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ENERGY-USE, THE ENVIRONMENT AND DEVELOPMENT: OBSERVATIONS WITH REFERENCE TO CHINA AND INDIA

C A Tisdell and K C Roy

1. Introduction

The economic progress of humankind has depended on the ability of humans to harness sources of energy additional to human energy. These extra energy sources originally included wind, water and animal power. A quantum leap forward occurred during the Industrial Revolution as fossil fuels came to be increasingly used as power sources – first coal and later oil and natural gas. While this enabled a tremendous expansion in production to be achieved, such fuels have the disadvantage that they are non-renewable and they are relatively polluting. For various reasons (discussed), developed countries are reducing the intensity of their energy use, particularly fossil fuel use. The environmental Kuznets curve provides a basis for discussing this development tendency. By contrast, developing countries, such as China and India, have been increasing the intensity of their energy use. This is not surprising given their stage of development. However, it appears that, for reasons explained, China and India are inefficient users of energy resources and this increases their pollution levels in relation to their production. Their inefficiencies in using energy arise both from poor management of energy demand as well as supply-side inefficiencies. The latter, in the case of China, are partly a legacy of its central planning past. To some extent, India has similar problems. These problems and related pollution problems are outlined and discussed. Some critical comments are provided in the discussion also about the environmental impacts of alternative methods of generating electricity supplies, for example, via hydroelectricity and nuclear stations. These are possible alternative means to fossil fuels for generating electricity.

In this paper we first consider environmental Kuznets curves and their relevance for the problems at hand, then outline China's environmental pollution problems and continue by discussing energy use in China, along with its implications for air quality, making some comparisons with India. Some specific observations follow on India's energy supply and its air quality. Significant policy matters are raised in the concluding section.

2. Environmental Kuznets Curves, Economic Development and Energy Use

The environmental Kuznets curve has become a popular macroeconomic technique for analysing the impact of economic growth on pollution (Barbier, 1997). The term and the concept of an environmental Kuznets curve was introduced by Selden and Song (1994). From a long-term perspective, it takes a rather optimistic view of the consequences of economic growth for environmental quality. It implies that if income levels in a country can be raised sufficiently, environmental quality will eventually improve, even though it may first deteriorate in the early stages of economic growth. Thus, economic growth becomes a means for raising environmental quality, rather than a source of continually declining environmental quality; a view eagerly subscribed to by the World Bank (1992), but critically assessed by others (Tisdell, 1993a; Arrow *et al*, 1995). While the environmental Kuznets curve is not without empirical support, some caution is required in drawing policy conclusions from it for reasons partially provided by Tisdell (1993a; 2001). Further recent critiques include those of Rothmann and De Bruyn (1998), Stern (1998) and Cavlovic et al. (2000). Nevertheless, the environmental Kuznets curve does provide a useful framework for discussing pollution issues related to energy use and pollution, as will become clear in this article.

