Potential Impacts of a Global Cap and Share Scheme on South Africa

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1 Introduction

Stabilising the world's climate system and preventing a climate catastrophe requires urgent and co-ordinated international action to reduce the atmospheric concentration of global greenhouse gases (GHGs) (see IPCC, 2007; Stern, 2006; Hansen et al, 2008). The Cap and Share (C&S) scheme proposed by the Feasta, the Ireland-based Foundation for the Economics of Sustainability, provides a potential framework for achieving a rapid reduction in the rate at which further emissions add to that concentration.

1.1 Overview of the Cap & Share scheme[2]

Cap and Share was developed to meet the twin challenges of climate change and the peak in the world supply of easily-extracted oil. It works by imposing a limit – a cap – on global emissions from the use of coal, gas and oil and then charging fuel users whatever price is necessary to balance their demand with the capped supply. The bulk of the payments made by the fossil fuel users are then shared amongst the whole human population on an equal-per-capita basis. This compensates people, at least in part, for the increase in energy prices caused by the scarcity created by both the decline in oil production from its peak and the limited production of gas and coal as a result of the emissions restrictions. In this way, it shares out the benefits from using fossil fuel amongst everyone in the world.

Essentially, then, C&S is a way of capturing the scarcity rent – the extra that consumers are prepared to pay when whatever they are consuming gets scarce – and redistributing it. If C&S or some equivalent system is not introduced, the scarcity rent as a result of the restricted supply of oil will continue to go to the oil producers and to the producers of gas and coal because of the increased prices they have been able to charge as a result of oil's scarcity. Recent reports indicate that these rent payments are already leading to an extreme concentration of wealth and threatening global financial stability (see for example Llewellyn, 2006).

Under C&S, the level of emissions permitted under the cap would be reduced year by year at whatever rate the international community decided was necessary to guarantee climate stability. As Appendix A explains, this rate would need be to be at least as fast as oil production was declining if the maximum amount of scarcity rent was to be available for distribution. This is because, to capture the most rent, the emissions permits issued under the cap would have to be a scarcer resource than the oil supply.

It is important to recognise that, if adopted globally, C&S would only increase fossil fuel prices by an amount based on the additional scarcity it had created for climate reasons. All of the extra money that people paid for their fuel because of this climate surcharge would be returned to them in one way or another. It would not be a tax. Moreover, C&S would retrieve some of the money currently being paid to fossil fuel producers as scarcity rent and distribute it around the world. It has therefore the potential to make millions of poorer people better off.

[2] This summary of C&S has been provided by Feasta. For more details see Feasta (2008).

C&S shares the scarcity rent by distributing most of the emissions permits issued under the cap directly to individuals, who then sell the permits, known as Pollution Authorisation Permits, or PAPs, at whatever is the current market price, to financial intermediaries such as banks and post offices. The intermediaries then consolidate the PAPs and sell them on to fossil fuel producers who would be required to buy sufficient permits each year to cover the emissions from the fuel they had produced. Inspectors would ensure that they complied.

1.2 Aims of the study

This study aims to assess the initial impact that the introduction of a global C&S scheme would have on South African households and industries. The word initial needs to be emphasised because the introduction of C&S would generate a new set of relative prices. In particular, it would create a climate within which people believed that energy prices would not only remain high but get higher over the years and that they should therefore develop ways of living and working which required as little fossil energy as possible. They would also want to invest in developing non-fossil energy sources. In other words, C&S would initiate such a flood of investment and change that conditions after it has operated for a little while are impossible to predict.

Because C&S would not only enable poorer people to spend more but can also be expected to touch off a wave of energy-intensive capital investment, it could increase fossil energy demand and, consequently, energy prices. It is impossible to say how high these prices might be on its introduction and what proportion of the price it would be possible to capture to redistribute to people. The study therefore suggests what would happen to South African prices and incomes for a range of energy prices with varying proportions of those prices being captured by Cap and Share. The initial effects it explores are those on:

- the prices of energy products and the prices of energy-intensive goods;
- the current account of the balance of payments;
- the aggregate macroeconomy;
- household expenditure, income and inequality;
- energy-intensive industries; and
- opportunities for developing renewable energy sources.

1.3 Scope

This report is limited both by current availability of data and by time. It is not intended to be a comprehensive analysis. The report covers potential impacts of C&S on the macroeconomy, households (at income deciles and by rural or urban residence) and major sectors of the economy.

1.4 Assumptions

The analysis in this study is based on the following assumptions about the implementation of C&S:

- C&S is introduced globally now (mid 2008). This is to allow current data to be used.
- PAPs are allocated on a per capita basis rather than a per adult basis to allow household data to be used.
- The possible prices of oil, including the Cap and Share element, range from $60 per barrel to $400 immediately after C&S's introduction. Appendix A sets out the

estimates for the shares of the scarcity rent that C&S might be able to capture at the various prices. It also converts the scarcity rents into prices per tonne of CO_2. These range from zero to $780 or €500. The benchmark prices used in this study are €25, €50, €100, €200 and €400.

- The prices of coal and gas are assumed to maintain their current relationship with the oil price after allowing for the effects of the CO_2 price.
- Prices around the world are assumed to adjust instantaneously to the new level of energy prices brought about by C&S. In actual use, of course, prices would adjust over a period of months or years and economic behaviour and production processes would change as well. This assumption consequently exaggerates the price changes that would occur.
- The global per capita CO_2 emission allowance is assumed to be 3.71 tonnes per capita. This figure is based on the EIA's (2005) estimate of average global emissions of 4.37 tonnes of CO_2 per person, less 15% (5% for the Transition Fund, 9% for sequestration and 1% for overheads). This includes CO_2 emissions from the burning of fossil fuels only (not from land use, waste, agriculture, etc.).

1.5 Methodology

The study employs a mix of quantitative and qualitative analysis. Wherever suitable data permit, quantitative projections are made. No attempt is made at formal modelling as it is considered beyond the scope of this exploratory report.

1.6 Data

This study utilises data from a variety of international and South African sources, including the following:

- International Energy Agency (IEA)
- US Energy Information Administration (EIA)
- Statistics South Africa (SSA)
- Department of Minerals and Energy (DME)
- South African Petroleum Industry Association (SAPIA)
- Eskom (Annual Reports)

The data are mostly taken at face value and are assumed to be sufficiently reliable, or at least the most reliable data sources that are publicly available. The most recent available (annual) data are utilised. In the case of energy and emissions, as well as household income and expenditure, the most recent publicly available data are for 2005. Energy prices are available as of July 2008.

