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The Economic Impact of Rising Energy Prices: A Constraint on South Africa's Growth and Poverty Reduction Opportunities

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Accelerated and Shared Growth in South Africa: Determinants, Constraints and Opportunities

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"Accelerated and Shared Growth in South Africa: Determinants, Constraints and Opportunities"

"The Economic Impact of Rising Energy Prices: A Constraint on South Africa's Growth & Poverty Reduction Opportunities"

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Abstract:

The South African economy is by all accounts an energy-intensive economy. This would suggest that the economy's economic growth and poverty reduction potential would be seriously undermined by a world of rising energy prices. The research undertaken in this paper has clearly shown that South Africa's overall energy-intensity has decreased after reaching a peak in the year 1995. It is argued however, that this decrease is NOT a response to changes in the country's energy prices. Rather, it is argued that the decreasing energy-intensity of the economy is attributable to changes over time in both the composition and scale of South Africa's economic activities. Energy prices, by remaining relatively unchanged for most of the period 1971-2002 under investigation have at most only played a minor role in such changes.

The report confirms that much of South Africa's international competitiveness in energy-intensive mining and manufactured goods is based on South Africa's vast coal deposits. Rising international oil price are a much more recent concern. South Africa's low vulnerability to such oil price shocks are largely on account of its relatively low dependence on oil as an energy carrier and the numerous available energy substitution possibilities, made technologically and financially viable by higher international oil prices.

The research highlights, the notion that South Africa's future energy policy needs to take into account the delicate trade-off between addressing the energy requirements of the poor and promoting the efficiency & competitiveness of the entire economy through providing the country with low-cost and high-quality energy inputs.

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1. **Introduction**
2. **The South African Energy Sector: An Overview**
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5. **Energy Policy in South Africa**
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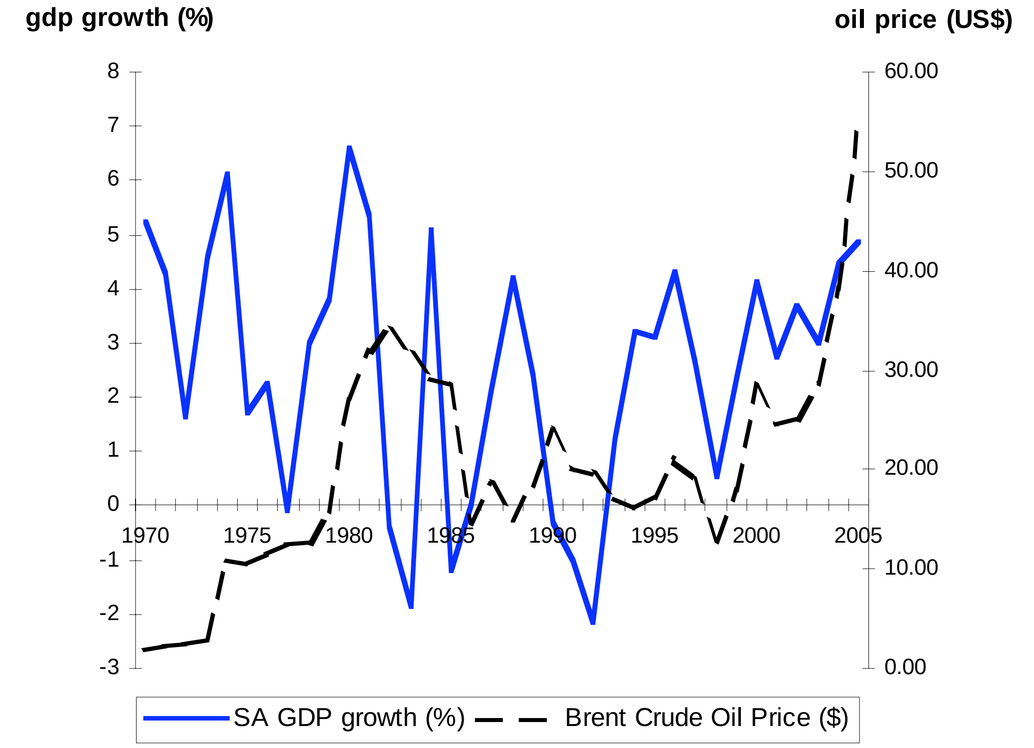
1. Introduction

The global economy has now withstood more than two years of high oil prices since the preparations for the Iraqi War began in earnest early in 2003. Until now, little harm appears to have been inflicted on the world economy. (The rule of thumb being that a $10 per barrel increase in the price of oil will, over the course of a full year, raise the global inflation rate by around 0,5% and dampen economic growth by roughly 1%) (ABSA 2005). Oil is currently more expensive than at any time in the past 20 years. It costs approximately twice as much as in 2003. The World Bank expected the world economy to grow by 5.9% in 2005, its forecast for 2006 is 5.7%. Although these figures stay below the 6.8% reported for 2004, developing countries continue to show very robust levels of growth – more than twice those of the developed Western countries.

Figure 1:

SA Growth vs Oil Price (US$): 1970-2005



Source: SARB quarterly bulletin various issues

The South African economy's recent performance mimics this scenario quite well, with GDP growth (as shown in Figure 1) having risen somewhat higher than in previous years, reaching 4.47% in 2004 and 4.87% in 2005 (SARB 2006). Casual observation of these statistics would seem to suggest that many of the world's economies are now less energy intensive than three decades ago, when the first oil price shock materialised in 1973-74.

The South African economy produces and uses a large amount of energy, and is highly energy-intensive by international standards (see: Appendix A). Recent South African energy and economic performance statistics suggest however (see: Appendix B) that the overall energy insensitivity of the economy is on the decline, in line with international trends. This would suggest that as in other developing countries, the economy's performance should remain fairly resilient despite a world economy characterised by rising energy and particular world oil prices. It is in this context, that this study seeks to establish to what extent South Africa's energy-intensive exports are sensitive to rising energy prices and in so doing shed some light on the impact of rising energy prices on the economy's growth performance and poverty reduction potential.

Section 2 of this paper, provides an overview of South Africa's energy sector, namely, energy production, energy consumption and developments in energy prices. Section 3, goes on to provide a broad overview of the economic impacts of rising energy prices on the world economy. While, Section 4, provides an a discussion of energy's role in international trade from the perspective of changing international cost advantage in South Africa's energy-intensive exports. Section 5, ends the discussion by providing a brief commentary on South Africa's energy policy.

2. The South African Energy Sector: An Overview

The South African economy produces and uses a large amount of energy. It is highly energy-intensive and heavily dominated by extraction of raw materials and primary processing. The energy sector as a producer contributes 15% to GDP and employs a labour force of over 250,000. The demand for energy is expected to grow, with the energy sector remaining of central importance to the country's economic growth, especially with regard to attracting foreign investment in the industrial sector. The South African energy sector is characterised by several important features, including the following:

- A strong natural resource base with a variety of energy options. The country has vast coal reserves, although estimates of their size vary considerably. Besides the geological quantities, the value of coal reserves is also a function of the resource price, the price of coal substitutes, and improvements in technology, exploration, and the development of alternatives.
- A well-developed energy and transport and grid infrastructure.
- An electrification drive to increase access to electricity in disadvantaged communities. Most of those without access to electricity are low-income households.
- To produce electricity at a cost that is among the lowest in the world, the South African economy depends heavily on coal, despite that fact that the generation and production of coal is polluting, and has a significantly negative environmental impact.
- The level of competition between producers in the energy sector is low. Apart from the high cost of capital required to enter the energy industry, there are other barriers to entry. The technology is specialised and the existing structure and regulatory environment is not conducive to entry.
- The government seems to be reluctant to restructure the energy sector and there is lack of legislation to stimulate competition and efficiency.

2.1 Energy and South Africa's Economic Performance

South Africa's energy use reflects changes in its overall economic performance, although this relationship is a complex one and affected by a number of factors. Major factors include, the scale effect, which reflects changes in economic activity within the country over time; another is structural change, which leads to changes in energy technology, and hence in the country's demand. Important also, is energy conservation, which has a significant bearing on energy demand, mainly through the replacement of old appliances by new ones.

Figure 1 shows fluctuations in South Africa's economic growth rates over time. The economy experienced high growth rates in the 1960s, largely because of the high growth rate in the mining and raw materials sector. In the 1970s, factors such as the world oil crises and changing gold prices slowed down the economy. From the 1970s until 1993, increased public spending, economic sanctions, and the effects of political instability stifled the economy. This period was characterised by poor growth performance, low levels of investment, rising unemployment, political instability, currency instability, widening deficits, falling living standards and growing inequalities.

Since 1994, the government has been firm about getting the macroeconomic balance right, in order to attract investors, reduce the budget deficit and fight inflation through high interest rates. The government set economic objectives to achieve economic growth to create employment, and in that way lessen inequality and poverty. Despite the government's GEAR strategy to promote growth, the economy did not achieve rates of economic growth as high as predicted. Employment levels contracted substantially, and private sector investment, a driving force behind growth, grew by 2.7% instead of the predicted 12%. Despite these problems, the government has met key fiscal and monetary targets, and has been successful in reducing the fiscal deficit, inflation, and interest rates. Overall, the rate of economic growth has disappointed however, averaging 2.5% between 1996 and 2000 against the predicted GEAR strategy average of 4.2%. More recently, GDP growth has risen somewhat higher, reaching 2.98% in 2003, 4.47% in 2004 and 4.87% in 2005 (SARB 2005).

There has been rapid substitution of unskilled and low-skilled labour by capital equipment in almost all sectors (Bhorat et al 1998). An increase in capital intensity influences production methods and implies an increased demand for energy. As the economy has become more capital-intensive it has also become more unequal, showing increasing job losses and increased labour productivity, with no 'trickle-down effect' experienced by the poor. Because energy is cheap, the economy has become highly energy-intensive, with more energy used to produce equivalent levels of economic output than in most other countries (see: Appendix A). It is therefore not surprising that many economists argue that 'the trajectory of growth must shift towards labour intensive industries, and away from the current emphasis on mining and refining and relatively high class consumer durables' so as to ensure that the poor have access to productive assets. While this may be desirable at a small-enterprise level, as a general trend, the move from high value-added industries will have low profit levels and therefore low investment potential.

The low cost of energy has also helped provide South Africa with a competitive advantage, and encouraged the growth of very energy-intensive industries, such as aluminum smelting and mining. The use of this low-cost energy is inefficient, and there are significant opportunities to save energy cost effectively via energy efficiency measures (Trikam 2002). Further, these measures will not necessarily change the economy's energy-intensive structure, but rather move it towards better practice and closer to its efficient frontier (Laitner 2001). Several studies have documented reasons for the non-realisation of these energy savings (DME 2004). Recently the South African Department of Minerals and Energy (DME) developed an energy efficiency strategy in order to help realise policy goals. While the DME has supported energy efficiency initiatives (DME 1998), there has been very limited active policy.

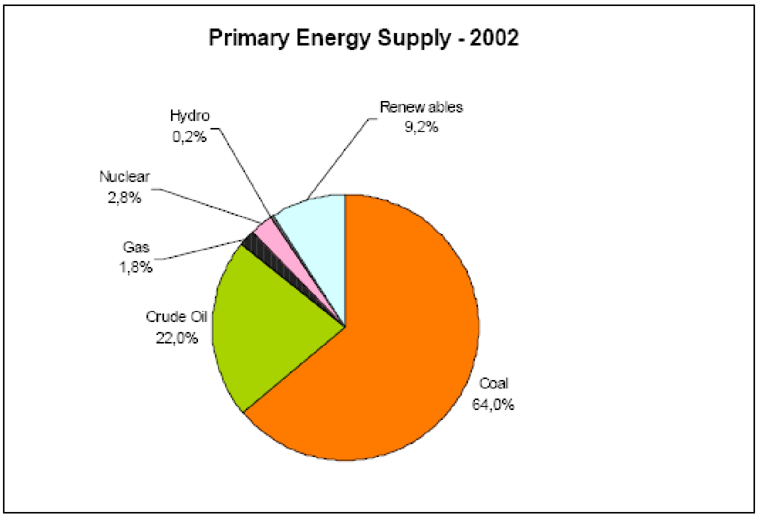
2.2 The Production and Consumption of Energy in South Africa

2.2.1 Energy Supply:

"Guaranteeing a sustainable supply of affordable energy is one of the best ways to address poverty, inequality, and environmental degradation everywhere on the planet." (NEPAD 2002).

