CHAPTER 2

THE USE OF COAL AND CARBON POLLUTION

2.1 INTRODUCTION

South Africa is an energy and carbon intensive country in comparison to other African countries and developed nations. The country is ranked 16th in the world in terms of the total amount of primary energy consumption, and depends mainly on fossil fuel to supply its energy needs. Coal provides approximately 75 percent of the required fuel, while the remaining 25 percent of primary fuel supply comes from crude oil (10.1 percent) and renewable resources such as wood and bagasse (9.8 percent). The contribution of nuclear energy in South Africa is small compared to the importance it has in energy supply in some European countries, with only about 3 percent of the country's primary energy taken from nuclear sources (http://www.environment.gov.za/soer/nsoer/drivers/general/energy.doc).

The aim of the research in this study is to analyse the economy-wide effects of a revenue neutral tax on coal, and it is therefore important to describe the country's dependence on this resource for its energy needs. It is also necessary to analyse the structure of the South African coal sector and its economic linkages. This will provide insight into the possible effects that the proposed tax would have on the South African economy.

Below is an introduction to the South African coal industry. The introduction is followed by an analysis of the structure of the coal sector and its economy-wide linkages. Finally, the environmental consequences of CO_2 pollution are briefly described and a motivation is given for the use of environmental taxes.

2.2 AN INTRODUCTION TO THE SOUTH AFRICAN COAL INDUSTRY

Coal has played an important role in the South African economy from as early as 1880, when coal from the Vereeniging area was supplied to the Kimberley diamond fields. The subsequent discovery of gold in the Witwatersrand region, and the growing rail infrastructure across the sub-continent assured an ever-increasing demand for South Africa's coal deposits. This trend continued, and as South Africa's economy became more dependent on the mining sector, coal was

increasingly used to generate steam, compressed air and electricity (http://www.eskom.co.za/about/companyinformation/factsheets).

At present, the use of coal is more diversified and this natural resource mainly serves the primary energy needs of the electricity, petro-chemicals and steel industries. Other industries have also become dependent on the use of coal. These include the brick-making, cement and lime industries. Apart from being a significant source of energy, the coal industry has also evolved into one of the sectors that contributes significantly towards South Africa's foreign exchange earnings, and South Africa has become one of the world's largest exporters of coal (http://www.eskom.co.za/about/companyinformation/factsheets). This is not surprising if one considers that South Africa is one of the world's leading producers of coal. Table 2.1 summarises the production statistics of the world's main coal producing countries in 2000. It is interesting to note that South Africa is ranked sixth among these coal producers.

Table 2.1: Production statistics for the world's coal producing countries 2000

	Production		
Country	**Million tonnes**	**% Of total**	**World Ranking**
China	1171.1	32.2	1
USA	899.1	24.7	2
Former Soviet Union	321.6	8.8	3
India	309.9	8.5	4
Australia	238.1	6.5	5
South Africa	224.1	6.2	6
Poland	102.2	2.8	7
Indonesia	78.6	1.9	8
Canada	59	2.2	9
Germany	37.4	1.0	10
Colombia	37.1	1.0	11
UK	32	0.9	12
Other	153.7	4.2	13
Total	3663.9	100	14