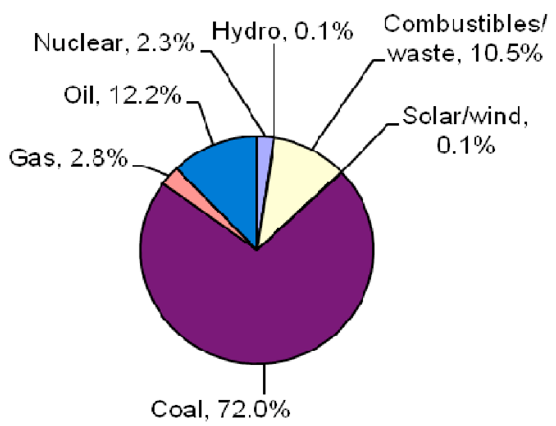
2 South African Background

Before exploring the impact of C&S, it is necessary to sketch the context of the South African energy socio-economy. Section 2.1 provides an overview of energy sources and consumption. Section 2.2 details the country's CO_2 emissions from energy. Section 3.3 briefly describes the current socio-economic context.

2.1 Energy supply and consumption

Fossil fuels comprise approximately 87 per cent of South Africa's total primary energy supply (TPES). Chief amongst these is coal, which provided 72% of primary energy in 2005 (see Figure 1). South Africa has the world's sixth largest coal reserves. Approximately one third of the country's annual coal production is exported, and South Africa is amongst the world's top coal exporters. Nearly 60% of the coal that is consumed domestically is used to generate electricity, while another 18% is converted into synthetic liquid fuels by a private company, Sasol. In 2005, 12 per cent of South Africa's primary energy needs were met by oil. Imported crude oil makes up about 65 per cent of South Africa's annual consumption of petroleum products. The remainder comes from a small amount of domestically produced oil plus the well-developed synthetic fuels industry, which together supply approximately 35 per cent of domestic consumption. About three quarters of petroleum energy is used by the transport sector. Natural gas contributes just 2,8% of primary energy, while combustibles and waste (i.e. biomass) make up approximately 10%.

Figure 1: Shares of total primary energy supply in South Africa, 2005



Source: IEA (2008)

Overall, South Africa is a net energy exporter thanks to its coal exports. However, it has a high oil import dependence and high energy intensity (energy per unit of GDP) by developing country standards.

South Africa's primary electricity production is overwhelmingly dependent on coal (93%), with nuclear power (6%) supplying a small fraction. Renewable energy production is currently insignificant (0.1% of TPES). The government is in the process of promoting a domestic biofuel industry, but its target for 2013 is just 2% of liquid road fuels.

2.2 CO2 emissions

Because of its heavy reliance on coal, South Africa is one of the world's top emitters of CO2 (from energy consumption) on a per capita basis (see Table 1). In 2005, per capita CO2 emissions (9.56 tonnes per capita) were more than twice the global average (4.37) and were higher than those of the EU, China, India and Brazil. South Africa also ranks highly in CO2 emissions per unit of economic activity, especially when this is measured in terms of market exchange rates. While this reflects the high energy intensity of the South African economy, a significant part of that energy use is attributable to consumers in other parts of the world.

Table 1: Carbon dioxide emissions for selected countries, 2005

	CO2 emissions in 2005		
	t/$ 000 (PPP)	t/$ 000 (MER)	t/capita
USA	0.54	0.54	20.14
Canada	0.61	0.77	19.24
Australia	0.67	0.90	20.24
Europe	0.39	0.47	7.93
Russia	0.84	4.85	11.88
Brazil	0.24	0.54	1.94
China	0.63	2.84	4.07
India	0.29	1.78	1.07
Africa	0.46	1.41	1.17
World	0.49	0.78	4.37
RSA	0.84	2.65	9.56

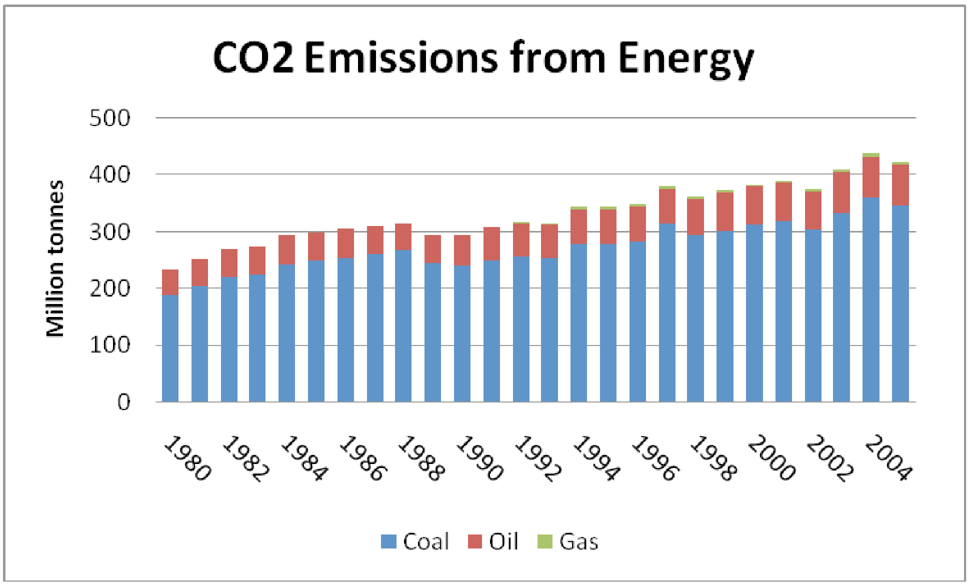
Notes:

- *t = metric tonnes*
- *PPP = purchasing power parity*
- *MER = market exchange rates*

Source: Energy Information Administration (2008a)

Figure 2 shows that South Africa's CO2 emissions from the burning of fossil fuels have grown considerably over the past two and a half decades, nearly doubling in that period.

Figure 2: Carbon dioxide emissions from fossil fuel consumption in South Africa



Source: Energy Information Administration (2008a)

2.3 Socio-economic context

South Africa represents a fascinating case study of the potential impacts of a C&S scheme as in many ways the country resembles a microcosm of the world. Although classified as an 'emerging market' or 'developing' economy, SA contains a mixture of a fairly well developed formal economy with sophisticated financial, corporate, transport and telecommunications sectors, together with what President Thabo Mbeki refers to as the "second economy", comprised of the informal sector, the underemployed and the unemployed.

The South African economy dominates the region and some of its largest corporations are multinational giants. Economic growth over the past few years has averaged around 4-5%. And yet about half the nation's population lives in poverty, the HIV infection rate is about 11%, and the official unemployment rate is over 25% (the unofficial rate, which includes those who have given up searching for jobs, stands at nearly 40%). The degree of income inequality is amongst the highest in the world. This largely reflects the legacy of Apartheid, although within-black inequality is rising rapidly with the emergence of a black middle class as well as government and business elites. In short, South Africa is a land of stark contrasts.

There are deep inequalities in access to and consumption of energy across households in South Africa, mirroring the extensive income and wealth inequality. SA's state power utility Eskom produces amongst the cheapest electricity in the world, but about a third of its citizens – mainly in the rural areas – have no access to electricity. About a quarter of the population have access to private motor vehicles, while minibus taxis are the dominant mode of transport, especially amongst the lower income groups.