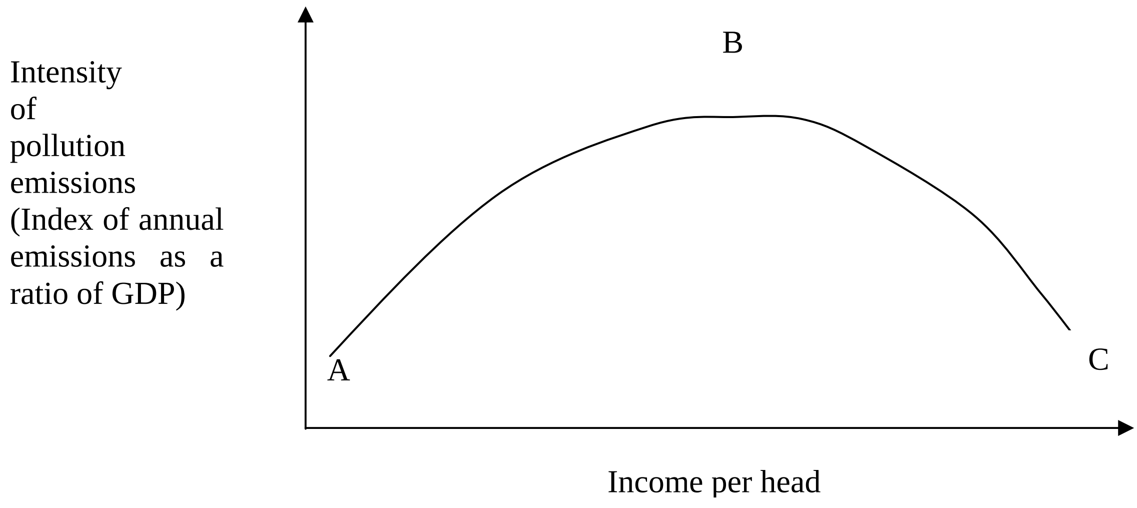

Figure 1 The typical environmental Kuznets curve is of an inverted U-shape

The standard environmental Kuznets curve is of an inverted U-shape of the type shown in Figure 1 and usually graphs the relationship between pollution intensities (pollution emissions in relation to GDP) and income per head, which is used as an indicator of the level of economic development achieved in a country. It shows pollution intensities at first rising with increased levels of per capita income and then declining. One of the practical difficulties is how to generate a suitable indicator of the aggregate level of pollution emissions. But let us not worry about this problem here. There are, however, several other issues worth raising.

In principle, an environmental Kuznets curve can be of at least three very different types:

(1) an historical-type curve showing the type of paths which economies typically follow,
(2) a pollution efficency-type, and
(3) an institutional-type varying, for example, according to whether the economy is a market economy or a centrally planned economy.

In addition to the above, it should be stressed that Kuznets curves are likely to vary between countries depending on the composition of the production of countries (that is, their different industrial structures) and the type of resources available to them, eg countries having relatively more polluting energy resources are likely to have a higher environmental Kuznets curve. These Kuznets curves will also vary according to the efficiency with which resources are used. Resources are liable to be used with greater efficiency in market economies because of the economizing nature of the market system and the ability of such systems to encourage the development and adoption of resource-saving technology. Consequently, the environmental Kuznets curve is liable to be lower in market economies than in non-market economies.

The typical environmental Kuznets curve for market-type economies may also reflect the operation of the Clark-Fisher hypothesis of changing sectoral composition of production as income levels rise. According to this hypothesis, the secondary sector first expands in relative size with economic development and then the tertiary sector grows comparatively. Production by the latter sector involves a much lower pollution intensity than the former sector.

The shape of the environmental Kuznets curve reflects, to a large extent, energy use in a country. The intensity of energy use in an economy is also typical of an inverted U-form which mirrors the environmental Kuznets curve. Energy used in relation to GDP at first rises with economic growth and then declines. Because energy-use gives rise to much of the pollution experienced in economies and globally, particularly air pollution, it has a major influence on the environmental Kuznets curve. Inefficient use of energy will cause the environmental Kuznets curve to be higher than it otherwise may be.

Both in China and India, a number of factors result in the inefficient energy use. These include:

(1) Supply-side shortcomings, eg operation of technologically inefficient plants for using energy and for generating electricity of power, failure to maintain or service plants adequately, operation of greatly depreciated as well as obsolete equipment; and

(2) demand-side failures, such as the underpricing of energy resources. The latter means that there is a tendency for consumers to waste such resources in relation to output. Underpricing results in failure to economise on energy-use and install equipment and maintain equipment so as to reduce energy use.

Nevertheless, although both China and India continue to have supply-side and demand-side inefficiencies in energy use, it should also be recognized that as their economic development proceeds, those inefficiencies are likely to be reduced.

3. China's Environmental Pollution Problems

China may now be approaching the peak of its environmental Kuznets curve. It is experiencing considerable water, air and solid waste pollution. Its air pollution is largely a consequence of its increased energy consumption, plus its inefficient use of energy resources.

Many of China's water resources have become polluted. Some lakes are reported to contain unacceptable levels of heavy metals released from industry, for example, those in the Wuhan area. The organic levels and sediments carried in most rivers have increased significantly. Furthermore, high rates of application of artificial fertilizers in agriculture and inadequate treatment of sewage, have significantly added to the nitrate and phosphorous levels in China's rivers. It has been suggested that the discharge of these nutrient-rich waters into the China Sea is a prime factor making for the periodic occurrence of red tides. These red tides contain algae that kill fish *en masse* and/or make them poisonous for human consumption. It ought to be noted that all these types of water pollution threaten China's aquaculture industry, which in terms of volume of production, is by far the largest in the world and a significant source of animal protein for China's population. Of course, the economic costs of water pollution are much wider than this example indicates and its health consequences and its impact in reducing biodiversity should not be ignored.