Source: International Energy Agency, 2001

2.3 THE STRUCTURE OF THE COAL INDUSTRY

2.3.1 Coal Production

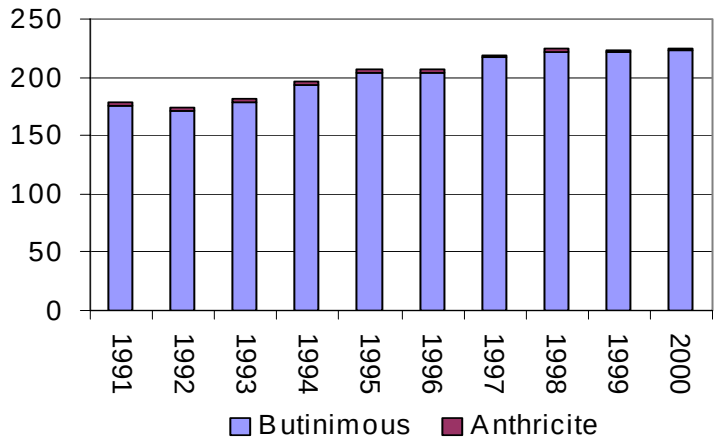
South Africa's coal deposits are located in 19 different coal fields situated in the North–Eastern region of the country, with 80 percent of total coal extraction taking place in Mpumalanga, 10 percent in Limpopo Province and the remaining 10 percent in the Free-State and KwaZulu-Natal. The three largest mining groups (Ingwe, Anglo Coal and Sasol) are responsible for 80 percent of total extraction in these provinces. The coal extracted in Mpumalanga and Limpopo Province is classified as bituminous, while the coal that is mined in KwaZulu-Natal consists of anthracite. The recoverable coal reserves in South Africa amount to approximately 55 billion tonnes, which is equivalent to nearly 11 percent of the world's total coal reserves.

During 2000, opencast mines provided 57.3 percent of the run-off mine coal production. The seven largest collieries were responsible for 57 percent of total output. Five large mines produced 16 percent, nine medium sized mines produced 15 percent and forty-one small mines produced the remaining 12 percent.

2.3.2 Coal consumption and forward linkages

South Africa's total coal production increased over time and stabilised during the late 1990's at levels of around 220 million tonnes per annum. Figure 2.1 reflects South Africa's coal production during the 1990's.

Figure 2.1: South African coal production (millions of tonnes) 1990 - 2000



Source: Digest of South African Energy Statistics, 2001

During 2000 the coal industry in South Africa produced 224.2 million tonnes of coal. Approximately 70 percent of total production was used domestically in either the energy transformation sector or as an important input in specialised industries. The remaining 30 percent that was not domestically consumed, was exported to over 41 countries of which Spain, the Netherlands, France, Israel, India, Germany, Italy, Great Britain, Portugal, Korea and Taiwan were, in order of importance, the largest customers, receiving nearly 90 percent of South Africa's coal exports. The diversified export base that the coal sector enjoys is also reflected in the ever-increasing amount of coal that is exported. It is therefore not surprising that the 68.2 million tonnes exported from South Africa in 2000 had more than double from the 31.1 million tonnes exported in 1980 (Prevost, 2001, p47).

Within the energy transformation sector, electricity plants and the fuel transformation sector are the main users of coal. The high dependence of the energy sector on coal is not surprising if one considers the abundance of coal in South Africa and the historical support that the electricity and synthetic fuel industries have enjoyed from the government.

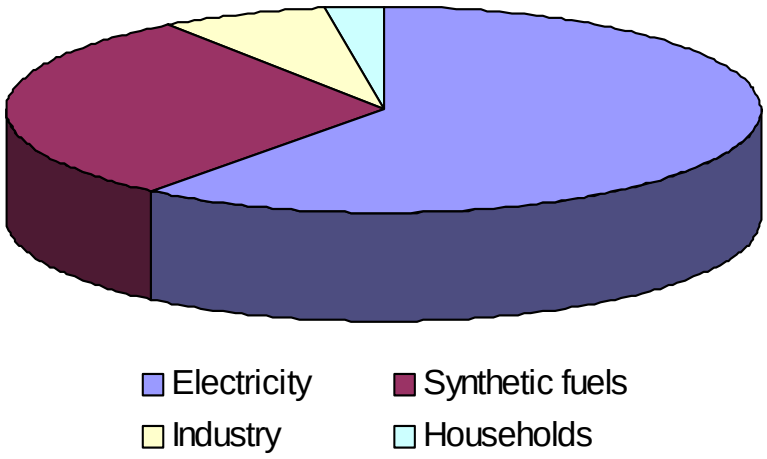
A case in point is South Africa's main electricity provider, Eskom, which has managed to extend access to electricity at low prices to more than 2.5 million households. This performance has been made possible by low coal prices, utilising power station technologies that maximise economies of scale and exploit the lowest cost of coal, exemption from taxation and dividends, financing subsidies and over–capacity. It seems as if investments in Eskom power plants have effectively been subsidised using public funds. Examples of this subsidisation are the forward cover protection that Eskom enjoyed to protect it against changes in exchange rates and exemptions from having to pay taxes and dividends even after investments have been paid off. This has resulted in the current situation where consumers are only paying for energy costs, because capital costs have been paid off. The overall effect of this situation is that the price of electricity does not reflect its true costs; full capital costs are not reflected, nor are externalities priced. The low price of electricity has, however, resulted in an increase in electricity provision and a subsequent increase in the use of coal, which does not reflect opportunity costs to South Africa as a whole (Winkler et al, 2001, p2).