Aside from poverty and unemployment, one of the significant economic challenges for South Africa is how to reduce the energy intensity of its economy, especially the mining and manufacturing sectors. Domestic firms have long benefited from amongst the lowest electricity tariffs in the world, but as carbon emissions and trading become more important globally, this former source of competitiveness could increasingly turn against South African firms.

3 Impact on Prices

Restrictions on the use of fossil fuels will raise their price and the price of electricity. These direct price effects are explored in section 3.1, while the resulting impact on the consumer price index is dealt with in section 3.2. CO2 restrictions will also feed through into higher prices of many other goods and services since electricity and transport fuels are input costs for many economic activities and products. These indirect price effects are addressed in section 3.3. Section 3.4 considers the sensitivity of the computed price effects to the assumptions, and notes that the effects would occur within a context in which energy prices have been rising steeply for several years already.

3.1 Energy prices

Before calculating the effect of C&S on energy prices, one needs estimates of the CO2 emission factors for the various energy carriers. Table 2 gives estimates of the mass (in kilograms) of CO2 emissions per unit of energy for the main energy carriers used in South Africa. Electricity has a relatively high CO2 emission factor per kilowatt hour due to the fact that 90% of the country's electricity is generated from low-grade coal.

Table 2: CO2 emission factors for various energy carriers

Energy carrier	CO2 emission (kg)	Unit of energy
Coal	2.46	kg
Petrol	2.34	litre
Diesel	2.68	litre
Paraffin	2.58	litre
LPG	1.53	litre
Electricity	1.00	kWh

Source: EIA (2008b), Eskom (2008) and own calculations.

Table 3 displays prices for the main retail energy products in South Africa as of July 2008. The retail prices of petrol and paraffin, and the wholesale price of diesel, are regulated by the Department of Minerals and Energy. Coal is used by a minority of households, mostly in areas adjacent to coal mines (in Mpumalanga, Gauteng and Free State provinces). Since the price is not regulated, there is no standard average national retail price of coal for households. Coal is also consumed by various industries, such as steel making, typically under long-term supply contracts. Eskom purchases most (about 80%) of its coal under long-term contracts for approximately R80-R90 per tonne, with the remainder being procured on the spot market for higher prices (Hill, 2007). The price of coal cited in the table is an estimate for households, since this is relevant for the calculations in section 5 on household expenditures.

Table 3: Energy price increases at various CO2 prices per tonne

			CO2 price				
		Euro/tonne	25	50	100	200	400
		Rand/tonne	300	600	1200	2400	4800
		Rand/kg	0.3	0.6	1.2	2.4	4.8
Energy carrier	**Initial price**	**Unit**	**Price increase due to restrictions**				
Coal	2.00	Rand/kg	0.74	1.48	2.95	5.90	11.81
Petrol	10.55	Rand/litre	0.70	1.40	2.81	5.62	11.23
Diesel	11.40	Rand/litre	0.80	1.61	3.22	6.43	12.86
Paraffin	12.52	Rand/litre	0.77	1.55	3.10	6.19	12.38
LPG	5.25	Rand/litre	0.46	0.92	1.84	3.67	7.34
Electricity	0.23	Rand/kWh	0.30	0.60	1.20	2.40	4.80
Energy carrier	**Initial price**	**Unit**	**Percentage price increase**				
Coal	2.00	Rand/kg	36.9	73.8	147.6	295.2	590.4
Petrol	10.55	Rand/litre	6.7	13.3	26.6	53.2	106.5
Diesel	11.40	Rand/litre	7.1	14.1	28.2	56.4	112.8
Paraffin	12.52	Rand/litre	6.2	12.4	24.7	49.5	98.9
LPG	5.25	Rand/litre	8.7	17.5	35.0	69.9	139.9
Electricity	0.23	Rand/kWh	131	261	523	1046	2092

Notes:

- *The rand/euro exchange rate is assumed to be 12.0.*

- *The price of coal is an estimate for that paid by households (see Balmer, 2007: 27).*
- *The prices of petrol and diesel are averages across inland/coastal prices.*
- *The price of paraffin is the maximum retail price stipulated by the DME.*
- *The price of LPG is the maximum refinery gate (wholesale) price.*
- *The price of electricity is the 2007 national average price (0.18 R/kwh) adjusted by the percentage increase for 2008/9 (27.5%) awarded in June by the National Energy Regulator. Households would typically pay higher electricity tariffs than industrial users as they purchase electricity from local municipalities.*

Source: Balmer (2007), DME (2008), Eskom (2007) and own calculations.

Table 3 also displays the absolute and percentage price increases that would arise if the restrictions on fossil energy use produced a CO2 permit price at various levels. It can be seen that the proportional impact on the prices of liquid fuels is small for the lowest level of the CO2 price (€25), although the prices double if the price is at the highest level (€400). The price of coal rises markedly – by more than a third at the lowest CO2 price level. The price of electricity more than doubles even at the lowest carbon emissions price, and increases by more than 2000% (a twenty-fold increase) at the highest rise considered in this study. This reflects the fact that 90% of electricity is generated in coal-fired power stations, and that the current price of electricity is very low (by international standards).

3.2 Direct impact on the consumer price index

Table 4 shows the effect on the consumer price index (CPI) of the rise in energy prices according to the various levels of the CO2 price. The rise in transport fuel (petrol and diesel) prices has a modest impact on the CPI while the rise in household energy prices – driven mainly by electricity – has a dramatic impact on the overall CPI when the CO2 price is high. Taken together, the higher energy prices raise the CPI by between 4% and 66%, depending on the CO2 price level.

Table 4: Direct impact on CPI of higher energy prices

	CO2 price				
Euro/tonne	25	50	100	200	400
Rand/tonne	300	600	1200	2400	4800
	Percentage price increase				
Transport fuel	6.9	13.7	27.4	54.8	109.7
Household energy	95.7	191.4	382.7	765.5	1530.9
	Resultant percentage change in CPI				
Transport fuel	0.2	0.5	1.0	1.9	3.8
Household energy	3.9	7.8	15.6	31.2	62.5
Total	4.1	8.3	16.6	33.2	66.3

Notes:

- *Transport fuel has a weight of 3.5% in the CPI basket. The price increase is the average across petrol and diesel.*
- *Household energy (fuel and power) has a weight of 4.08% in the CPI basket. The relative weightings of the energy sub-components (electricity, coal, LPG and paraffin) are drawn from StatsSA's Income and Expenditure Survey 2005/6.*

Source: Own calculations based on StatsSA (2008a, b).

3.3 *Indirect price effects*

As mentioned earlier, increases in the prices of basic energy carriers (liquid fuels and electricity) will feed through into higher prices of other goods and services in the economy. Of particular interest is the impact on food prices, since food accounts for the single largest item in the consumption basket of poorer households. Estimating these indirect price effects in a comprehensive manner would be a very complex task requiring econometric models, and is beyond the scope of this report. At the most basic level, such estimates would require data on (1) the percentage of total domestic production costs attributable to energy (principally diesel and electricity) and (2) the proportion of retail costs attributable to transport fuel costs, for all major categories of goods and services. These factors would differ according to production methods (energy intensity) and the distance that products travels to their markets around the country.