Air quality in China has deteriorated seriously with its economic growth. Excluding township enterprises (considered by some to be a source of serious pollution), sulphur dioxide remissions in China increased by more than one-third in the period 1982-1992 and other gases contaminating the air more than doubled (estimates from figures supplied by Wu and Flynn, 1995, p.4). Most of China's large cities have air quality much lower than the acceptable standards set by the World Health Organization. For example, the air in Shenyang is heavily polluted. This has been suggested as a source of the high incidence of cancer amongst its population. Air pollution is responsible for a high incidence of respiratory illness in many of China's cities.

In fact because air quality is so poor, 26 per cent of all deaths in China are attributed to it, five times the US level of such deaths (Bingham, 1993, p.12). Respiratory disease is the biggest single source of death in China. Acid rains are a serious problem and sometimes cause pH levels in rivers south of the Yangtze to fall below 5.6. Consequently, these rivers become quite acidic, even though alkaline loess dust helps to reduce this acidity. Inefficient coal-fired boilers and smalll power stations are a major source of this pollution (Bingham, 1993).

China is relatively rich in coal resources, but Chinese coal has a high sulphur content and the burning of coal in China is a serious source of local air pollution. Furthermore, the burning of fossil fuel in China is adding significantly to greenhouse gases and China's emissions of such gases is predicted to rise significantly. In 1989, China ranked third in the world in terms of greenhouse gas emissions, after the US and the Soviet Union. "However, by 2020, China would be the world's largest producer of carbon dioxide, releasing three times as much as the US". (Bingham, 1993, p.12).

The disposal of solid wastes creates serious problems. About 55,000 ha of land is covered with untreated solid waste, most of it industrial and much of it contains heavy metals and toxic substances. Leaching from such waste dumps threatens aquifers and groundwater (Bingham, 1993, p.14).

Taking the situation overall, Chinese authorities estimate that almost 7% of China's GDP is lost due to environmental pollution, about twice the estimated percentage in high income countries (Bingham, 1993, p.10). Chinese estimates put the annual economic costs of pollution (to China) at about 90 billion yuan, 40 billion of which is attributed to water polllution, 30 billion to air polllution and around 25 billion to pollution from solid wastes and pesticides. However, actual economic costs for China may be much higher than this when, for example, full account is taken of the adverse impact of pollution on human health.

However, today the environment of most countries is not solely their own business, but is often of global concern. This is particularly so in China's case because of its immense size, both in terms of population and land area. The main reason why a country's environment concerns the rest of the world is the presence of externalities from the state of its environment.

China's potential level of economic activity and its possible environmental impacts are so large that they cannot be ignored by the rest of the world. Some of its impacts are global. Its possible global impacts are not restricted to its large (and potentially much larger) addition to greenhouse gases. A recent additional example was its emissions of CFCs, as a threat to the ozone layer. As a result of the Montreal Agreement and subsequent international meetings, arrangements have been made to phase out the use of CFCs in countries like China and an international fund has been set up to provide financial assistance for the phase-out (Litfin, 1994). China is one of the recipients of such aid.

The environmental policies of a country can influence the international location of polluting industries and international trading. Countries which have low environmental standards may attract polluting industries from abroad and have an advantage in exporting goods, the production of which generates pollution. The fact that those in polluting industries do not pay the full social costs of their economic activities means that, in effect, they are granted a subsidy. The 'concession' benefits special economic interests, but often imposes greater costs on the community than the benefits received by these special interests. Therefore, extreme care is needed in making environmental concessions to particular businesses or industries. Some Taiwanese economic activities have, it is claimed, been located in China for environmental reasons. In a relatively decentralised system, as in China, it is very difficult to prevent local authorities competing with one another by making environmental concessions to attract foreign investment. Increased central control over pollution in China may, however, be exerted as its National Environment Protection Agency becomes stronger. In fact, the increasing importance attached by China to environmental control was signalled at the beginning of the 21st century by the elevation of this agency to the level of a full ministry.