South Africa has a well-developed energy supply and production system. The country is well endowed with large resources of coal. As can be seen from Figure 2, coal dominates the energy picture in South Africa, providing approximately 64% of the primary energy. Crude oil production is very limited and consequently the bulk of our crude oil is imported. Imported crude oil accounts for 22% of primary energy used, mainly by the transport sector. Uranium reserves are large. Nuclear energy, natural gas, and renewables including biomass, account for the rest of the energy needs.

Figure 2



Source: DME (2005)

Renewable energy plays a limited but significant role, particularly large hydroelectric power generation. The country generally has a low rainfall, which limits the exploitation of this form of energy however. South Africa's abundant sunshine is only beginning to be tapped in more remote areas for electricity generation for domestic and institutional application. Wind energy is a potential source of commercial energy in some parts, but like other renewable energy technologies it struggles to match the lower costs basis of conventional energy, in particular our cheap coal.

Table 1

Total Primary Energy Supply - TJ

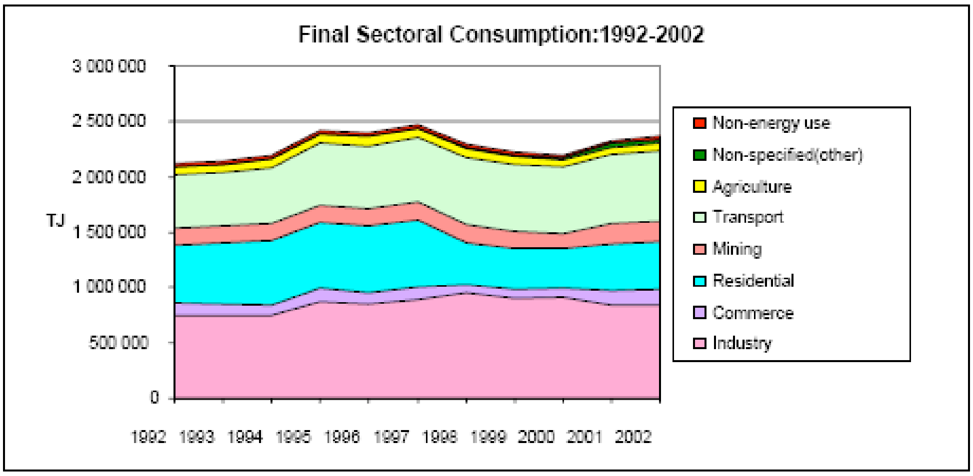
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Coal	2 990 691	3 028 745	3 117 230	3 243 737	3 299 787	3 370 254	3 268 198	3 413 499	3 425 725	3 065 619	2 961 026
Crude Oil	414 946	334 047	428 321	459 980	376 059	450 863	933 682	764 067	420 746	452 895	1 018 769
Gas	11 969	71 814	71 814	71 814	71 814	71 814	53 983	70 628	65 024	84 478	83 764
Nuclear	101 324	79 145	105 785	123 284	128 455	137 967	148 375	140 040	141 927	116 935	130 811
Hydro	2 707	526	3 866	1 904	4 748	7 531	5 742	2 614	4 835	7 420	8 485
Renewables	414 000	419 000	433 432	408 739	408 739	408 739	237 400	237 400	237 400	237 400	426 467
TOTAL	**3 935 637**	**3 933 277**	**4 160 448**	**4 309 458**	**4 289 602**	**4 447 168**	**4 647 379**	**4 628 248**	**4 295 657**	**3 964 746**	**4 629 322**

Eskom produces over 90% of South Africa's electricity, and it owns and operates the generation and transmission system. Eight municipalities generate the remaining electricity for their own use. Electricity production costs, in South Africa based on our large coal reserves are among the cheapest in the world. This together with a natural resource based economy, resulted in the country becoming a large energy user with high energy-intensity. The total primary energy supply increased from 1,898PJ in 1971 to 4,629PJ in 2002, an increase of 144%. Recent energy and GDP data indicates that energy intensity of South Africa reached a peak of 5.42 TJ/GDP and appears to be declining as the economy is restructuring (see: Appendix B).

2.2.2 Energy Demand

Energy remains a key factor in the growth and development of South Africa's economy. Historically, electricity supply was driven by demand from the mining industry. Concerned about energy security, the apartheid government developed a synthetic fuels programme to meet demand for liquid fuels and to lessen the country's dependence on energy imports. South Africa's massive investment in the 1960s and 1970s in coal-fired power plants (including some nuclear capacity) left the national utility with large excess capacity in the 1980s and 1990s. The excess capacity has helped to keep electricity prices low, but it is now practically exhausted (Eskom 2000).

Figure 3



Source: DME (2005)

In recent years, industrial demand has been the major source of growth across all energy carriers (see: Figure 3 above and Appendix C). Some growth can be seen in the transport sector, while in mining production the demand declined slightly towards the end of the past decade. Historically, energy demand in South Africa has been dominated by heavy industry and mining, which have determined the economic and energy structure of the country. Much of the manufacturing sector is linked to mining activities through minerals beneficiation and metals production. These industries are all energy intensive, and rely on the availability of inexpensive coal and electricity. Appendix D shows sector specific energy intensities.

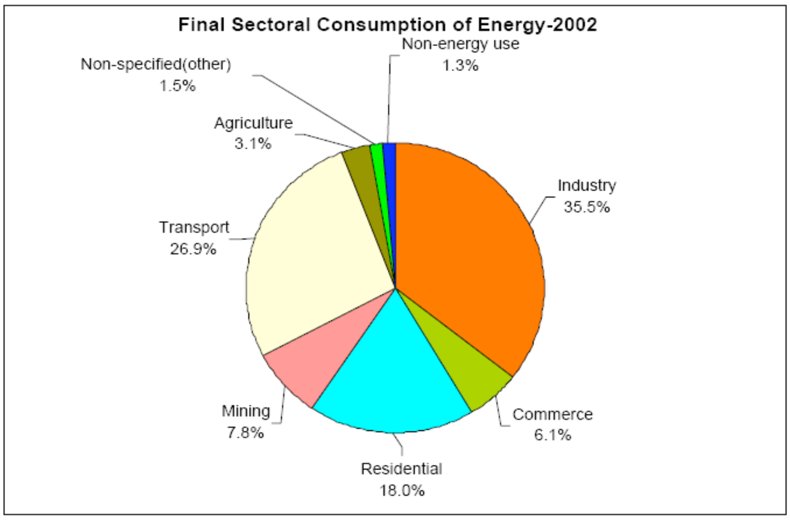
Final energy consumption by sector:

The breakdown of final energy consumption by economic sector has been described in some detail in Preliminary energy outlook for South Africa (ERI 2001), a document which sets out the basis for an integrated energy plan (IEP). Another recent publication is the Digest of South African Energy Statistics (DME 2005), although most of the data is for 2001/2.

Industry & Mining

The industrial sector (35.5%), together with mining (7.8%) accounts for the largest proportion of energy consumed (43.3%), as can be seen from Figure 4 (DME 2005). Gold mining in particular consumes a large amount of South Africa's energy requirements.

Figure 4



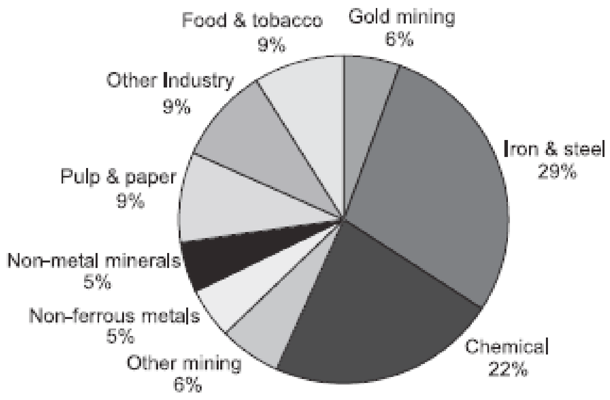
Source: DME (2005)

The need to mine gold at very deep levels due to declining ore grades accounts for the subs-sectors high-energy demands, this demand is however on the decrease. Although this may be true for gold mining, the demand for energy from 'other-mining' is growing.

Figure 5

Final Industrial Energy Consumption by sub-sector

(2002 total: 1036PJ)



Source: DME (2005) & Authors Own Calculations

Unlike other economic sectors of the South African economy whose demand for energy is expected to keep pace with or even exceed the rate of economic growth, the mining sub-sector's demand for energy is expected to grow more slowly than gross domestic product (GDP) (SANEA 2003).

Within the industrial sector, the major sub-sectors with high-energy demands include: iron and steel, pulp and paper, non-ferrous metals, chemicals and petro-chemicals, food and tobacco, and other (see breakdown in Figure 5). In terms of energy carriers for the industrial and mining sectors, gold mining and non-ferrous metals consume the largest amount of electricity. Coal is the main energy source for the production of iron and steel, chemicals (as feedstock), non-metallic minerals (where coal is mainly burnt in clamp kilns), pulp and paper (which relies heavily on 'black liquor' to produce most energy requirements), food, tobacco, and beverages. According to Eberhard & Van Horen (1995) coal-based industries have low energy conversion efficiencies compared with oil, gas and hydro plants.

Undoubtedly, the low cost of energy has given South Africa a competitive advantage, and encouraged the investment in and growth of energy-intensive industries such as aluminium smelting and mining. Many other industries within the manufacturing and mining sectors are linked through beneficiation and metals production. These activities are all energy-intensive, and rely on low prices for coal and electricity.

Energy intensities for the industry and mining sectors as tabulated in Appendix D are high relative to Organisation for Economic Cooperation and Development (OECD) countries, and certain industries consume up to twice as much energy per ton of output. It has been estimated that a 9-12% energy saving is possible through improved efficiency standards compared to current specific intensity, with attendant pollution decreases and a five-year payback period (Trikam 2002).

Transport

The transport sector currently consumes 27% of final energy consumption, of which about 97% is petroleum products, 3% electricity, and 0,2% coal (DME 2005). Energy intensities in this sector (see: Appendix D) are high due to various inherited problems and poor fiscal control. The national transport fleet is old, poorly maintained, and has low occupancy. Commuting patterns, shaped by the geography of apartheid settlements have resulted in high fuel consumption patterns for the sector. (Winkler et al 2006). The use of energy for transport is expected to grow more quickly than GDP (SANEA 2003).

Commercial

The commercial sector consumes only 6% of the national total primary energy consumption, in the proportion of electricity 64%, coal 35% and gas 1% (DME 2005). Currently there are no thermal efficiency standards for South African buildings, which means the costs of temperature control remain high. Utilities costs are normally borne by tenants, so there is little incentive for developers and property owners to focus on energy efficiencies. If energy- efficiency standards were made mandatory for commercial buildings, significant savings could be made. (Winkler et al 2006). Some studies (IEA 1996) estimate that 20-40% energy savings are possible in this sector. The commercial sector, like transport, shows higher growth rates in energy consumption than other sectors, and energy consumption can be expected to grow faster than economic output (SANEA 2003).

Residential

The residential sector consumes 18% of final energy, of which biomass contributes 14%, electricity 62%, coal 8%, paraffin 12%, and LPG and candles 2% each (DME 2005). Electrification is taking place rapidly. Recent estimates suggest that by 2025, 92% of households will be electrified, with 87% using electricity only, and 5% using electricity together with other fuels. (Winkler et al 2006). Within this sector, as with commercial buildings, there is significant potential for energy-efficiency improvements. An important distinction needs to be made, however, between the low-income residential sector and those of other income levels. Relatively cheap energy conservation interventions (such as installation of ceilings) are mostly not affordable for poor households and would probably require subsidies; on the other hand middle- and upper-income households generally have the means to invest in various forms of energy saving, for example by installing solar water heaters. The three major challenges faced by the residential sector are: firstly, the provision of energy needs and environment reclamation, where population pressure on fuel-wood gathering has depleted traditional biomass supplies and damaged large areas of land; secondly, the provision of lighting as a precursor for the education and economic empowerment of rural people; and, thirdly, a more widespread adoption of 'clean energy' in order to reduce concentrations of pollutants within residential houses. Energy costs for the poor are high; thus improved efficiencies are of special importance. In the current low-cost housing programmes, 50-90% efficiency savings are attainable with only a 1% to 5% increase in costs (IEA 1996) – a significant window of opportunity to improve the energy efficiencies and emissions of residential dwellings. By 2015, an estimated 7 million new houses will be constructed in South Africa. (Winkler et al 2006).