However, a rough approximation of the indirect impact on prices can be made at a macro level. StatsSA (2008c) provides the weightings of "products of petroleum and coal" (4.98%) and electricity (6.86%) in the producer price index (PPI) for domestic output of South African industry groups. These figures can be used as a proxy for the proportion of energy costs in total production costs for goods and services in the domestic economy. The weights are used to approximate the impact of rising energy prices on the prices of non-energy goods and services following the introduction of C&S. The results are shown in Table 5. Again, the much higher electricity prices push up the PPI quite dramatically, while the increased prices for coal and petroleum products have a more muted impact.

The foregoing producer price effects can be used to estimate the impact of rising energy input costs on retail (consumer) prices. It is assumed that production costs make up 60% of final retail prices, on average.[3] In other words, it is assumed that retail prices rise by 6% for every 10% rise in domestic production prices.

The final step in estimating the indirect price effect of rising energy prices is to approximate the impact of higher transport fuel costs on retail prices of consumer goods and services. The average contribution of transport fuels to retail prices in the country as a whole is estimated at approximately 5%.[4] This means that when transport fuel costs rise by 10%, retail prices are assumed to rise by 0.5% on average. The final row of Table 5 contains estimates of the combined indirect effect of higher energy prices on consumer prices, i.e. those attributable to energy inputs plus transport fuels (but excluding direct costs of energy

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[3] A linear regression of the CPI on the PPI (both in natural logarithms) for the period 1997 to 2007 yielded a slope coefficient of 0.83, which means that every 10% rise in the PPI is associated with an 8.3% rise in the CPI. However this simplistic figure is probably an overestimate of the pass-through of production prices to retail prices. More complex econometric modelling would be required for a more precise and reliable estimate.

[4] This figure is derived as follows. Logistics costs account for approximately 14.7% of GDP, of which 75% represents transport costs, i.e. 11% of GDP (RSA, 2007). The proportion of fuel costs out of total transport costs is 47% in the CPI (StatsSA, 2008a). Thus the ratio of transport fuel costs to GDP is approximately 5.2%. For comparison, the weighting of vehicle running costs (including petrol and diesel costs) in the CPI for the country as a whole is 6.22%, although this applies to direct consumer expenditure on fuel rather than freight transport costs (StatsSA, 2008a). In the absence of more specific data, a 5% contribution of transport fuel costs to retail prices seems like a reasonable approximation.

bought by consumers). It can be seen that carbon restrictions lead to a 6% rise in the CPI at the lowest CO2 prices but nearly a doubling of retail prices at the highest CO2 price level.

Table 5: Indirect effect of higher energy prices on consumer prices

	CO2 price				
Euro/tonne	25	50	100	200	400
Rand/tonne	300	600	1200	2400	4800
	Percentage energy price increase				
Electricity	131	261	523	1046	2092
Petroleum & coal	6.6	13.3	26.5	53.0	106.1
	Impact on PPI (%)				
Electricity	9.0	18	36	72	143
Petroleum & coal	0.3	0.7	1.3	2.6	5.3
Total	9.3	18.6	37.2	74.4	148.8
	Impact on retail prices (%)				
Electricity	5.4	10.8	21.5	43.0	86.1
Petroleum & coal	0.2	0.4	0.8	1.6	3.2
Total	5.6	11.2	22.3	44.6	89.3
	Increase in transport fuel price (%)				
Diesel	7.1	14.1	28.2	56.4	112.8
	Impact of transport fuel cost on retail prices (%)				
	0.4	0.7	1.4	2.8	5.6
	Total indirect impact on consumer prices (%)				
Total	5.9	11.9	23.7	47.4	94.9

Notes:

- *Electricity has a weight of 6.86% in the PPI.*
- *Petroleum and coal products have a weight of 4.98% in the PPI.*
- *The price increase for petroleum & coal products is proxied by the average price increase for petrol, diesel and paraffin as these figures are more reliable than the price of coal, whose consumption by households is relatively small in quantity in any case.*

Source: Own calculations based on StatsSA (2008c).

3.4 Sensitivity of price effects to initial prices and assumptions

Clearly, the percentage increases in energy prices calculated above are sensitive to the starting prices, some of which have been volatile in recent months.

Firstly, liquid fuel prices (e.g. petrol and diesel) in South Africa have been rising steeply over the past year, driven by the price of crude oil, which has risen from about $20 per barrel in 2002 to around $130 per barrel in mid-2008, as well as by a weakening exchange rate. These price increases are already translating into altered patterns of demand for fuel and car types, and the choice between private and public transport.

Secondly, electricity prices are set to increase markedly over the next few years. Since early in 2007 – and intensifying in January 2008 – the state monopoly Eskom has been experiencing problems meeting peak electricity demand. Eskom's low reserve margin is expected to persist at least until 2013 when the first units of two new coal fired power stations are due to be commissioned. Eskom and the government have been forced to implement load-shedding and efficiency measures this year. Eskom has warned that the average price of electricity will need to rise by about 20% a year for at least the next five years in order to help fund its capital expansion projects, estimated at R300 billion (in real terms) over the next five years. This implies that the unit cost of power could double within five years.

In the future, rising fuel prices might be primarily determined either by C&S (depending on how fast the emissions cap and therefore consumption is reduced year-to-year) or by the rate of oil depletion after the global oil peak is passed (if the depletion rate is relatively rapid). In the latter instance, the PAP price of CO2 would be relatively low, whereas in the former it would be high.

The results in the preceding subsections are also somewhat sensitive to the other assumptions. For instance, the rand/euro exchange rate has also been somewhat volatile in recent months. However the fact that a range of euro-denominated CO2 prices is used means that the quantitative estimates give a range of possible outcomes; they should not be interpreted as precise point estimates. Nonetheless, it is important to bear the sensitivities in mind as they carry through into the estimated impact of price changes on household expenditures (see section 5).

4 Impact on the Macroeconomy

It is useful to begin the analysis at the macroeconomic level. Section 4.1 examines the potential impact of C&S on the balance of trade, taking account of CO2 emissions embodied in traded goods. Section 4.2 compares the overall national cost of CO2 emissions from fossil energy use with the total income that would accrue to South Africa from its share of world PAPs.

4.1 Balance of payments

C&S would have an impact on South Africa's exports and imports to the extent that traded goods embody fossil energy and therefore carbon dioxide. Fossil fuels are embodied in traded goods at two stages: (1) when fossil energy sources are used in the production process; and (2) when the goods are transported (since transport is overwhelmingly reliant on oil and to a small extent gas and coal). Export companies that utilise fossil fuels will have to purchase permits to cover their emissions, and will as far as they are able to pass on the extra costs to their customers.[5] The same will apply to firms in other countries that export to South Africa. In addition, the prices of traded goods will rise as a result of the higher transport costs (since these will also have a CO2 cost component).