4. Energy Supply and Air Quality in China with some Indian Comparisons

Modern societies depend heavily on non-renewable natural resources for their energy requirements. There can be no doubt that use of such sources of energy has made human life easier, has provided humans with greater control over nature, and has significantly contributed to economic abundance in high income countries. Nevertheless, combustion of such fuels is a major source of air pollution in large urban areas and in several regions in Asia. In addition, according to the greenhouse gas thesis, this combustion is a major source of atmospheric warming. As is well known, developing countries in Asia, such as India and China, are predicted to increase their consumption of fossil fuels substantially, thereby becoming major contributors to greenhouse gas emissions. How best to deal with the threat of the greenhouse problem still remains a major issue (Tisdell, 1995). It is one that requires both regional and global co-operation. At the same time, industrial activities in cities emit localized air pollutants, affecting the health of their inhabitants. Air pollution in many of Asia’s cities, such as Shenyang, Beijing and Calcutta, is a serious and increasing problem. As Asian countries become more urbanised and expand their industrial activity, their air quality must be expected to deteriorate further unless countermeasures are adopted.

The importance of China’s case serves to illustrate the problems of energy supplies and the impact of their use on air quality. In this century, China is expected to become the world’s major user of fossil fuels, overtaking the USA. According to Haugland and Roland (1994, p.212), ‘China faces two main challenges in its energy policy: (1) to provide adequate energy supplies to foster economic growth, and (2) to limit environmental damage from energy production and consumption'. China is now the world's leading coal producer, having overtaken the United States in 1983. Both China's GDP and energy production and consumption have increased remarkably since the establishment of the People's Republic. Between 1953 and 1980 China's GDP grew at an average rate of 6 per cent pa and its energy use expanded at 9.8 per cent pa. After China's market reforms, its GDP grew at an even faster rate averaging 9 per cent pa in the 1980s, but its energy use expanded at only 5.5 per cent pa in the 1980s.

In other words, it is clear that China's intensity of energy use in relation to its GDP rose in the twenty-seven year period prior to 1980, but declined during the 1980s. This reflects both the restructing of China's economy and China's improving economic efficiency. Consequently, although absolute emission of pollutants increased in China in the 1980s, the intensity of this emission in relation to its GDP has declined. Nevertheless, because aggregate pollution levels in China have continued to rise, dangers to human health from pollutants have grown.

Although the intensity of China's use of energy has fallen, it is very high by world standards. In 1989, it was almost three times that of a comparable country, India, more than twice that of Japan and more than four times that of the United States (Haugland and Roland 1994, p.217). There may be some reasons for this: (1) China's GDP may be underestimated. (2) The economy may not have fully restructured following its forced emphasis on high-energy using industries during the pre-reform era (Tisdell, 1993b). (3) Technology used in its power generation industry and technology employed in industry using energy may be relatively inefficient. (4) Proper procedures may not be in place to encourage users to economize in energy.

China still has a long way to go to reach the levels of per capita energy consumption of high income countries. Its energy consumption would need to increase more than five times to reach per capita levels comparable to those of Japan and more than twelve times to reach a similar per capita level to the United States. In many parts of China, electricity is still considered to be in very short supply by local communities.

The high sulphur content of Chinese coal constitutes an environmental problem. Sulphur dioxide emissions, with other compounds such as nitrogen oxides arising from coal combustion, are a serious source of air pollution in China and result in acid rains in several parts of the country. The effects are pervasive. They are not confined to the locality or province where fuel combustion occurs, but extend internationally. For example, prevailing winds from China's industrial Northwest bring acid rains to Japan (cf. Foell, 1994, p.229, Fig.2; Bleck, 1996) and to Korea (Kim, 1996). As India's use of coal, and other fossil fuels, increases, India's emissions of SO_2 are also rising, and so the incidence of acid rains in South Asia is rising. Acid rain problems can be expected to become more prevalent and serious, and will call for greater interregional co-operation to deal with the problems. The interregional dimensions of this problem (and many other environmental problems) in Asia should not be neglected.

