54929
1983	282733	12.552	88.452	4.4825	137394	11.831	83845	11.337	144865	11.884	0.94843	-0.05295	2000.9	7.6014	6.11E-04	-7.4011	1.9517	0.66870	0.57878	-0.54683
1984	299740	12.611	92.987	4.5325	154180	11.946	95617	11.468	150433	11.921	1.0249	0.02460	2038.4	7.6199	6.18E-04	-7.3888	1.9925	0.68948	0.63561	-0.45317
1985	341608	12.741	107.23	4.6750	168307	12.034	109553	11.604	156566	11.961	1.0750	0.07231	2076.5	7.6384	6.85E-04	-7.2863	2.1819	0.78019	0.69972	-0.35707
1986	383194	12.856	120.80	4.7942	183776	12.121	122478	11.716	163271	12.003	1.1256	0.11831	2117.7	7.6581	7.40E-04	-7.2090	2.3470	0.85313	0.75015	-0.28748
1987	449605	13.016	141.21	4.9502	199030	12.201	143193	11.872	170322	12.045	1.1686	0.15576	2164.2	7.6798	8.29E-04	-7.0952	2.6397	0.97068	0.84072	-0.17349
1988	466312	13.053	147.48	4.9937	219070	12.297	151929	11.931	188461	12.147	1.1624	0.15050	2347.0	7.7609	7.83E-04	-7.1530	2.4743	0.90596	0.80616	-0.21549
1989	530580	13.182	166.23	5.1134	238767	12.383	171590	12.053	201453	12.213	1.1852	0.16993	2456.7	7.8066	8.25E-04	-7.0999	2.6338	0.96842	0.85176	-0.16045

SOURCE: COMPILED AND COMPUTED BY THE AUTHOR.

APPENDIX: 8E (- TRANSPORT SECTOR)

	TRPAX	LTRPAX	BPOPLN	LBPOPLN	TRANSCA	LTRANCA	TRANSCO	LTRANCO	GDPFC	LGDPFC
1970	328.00	5.7930	0.54100	-0.61434	114649	11.650	36.241	3.5902	90426	11.412
1971	350.00	5.8579	0.55400	-0.59059	129167	11.769	40.358	3.6978	91339	11.422
1972	356.00	5.8749	0.56700	-0.56740	160309	11.985	48.693	3.8855	91048	11.419
1973	392.00	5.9713	0.58000	-0.54473	156752	11.962	47.167	3.8537	95192	11.464
1974	419.00	6.0379	0.59300	-0.52256	164627	12.011	49.512	3.9022	96297	11.475
1975	457.00	6.1247	0.60700	-0.49923	171187	12.051	51.409	3.9398	104968	11.561
1976	482.00	6.1779	0.62000	-0.47804	170055	12.044	50.799	3.9279	106280	11.574
1977	573.00	6.3509	0.63400	-0.45571	176287	12.080	52.387	3.9587	114219	11.646
1978	602.00	6.4003	0.64800	-0.43386	180914	12.106	53.157	3.9732	120504	11.699
1979	620.00	6.4297	0.66400	-0.40947	187453	12.141	54.875	4.0051	114236	11.646
1980	752.00	6.6227	0.67900	-0.38713	193608	12.174	56.893	4.0412	122427	11.715
1981	815.00	6.7032	0.69400	-0.36528	196357	12.188	57.638	4.0542	129889	11.774
1982	824.00	6.7142	0.70900	-0.34390	205604	12.234	60.223	4.0980	133915	11.805
1983	897.00	6.7991	0.72400	-0.32296	214350	12.275	62.612	4.1370	144865	11.884
1984	965.00	6.8721	0.73800	-0.30381	219057	12.297	63.372	4.1490	150433	11.921
1985	1091.0	6.9949	0.75400	-0.28236	233629	12.361	67.629	4.2140	156566	11.961
1986	1149.0	7.0466	0.77100	-0.26007	241981	12.397	69.436	4.2404	163271	12.003
1987	1237.5	7.1209	0.78700	-0.23953	257899	12.460	74.010	4.3042	170322	12.045
1988	1330.9	7.1936	0.80300	-0.21940	272768	12.516	77.773	4.3538	188461	12.147
1989	1435.5	7.2693	0.82000	-0.19845	288971	12.574	81.984	4.4065	201453	12.213

SOURCE: COMPILED AND COMPUTED BY THE AUTHOR.