Table 6 displays South Africa's exports, imports and trade balance in 2005 disaggregated into the main sectors (viz. agriculture, mining, manufacturing and other). Agriculture comprises a very small share of both exports and imports. Mining contributes nearly a third

[5] Except in the case of coal exporters, these permit purchases will be made indirectly when the firms involved buy energy from fossil sources, as it is the coal mines and the oil and gas producers who need to buy the permits and add the cost of these to their prices.

of exports but less than 15% of imports. Manufacturing dominates exports and especially imports (84%). Agriculture and mining bring in net revenues while manufacturing has a large negative trade balance which outweighs the two primary sectors' combined balances.

Table 6: South Africa's trade by sector in 2005

	Exports	Imports	Trade Balance
		R million	
Agriculture	15,062	4,698	10,365
Mining	103,186	50,951	52,235
Manufacturing	212,370	294,858	-82,489
Other	787	1,158	-371
Total	331,405	351,665	-20,260
		Per cent share	
Agriculture	4.6	1.3	7.1
Mining	31.1	14.5	35.9
Manufacturing	64.1	83.9	-56.7
Other	0.2	0.3	-0.3
Total	100	100	-14

Source: DTI (2008).

However, the negative overall trade balance does not necessarily imply that the embodied energy (and CO2) content of imports is larger than that of exports. This is mainly because of the high energy intensity of South Africa's mining and manufactured exports, relative to manufactured imports. The bulk of mining exports comprise gold, platinum group metals and coal, with the latter generating 6% of total export revenues in 2005. In 2005 South Africa's net exports of coal amounted to approximately 71 million tonnes, or nearly 34% of total domestic coal production (IEA, 2008).

Table 7: Balance of emissions embodied in trade (BEET) for select countries

Annex B			Non-Annex B		
	BEET MtCO2	BEET as a % of production-based emissions		BEET MtCO2	BEET as a % of production-based emissions
Switzerland	-63.1	-122.9%	Singapore	-62.8	-128.2%
Latvia	-4.6	-60.7%	South Korea	-45.4	-11.4%
United Kingdom	-102.7	-16.6%	Morocco	-2.5	-6.3%
Germany	-139.9	-15.7%	Mexico	-17.6	-4.5%
Japan	-197.0	-15.3%	Brazil	2.5	0.8%
United States	-438.9	-7.3%	India	70.9	6.9%
Canada	15.5	2.8%	China	585.5	17.8%
Australia	57.9	16.5%	Indonesia	58.1	19.0%
Russia	324.8	21.6%	**South Africa**	**123.5**	**38.2%**

Source: Peters & Hertwich (forthcoming) in Kejun, Cosbey & Murphey (2008).

Table 7 contains estimates of the balance of emissions embodied in trade (BEET) for a selection of countries, which are grouped according to those which are obligated to reduce emissions under the Kyoto Protocol (Annex B countries) and those that are not (non-Annex B countries). BEET measures the CO2 emissions embodied in exports minus those embodied in imports. As can be seen, South Africa has quite a large positive BEET, meaning that the carbon content of its exports exceeds that of its imports by a substantial margin. What is also striking is that South Africa's BEET as a percentage of production-based emissions is estimated at 38.2%, which is the highest proportion out of the countries in the sample. The BEET represents nearly 30% of South Africa's total CO2 emissions from energy consumption in 2005.

This report is concerned with the immediate impact of C&S, which would be to raise the prices of both imports and exports by the cost of the emissions involved in their production. Using the BEET figure of 124 million tonnes of CO2, and assuming that prices of net exports changed in direct proportion to the cost of embodied CO2 and that the quantities of trade flows remain constant, the instantaneous impact on the trade balance can be estimated (see Table 8). The impact is significant as a proportion of GDP even at the lower levels of the CO2 price. However, even if firms in the fossil fuel-intensive sector (including coal exporting companies) are able to pass on the full higher costs in their export prices as assumed here, they would have to purchase emissions rights from other countries. The cost of these permits would offset the higher export revenues.

Table 8: Impact of C&S on South Africa's trade balance

			CO2 price		
Euro/tonne	25	50	100	200	400
Rand/tonne	300	600	1200	2400	4800
			Change in trade balance		
R million	37,050	74,100	148,200	296,400	592,800
% of GDP	2.4	4.8	9.6	19.2	38.5

Source: Own calculations based on Peters & Hertwich (forthcoming) in Kejun et al (2008), and SARB (2008).

Over time the patterns of exports and imports will change as the economic incentives for trading are altered by the carbon cost component. While the precise second-round impacts are impossible to determine, it is reasonable to expect some general trends. First, the demand for South Africa' coal exports should decline (since C&S is designed to reduce fossil fuel consumption). Second, the demand for energy-intensive merchandise exports (such as beneficiated minerals and metals) will also likely decline, other things being equal. Third, the demand for traded goods should decline relative to the demand for non-traded goods since the former have higher transport costs. South Africa's trade with most of its trading partners has a comparatively high energy component by virtue of the country's extensive geographical distances from its major trading partners (respectively the EU, the United States, Japan, China and South Korea).

4.2 Aggregate expenditure on CO2 and PAP income

Table 9 contains estimates of the total cost of South Africa's CO2 emissions from domestic consumption of fossil fuels under various assumptions about the price per tonne of CO2. Even at the lowest price for CO2 (€25), the total cost of CO2 emissions represents 8.3% of Gross Domestic Product (GDP). This is a significant fraction and is approximately equal to the current account deficit in 2007. At the highest level of the levy (€400) the cost of CO2 is significantly greater than the entire GDP.

However, the macroeconomic impact of C&S needs to be adjusted to reflect the balance of emissions embodied in trade. If about 30% of South Africa's fossil energy consumption is used to produce net exports (as shown above), then effectively foreigners will pay for the CO2 permits needed to cover those emissions. In other words, the cost of CO2 permits must be offset against the higher prices achieved for South Africa's energy intensive net exports. As seen in Table 9, the trade-adjusted costs of CO2 permits ranges from about 6% to 92% of GDP.

The costs of purchasing CO2 emissions permits must also be offset against the aggregate income received from PAPs. South Africa's population in 2005 stood at 47.4 million, which results in a total CO2 allowance of 176 million tonnes. This yields gross income as shown in Table 9.