As is well known, developing countries in Asia, such as India and China, are predicted to increase substantially their consumption of fossil fuels (Drysdale and Huang, 1995; Fesharaki and Wu, 1992), thereby becoming major contributors to greenhouse gas emissions. How best to deal with the threat of the greenhouse problem still remains a major issue (Tisdell, 1995). It is one that will require both regional and global co-operation (ABARE, 1995). The potential of hydroelectricity to substitute economically for fossil fuels in electricity production and reduce greenhouse gas emissions appears to be limited, but, as discussed below, nuclear energy is a possibility. Alternative energy sources can also play a larger role (Byrne and Shen, 1996), but can only be expected to supply a very small fraction of Asia's energy requirements. From a social point of view, the choice of energy sources should be influenced by the externalities associated with the alternatives. The size of these is still difficult to quantify, particularly in relation to greenhouse gases. ABARE (1995, p.139) states that "while there are considerable uncertainties associated with the science of global change, the potential risks posed by global warming are sufficient to justify some abatement action".

Naturally, China has considered the question of whether it can use 'cleaner' means of generating electricity than from coal. In its *Agenda 21 – White Paper on China's Population, Environment and Development in the 21st Century* (State Council, 1994), alternatives to using coal for energy generation, especially hydro-electricity, are discussed. While China has significant potential for expanding its production of hydro-electricity, there are some problems. Its greatest potential is in the southern inland of China. But this area is not well located for supplying northern and coastal areas of China. These areas have the largest concentration of China's population and industry and therefore the greatest demand for electricity. Large amounts of investment are required. Furthermore, dams associated with hydro-electricity generation are not without environmental costs and risks. They may inundate areas of value for biodiversity conservation and tourism, they may flood productive farmlands, interfere with waterflows (especially if there is associated irrigation) and result in increased salting of rivers and in navigation problems. The list could be extended.

In Xishuangbanna Prefecture of Yunnan, for example, there has been a perceived shortage of electricity. Therefore, some local authorities favoured the construction of a dam on the Lancang (Mekong) river to generate electricity and provide water for irrigation. Consequently, this dam has now been constructed. However, it has flooded a large portion of Xishuangbanna State Nature Reserve and reduces water supplies to Thailand, Laos, Cambodia and Vietnam.

The Three Gorges Dam, being completed on the Yangtze (Changjiang) River, provides another example. On the one hand, it will add significantly to electricity generation, provide for irrigation and flood control. On the other hand, it involves loss of cultural and natural assets, massive relocation of communities due to flooding from the water body, deterioration in important wetlands below the dam, and loss of valuable additions to silt on agricultural land below the dam. There is some concern about the risks to the dam from earthquakes. In addition, disease patterns in environments affected by the dam are liable to alter. The parasitic disease schistosomiasis (Mahmoud, 1987; Sleigh and Mott, 1986), for which water snails are an important host (Sobhon and Upatham, 1990) may well increase, as has occurred in parts of Africa following the construction of large dams. The economic costs of the disease are as yet poorly known (Huang and Manderson, 1992).

Nuclear energy is probably still not an economic alternative for China, in comparison to its generation of electricity by the use of coal. Furthermore, while nuclear power stations avoid many of the pollution problems associated with the use of coal for electricity generation, there are still concerns about the environmental radiation hazards associated with nuclear plants.

In 1985, it was thought that China might embark on a substantial programme to increase its electricity production by 2000 by building nuclear plants. As a result both the United States and Europe were hopeful of selling it reactors. But China's ambitious plans in this regard were shelved in 1986. Owen and Neal (1988, p.28) believe that the principal reason for China's change in policy was probably the stress it would place on China's stock of foreign exchange because of the high initial cost of imported nuclear plants. In addition, the Chinese were sceptical about the purported cost advantage of nuclear power over coal-generated power.

The comparative cost of generating electricity from coal or other sources compared to nuclear varies by country and location. The Nuclear Energy Agency (1992, p.43) of the OECD claims that, in many OECD countries, electricity from nuclear energy will be at least 10 per cent cheaper than from coal for plants commissioned in 2000. However, it points out that this will not be so in the cheap coal regions of the United States, Canada, Brazil and China.

Yoda *et al*. (1994) suggest that in Japan the cost of electricity generation from coal and LNG was higher than from nuclear up to the mid-1980s, but from 1986 onwards the position reversed. Nevertheless, in 1994, Japan generated 28 per cent of its electricity from nuclear (Akiyama, 1994) and was planning in the longer term to generate 60 per cent of its electricity from this source. According to Akiyama (1994, p.220), President of Kansai Electric Power Co. Inc.,

> "Utilities put aside reserve funds to cover high level radioactive costs, decommissioning costs and internalise them into revenue requirements. Electricity production is calculated at 13 yen per kilowatt hour by hydro power, at 10 to 11 yen by fossil fuels and at 9 yen by nuclear. Therefore, nuclear energy proves [to be] cost competitive".