Agriculture

Agriculture's share of the economy has been in decline for many years. In 1965 its share of GDP was 9.1% and by 1998 it was only 4.0% (NDA 2000). This trend is likely to continue in future. With a declining share of GDP, agriculture can expect very slow growth in energy demand, although exactly what this will be is difficult to predict. Agriculture requires energy primarily for draft power and other tasks of land preparation, which are necessary for the effective utilisation of land. Energy for water pumping is the second major use, followed by smaller energy demands for activities such as crop processing, transport and lighting. (Winkler et al 2006). Energy in agriculture is used primarily in the form of diesel, followed by electricity and coal (DME 2005).

2.3 Energy intensity and inefficiency

The Integrated Energy Plan (DME 2004) acknowledges that by international standards, South Africa has a high-energy intensity. Appendix B shows South Africa's energy intensity between 1971 and 2002. After 1995, GDP rises and final energy consumption falls, resulting in a lowering of energy intensity over that period. If we compare South Africa to an industrialising nation like South Korea, South African energy intensity is higher in relation to GDP, similar if adjusted for power purchasing parity, and lower if measured by per capita consumption of primary energy.

Table 2
Energy consumption and intensity indicators, 2000

	TPES/capita (Toe/capita)	*TPES/GDP (Toe/000 1995 US$)*	*TPES/GDP (Toe/ 000 PPP 1995 US$)*	*Electricity consumption per capita (national average) (kWh/capita)*
South Africa	2.51	0.63	0.29	4 533
Africa	0.64	0.86	0.32	501
South Korea	4.10	0.31	0.30	5 901
Indonesia	0.69	0.70	0.25	390
Non-OECD	0.96	0.74	0.28	1 028
OECD	4.78	0.19	0.22	8 090
World	1.67	0.30	0.24	2 343

TPES = total primary energy supply, toe = tons of oil equivalent, PPP = purchasing power parity (adjusted to remove distortions of exchange rates), GDP = Gross domestic product

Source: IEA (2002)

South Africa's energy intensity is close to that of Indonesia, although with a higher level of primary energy and electricity consumption per capita. If we compare South Africa to other middle-income countries, like Brazil and Egypt (see: Appendix A) there is clearly room for energy efficiency improvements (Clark 2000).

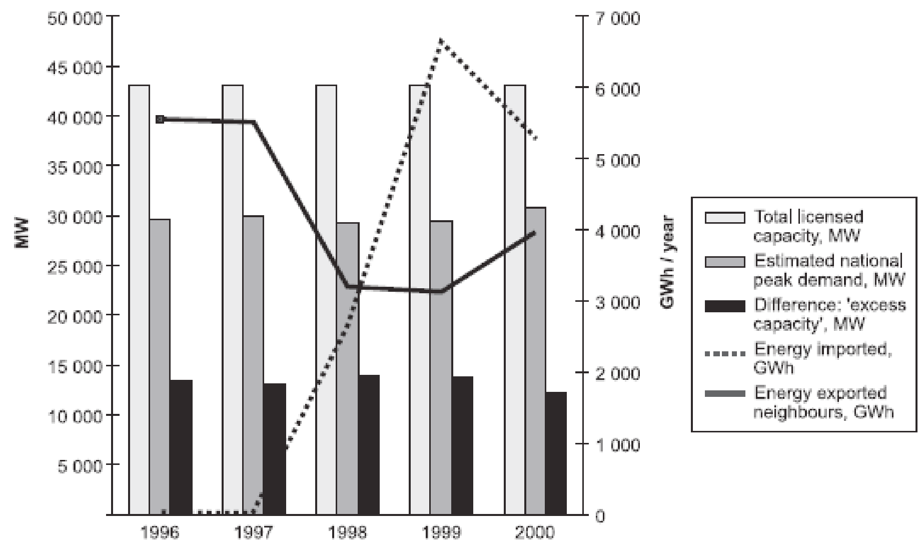
The best areas for improvements are those industries that require high levels of energy per unit of output – mining, iron and steel, aluminium, ferrochrome, and chemicals – the same sectors that make up a large share of South African exports. Low energy prices do not provide much incentive for energy efficiency, because it makes economic sense to use more energy if energy is cheap. Nonetheless, South Africa has made improvements in some sectors, notably iron and steel. Even here, while South Africa's energy intensity for iron and steel improved from 40 TJ per ton of steel in 1971 to 30 TJ/ton in 1991, in Taiwan the improvement over the same period was from 31 to 14 TJ/ton. In gold mining, while annual production has been generally declining since the 1970s, the input of energy per unit (TJ/ton) has been increasing over time. An effective comparison of intensity levels would require more detail regarding resource endowment, type of mining and industrial processes. While primary extraction and relatively low-grade processing dominate South African industry, it will remain a heavy user of energy; but as the industrial sector diversifies into more high-technology manufacturing and processing, its energy intensity should reduce. On the other hand, there are pressures for the energy intensity of the sector to increase: international trends show that countries like South Africa become receptors of investment in energy-intensive activities as developed countries shed these activities in favour of more service-oriented and lucrative activities using more skilled labour. Recent investments in South African aluminium smelters and iron and steel mills, and also the SAPP strategy, indicate such future industrial trends. (Winkler et al 2006).

The Energy Research Institute has conducted benchmark studies of energy efficiency in the industrial, residential, transport and commercial sectors in South Africa (Hughes et al. 2002). Whole sector studies are broad approximations, because of large differences within each sector due to variations in products, raw materials, and processes. Examples from specific sub-sectors would possibly be more illuminating. Further research is needed in this area and data quality remains a problem. Industrial production in South Africa has shifted over time from mining to manufacturing, with major contributions to economic output coming from iron and steel, chemicals and petrochemicals, pulp and paper, and mining. A greater shift is expected in future towards the production of technically advanced products, which require lower energy input but make high value-added contributions (Hughes et al. 2002). A specific example of a South African industrial sub-sector, which is relatively inefficient, compared with OECD countries is the pulp and paper sub-sector. In the pulp and paper industry, South Africa produces pulp at an energy-intensity per gross product output higher than that of other pulp-producing countries. Paper, on the other hand, is produced at similar energy intensity to many of the countries running best practice programmes in this industry (see: Table 3 below). High energy-intensities imply that there is potential for improvements in efficiency. For most sectors there is insufficient information for an accurate estimate of potential energy savings; however, attempts have been made to identify areas where savings are possible. There are a number of standard energy efficiency measures that can be applied. (Hughes et al. 2002).

2.4 Energy Investment

South Africa's massive investment in coal-fired power plants over time has led to excess energy capacity, with the country's licensed capacity having exceeded peak demand for at least 25 years. Figure 6 below shows the degree of excess energy capacity (in MW) as well as energy exports and imports (in GWh) between 1996 and 2000. With little need for new investment in generation capacity over recent decades, debt has been reduced, as most of the capacity has already been paid off.

Figure 6
Excess capacity of all power stations



Source: NER (2004)

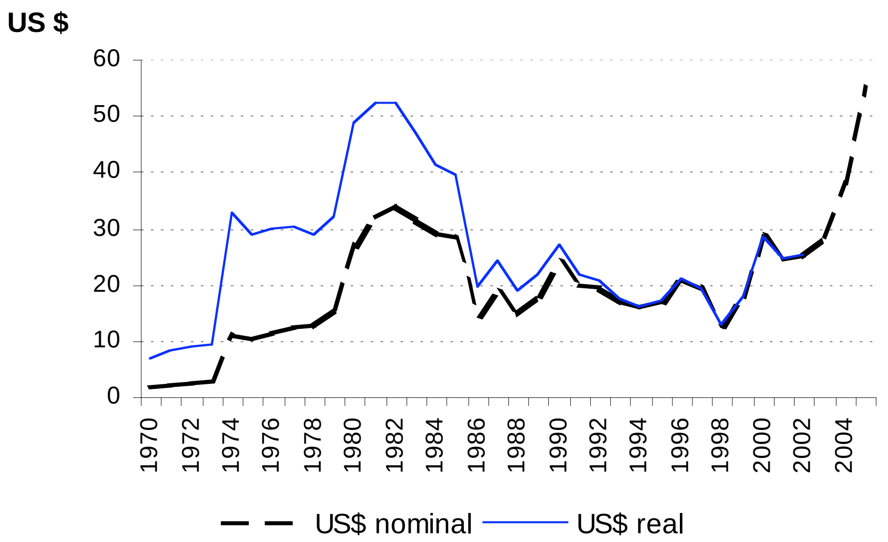
South Africa's low energy prices, mainly because of coal-generated electricity, has been one of the country's key competitive advantages, and continues to a large extent to drive new investment in industry. According to Winkler et al. 2006 however, such low energy costs also have the effect of retarding investment in the development of new energy sources, thus limiting the diversity of the fuel mix, its associated supply security, and possible efficiency improvements. The recent burgeoning of South Africa's economic growth indicates that before long there will need to be new investment in electricity generation capacity. What is clear is that when such new investment occurs, the capital costs and electricity prices are expected to rise.

2.5 Energy prices:

Oil

Worldwide energy prices are on the increase. Both in nominal and in real terms, the world oil price is currently more expensive than any time in the past 20 years (see: Figure 7). Fortunately, the South African economy's performance has been largely shielded from this by its relatively low vulnerability to recent oil price shocks.

Figure 7:
International Crude Oil Prices: per barrel of brent

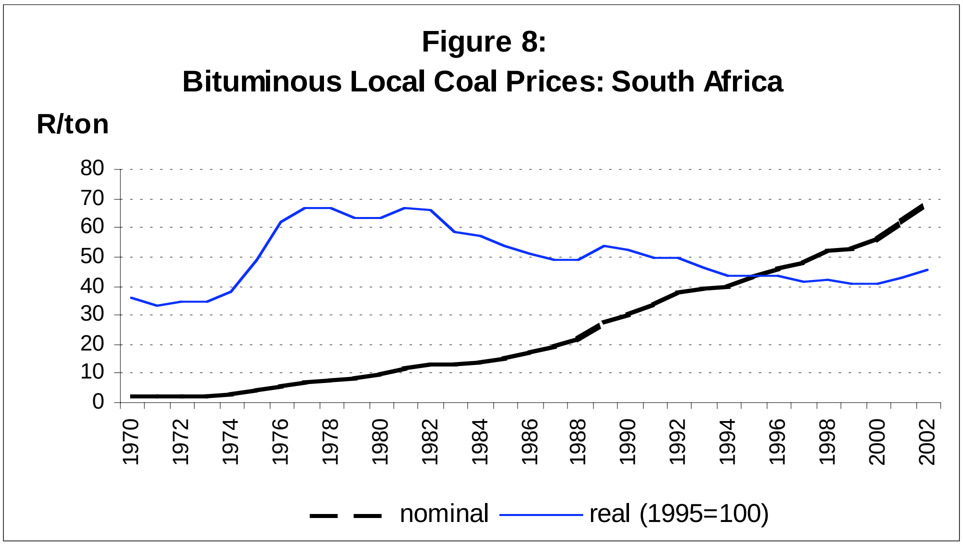


Source: EIA (2003)

The relatively low vulnerability of the South African economy to world oil price fluctuations is largely due to the fact that in the last decade crude oil only accounted for an average of 12% of South Africa's total energy requirements (DME 2005). Other factors include: the recent robust performance of the South African Rand, the low inflationary expectations of economic agents to rises in the world oil prices and the overall lower energy intensity of the South African economy, given structural economic changes in its GDP production. (Note, these factors are discussed in more detail in the next section.)