Table 9: Projected total cost of CO2 emissions and PAP income based on 2005 data

	CO2 price				
Euro/tonne	25	50	100	200	400
Rand/tonne	300	600	1200	2400	4800
	Gross cost of CO2 emissions (R millions)				
Coal	104,333	208,666	417,332	834,663	1,669,326
Oil	21,440	42,880	85,759	171,519	343,038
Gas	1,370	2,740	5,481	10,962	21,923
Total	127,143	254,286	508,572	1,017,144	2,034,287
% of GDP	8.3	16.5	33.0	66.0	132.0
	Cost of CO2 emissions net of BEET				
R million	89,000	178,000	356,000	712,001	1,424,001
% of GDP	5.8	11.6	23.1	46.2	92.4
	Gross income from CO2 allowance				
R million	52,810	105,620	211,241	422,481	844,963
% of GDP	3.4	6.9	13.7	27.4	54.8
	Net income from CO2 trading				
R million	-36,190	-72,380	-144,760	-289,519	-579,039
% of GDP	-2.3	-4.7	-9.4	-18.8	-37.6

Notes:

- *Rand/Euro exchange rate assumed to be 12.0.*
- *Population = 47.4 million (StatsSA, 2008b).*
- *CO2 allowance = 3.71 tonnes per capita (4.37 less 15%).*
- *Total CO2 allowance = 176 million tonnes.*

- *BEET = 30% of total CO2 consumption.*
- *Emission, population and GDP figures are for 2005.*

Source: EIA (2008), StatsSA (2008b), SARB (2008) and own calculations.

The final section of Table 9 displays the net income (gross income minus total costs adjusted for the BEET), which ranges from -2.3% to -37.6% of GDP. The negative net income from trading CO2 permits reflects the fact that South Africa's per capita emissions are significantly above the world average. Thus at a macroeconomic level, South Africa is disadvantaged by its high energy (carbon) intensity.

5 Impact on Households

Households will be affected in two primary ways by C&S. First, their expenditures on energy products and their derivatives (including food and other goods and services with an energy content) will rise as the price of fossil fuels rise. Second, their incomes will be boosted by their per capita tradable CO2 allowances (PAPs). Thus each household will have a net impact, depending on their initial levels and patterns of income and expenditure. Clearly one can expect there to be winners and losers from C&S. The following subsections estimate the impact of C&S on household expenditures, incomes and net income, respectively. A number of simplifying assumptions have to be made in order to do this tractably, as noted in the text.

5.1 Household expenditure

Table 10 displays the average annual expenditure of households on energy, transport and food in 2005/6, in total and disaggregated by income decile and by geographical area (rural/urban settlement). Food captures the largest share for all income deciles and settlement areas, although the proportion is nearly double for rural dwellers compared to urban dwellers. The percentage of total expenditure on both food and energy generally declines as income level rises, but the pattern is somewhat different for transport. The percentage of household expenditure on energy is generally small, especially for wealthier and urban households.

Table 10: Average annual household expenditure in 2005

Income	Energy		Transport		Food		Total
Group	R	%	R	%	R	%	R
Decile 1	606	5.3	910	8.0	3,735	32.8	11,381
Decile 2	809	5.8	1,143	8.1	4,638	33.2	13,982
Decile 3	924	5.5	1,315	7.8	5,190	30.9	16,784
Decile 4	1,012	4.9	1,770	8.7	6,108	29.7	20,547
Decile 5	1,062	4.7	2,121	9.3	6,600	28.9	22,819
Decile 6	1,082	3.8	2,778	9.8	7,392	26.1	28,374
Decile 7	1,185	3.3	4,029	11.3	7,904	22.2	35,654
Decile 8	1,544	2.8	5,567	10.1	9,225	16.8	55,055
Decile 9	2,311	2.1	10,349	9.6	11,990	11.1	108,024
Decile 10	3,179	1.3	17,384	7.0	18,267	7.3	248,823
Average	1,371	2.4	4,737	8.4	8,105	14.4	56,152
Rural	1,167	4.6	2,276	8.9	6,334	24.8	25,576
Urban	1,481	2.0	6,055	8.3	9,054	12.5	72,529

Notes:

- *Energy includes electricity, gas, liquid and solid fuels used in homes.*
- *Transport includes operation costs (including fuel) [5.0%] plus transport services [3.4%].*
- *Food includes foodstuffs plus non-alcoholic beverages.*

Source: StatsSA (2008b)

Estimating the impact on total household expenditure of CO2 prices under C&S would be very complicated if attempted in a comprehensive manner. It would require estimates of price elasticities of demand for the entire range of goods and services consumed. Both income and substitution effects would come into play as consumers adjusted their expenditure in response to rising prices of fuels and electricity, as well as the indirect price increases mentioned in section 3.3 (which are themselves very difficult to estimate). For tractability, only the instantaneous effects are estimated; it is therefore assumed that households consume the same amounts of all goods and services (including energy) after the CO2 price increase. The estimated expenditure changes are therefore a function only of price changes.

5.1.1 Direct change in expenditure

Table 11 shows the average annual household expenditures on energy (including household fuels, electricity and transport fuels) in 2005/6 for the income deciles. The final column gives expenditure on energy as a percentage of total household expenditure. As can be seen, the proportions are very similar across the income deciles while the absolute expenditures rise as income rises. In addition to the obvious inequality in expenditures on energy (which results from income inequality), many poorer households have to use less efficient sources of energy which cost more per energy unit – for instance paraffin rather than electricity for cooking. Rural households rely primarily on wood, paraffin and coal for cooking and for space and water heating. The urban poor rely primarily on paraffin and electricity (where it is available). The urban non-poor consume electricity and petrol/diesel. In 2006, 80% of all households had access to electricity while 31.6% used either wood or paraffin for cooking (StatsSA, 2006).

Table 11: Household expenditure on energy in 2005/6

Income	Household energy				Transport	Energy	Grand	% of
Group	Electricity	Gas	Liquids	Solids	Fuels	Total	Total	total
Decile 1	279	10	185	132	96	702	11,381	6%
Decile 2	355	12	215	228	61	871	13,982	6%
Decile 3	470	18	206	230	80	1,004	16,784	6%
Decile 4	512	23	238	239	131	1,143	20,547	6%
Decile 5	653	24	208	176	155	1,216	22,819	5%
Decile 6	674	37	198	174	474	1,557	28,374	5%
Decile 7	878	25	161	121	869	2,054	35,654	6%
Decile 8	1,323	39	123	60	1,844	3,389	55,055	6%
Decile 9	2,109	82	78	41	5,381	7,691	108,024	7%
Decile 10	2,989	89	33	68	10,293	13,472	248,823	5%
Average	1,024	36	165	147	1,939	3,311	56,152	6%

Source: Own calculations based on StatsSA (2008b), DME (2008) and Eskom (2007).

Table 12 shows the household expenditure on energy after a CO2 price of R300 (€25) per tonne is introduced.[6] It also gives the change in energy expenditures in absolute terms and as a percentage of total household expenditure. Additional expenditures on energy are driven mainly by the sharply rising price of electricity. The impact is lowest on the top two income deciles (i.e. the wealthiest households) in percentage terms because the proportion of their budgets spent on energy is smaller.