These figures differ slightly from those of Yoda *et al.* (1994), but may refer to plants to be commissioned around 2000. It should be noted that in Japan much of the cost of using fossil fuels is internalised as a result of the emission standards set, and these increase the cost of generating electricity from fossil fuels.

Akiyama (1994) noted that several nuclear power plants were in operation in Asia in 1994. These plants were in Japan, Korea, Taiwan, India and, in China, a trial plant was operating and two were under construction. Furthermore, Indonesia was planning to construct twelve reactors over the next fifteen years with Japanese advice. However, the World Bank (1994, p.265) claims that compared to coal based generation, nuclear is a high cost option for Indonesia. It concludes “the nuclear option does not appear to be competitive with coal fired generation unless there is a willingness to pay a premium equivalent to about $37.64 per ton of carbon abatement”.

Differences of opinion exist about the comparative costs of generating electricity from nuclear compared to coal and about the size of the environmental externalities associated with each, and about how these should be monetised. While nuclear-based electricity generation appears to be an economic option for some Asian countries, for example, Japan, it is not the most economic option for all. Furthermore, nuclear power stations are really only suitable for supplying base-load electricity requirements and non-nuclear sources are needed to supply the remainder. Much depends on technological progress. While further progress in nuclear technology is to be expected, there is also a possibility of coal-fired stations recovering many of their present emissions, processing these and selling these as by-products. Given Asia’s large coal reserves, particularly China’s, the option of cleaner coal-fired power stations needs to be vigorously pursued, especially since it is predicted that fossil fuels will still be supplying 90 per cent of the world’s energy consumption in 2010 (OECD, 1994, p.14).

5. Further Brief Comments on India’s Energy Situation and its Air Quality

In the absence of appropriate pricing policies and of effective enforcement of government guidelines for pricing for goods and resources supplied by public enterprises, India’s public sector enterprises (PSEs) have contributed to the excessive use of polluting goods and resources and, thereby, to considerable decline in overall environmental quality in general, and air quality in particular, in India.

The Government of India’s policy from 1951, when the First Five Year Plan began to the end of the 1980s, was that public sector enterprises should not operate on commercial principles. For example, it was believed that public sector goods should not necessarily be sold at prices that included economic profits. In fact, public sector goods were often sold at prices which did not ever cover their cost of production (Roy 1991). In such a situation, public sector enterprises did not have to observe economy in the use of inputs to produce final goods.

Consequently, there was waste and excessive use of natural resources. This contributed to a deterioration in air and overall environmental quality. One example is the public sector production and use of energy for electricity generation. The electricity generation process in thermal power stations has contributed to the discharge of significant amounts of pollutants which have completely covered hundreds of acres of good quality agricultural lands in the surrounding areas and have made these totally off-limits to humans and animals due to the diverse effects of such pollutants. Since authorities operating thermal power stations do not have to use inputs which are less damaging to the environment, humans and animals, greater use has been made in the production of electricity, and of inputs which discharge pollutants which damage the quality of air and environment.

In the late 1990s, National Thermal Power Corporation (NTPC) stopped supplying power to one thermal power station in West Bengal and to Damodar Valley Corporation (DVC) because of the failure of the State Power Department and of DVC to pay their dues to NTPC. The failure of the State Power Department to pay dues resulted from the failure of West Bengal State Electricity Board (WBSEB) to collect electricity dues from state government and central government establishments, other states, Indian Railways, and Calcutta Electric Supply Corporation (CESC) of the order of RS6.6 billion (*The Statesman Weekly 1998).* Since large public sector establishments consume electricity without paying any price at all, there is excessive use of electricity. On the other hand, public sector undertakings obtain their supplies of oil at a heavily subsidised price.