Coal

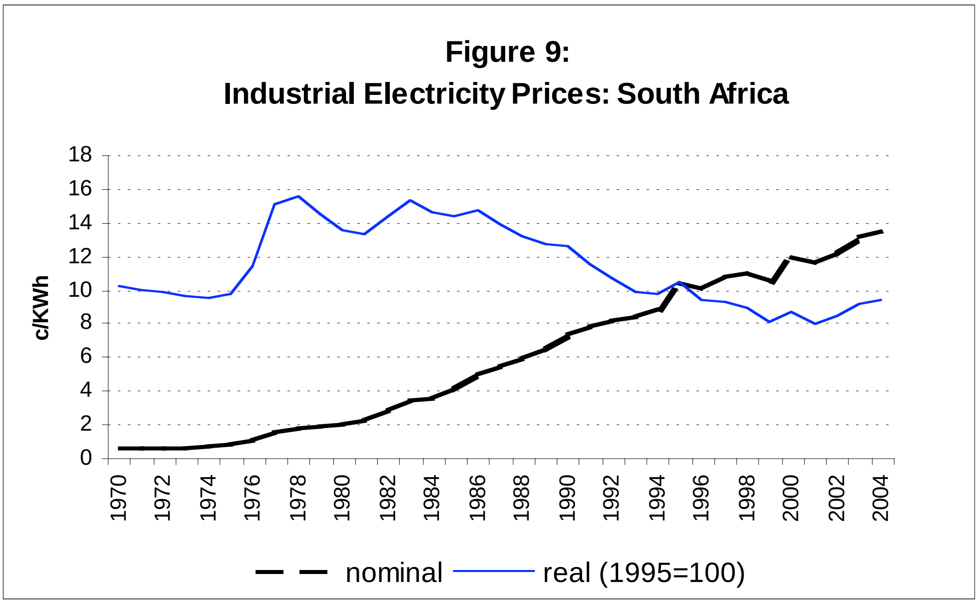
By far the largest share of South Africa's total energy requirements come from the energy carrier coal. Coal has contributed an average of 77% of South Africa's total energy supply over the period 1992-2002 (DME 2005). The low and relatively stable price of coal in real terms as shown in Figure 8 is a major contributing factor responsible for the maintenance of South Africa's low energy, and in particular electricity prices by international standards. (See: Appendices E and F for a full set of energy prices for South Africa in both nominal and real terms over the period 1971-2005.)



Source: DME (2002)

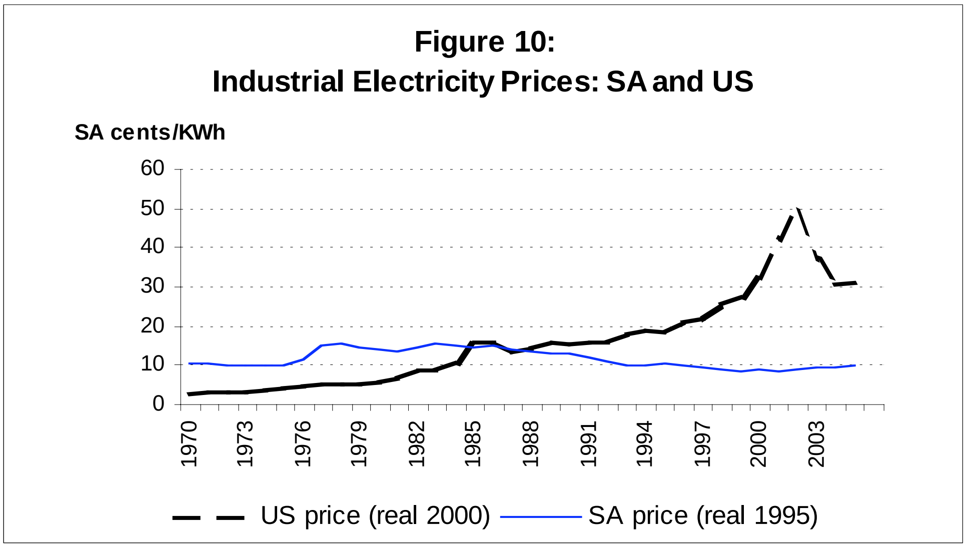
Electricity Tariffs

Electricity price increases in South Africa have remained below inflation increases (see: Figure 9) providing sound reasons for Eskom to allow prices to rise in real terms so as to earn an acceptable rate of return on capital invested, and to ensure sufficient generation of interest. But this raises the problem of affordability by poorer households, especially given the government's commitment to making electricity accessible to all its citizens. Eskom sells electricity to distributors, who then resell it to residential consumers, commerce and industry.



Source: DME (2002)

The average price of electricity in South Africa, per kilowatt-hour, is amongst the cheapest in the world. See: Figure 10, for a comparison of SA and US industrial electricity tariffs.



Source: DME (2002) and EIA (2003)

This is attributable to several factors:

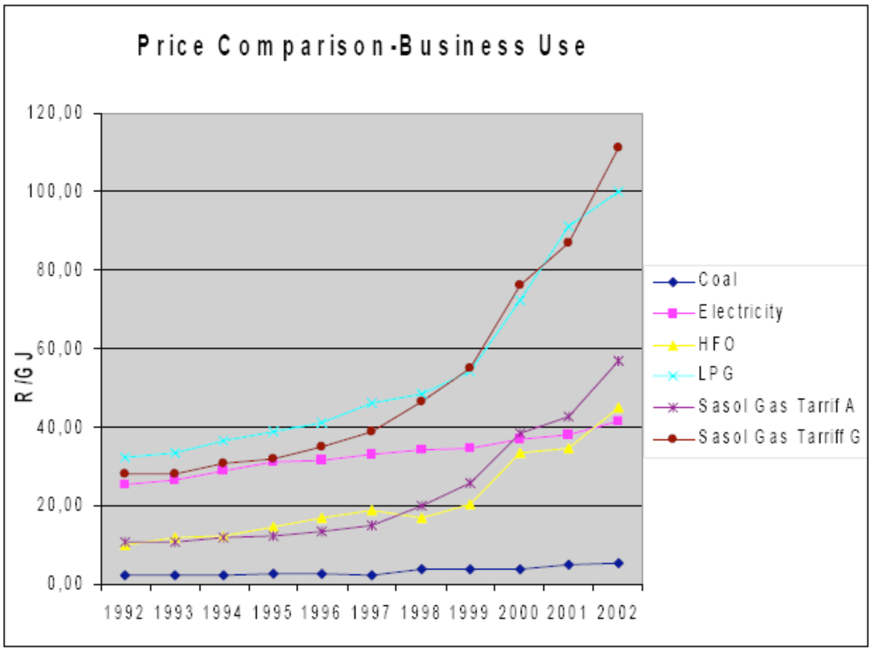
- Access to large reserves of low-grade coal, which are converted into energy through the use of technologies that maximise economies of scale. Power stations are located near coalmines and have the benefits of long-term contracts.
- Overcapacity from power stations, which are already paid for. This reduces Eskom's finance costs and enables it to peg electricity prices at a low marginal cost.
- Environmental costs are not included in the price of electricity.
- Eskom's investment has been subsidised through Reserve Bank forward cover, thus protecting Eskom against exchange rate fluctuations. A financial benefit for Eskom is that it is exempted from taxation and payment of dividends.

Low energy prices have a number of advantages, in that they:

- Benefit the poor.
- Give South African industry a comparative advantage.
- Act as an incentive for energy-intensive mainly export-oriented industries in the manufacturing and mining sectors (in particular, those linked through beneficiation and metals production).
- Provide a subsidy to foreign markets.

Despite the numerous advantages to the economy of low electricity tariffs, such prices do not reflect the long-term economic costs of either increasing energy capacity or the costs of fully including externalities into energy prices. Furthermore, the low price of coal has not promoted incentives for investments in either energy efficient technologies or renewable energy. With the prevailing low costs of energy there has been very little incentive for either industry or households to adopt energy efficiency measures. There is substantial scope for energy saving in the commercial and industrial sectors where the price of energy for business use by energy carrier has remained artificially low over the last decade (see: Figure 11).

Figure 11



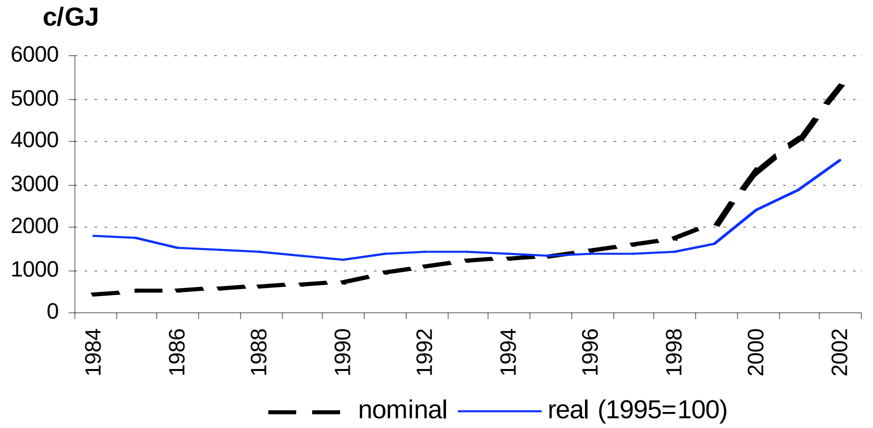
Source: DME (2002)

For the commercial sector, the energy savings opportunities lie in better design of buildings and improved management of energy use. In the industrial sector, the opportunities are in energy management and good housekeeping, providing incentives to adopt specific technologies, conducting energy assessments to identify areas for energy savings, and implementing standards for electrical equipment. The main challenge is the adoption and promotion of economically efficient energy measures, which would guarantee the achievement of market transformation and demand-side management sustainability. But there remain sharp conflicts over the meaning of sustainable development and its implications for policy. If, for example, economic efficiency is the prime objective of sustainable development, then energy subsidisation to alleviate poverty will receive limited attention. However this would limit the role of energy as an essential precursor to redressing the challenges of social and economic inequities. Thus a trade-off is necessary between addressing the energy requirements of the poor and promoting the efficiency and competitiveness of the whole economy by providing low-cost and high-quality energy inputs (Eberhard & Van Horen 1995).

Gas

Besides oil, gas is the only other energy carrier where substantial price increases have been witnessed in recent years (see, Figure 12). Despite the exponential increase in the price charged for gas in South Africa, such price rises are unlikely to have any significant impact on overall energy prices in South Africa since gas has contributed a mere 1.5% of the country's total primary energy supply as an energy carrier over the last decade (DME 2005).

Figure 12:
Local Gas Tariffs: South Africa



Source: DME (2002)

3 The Impact of Rising Energy Prices: An International Perspective

3.1 Economic Growth:

The conventional wisdom is that rising energy prices are bad for economic growth because they reduce the purchasing power of consumers and raise business costs, and thereby contribute to the slowing down of global economic growth rates. It is argued however by Bernake et al. (2004), and others FEASTA (2005) agree, that it would take a sudden dramatic increase in world oil prices to send the global economy into recession. Bernake et al. (2004) argue that if an oil price increase was spread out over a number of years, the investment opportunities it would generate would tend to balance out the contractions it caused and the growth rate would be largely unaffected. Research by Bernake et al. (2004) in America indicates that for every $10 a barrel rise, the US growth rate falls by 0.4% for about four months. After that, the economy recovers rapidly so that after 18 months the higher energy prices actually boost the growth rate by 0.1%, an effect that lasts for another year and a half.

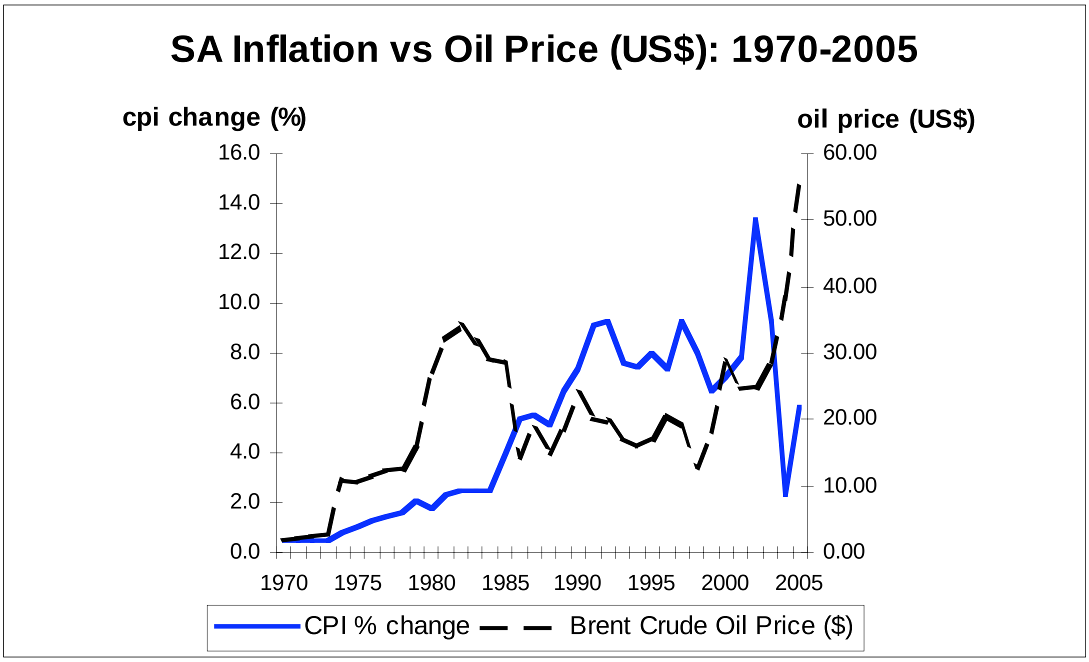
Bernake et al. (2004) argue that higher oil prices affect oil demand and the level of activity in an economy in three ways:

1. When oil is expensive, people try to use less of it. They may reduce the amount they drive, or reduce the temperature to which they heat their houses. Their minor economies have very little effect on oil consumption.
2. Higher oil prices also mean that consumers have less money to spend on other things. This reduces the amount of oil the economy uses because most of the goods and services the consumers would have bought would have required the use of oil for their production and delivery.
3. If higher oil prices reduce consumer demand very much, some manufacturers and retailers will find that their profits suffer and that they have surplus capacity. They will therefore defer their plans for expansion. This will result in very large energy savings because construction work is energy intensive. It is estimated that around half of all the energy used in an industrialised economy is necessitated by projects designed to expand the economy. However, other firms will find that new opportunities open for them, such as supplying equipment for renewable energy projects. It takes a little time for their new projects to be developed so, in the short term, higher energy prices will reduce growth. In the longer term, however, they could even have a positive effect on growth in OECD countries.