APPENDIX: 8F (- TOTAL ECONOMY)

	TOTCAL	LTOTCAL	TOTCO2	LTOTCO2	GDPFC	LGDPFC	GTOTCAL	LGTOTCA	GTOTCO2	LGTOTCO	PCYGDP	LPCYGDP	T
1970	582940	13.276	179.65	5.1910	90426	11.412	6.4466	1.8636	0.00199	-6.2213	1871.5	7.4215	1.0000
1971	628617	13.351	193.71	5.2663	91339	11.422	6.8822	1.9289	0.00212	-6.1560	1648.7	7.4078	2.0000
1972	707801	13.470	218.12	5.3851	91048	11.419	7.7739	2.0508	0.00240	-6.0341	1605.8	7.3814	3.0000
1973	719943	13.487	219.90	5.3932	95192	11.464	7.5631	2.0233	0.00231	-6.0705	1641.2	7.4032	4.0000
1974	758740	13.539	237.18	5.4688	96297	11.475	7.8792	2.0642	0.00246	-6.0064	1623.9	7.3926	5.0000
1975	808682	13.603	254.01	5.5374	104968	11.561	7.7041	2.0418	0.00242	-6.0240	1729.3	7.4555	6.0000
1976	878144	13.686	275.88	5.6200	106280	11.574	8.2626	2.1117	0.00260	-5.9539	1714.2	7.4467	7.0000
1977	922618	13.735	287.87	5.6625	114219	11.646	8.0776	2.0891	0.00252	-5.9834	1801.6	7.4964	8.0000
1978	942528	13.756	288.49	5.6647	120504	11.699	7.8215	2.0569	0.00239	-6.0348	1859.6	7.5281	9.0000
1979	982570	13.798	306.94	5.7266	114236	11.646	8.6012	2.1519	0.00269	-5.9194	1720.4	7.4503	10.000
1980	1006482	13.822	323.17	5.7782	122427	11.715	8.2211	2.1067	0.00264	-5.9371	1803.0	7.4972	11.000
1981	1096822	13.908	354.57	5.8709	129889	11.774	8.4443	2.1335	0.00273	-5.9035	1871.6	7.5345	12.000
1982	1176236	13.978	385.14	5.9536	133915	11.805	8.7834	2.1729	0.00288	-5.8514	1888.8	7.5437	13.000
1983	1242211	14.032	411.89	6.0208	144865	11.884	8.5750	2.1488	0.00284	-5.8628	2000.9	7.6014	14.000
1984	1319070	14.092	432.72	6.0701	150433	11.921	8.7685	2.1712	0.00288	-5.8512	2038.4	7.6199	15.000
1985	1403656	14.155	469.26	6.1512	156566	11.961	8.9653	2.1934	0.00300	-5.8101	2076.5	7.6384	16.000
1986	1501295	14.222	506.50	6.2275	163271	12.003	9.1951	2.2187	0.00318	-5.7756	2117.7	7.6581	17.000
1987	1611009	14.292	555.19	6.3193	170322	12.045	9.4586	2.2469	0.00326	-5.7261	2164.2	7.6798	18.000
1988	1732392	14.365	592.78	6.3848	188461	12.147	9.1923	2.2184	0.00315	-5.7618	2347.0	7.7609	19.000
1989	1859810	14.436	642.03	6.4646	201453	12.213	9.2320	2.2227	0.00319	-5.7487	2456.7	7.8066	20.000

SOURCE: COMPILED AND COMPUTED BY THE AUTHOR.

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