Apart from Eskom, South Africa's largest synthetic fuel producer, Sasol has also benefited from generous government subsidies in order to allow the industry to develop the technology and infrastructure for converting coal into liquid fuels. These subsidies have taken the form of schemes such as protection against low oil prices. Although levels of protection have decreased

significantly, interventions have enabled Sasol to provide synthetic fuels to the South African market by making use of low cost coal inputs.

Outside of the energy transformation sector, the steel and the non-ferrous metals industry is highly dependent on the use of coal for its smelting ovens, while individual households use less than one percent of South Africa's coal production (Prevost, 2001, p49). Figure 2.2 reflects the broad breakdown of domestic coal consumption during 2000.

Figure 2.2: South African coal consumption during 2000



Source: Digest of South Africa Energy Statistics, 2001

It is apparent that the electricity, synthetic fuels and iron and steel industries would be adversely affected by the introduction of a policy that taxes the intermediate use of coal. Apart from making intensive use of coal, these industries employ 1.60 percent of South Africa's labour force and 11.35 percent of the country's capital stock (Social Accounting Matrix of South Africa, 2001). This implies that the aforementioned industries are relatively capital intensive and that the burden of the tax policy would primarily fall on capital.

Although environmental taxation could have a negative effect on the aforementioned industries, these industries contribute significantly towards South Africa's pollution problems and it is increasingly clear that measures need to be implemented to address this environmental concern.

2.4 COAL CONSUMPTION AND THE ENVIRONMENT

Concerns about the consequences of environmental exploitation have been raised for decades. A quote by Schumacher in 1970 summarises the concerns of environmental economists more than three decades ago.

"Modern man does not experience himself as a part of nature but as an outside force destined to dominate and conquer it. He even talks of a battle with nature, forgetting that, if he won the battle, he would find himself on the losing side ……..many people, albeit a minority, are beginning to realise what this means for the continued existence of humanity" (Schumacher, 1973, p13)

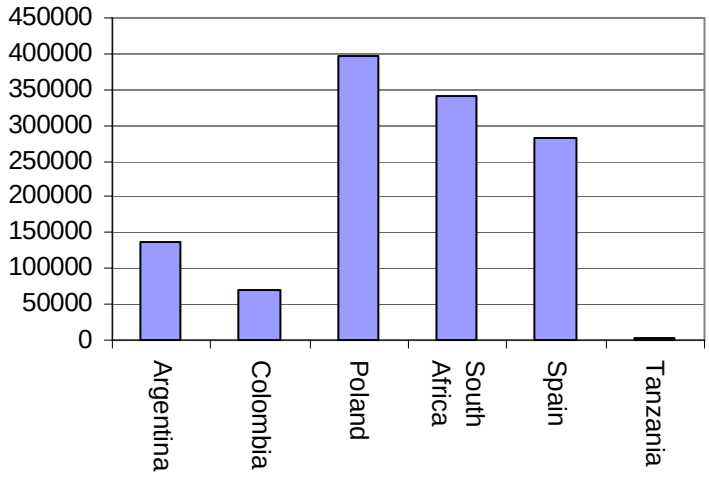
Although these concerns had been raised for decades, it was only during the 1990's that the threat of environmental degradation increasingly came to the fore. It became evident that excess greenhouse gas emissions (especially carbon dioxide (CO_2) and sulphur dioxide (SO_2)) were increasing temperatures on earth. This increase in the earth's temperature is referred to as global warming and holds significant economic and health costs. It is therefore not surprising that a number of international policies and agreements have been put in place to address the issue. One such agreement is the Kyoto protocol of 1997 in which 160 nations decided to reduce the emissions of CO_2 and other greenhouse gases to an average of five percent below the levels experienced in 1990.