3.2 Inflation:

Viewed from a long-term perspective, inflation, measured by the rate of change in the consumer price index (CPI), tracks movements in the world oil price (See: Figure 13).

Figure 13



Source: SARB quarterly bulletin, various years

Not only do oil and other energy prices constitute a portion of the actual CPI, but downstream impacts on other commodity prices also have a lagged effect on the CPI inflation. FEASTA (2005) argue that since higher energy prices add to inflation, it is it is the likely reaction of the central banks to that inflation which threatens the world economy and not the higher world energy prices themselves. It is argued that if the central banks ignored the inflation, it would help the world economy because the inflation would lower the effective interest rate and thus make investments in the new technologies even more attractive. The danger is that the central banks will fulfill their mandates and act against the inflation by pushing up interest rates in the way they did when oil prices rose in 1973 and 1979. This would increase business costs (since all businesses use borrowed money) at exactly the same time as firms were having to pay more for their energy and, in some cases, were finding that consumer demand was falling. This would damage many firms and cause them to postpone investment plans. When interest rates are increased, firms not exposed to foreign competition and not suffering from a declining consumer demand increase their prices to pass on the extra interest costs. This is itself inflationary and may cause the central banks to raise interest rates again. Several rounds of this cycle could take place until the economy is so battered and bruised that all capital investment stops and unemployment soars. If this happened in several major countries at the same time, it would cut global energy demand sharply and energy prices would fall and, with no investment going on, the world economy could stay in a depressed state for many years. There is a serious danger that the central banks of the industrialised world will cause such a depression in the next few months. Not only would this cause great hardship for many millions of people but it would also mean that, with oil and gas cheap again, there would be no incentive to switch to renewable energy or for the oil companies to explore for new sources. (FEASTA 2005)

According to FEASTA (2005), central bankers must recognise that higher energy prices are necessary to enable the energy companies to develop more expensive sources of fuel, and that, consequently, they must allow the inflation to take its course. They must not choke it off by preventing the higher energy prices being reflected in the prices charged for the goods and services, which use fossil energy. Inflation is the only relatively painless way that every price in the global economy can change by a different amount to reflect the new energy price level. The inflation needs to proceed for several years as, initially, firms will put prices up by only the amount their direct fuel costs rise. They will consequently require further increases later when the higher cost of the fuel used in the products they purchase works its way through to them and has to be passed on. Resisting inflation would essentially be an attempt to maintain the purchasing power of money in terms of the amount of energy it buys. This is obviously an inappropriate response if energy is getting scarcer and/or requires more resources to produce. (FEASTA 2005)

In the past 10 years inflation has averaged just 1.8% in major world economies. This followed a slightly higher bout in the late 1980s and the early 1990s. The last period of double-digit inflation followed the 1979/80 oil price crisis. In developing countries hyperinflation has also been largely eliminated, persisting only in Zimbabwe, where exceptionally poor policies have overwhelmed a very conducive global environment. The recent period of low global inflation is remarkable, given the massive rise in energy prices since mid 2002. Every other period of significant oil price increase over the past

35 years has had an immediate and strong effect on inflation, but this time the effect on both inflation and economic growth has been very muted.

Many possible reasons have been offered for the lack of a negative effect on both production and prices. Most obviously, major economies are much less exposed to energy price fluctuations than they were, because they are now service rather than heavy manufacturing orientated. Over the past three decades the percentage contribution of manufacturing to GDP in the US has fallen to around 13% from 22%, a trend also typical in Europe and Japan as well as certain developing countries such as India. More importantly, low inflationary expectations have become more entrenched. The belief that 'inflation is dead' has changed the behavioural response of consumers, workers and producers. Before the first oil shock in the early 1970s inflation had already been on the rise. The rise in energy prices was treated not as a comparative price increase, but rather as an increase in the absolute price level that necessitated higher wages and increased prices of other goods. The monetary authorities were forced to push interest rates up drastically in order to restore price stability, exerting a heavy cost on the economy. In contrast, in the recent environment of low inflationary expectations, the rise in world oil prices has been treated in the same way as the rise in the price of any other good – there has been some substitution out of the pressure on other prices, including that of labour. As a result the overall price level has been relatively stable. The strict monetary policies of earlier decades have given central banks unprecedented credibility, which is paying dividends in the form of lower inflation and higher growth. Perhaps more importantly, there have been other significant deflationary forces in the form of technological change, increased globalisation and China. Technology has introduced direct improvements to products at lower cost and helped massive productivity gains, but has also assisted in spreading the benefits of increased trade in goods and services. More liberal trade regimes have increased specialisation and economies of scale, driving down prices everywhere and improving international economic growth. China has been the most spectacular gainer of this process, with GDP rising by nearly 10% annually over the past decade. However, China's massive, cheap and increasingly skilled labour force has kept wages and prices in check elsewhere. This has not always been beneficial to all industries and workers, but has been overwhelmingly positive for consumers and particularly producers, who have been able to outsource many of their processes to much lower cost environments, not only in China, but worldwide.

Nonetheless, inflation fears worldwide are rising, with headline inflation rates having started to move higher over the past few months in many major economies. US inflation moved to 4,7% September, its highest level in 14 years, while at 2,6% in European inflation is more modest, but is still the highest since mid-2001. Added to this is the fear that the rise in energy prices may continue rather than fall back as has been the pattern so often in the past. The price shocks of the 1970s were largely supply-side shocks, but the current world oil price rise has been a combination of supply-side disruptions and unexpectedly strong demand conditions, largely emanating from the two locomotives of the global economy, the US on the consumption side and China on the production side. Thus if oil prices do continue to rise, they could overwhelm the positive deflationary forces present elsewhere in the system. Producers might ultimately be forced to raise prices in the face of higher production and transport costs, and expectations could gradually start adjusting to higher price levels, with consequences for wages. Already surveys are starting to signal changing expectations, an important warning signal for central banks.

3.3 Sustainable Development & Poverty:

According to FEASTA (2005) higher energy prices are a good thing provided that they don't rise so rapidly that they dislocate the global system and that the poor are protected. FEASTA (2005) argue that higher prices are certainly necessary to bring about important changes in the way we use energy and in the types of energy we use. They shift the balance away from energy- and capital-intensive forms of production towards more labour-intensive ones. They do this by making machinery more expensive to build and to operate, and by greatly increasing the cost of transport and distribution. In particular multinational companies that use automated, specialised equipment to make very large quantities of one thing in one place and then need to ship it to markets around the world, tend to lose, while smaller firms which use rather more labour with a higher level of skill and less specialized equipment to make a wide range of things for their local markets, tend to gain. Higher energy prices also shift the balance away from the centralised supply of energy drawn from fossil sources to local systems supplying energy from local sources. Local energy sources become important again and, just as in the past, instead of energy being taken to wherever in the world is currently a cheap place to manufacture, economic activity will move to wherever there is a reliable supply of competitively priced energy available for its operations. This has the potential to bring about a shift in political and economic power. Naturally, the effect of raising energy prices differs from country to country. Those, which import a lot of energy, will see the rate of consumption growth slow or fall but the recent rise of world oil prices to around the $70 level seems to be benefiting many national economies, at least according to conventional criteria. (FEASTA 2005)

According to the World Bank, higher energy prices can hit the poor twice as hard as those in the highest income group. A study by ESMAP (2005a) in Yemen found that a $15 rise in the price of a barrel of oil raised the cost of goods which the poor bought by 14.4% whereas the cost of the goods bought by the richest 10% of the population rose by only 7.1%. Even if the price increases faced by the poor in Africa are not as great as in Yemen, the fact that world oil prices have risen by around 100% in the last 24 months must mean that they have lost considerable spending power.

Higher oil prices have not only widened the gap between richer and poorer people. They have also widened the gap between richer and poorer countries. The governments of oil- and mineral-exporting countries in Africa are enjoying much higher royalty payments while, according to another World Bank report, sub-Saharan countries, which are net oil importers, have seen their national incomes fall by 3-4% in the past two years (ESMAP 2005b). Attempts to protect the poor by subsidising their fuel are providing financially ruinous for many governments around the world and violence has broken out as several schemes have been scrapped.

The most promising policies to reduce vulnerability to world oil price shocks appear to be related to the ability to encourage countries to reduce their use of oil and energy simultaneously (since there is little short-run prospect of large-scale fuel substitution).
According to ESMAP 2005b, a successful policy to improve the oil intensity of an economy would be to allow prices to rise at least to their international levels, which would then allow the effects of price elasticities to work. It is recognised though that the effect on the country's oil demand may not be large and will not be felt immediately.

ESMAP 2005b argue that this policy may affect poorer members of society, so that a careful balance between economy-wide objectives and distributional considerations would be needed. Policies to encourage oil saving through transport schemes designed to favour mass transportation, as suggested by the IEA for developed countries, are much less applicable to developing countries. However, there may be transport-related policies more suited to the African context to encourage more efficient and less wasteful oil use. The investigation of such possibilities, for individual countries, should hence be a high priority.

Essentially it can be argued that, there are two economic systems in the world – the one to which to which the oil and mining companies belong, a high energy, capital-intensive, globalised one, owned by international investors, and a low-energy, low-capital, localised economy, which is largely locally owned. These two economic systems are in competition with each other and while people in the HEGO (High Energy, Globally-Owned) economy are doing quite well from the higher energy prices, those in the LELO (Low Energy, Locally Owned) economy are doing badly.

One thing is clear, if fossil energy prices do rise further over the coming years, the world's poor, especially the landless among them, will be seriously hurt. Food will become increasingly scarce and expensive because of the large amount of energy required by industrialised agriculture and also because huge areas of land are likely to be taken out of food production to produce energy crops. The situation will almost certainly arise in which the rich – in whatever country they live – will be running their cars using fuels produced by starving the poor. Everything the poor buy will go up in price and there is no guarantee that their incomes will increase in step with the prices they will be asked to pay. Moreover, market prices will deny the poor the energy they need to make themselves more productive in their local economies. The market economy was once defined by the Australian writer, Ted Trainer, as "an ingenious device for ensuring that when things become scarce only the rich can get them". This will prove true about fossil fuel based energy as it becomes scarce unless something is done to prevent it. The rich will have plenty of energy and use it, one way or another, to maintain their wealth and political power. The same can not however be said of the world's poor, where the lack of access to energy, due to rising fossil fuel prices, may mean that people will die.

4. Energy's Role in International Trade: Changing International Cost Competitiveness in Energy Intensive Exports

The Institute for Managerial Development in its yearly publication, The World Competitiveness Yearbook defines competitiveness as "the degree to which a nation can, under free and fair market conditions, produce goods and services that meet the test of international markets while simultaneously maintaining and expanding the real incomes of its citizens." Balanced trade alone is not the measure of competitiveness since every nation must balance its account in the longer term. Trade imbalances may result from changes that are occurring in the economy such as adjustments to major shocks imposed from outside the economy; the energy (in particular, world oil) price shocks provide such an example. Such adjustments are reflected in structural changes to the economy and therefore provide a way of assessing the role of energy in the competitiveness of a country's goods in international trade.