Table 12: Change in household expenditure due to CO2 price of R300/tonne

Income Group	Household energy Electricity	Gas	Liquids	Solids	Transport Fuels	Energy Total	Change in Total	Change as % of total
Decile 1	644	11	196	181	103	1134	432	3.8
Decile 2	819	13	228	312	65	1438	567	4.1
Decile 3	1084	20	219	315	85	1723	719	4.3
Decile 4	1181	25	253	327	140	1926	783	3.8
Decile 5	1507	26	221	241	166	2160	944	4.1
Decile 6	1555	40	210	238	506	2550	993	3.5
Decile 7	2026	27	171	166	929	3318	1264	3.5
Decile 8	3052	42	131	82	1970	5278	1889	3.4
Decile 9	4866	89	83	56	5750	10844	3153	2.9
Decile 10	6896	97	35	93	10998	18120	4648	1.9
Average	2363	39	175	201	2072	4850	1539	2.7

Source: Own calculations based on StatsSA (2008b), DME (2008) and Eskom (2007).

Table 13 provides estimates of the direct impact of rising energy prices on household expenditure in absolute and percentage change terms for the various CO2 prices. The underlying assumption, once again, is that the quantities of energy consumed do not change as the price changes, so that the percentage change in expenditure is equal to the percentage change in price. In other words, only the instantaneous effect of rising prices is calculated.

[6] Solid fuels comprise coal, wood and other biomass in the StatsSA Income and Expenditure Survey. However the price of coal alone is used in this instance as prices of wood and biomass are highly variable. As a result the expenditure changes are overestimates.

Table 13: Direct change in total expenditure due to higher energy prices

	Price of CO2				
Euro/t	25	50	100	200	400
Rand/t	300	600	1200	2400	4800
	Additional expenditure on energy				
Decile 1	432	865	1,729	3,458	6,917
Decile 2	567	1,133	2,267	4,534	9,067
Decile 3	719	1,438	2,876	5,752	11,505
Decile 4	783	1,566	3,133	6,265	12,531
Decile 5	944	1,888	3,776	7,553	15,106
Decile 6	993	1,986	3,973	7,946	15,891
Decile 7	1,264	2,528	5,056	10,112	20,225
Decile 8	1,889	3,778	7,556	15,112	30,223
Decile 9	3,153	6,306	12,611	25,222	50,444
Decile 10	4,648	9,295	18,590	37,180	74,360
Average	1,539	3,078	6,156	12,312	24,625
	Percentage change in total expenditure				
Decile 1	3.8	7.6	15.2	30.4	60.8
Decile 2	4.1	8.1	16.2	32.4	64.8
Decile 3	4.3	8.6	17.1	34.3	68.5
Decile 4	3.8	7.6	15.2	30.5	61.0
Decile 5	4.1	8.3	16.5	33.1	66.2
Decile 6	3.5	7.0	14.0	28.0	56.0
Decile 7	3.5	7.1	14.2	28.4	56.7
Decile 8	3.4	6.9	13.7	27.4	54.9
Decile 9	2.9	5.8	11.7	23.3	46.7
Decile 10	1.9	3.7	7.5	14.9	29.9
Average	2.7	5.5	11.0	21.9	43.9

Source: Own calculations based on StatsSA (2008b), DME (2008) and Eskom (2007).

Table 14 displays the additional expenditures households make on energy for the home (including electricity, gas, paraffin and coal) in absolute and percentage terms after the introduction of C&S, for various prices of CO2. The proportions of household expenditure on the four energy types varies across rural, urban and all households. The figures are based on weighted price changes across these fuel types, the weights being drawn from StatsSA's (2008b) *Income and Expenditure Survey 2005/6*.

Table 14: Change in expenditure on household energy according to CO2 price

	CO2 price				
Euro/t	25	50	100	200	400
Rand/t	300	600	1200	2400	4800
HHs	Extra expenditure on household energy (R/annum)				
Rural	839	1,678	3,357	6,714	13,428
Urban	1,600	3,201	6,402	12,803	25,606
All	1,289	2,578	5,156	10,311	20,623
	Percentage extra expenditure on energy (%)				
Rural	72	144	288	575	1,151
Urban	108	216	432	864	1,729
All	94	188	376	752	1,504

Source: Own calculations based on StatsSA (2008b), DME (2008) and Eskom (2007).

Table 15 shows the additional expenditures households make on transport fuels in absolute and percentage terms at various CO2 prices. In this case, in the absence of more detailed data, it is assumed that both urban and rural households consume equal proportions of petrol and diesel.

Table 15: Change in expenditure on transport fuel at various CO2 prices

	CO2 price				
Euro/t	25	50	100	200	400
Rand/t	300	600	1200	2400	4800
HHs	Extra expenditure on transport fuel (R/annum)				
Rural	135	269	539	1,078	2,155
Urban	39	77	154	308	617
All	184	368	736	1,471	2,943
	Percentage extra expenditure on fuel (%)				
Rural	7	14	27	55	110
Urban	7	14	27	55	110
All	7	14	27	55	110

Source: Own calculations based on StatsSA (2008b), DME (2008) and Eskom (2007).

5.1.2 Indirect change in expenditure

As described in section 3.3, rising energy prices also push up the costs of producing goods and services to the extent that production utilises energy inputs. In addition, rising liquid fuel prices lead to higher costs of transportation and consequently to higher retail prices. Households will thus face higher prices and expenditures as a result of these indirect price effects in addition to the direct impact of higher expenditures on energy products. Based on these indirect price effects estimated in section 3.3, Table 16 shows the indirect increase in expenditure by households as the prices of non-energy goods and services rise following the introduction of C&S.

Table 16: Indirect increase in annual expenditure due to higher energy prices

	Price of CO2				
Euro/t	25	50	100	200	400
Rand/t	300	600	1200	2400	4800
	Percentage increase in PPI				
	5.9	11.9	23.7	47.4	94.9
	Additional expenditure on non-energy G&S (R)				
Decile 1	633	1,267	2,534	5,067	10,134
Decile 2	778	1,555	3,111	6,221	12,442
Decile 3	936	1,872	3,744	7,487	14,975
Decile 4	1,151	2,302	4,603	9,207	18,414
Decile 5	1,281	2,563	5,125	10,250	20,501
Decile 6	1,591	3,181	6,362	12,724	25,449
Decile 7	1,993	3,986	7,971	15,943	31,886
Decile 8	3,064	6,129	12,257	24,515	49,030
Decile 9	5,951	11,902	23,803	47,607	95,214
Decile 10	13,959	27,918	55,836	111,672	223,343
Average	3,134	6,268	12,536	25,072	50,145

Source: Own calculations based on StatsSA (2008a, b, c), DME (2008) and Eskom (2007).

In Table 17 the direct and indirect additional expenditures as a result of higher energy prices are added together to give the total impact on household expenditure. The lower panel gives the increase as a percentage of total initial expenditure.