Although South Africa as a developing country is not bound by the targets set out by the Kyoto protocol, it does support the agreement in principal, and policy makers are investigating methods of reducing South Africa's greenhouse emissions.

With regards to global air pollution, South Africa contributes significantly to this problem on the African continent. Given the dependence of the South African energy industry on coal burning, it is not surprising that the energy sector is the single largest source of CO_2 and SO_2 pollution in the country. South Africa is among the top ten countries contributing to the global greenhouse gas effect, making up 1.2 percent of the total contribution in 1990 (van Tienhoven, 1999, p1). South Africa also accounts for 15 percent of the greenhouse gas emissions on the African continent and it should be no surprise that South Africa's carbon dioxide equivalent emission rate per person is 10 tonnes of CO_2 per year. This is well above the global average of 7 tonnes of CO_2 per person per year. It is also twice as much as that of other developing countries such as Mexico, Argentina, Zimbabwe and Algeria. In spite of this, it is also important to note that South Africa's emission rates are considerably below those of countries such as the U.S., which has emission rates above 20 tonnes per person per year (http://www.environment.gov.za/soer/nsoer/drivers/general/energy.doc). Figure 2.3 compares the World Bank's projected South African CO_2 emissions with countries that have a population size that is comparable to South Africa's. Countries with a population of

between 35 and 45 million people are included. The figures indicate that South Africa's CO_2 emissions are indeed relatively higher than those of its peers.

Figure 2.3: A comparison of total CO_2 emissions (million tonnes) 2002



Source: World Bank World Development Indicators

The high level of CO_2 emissions has negative externalities, not only for the global environment but also domestically. Terblanche (1993) indicates that warmer temperatures in South Africa may result in a significant number of health related problems. A few of the problems that he highlights are listed below.

i. More heat related deaths, especially among the elderly.
ii. Increased risk of epidemic and infectious illnesses, such as Malaria, which have been positively linked to both temperature and rainfall increases in South Africa. It seems as if the incidence of Malaria epidemics has slowly increased since 1993.
iii. Increased ozone levels in the lower atmosphere, which could have an effect on respiratory health.
iv. Depletion of upper atmosphere stratospheric ozone, which results in more of the harmful ultra-violet B radiation reaching ground level. This could lead to an increase in the incidence of skin cancer and cataracts. It could also result in a reduction in the effectiveness of the immune system.
v. Although most people associate air pollution with urban outdoor environments, some of the highest pollution concentrations are found in rural, indoor environments. About 2.8 million people die each year in developing countries due to indoor exposure to particulate matter and 0.2 million due to outdoor exposure to suspended particulate matter. In South Africa

this problem is particularly evident among children of low-income families who live mainly in rural areas and in inadequate housing.

Despite these negative health effects, Terblanche (1993) also lists the possible negative externalities that increased CO_2 emissions hold for the ecosystem.

i. Increased ultra-violet B radiation could cause damage to the photosynthetic pathways and the genetic structures of plants.

ii. Rising carbon dioxide levels generally have a stimulatory effect on plant growth, and especially on water use efficiency which results in higher ocean water levels. Although it is difficult to predict, continued rapid rise of the oceans above levels that have been experienced over the past million years could have a negative impact on the climate (Terblanche, 1993).

It is evident that South Africa's contribution towards the world's carbon emissions is significant and that this issue needs to be addressed. The high level of carbon emissions is a direct result of the high level of coal consumption in the country and measures need to be taken in order to reduce the high level of pollution.