In order to fully understand how higher energy prices influence a country's competitiveness in world markets, it is necessary to first understand how the behaviour of the economic decision makers is influenced by the structural changes to the economy brought about by these events. Business, or the managers of business, constitutes one set of agents. The resource allocation process that is part of their activity is reflected in the internal operation of the firm, the purchase of factor inputs (labour and materials, in the short-run; land, equipment, and buildings over longer periods of time) and the offer of products for sale. The purchase of materials, especially, has implications for changes in the inter-industry structure of the economy over time. If energy prices rise, the materials that adjust will be energy-intensive materials; businesses adjust the intensity of energy use through conservation, equipment changes, recycling, and simple housekeeping operations that reduce energy use per unit of output. The efficiency with which these and other inputs are used is reflected in productivity changes, of which energy productivity is of special interest. The technology available also has a bearing on this choice, as do the forces that otherwise shape the decision making of the agent. Economising on factor inputs increases efficiency and influences the rate at which energy productivity improves. Other productivity changes allow increased production with less labour and material inputs. Of these adjustments, the economising on the more energy-intensive materials, i.e., the internal allocation decisions of firms, is one direct factor that has changed the inter-industry structure of the economy, Clearly, then, a key figure in this tale of structural change is the business agent.

The other major set of actors falls into the category of consumers. Most important among these is the individual household that engages in personal consumption, provides the labour input to business, and generates the savings that, in part, finance the purchase of plant and equipment. Another major consumer is government, with actors at the state, and local levels. Foreign consumers are also of importance, since their purchases add to other consumers' purchases to make up total demand. Even businesses qualify as consumers, since capital purchases (i.e., investment) are considered final demand rather than intermediate materials. Consumers alter their choice of goods and services in the face of a changing set of relative prices; these shifts affect the growth rates of industry. With differential growth rates over time, the relative size of these industries will change, so, the contribution of any particular industry to total output will change.

In essence then, the structure of the economy changes as millions of different economic agents make decisions or choices. A variety of factors influence these decisions; changes in relative prices that result from a sharp increase in world oil prices are one such example. What is clear, it that a dramatic shock, such as the doubling of world oil prices, sets in motion a chain of events that over time substantially change the structure of the economy. As economic agents respond to this change, we would expect events to unfold as follows. The now higher price of crude first raises the price of refined petroleum products. Businesses would substitute other fuels, coal or natural gas for example for oil, thus bidding up the price of these other fuels. The price of electricity would also increase because coal is widely used to produce electricity. All fuels and electricity, now somewhat higher priced, would add to the cost of the commodities produced. When these cost changes are fully reflected in prices, further changes will occur. With refined petroleum products and energy-intensive goods now higher in price, consumers (individuals, governments, and foreigners) will buy relatively more of the cheaper commodities. These goods will be relatively less energy-intensive. Imported goods, that do not fully reflect these higher domestic energy prices for one reason or another, will likewise be relatively less expensive and thus more attractive. As changes occur in the composition of goods purchased by consumers, the growth of domestic industries producing those goods will be affected. The result will be a shift in the growth and relative position of industries. Energy-intensive industries will produce relatively less; less energy-intensive industries will produce relatively more. Because the less energy-intensive industries have had the least incentive to substitute other factors for energy, their energy use will change the least, but now their fraction of total output will be relatively larger. In short, both the consumer adjustments and the substitution mechanisms operational at the firm level will have the effect of altering the mix of goods sold to final demand and the selection of intermediate materials used in production; accordingly, the array of goods sold will change in response to a world oil price increase.

Now that the behaviour of the decision makers to the structural economic changes brought about by higher energy prices is better understood, we turn our attention directly to how energy price shocks are expected to influence world trade patterns. It is after all changes to these trade patterns, which mirror changes in the structure of the economy, that are the basic measure of a country's competitive position vis-a-vis the rest of the world. The country with the relative cost advantage in energy will be expected to export those commodities that are more energy-intensive (i.e., chemicals, primary metals, pulp and paper, etc.). Many factors can give rise to relative cost advantages: lower material prices, lower wage rates, lower costs of capital, etc. are all such examples. Lower energy prices can thus be an important source of a country's cost advantage in energy intensive products. Where however, embodied energy is only an insignificant element in the costs of a product's production, it is expected that the country with the higher energy costs will export relatively more commodities with low levels of embodied energy. Stated slightly differently, a particular country that has a cost disadvantage in energy can either overcome this disadvantage by using other materials, labour and capital more efficiently or it can focus its production on commodities that have smaller-embodied energy content and rather trade these on world markets. Note though, that where aggregate adjustments to changes in world energy prices are similar between trading partners, trade patterns and resulting trade flows are unlikely to be materially affected.

As has already been mentioned, low energy prices are an import source of comparative advantage to South African manufactures in world markets, in particular her highest energy-intensive industries such as: petroleum refineries, primary metals, other metal products and other non-metallic minerals (See: Appendix G). It is not surprising then that these same industries rank amongst South Africa's most export-oriented industries and on a bilateral SA-US trade basis help explain the South African industries' relatively higher export to output share (See: Appendix G). What is clear is that South Africa's relative cost advantage in energy-intensive goods is particularly strong in those manufacturing industries linked through beneficiation and metals production. What follows therefore, is a more detailed discussion of how rising energy prices will potentially impact on three such industries, these are: iron & steel, ferrochrome and aluminum production.

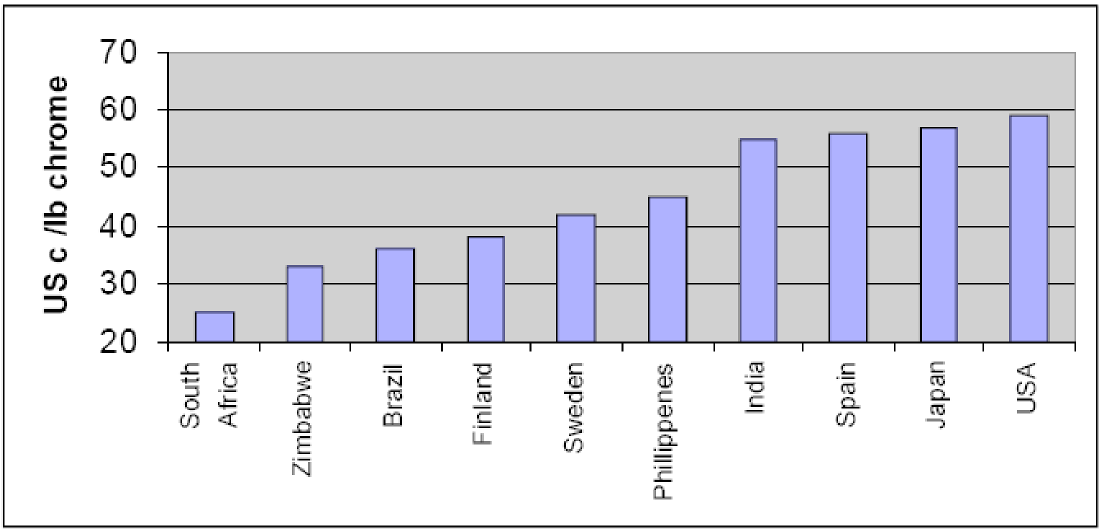
Iron and steel – changing energy prices and comparative costs

Energy requirements for the production of iron range from 12 GJ/ton (Worrel 1994) in Italy to 20GJ/t in South Africa (West et al 1995). Energy consumption in the EU for the production of steel is 19 GJ/ton on average, which is less than the specific energy requirement for iron production in South Africa. South Africa's high energy consumption is partly a result of the technologies employed locally, with a strong component of iron-making rather than scrap usage, and partly as a result of the type and quality of materials used (West et al 1995). Although the relative intensity of South African producers is decreasing it is still significantly higher than elsewhere. The steel industry operates within a very narrow cost margin, where variations in total cost range from 5 to 8 per cent only. The potential implications for the industry if electricity prices were to increase are not clear, but it seems feasible that, with the level of competition and a fickle market, these changes might affect the competitiveness of the steel industry in the short-to-medium term. Although technology improvements offer some flexibility in the usage of energy and in production volumes, if electricity prices however increased significantly and market demand were insufficient, no medium-term solutions exist that would rescue local industries. The financial crisis in which the local steel industry found itself in past years because of the low prices in the steel market creates a harsh atmosphere for energy reform. More than any of the industries discussed here, the iron and steel industry would be affected by changing electricity prices.

Ferrochrome – changing energy prices and comparative costs

South Africa's competitive position in ferro-alloy production is arguably its raw material availability, cheap energy and labour. Figure 14 compares the production costs for selected ferroalloy-producing countries for 1988. South African companies (1989) produced at the lowest cost of all countries listed, by a considerable margin. The electricity price for ferrochrome production in South Africa is about 75 per cent of what it is in other countries.

Figure 14



Source: Granville & Freeman (1991)

For the standard process of ferrochrome production, electricity costs make up approximately 35 per cent of total operating costs. Significant changes in energy prices are thus likely to affect production and competitiveness in the longer run. South African tariffs compare very favourably with international utilities and electricity is on average purchased at two UScents/kWh (9,2 SAcents/kWh in 1997 currency). Other international ferrochrome producers operate at up to three UScents/kWh (13,8 SAcents/kWh in 1997 currency). The effect of energy prices on energy resources should however not be under-estimated. Primary energy industry specialists are of the opinion that at a 15 per cent increase in electricity prices major changes in the structure of the industry would be seen. A possible scenario would be the closing down of marginal plants and the emergence of smaller industry producers. Others expect that increasing electricity prices by 50 per cent would place a large proportion of local industries at risk, but that current electricity prices would have to double for a large proportion of existing manufacturers to close down. This extent of fluctuation (50-200 per cent) in the short term is unlikely however (Visser 2000). One feature in favour of the South African ferrochrome industry in the light of changing energy prices locally is that South Africa currently exports 50 per cent of total world ferrochrome. As a price-maker in the global market, it has the ability to reflect increased internal costs in the price that it charges consumers. It is however wise to consider that in 1972 the world's four largest stainless steel producers produced 60 per cent of the West's ferrochrome. This percentage had declined to 20 per cent by 1990 as a result of a loss in comparative advantage due to increasing energy and labour costs in those countries (Visser 2000).

Aluminium – changing energy prices and comparative costs

Alusaf, as the only aluminium producer in South Africa, is Eskom's single largest industrial customer. In utilising a significant proportion of Eskom's surplus capacity, sales to Alusuf contribute largely towards Eskom's total revenue (Duperrut 1998). More than two thirds of the costs associated with aluminium production are made up of raw material and electricity. The economic viability of aluminium plants depends, among other things, on competitively priced electricity. It is therefore crucial for these companies to secure competitive supply contracts for its major inputs, alumina and electricity. Labour costs represent a relatively small share of total costs. Alusaf's overall competitiveness is reliant on a combination of cheap electricity and alumina, as well as low labour costs, which allows South Africa to be the second lowest-cost producer (Duperrut 1998). The technology used in producing aluminium is fixed, and changes in prices of electricity are therefore unlikely to influence technological development in the near future. According to Duperrut 1998, Hillside uses relatively more electricity than would be expected from a comparable plant of the same age and process route. This might be due to the fact that electricity is relatively cheap in South Africa, and that the technology purchased took this parameter into account. By contrast, recent improvements to the Bayside plant have improved its overall energy efficiency. Increasing prices in electricity since the 1960s (when electricity was cheap and natural gas was an abundant resource in Europe) have forced various European firms to close down (Visser 2000). Significant electricity price increases are hence also likely to put the longer-term future of the local aluminium industry in the balance. Within aluminium and ferrochrome production, the potential impact of changing energy prices is not likely to affect productivity as much as it would affect productivity and profitability in the steel industry. This is mainly due to the constant market demand for aluminium and ferrochrome. During times of low commodity prices these producers run closer to full capacity (given the commodity-linked agreements) than under other circumstances. The iron and steel industry is, however, not blessed with constant demand for its products and export opportunities are limited. Most countries tend to have domestic iron and steel production facilities. During times of low prices, production in this industry is cut back significantly to prevent flooding of the market. The steel industry is therefore likely to be more affected than the other metals producers, by changes in electricity pricing (Visser 2000).

5. Energy Policy in South Africa

According to Winkler et al. 2006, the fundamental drivers of energy policy in South Africa have shifted from the supply-side to the demand-side. During the apartheid years, top-down planning and concerns around energy security (amongst other factors) lead to large investments in synthetic fuels from coal, nuclear power generation and predominantly coal-fired electricity generation. Furthermore, Winkler et al. 2006 argues that since the first democratic elections in 1994, socio-economic development has become the key-driving factor for all policy. The new government is determined that energy should not only support economic development, but also improve the lives of the poor – the black majority. In the energy sector, this has meant giving more attention to demand-side management and to delivering energy services, including productive energy for all South Africans and domestic energy for cooking.