Also, millions of poor Indians in villages use kerosene as fuel for cooking and lighting, and coal as fuel for cooking. The consumption of kerosene has always been heavily subsidized. Apart from public sector undertakings, many private sector industries such as textiles, pulp and paper, industrial chemicals, non-metallic mineral products, small scale foundries, chemical manufacturing and brick-making and so on, also use energy. Similarly, vehicular traffic has registered a phenomenal growth from 2.1 million registered vehicles in 1973 to 25.2 million registered vehicles in 1993 (Ministry of Surface Transport, 1993). These vehicles also are users of energy, particularly diesel, at a subsidized price. All these factors have contributed to a significant deterioration in air quality in larger urban and industrial centres in India.

Vehicular emission loads in 1994 are estimated at 3596.8 tonnes per day in twelve major Indian cities. Six of the ten largest cities in India – Mumbai, Calcutta, Delhi, Ahmedabad, Kanpur and Nagpur – have severe air pollution problems with average levels of suspended particulate matter (SPM) at least three times higher than WHO standards (Government of India, 1999).

The total suspended particulates and PM10 (particles less than 10 microns in diameter) have been associated with the premature mortality and increased morbidity (Parikh 1999). Apart from the particulate matter, lead, carbon monoxide, sulphur dioxide and toxic substances have been shown to produce significant adverse affects on human health. Apart from its effects on health, the significant rise in energy consumption through air pollution, impairs economic productivity, especially agricultural productivity, damages material property such as buildings and land, and causes ecological changes that increase the risk of environmental disasters.

In fact, the previous Congress government which was in power in New Delhi for four decades following India's independence, never framed and adopted an appropriate energy use policy. Under Nehruvian ideology of State socialism, public sector enterprises were never granted autonomy to operate strictly on market principles. Many of these enterprises were required to sell their products at a price well below their cost of production (Roy, Tisdell and Sen, 1992, 1995). Hence, these enterprises did not have to exercise prudence in using energy as inputs in production.

Many inefficient and loss-making public-sector enterprises continue to survive and contribute to pollution today because the previous Congress government never adopted an exit policy for sick enterprises, and the current coalition government has also failed to adopt such a policy.

Substantial reductions in subsidies is a major component of the economic reform package that India began to adopt after 1991. But between the mid 1990s and later 1990s, the Indian economy grew at a little over seven per cent per annum. The growth of industrial production and manufacturing averaged nearly nine per cent per annum during this period (Government of India, 1999). The manufacturing technology adopted by most of these industries used energy and other resources intensively, which placed a heavy load on the environment. Thus, the previous government was caught in a dilemma and the subsidies could not be reduced substantially. The current coalition government involves a centre minority government. It governs with support from a number of political parties that are not represented in the ministry. Several partners in the coalition are opposed to subsidy reduction on such inputs as kerosene, fertilizer, etc, on the grounds that the opposition Congress party will project this policy as anti-poor during the election time. Hence, in a democracy in a developing country like India, a government without absolute majority and a guarantee that it will be able to stay in power for a reasonably long period of time, may not be able to implement completely pro-market economic policies in resource use.

In this respect, a totalitarian state seems to be in a better position to implement such a policy. Nevertheless, some reduction in subsidies on kerosene, diesel, petroleum, natural gas, fertilizer, etc, has been taking place on a regular basis in India to make the prices of such input more realistic and thereby to reduce their consumption of such inputs.

6. Concluding Comments

It might be noted that the introduction of the market system in China seems to have helped in reducing pollution intensities in relation to its GDP. It also provides scope for the use of market-related instruments as a means to control pollution and China has made a cautious start in applying such instruments. Furthermore, politically, it seems easier to control pollution in a market system than in a centrally planned economy. Social pressure towards environmental ends is, however, likely to be even greater in a democratic society with freedom of the press and of expression.

India, of course, has a democratic tradition and although, in the past, its economy has been semi-planned, and the operations of the market system severely curtailed, this was never to the same extent as in China. Its energy supply is much more efficient than in the case of China. Nevertheless, there are still significant shortcomings and environmental problems present because of distortions in its pricing of energy. Consequently, not even democratic systems work perfectly, particularly when they are coupled with considerable political interference in the economic operation of industries. Growing economic liberalisation in India can be expected to result in less political interference with the economic policies of industrial enterprises. This could result in greater efficiency in energy use and a reduction in pollution intensities in India, compared to those eminating from a more politically controlled economic system. However, given that in 2002, the ruling BJP party in India lacked a parliamentary majority, its ability to carry out economic reforms, including those affecting energy use, have been curtailed.

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