It is against this background that the South African government is suggesting the introduction of environmental measures to address high levels of pollution. Table 2.2 below compares the status quo with regard to the management of South Africa's environmental resources and the proposed future management thereof.

Table: 2.2: Accounting for the Natural Environment

Status Quo	Future Outcomes
Some macroeconomic policies (e.g. subsidies) encouraging the depletion of natural resources and the degradation of the environment.	Optimal use of exhaustible resources and mechanisms for saving and investment in future times of depletion.
Market prices reflect low costs of energy, water, air and other environmental media.	Market prices need to reflect true cost of energy, air and other environmental media.
Fiscal base on income and labour taxing.	Fiscal base on taxing of pollution.

Source: Department of Environmental Affairs and Tourism, 1999

2.5 ECONOMIC INCENTIVES FOR REDUCTION OF CARBON POLLUTION

As stated in Chapter 1, environmental taxes are one of the measures that the South African government can implement to address environmental management in South Africa. Blackman *et al* (1999, p3), state that indirect instruments, such as environmental taxes may stand a better chance of being effective in developing nations (than command and control measures), because they are less demanding of regulators than direct measures of pollution control. They come to this conclusion, by evaluating the performance of tradable permits, emissions fee programs and environmental taxes in developing economies that have instituted some (or all) of these measures in order to address environmental concerns. Blackman *et al* (1999) distinguish between three types of environmental taxes:

i. taxes on final products associated with pollution (such as motor vehicles);
ii. taxes on goods which are generally used as inputs into a polluting activity (such as coal); and
iii. taxes on polluting substances contained in inputs (such as sulphur contained in coal).

According to Blackman *et al* (1999) these taxes can have two types of advantageous impacts, these being, fiscal and environmental impacts. These impacts are, however, inversely related and depend on the elasticity of demand for the taxed good. If demand for the taxed good is highly inelastic, taxes will generate significant revenue, but would not have significant environmental effects. If the demand for the taxed good is highly elastic, taxes will have significant environmental effects but will not generate significant revenue. Because demand elasticities are usually more elastic in the

long run, the impact of environmental taxes will usually be fiscal in the short run and environmental in the long run (Blackman *et al*, 1999, p4).

Apart from being a tool to raise revenue, environmental taxes are also relatively easy to administer. The reasons for this include the fact that quantities of goods are usually much easier to monitor than quantities of emissions; and environmental taxes operate through government tax collection institutions rather than environmental regulatory institutions, the former being more established and effective than the latter in most developing countries (Blackman *et al*, 1999, p4)

Environmental taxes, however, also have a number of disadvantages. Firstly, they do not create incentives to abate emissions per se, only to limit purchases of goods linked with emissions. Environmental taxes may also affect non-targeted activities. An example would be a tax on coal that would affect chemical manufacturers who use coal as a feedstock, not as a fuel. Environmental taxes may also be less politically acceptable than other regulatory instruments because the costs associated with them are highly visible. Finally, environmental taxes may have distributional impacts in that they could have a more severe impact on poor households than on rich ones. These distributional impacts may be redressed by using tax revenue to finance new expenditures that benefits poorer households (Blackman *et al*, 1999, p4).

Despite of the abovementioned disadvantages of environmental taxation, Blackman *et al* (1999), conclude that a comparison with other incentive measures such as tradable permits and emission fees indicates that environmental taxes would provide the most efficient way to overcome financial and institutional constraints on direct regulation (Blackman *et al*, 1999, p29).

2.6 CONCLUSION

The low cost of coal in South Africa has resulted in the development of an energy sector that has become highly dependent on the use of coal. Due to coal dependence, energy sector industries contribute significantly towards South Africa's levels of CO_2 pollution and make South Africa a major contributor towards CO_2 pollution on the African continent. Because higher levels of CO_2 pollution have negative health and ecological consequences, the global drive towards an improved environment is forcing South African policy makers to re-evaluate their environmental policies. Although a number of measures are available to policy makers, it seems as if environmental taxation would be the option that would be the least challenging with regard to environmental and regulatory requirements.