The major objectives of government policy for the energy sector are spelled out in the 1998 White Paper on Energy Policy (DME 1998). The five major objectives are:

- Increasing access to affordable energy services;
- Stimulating economic development;
- Improving energy governance;
- Managing energy-related environmental impacts; and
- Securing supply through diversity.

Much attention has focused on the first target of increasing access to energy, particularly electricity. Historically, provision of electricity in South Africa was limited to established towns and areas of economic activity. The national electrification programme is central to the development of the country and is increasing the number of people connected to the national grid. The proportion of households with grid electricity increased from 45% in 1995 to 66% in 2001, and the number of people using electricity (including non-grid electricity) increased from 58% in 1996 to 70% in 2001 (SANEA 2003). The main problem is that poorer households cannot afford enough electricity to render connection economically viable for Eskom and they cannot afford to pay for the necessary electrical appliances. Davidson et al (2002) argue that the existing system of electricity financing and implementation, while successful in meeting RDP targets, is not sustainable. Lack of access to electricity makes fighting poverty more difficult, as it hampers individual efforts to advance social and economic development goals.

The Energy White Paper (1998) fully commits the government to improving the plight of low-income and rural populations and addressing the fact that the poor generally only have access to the less convenient and less healthy fuels. Winkler et al 2006 argue that the success of this drive will depend on the response by stakeholders to issues such as pricing and financing of energy services, appropriate appliance/fuel combinations, and availability of efficient appliances. Greater energy efficiency will yield potential financial and environmental benefits, allowing industry to become more internationally competitive. Although the current cheap energy results in foreign exchange earnings, harmful environmental and health factors have not been included in energy pricing. Energy pricing needs to be balanced against sustainable environmental standards. The

South African National Energy Association (SANEA 2003) estimates that greater energy efficiency could save between 10% and 20% of current consumption and in turn lead to an increase of between 1.5% and 3% in the GDP. But to achieve this, a solution has to be sought to the critical barriers that hinder the uptake of such technologies, such as inappropriate economic signals, lack of public and official awareness, and the high capital costs involved. (Winkler et al. 2006)

In terms of the Energy White Paper's fifth objective, namely, that of securing energy supply through diversity, much scope for energy substitution exists within South Africa. According to the South African Petroleum Industry Association (SAPIA), South Africa produces about 45% of its fuel requirements. Sasol supplies around 33%, Mossgas about 7%, and other crude oil producers roughly 5%. It is estimated by industry sources that more than 200 000 barrels of oil per day emanate from domestic sources in the form of the natural gas-to-fuel refinery in Mossel Bay, two small independent oil fields off the southern Cape Coast and the oil-from-coal gas plant facilities of Sasol. Sasol's plants are estimated to supply about 175 000 barrels of oil per day. Sasol already has plans to boost its role as a major supplier of oil products in South Africa. It has plans, for instance, to build a plant at Secunda, which may be approved by the end of 2004. This plant would convert 400 000 tons of soya beans a year into 80 000 tons of diesel fuel. This project would obviously become more attractive if international oil prices were to remain high. Sasol has also opened a natural gas pipeline between central Mozambique and South Africa. The gas imported through the pipeline is to be used by Sasol to substitute some of the coal employed at its Sasolburg plant to make chemicals and diesel. If the gas deposits in Mozambique prove large enough, the Sasolburg plant could be expanded to produce more fuel supplies for the country. Again, such an investment would become more attractive with high oil prices. There is also the possibility that a natural gas-fuel refinery could be built on South Africa's west coast, possibly involving Sasol. Forest Oil and Mvelaphanda Holdings are looking for markets for gas from their Ibhubhesi deposit off the west coast south of the border with Namibia. In addition, Energy Africa is looking for a market for gas from its Kudu gas deposit to the north of Ibhubhesi off the Namibian coast. All these potential investments become more attractive with sustained high global oil prices. The recent co-operation agreement between PetroSA and Sasol, reached in April 2004, could also lead to future joint ventures in natural gas and chemical operations and boost domestic oil production. PetroSA needs gas for its Mossel Bay refinery, and it envisages future collaboration with Sasol to find gas reserves through drilling operations at PetroSA's Ibhubhesi exploration field, or Sasol's blocks 3A and 4A on the west coast of South Africa. (ABSA 2004)

In assessing the scope for import substitution in the face of any sustained rise in international oil prices, it should also be noted that South Africa's coal based syn-fuel industry could be increased significantly through the medium of Sasol. The low-grade coal resources available for this purpose are large, and the technology has greatly improved over the years. A sustained rise in international oil prices would therefore potentially furnish new opportunities for South Africa to increase its self-sufficiency in respect of oil supplies. This could strengthen its balance of payments position and reduce its vulnerability to increases in international oil prices. The airline and chemical industries in South Africa would be hit by surging oil prices, but the oil related investments rendered viable by any such an outcome could become far more important. More reliance on alternative energy sources could also benefit the local uranium and coal mining industries. What is more, upward pressure on oil prices could furnish added incentives for the government to introduce tax incentives for bio-fuels production to attract investment and expand the renewable energy sector in South Africa. (ABSA 2004)

6. Conclusion

The South African economy is by all accounts an energy-intensive economy. This would suggest that the economy's economic growth and poverty reduction potential would be seriously undermined by a world of rising energy prices. So far, however, energy prices for South Africa's main energy carriers have remained artificially low. In particular, the real price of coal, which provides on average 70% of South Africa's energy requirement, remains both low and very stable. Extremely competitive electricity tariffs based on these low coal prices have benefited the economy in a number of ways. This report verifies findings by earlier studies (Visser et al 2000, Winkler et al 2006) that much of South Africa's international competitiveness in energy-intensive mining and manufactured goods is based on South Africa's vast coal deposits. Low electricity prices have also done their part in helping South Africa meet its socio economic development goal of providing the country's poor with affordable access to modern forms of energy.

The research undertaken in this paper has clearly shown that South Africa's overall energy-intensity has decreased after reaching a peak in the year 1995. It is argued however, that such decreases are NOT really a response to changes in the country's energy prices. Rather, it is argued that the decreasing energy-intensity of the overall economy is more likely to be attributable to changes over time in both the composition and scale of South Africa's economic activities. Energy prices, by remaining relatively unchanged for most of the period 1971-2002 under investigation have at most only played a minor role in such changes.

Rising international oil price are a much more recent concern. The price of crude oil has more than doubled in world markets since the middle of 2002, and potential future price increases in the face of world security concerns and continued high demand by the world's major economies, pose a real threat to world economic growth. It is almost certain that any further significant increase in international oil prices would threaten world inflation targets, necessitating an environment of rising interest rates which would surely undermine world economic growth by reducing the purchasing power of consumers and by raising the costs of firms in their undertaking of business. South Africa's low vulnerability to oil price shocks is largely on account of its relatively low dependence on oil as an energy carrier and the numerous available energy substitution possibilities, made technologically and financially viable by higher international oil prices.

Finally, the research highlights, the notion that if improved energy efficiency is a prime objective of South Africa's energy policy, as stated in the Government's White Paper on Energy (1998), then energy subsidisation to alleviate poverty will receive limited attention. What is clear is that, the lack of energy subsidisation will however severely undermine energy's role as a key driver in addressing the challenges of South Africa's social and economic inequities. South Africa's future energy policy thus needs to take into account the delicate trade-off between addressing the energy requirements of the poor and promoting the efficiency & competitiveness of the entire economy through providing the country with low-cost and high-quality energy inputs.

Appendix A:

World Energy Intensity Comparisons
(Total Primary Energy Consumption Per Dollar of Gross Domestic Product), 1980-2003
(Btu per 2000 U.S. Dollars Using Market Exchange Rates)

Region/ Country	1980	1985	1990	1995	2000	2001	2002	2003
Russia	NA	NA	NA	111,258	105,716	101,462	98,339	94,774
South Africa	**29,430**	**35,477**	**32,713**	**36,552**	**36,000**	**34,536**	**33,657**	**35,348**
China	101,936	78,693	65,522	48,418	35,973	35,259	33,488	33,175
India	26,805	29,270	29,447	32,729	29,030	28,337	26,965	25,460
Egypt	24,100	26,357	24,530	22,896	21,747	23,609	23,313	22,925
Brazil	10,778	11,524	12,481	13,086	14,259	13,942	13,837	13,944
Australia	14,737	14,487	14,391	13,121	12,848	12,947	12,553	12,383
Mexico	10,873	11,896	12,209	12,166	10,886	10,724	10,668	11,619
United States	15,174	12,629	11,901	11,361	10,081	9,758	9,737	9,521
Botswana	14,981	11,689	11,157	11,722	11,367	9,519	9,278	9,014
France	9,776	9,022	8,377	8,784	8,299	8,292	8,192	8,269
Germany	NA	NA	NA	8,366	7,625	7,751	7,605	7,545
United Kingdom	10,112	9,031	8,153	7,646	6,711	6,667	6,485	6,427

Source: EIA (2003)

World Energy Intensity Comparisons
(Total Primary Energy Consumption Per Capita), 1980-2003
(Million Btu)

Region/Country	1980	1985	1990	1995	2000	2001	2002	2003
United States	345.7	321.3	339.3	347.2	350.7	338.5	340.7	339.9
Australia	187.7	200.0	217.9	224.1	254.1	259.8	258.8	260.4
Russia	NA	NA	NA	188.6	188.6	191.2	195.1	202.9
France	156.7	152.3	161.2	173.5	183.3	186.2	185.2	186.9
Germany	NA	NA	NA	175.2	173.3	177.5	174.4	172.7
United Kingdom	156.9	154.1	161.2	163.8	164.9	166.8	164.5	166.0
South Africa	96.5	106.4	95.0	100.3	104.7	102.2	102.4	108.8
World Total	**64.19**	**64.14**	**66.21**	**64.28**	**65.65**	**65.51**	**65.72**	**66.70**
Mexico	54.6	59.5	60.6	59.5	63.9	62.0	61.2	65.6
Brazil	33.3	35.0	40.0	43.9	49.9	48.8	48.8	49.5
China	17.5	21.0	23.4	28.8	30.4	31.8	32.5	34.9
Egypt	17.4	26.1	27.6	25.7	29.6	32.6	32.6	32.3
Botswana	17.1	17.5	25.3	27.7	32.1	28.9	28.4	29.1
India	6.2	7.9	9.6	12.3	13.3	13.4	13.1	13.2

Source: EIA (2003)

Appendix B:

SA Energy Intensity			
Year	**Total Energy Supply (TJ)**	**GDP (R millions 2000 constant)**	**Economy TJ/GDP**
1971	1,897,812	496143	3.83
1972	1,933,416	504353	3.83
1973	2,054,114	527412	3.89
1974	2,142,437	559643	3.83
1975	2,261,108	569131	3.97
1976	2,339,754	581936	4.02
1977	2,371,735	581389	4.08
1978	2,506,838	598915	4.19
1979	2,592,017	621616	4.17
1980	2,738,898	662771	4.13
1981	3,017,392	698301	4.32
1982	3,287,560	695624	4.73
1983	3,341,975	682779	4.89
1984	3,626,436	717594	5.05
1985	3,631,764	708900	5.12
1986	3,791,655	709027	5.35
1987	3,909,301	723922	5.40
1988	4,081,760	754327	5.41
1989	3,901,978	772392	5.05
1990	3,819,592	769937	4.96
1991	3,993,909	762098	5.24
1992	3,745,373	745811	5.02
1993	3,965,543	755011	5.25
1994	4,176,565	779429	5.36
1995	4,358,310	803713	***5.42***
1996	4,430,038	838327	5.28
1997	4,528,024	860516	5.26
1998	4,582,172	864968	5.30
1999	4,577,608	885365	5.17
2000	4,558,361	922148	4.94
2001	4,510,775	947373	4.76
2002	4,629,322	982327	4.71

Source: IEA(2005), SARB & Author's Own Calculations

Appendix C:

Energy Use by South African Economic Sector (TJ): 1971- 2002

Year	Total	Agric	Mining	Industry	Comm	Resid	Non Specified	Transp	Non Energy
1971	1,398,279	35,713	86,550	527,326	37,358	293,745	30,586	379,043	7,958
1972	1,454,143	38,195	85,703	551,510	56,019	301,962	28,943	383,772	8,039
1973	1,563,782	38,404	84,165	628,051	58,336	310,758	29,700	407,295	7,074
1974	1,572,501	38,743	88,712	634,126	63,191	323,236	30,078	387,180	7,235
1975	1,680,807	39,322	80,924	689,198	66,341	338,782	30,599	428,006	7,637
1976	1,740,862	41,760	86,603	759,301	67,999	333,680	30,883	412,998	7,637
1977	1,759,619	41,044	102,601	790,046	64,867	317,237	30,646	403,893	9,285
1978	1,791,677	40,454	106,762	794,485	66,945	328,163	30,930	414,692	9,244
1979	1,766,470	42,815	116,386	837,511	65,791	330,976	0	362,943	10,048
1980	1,828,535	45,665	124,584	883,640	69,254	322,394	757	370,184	12,058
1981	1,914,398	48,534	134,868	940,382	76,697	313,840	47	387,169	12,862
1982	1,824,782	45,766	128,483	859,860	74,710	314,134	0	388,566	13,264
1983	1,769,139	44,990	126,647	803,655	76,034	318,208	47	386,294	13,264
1984	1,883,973	48,734	135,405	848,173	87,034	342,516	0	409,651	12,460
1985	1,893,871	49,874	137,464	860,379	83,973	357,014	0	393,110	12,058
1986	1,882,230	48,912	138,569	858,844	79,865	356,002	47	387,931	12,058
1987	1,945,742	49,532	140,334	881,369	80,550	374,543	426	408,257	10,732
1988	2,052,362	53,509	148,849	928,448	89,341	388,360	0	429,908	13,947
1989	2,110,542	53,934	147,468	945,236	96,973	416,016	0	437,570	13,344
1990	2,125,081	53,638	145,027	933,395	99,586	434,321	0	446,694	12,420
1991	2,099,318	54,852	136,268	904,402	103,770	443,394	0	446,866	9,767
1992	2,039,341	54,221	147,485	801,246	88,163	431,567	46,808	459,521	10,330
1993	2,021,519	71,918	144,026	687,378	100,982	468,480	61,626	461,068	26,041
1994	2,059,447	80,531	146,218	701,813	98,695	471,082	54,736	478,341	28,030
1995	2,216,248	82,429	153,151	787,503	104,093	473,494	51,692	535,668	28,219
1996	2,274,789	84,274	159,173	867,092	107,228	488,365	8,054	529,488	31,115
1997	2,350,508	80,951	163,169	905,224	117,394	499,493	7,812	547,505	28,961
1998	2,393,566	76,474	166,500	979,051	76,864	489,889	16,710	562,798	25,282
1999	2,331,433	72,058	144,898	933,100	86,050	487,552	15,316	568,472	23,987
2000	2,314,421	61,429	129,600	943,656	83,928	484,432	21,884	567,142	22,350
2001	2,362,486	64,228	138,563	950,954	112,400	501,415	2,544	569,106	23,274
2002	2,367,890	72,904	143,795	892,496	123,556	502,538	34,583	566,332	31,687

Source: IEA(2005)

Appendix D:

Energy Intensity by South African Economic Sector:

Year	Economy	Agric	Mining	Industry	Comm	Trans	Resid
	Col.1	Col.2	Col.3	Col.4	Col.5	Col.6	Col.7
1971	3.83	2.09	2.15	8.87	0.27	**23.40**	13.64
1972	3.83	2.27	2.24	8.94	0.40	22.52	14.13
1973	3.89	2.63	2.22	9.32	0.39	21.98	14.25
1974	3.83	2.06	2.54	8.83	0.40	18.46	14.29
1975	3.97	2.25	2.44	9.24	0.40	19.70	15.07
1976	4.02	2.40	2.43	9.92	0.40	18.50	14.85
1977	4.08	2.15	2.82	**10.68**	0.38	17.58	14.47
1978	4.19	2.04	2.92	10.00	0.39	17.17	14.89
1979	4.17	2.22	3.10	9.76	0.38	13.68	14.81
1980	4.13	2.12	3.40	9.53	0.37	12.96	13.84
1981	4.32	2.12	3.70	9.30	0.39	12.84	13.09
1982	4.73	2.18	3.52	8.99	0.37	13.54	13.46
1983	4.89	2.64	3.46	8.56	0.36	14.51	14.21
1984	5.05	2.57	3.56	8.49	0.39	14.60	14.89
1985	5.12	2.20	3.61	8.90	0.38	14.20	16.06
1986	5.35	2.06	3.76	8.87	0.36	14.51	16.37
1987	5.40	2.06	3.99	8.87	0.35	15.42	17.23
1988	5.41	2.23	4.16	8.77	0.38	15.70	17.51
1989	5.05	2.02	4.17	8.75	0.40	15.41	18.71
1990	4.96	2.18	4.14	8.82	0.41	15.68	20.01
1991	5.24	2.15	3.99	8.95	0.42	15.95	21.07
1992	5.02	2.82	4.25	8.16	0.36	15.98	21.40
1993	5.25	3.07	4.06	7.05	0.41	15.81	23.43
1994	5.36	3.25	4.11	7.05	0.39	15.80	23.30
1995	***5.42***	***4.15***	*4.45*	*7.44*	*0.40*	*16.85*	*23.20*
1996	5.28	3.46	4.66	8.06	0.39	16.08	23.42
1997	5.26	3.28	4.70	8.22	**0.42**	16.07	**23.84**
1998	5.30	3.35	**4.86**	9.05	0.27	16.13	23.75
1999	5.17	3.06	4.26	8.65	0.29	16.13	23.58
2000	4.94	2.52	3.88	8.45	0.27	15.50	22.95

Column 1: TJ per gdp (constant 2000)

Column 2-6: TJ per sector value added (constant 1995)

Column 7: TJ per capita gdp (constant 2000)

Source: IEA(2005), & Author's Own Calculations

Appendix E:

SA Energy Prices: Nominal						
	elec	**coal**	**gas**	**oil**	**oil**	**cpi**
	c/kWh	**ZAR/ton**	**c/GJ**	**ZAR/bll**	**US$/bll**	**1995=100**
1970	0.55	1.90		1.39	1.80	3.31
1971	0.57	1.90		1.72	2.24	3.81
1972	0.60	2.10		1.91	2.48	4.30
1973	0.64	2.30		1.90	2.75	4.79
1974	0.71	2.80		7.37	10.84	5.59
1975	0.82	4.10		7.74	10.46	6.64
1976	1.06	5.80		10.01	11.51	7.94
1977	1.56	6.90		10.79	12.40	9.39
1978	1.80	7.70		11.05	12.70	11.02
1979	1.89	8.30		13.16	15.67	13.12
1980	2.03	9.40		21.06	27.00	14.92
1981	2.28	11.40		28.16	32.00	17.27
1982	2.83	12.90		37.06	34.00	19.75
1983	3.38	12.90		34.97	31.50	22.24
1984	3.60	14.00	435	42.92	29.00	24.72
1985	4.12	15.37	490	63.56	28.50	28.73
1986	5.03	17.21	501	32.79	14.38	34.12
1987	5.47	19.16	571	37.60	18.43	39.64
1988	5.88	21.72	618	33.96	14.96	44.75
1989	6.47	27.25	668	47.68	18.20	51.24
1990	7.33	30.41	719	61.67	23.81	58.56
1991	7.78	33.48	917	55.34	20.05	67.68
1992	8.17	37.80	1089	55.20	19.37	76.93
1993	8.35	38.86	1187	55.82	17.07	84.53
1994	8.91	39.34	1235	56.73	15.98	91.99
1995	10.40	42.90	1303	62.36	17.18	100.00
1996	10.10	45.93	1433	89.48	20.81	107.32
1997	10.78	47.69	1569	88.05	19.10	116.57
1998	11.02	51.86	1710	70.45	12.74	124.59
1999	10.56	52.65	2093	109.19	17.87	131.08
2000	11.94	56.13	3254	197.44	28.45	138.12
2001	11.56	62.06	4082	210.36	24.46	145.99
2002	12.14	68.90	5191	263.32	25.03	159.39
2003	13.16			215.54	28.51	168.65
2004	13.49			245.36	38.04	170.99
2005	13.97			349.42	54.94	176.80

Source: DME (2002) and SARB various issues

Appendix F:

SA Energy Prices: Real (1995=100)						
	elec	**coal**	**gas**	**oil**	**oil**	**R/$**
	c/kWh	**ZAR/ton**	**c/GJ**	**ZAR/bll**	**US$/bll**	
1970	10.20	35.23		5.29	6.87	0.77
1971	9.97	33.08		6.31	8.20	0.77
1972	9.86	34.45		6.77	8.79	0.77
1973	9.55	34.42		6.33	9.18	0.69
1974	9.48	37.61		22.16	32.59	0.68
1975	9.74	48.57		21.33	28.82	0.74
1976	11.34	61.84		26.08	29.98	0.87
1977	14.99	66.13		26.38	30.32	0.87
1978	15.50	66.34		25.08	28.83	0.87
1979	14.41	63.21		26.85	31.97	0.84
1980	13.55	62.89		37.85	48.52	0.78
1981	13.25	66.15		45.84	52.09	0.88
1982	14.30	65.30		56.87	52.17	1.09
1983	15.24	58.22		51.98	46.83	1.11
1984	14.53	56.60	1758	61.18	41.34	1.48
1985	14.32	53.41	1703	87.55	39.26	2.23
1986	14.73	50.46	1469	44.25	19.41	2.28
1987	13.80	48.36	1441	49.47	24.25	2.04
1988	13.15	48.63	1383	42.52	18.73	2.27
1989	12.63	53.19	1304	56.72	21.65	2.62
1990	12.50	51.88	1227	69.98	27.02	2.59
1991	11.52	49.53	1357	60.25	21.83	2.76
1992	10.62	49.11	1415	58.34	20.47	2.85
1993	9.88	46.00	1405	57.29	17.52	3.27
1994	9.68	42.75	1342	56.73	15.98	3.55
1995	10.40	42.90	1303	62.36	17.18	3.63
1996	9.41	42.78	1335	89.48	20.81	4.30
1997	9.25	40.92	1346	88.05	19.10	4.61
1998	8.84	41.62	1372	70.45	12.74	5.53
1999	8.06	40.17	1597	109.19	17.87	6.11
2000	8.65	40.64	2369	197.44	28.45	6.94
2001	7.92	42.54	2853	210.36	24.46	8.60
2002	8.41	45.18	3513	263.32	25.03	10.52
2003	9.12			215.54	28.51	7.56
2004	9.35			245.36	38.04	6.45
2005	9.73			349.42	54.94	6.36

Source: DME (2002), SARB various issues & Author's Own Calculations

Appendix G:

AVERAGE FOR PERIOD 1992-2002

Industrial Sub-Sector:	SA Energy Intensity	SA Exports as % of Output	US Energy Intensity	US Exports as % of Output	SA/US Exports as % of Output
Petroleum refineries	279.6775	0.84670	251.3401	0.17535	4.82868
Primary Metals	140.3222	1.70677	39.1184	0.29155	5.85421
Other metal products	129.3674	0.48229	33.6738	1.43337	0.33647
Other non-metal min	53.4758	0.27226	19.5217	0.11739	2.31937
Electrical machinery	35.0988	0.34253	0.8473	0.57772	0.59289
Other manufacturing	31.6940	0.48127	1.8015	0.22275	2.16053
Radio	15.4303	0.95638	2.5403	0.37686	2.53773
Leather	7.0664	3.24005	1.7417	0.55576	5.82993
Wood	4.7990	0.21252	15.4787	0.13406	1.58528
All chemicals	4.2284	0.79570	27.1011	0.28606	2.78158
Apparel & footwear	3.8077	0.26843	1.5787	0.27145	0.98885
Paper, Pulp	3.4243	0.88372	39.7404	0.18950	4.66337
Rubber & plastics	2.2960	0.32229	4.0484	0.16989	1.89705
Food	1.1007	0.52225	6.2796	0.14346	3.64047
Print	0.8684	0.05184	1.6942	0.08119	0.63843
Other machinery	0.6639	1.33915	1.6235	0.56336	2.37707
Beverages, Tobacco	0.3547	0.30757	1.8173	0.10411	2.95421
Textiles	0.1377	0.73138	8.6291	0.21090	3.46788
Transport equipment	0.0977	0.92969	2.1175	0.53803	1.72797

Source: IEA(2005), EIA(2003) & Author's Own Calculations

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