Table 17: Total change in annual expenditure due to higher energy prices

	Price of CO2				
Euro/t	25	50	100	200	400
Rand/t	300	600	1200	2400	4800
	Total increase in expenditure				
Decile 1	1,066	2,131	4,263	8,526	17,051
Decile 2	1,344	2,689	5,377	10,755	21,509
Decile 3	1,655	3,310	6,620	13,240	26,480
Decile 4	1,934	3,868	7,736	15,472	30,945
Decile 5	2,225	4,451	8,902	17,803	35,607
Decile 6	2,584	5,168	10,335	20,670	41,340
Decile 7	3,257	6,514	13,028	26,055	52,111
Decile 8	4,953	9,907	19,813	39,626	79,253
Decile 9	9,104	18,207	36,415	72,829	145,658
Decile 10	18,606	37,213	74,426	148,852	297,703
Average	4,673	9,346	18,692	37,385	74,770
	Percentage increase in total expenditure				
Decile 1	9	19	37	75	150
Decile 2	10	19	38	77	154
Decile 3	10	20	39	79	158
Decile 4	9	19	38	75	151
Decile 5	10	20	39	78	156
Decile 6	9	18	36	73	146
Decile 7	9	18	37	73	146
Decile 8	9	18	36	72	144
Decile 9	8	17	34	67	135
Decile 10	7	15	30	60	120
Average	8	17	33	67	133

Source: Own calculations based on StatsSA (2008a, b, c), DME (2008) and Eskom (2007).

5.2 Household income

Table 18 shows the average annual household income by decile and by rural/urban settlement area. The extreme degree of income inequality in South Africa is clearly evident, in that the wealthiest 10% of households derive more than half of total income while the poorest 50% of the population earns just 10% of gross income. Average household size first increases and then declines as income level rises from poorest to richest.

Table 18: Average annual household income by decile in 2005

Income group	R/annum	% of total	Av. HH size
Decile 1	4,312	0.2	2.8
Decile 2	9,587	1.2	3.3
Decile 3	13,297	2.2	3.8
Decile 4	17,626	2.9	4.4
Decile 5	22,974	3.5	4.7
Decile 6	30,522	4.7	4.9
Decile 7	43,572	6.4	4.6
Decile 8	69,495	10.3	4.4
Decile 9	128,785	17.8	3.8
Decile 10	405,617	51.0	3.6
Average	74,589	100	3.8
Rural	30,859		
Urban	98,011		

Notes:

- *Total income includes income from work and grants but excludes imputed rent.*
- *The last column represents average household size.*

Source: StatsSA (2008) IES 2005/6

Upon the introduction of C&S, each person in the country will receive a personal allocation permit (PAP). The value of the PAP will depend on the market price of CO2. The average number of persons per household for the 10 income deciles is used to calculate the average household income from PAPs, depending on the price of CO2 (see Table 19). The lower panel shows the percentage increase in household income by income decile that arises from the PAPs. It is clear that, despite the average household size being larger for middle-income households, the proportional increase in income declines monotonically as average income rises.

Table 19: Household income from PAPs

		CO2 price				
	Euro/tonne	25	50	100	200	400
	Rand/tonne	300	600	1200	2400	4800
Income group	**HH size**	**PAP income per household (R per annum)**				
Decile 1	2.8	3,120	6,240	12,481	24,961	49,923
Decile 2	3.3	3,677	7,355	14,709	29,419	58,838
Decile 3	3.8	4,235	8,469	16,938	33,876	67,752
Decile 4	4.4	4,903	9,806	19,613	39,225	78,450
Decile 5	4.7	5,237	10,475	20,950	41,900	83,799
Decile 6	4.9	5,460	10,921	21,841	43,683	87,365
Decile 7	4.6	5,126	10,252	20,504	41,008	82,016
Decile 8	4.4	4,903	9,806	19,613	39,225	78,450
Decile 9	3.8	4,235	8,469	16,938	33,876	67,752
Decile 10	3.6	4,012	8,023	16,047	32,093	64,187
Average	3.8	4,235	8,469	16,938	33,876	67,752
Income group	**Initial Income**	**Increase in income per household from PAPs (%)**				
Decile 1	4,312	72%	145%	289%	579%	1158%
Decile 2	9,587	38%	77%	153%	307%	614%
Decile 3	13,297	32%	64%	127%	255%	510%
Decile 4	17,626	28%	56%	111%	223%	445%
Decile 5	22,974	23%	46%	91%	182%	365%
Decile 6	30,522	18%	36%	72%	143%	286%
Decile 7	43,572	12%	24%	47%	94%	188%
Decile 8	69,495	7%	14%	28%	56%	113%
Decile 9	128,785	3%	7%	13%	26%	53%
Decile 10	405,617	1%	2%	4%	8%	16%
Average	74,589	6%	11%	23%	45%	91%

Notes:

- *Percentage increases have been calculated relative to the 2005 income data for the sake of comparability with the expenditure data, and in the absence of more recent figures. The important point is the impact on inequality, which can readily be seen and does not depend on the absolute numbers.*

Source: StatsSA (2008b) and own calculations.

5.3 Net impact on households

Now that the impact of C&S on both household expenditure and income have been estimated, it is possible to calculate the net effect, i.e. income from PAPs minus additional expenditure arising from higher energy prices. Table 20 displays this net income impact on households by income decile. For each CO2 price level, the poorer seven deciles are net beneficiaries whilst the richest three deciles are net losers. The middle income deciles gain the most, partly because of their larger average household sizes (which pushes up their PAP incomes). The higher the price of CO2, the more accentuated are the differences across income deciles. Overall, C&S these figures suggest that C&S would have a progressive effect on household budgets, i.e. it would serve to lower income inequality, all else being equal.

Table 20: Net change in household budgets at various C02 prices

	Price of CO2				
Euro/t	25	50	100	200	400
Rand/t	300	600	1200	2400	4800
Net income from PAPs minus higher expenditure					
Decile 1	2,054	4,109	8,218	16,436	32,872
Decile 2	2,333	4,666	9,332	18,664	37,328
Decile 3	2,580	5,159	10,318	20,636	41,273
Decile 4	2,969	5,938	11,876	23,753	47,505
Decile 5	3,012	6,024	12,048	24,096	48,192
Decile 6	2,877	5,753	11,506	23,012	46,025
Decile 7	1,869	3,738	7,476	14,953	29,906
Decile 8	-50	-100	-201	-401	-803
Decile 9	-4,869	-9,738	-19,476	-38,953	-77,906
Decile 10	-14,595	-29,190	-58,379	-116,758	-233,517
Average	-439	-877	-1,754	-3,509	-7,017
Net change in household income (%)					
Decile 1	48	95	191	381	762
Decile 2	24	49	97	195	389
Decile 3	19	39	78	155	310
Decile 4	17	34	67	135	270
Decile 5	13	26	52	105	210
Decile 6	9	19	38	75	151
Decile 7	4	9	17	34	69
Decile 8	0	0	0	-1	-1
Decile 9	-4	-8	-15	-30	-60
Decile 10	-4	-7	-14	-29	-58
Average	-1	-1	-2	-5	-9

Source: Own calculations based on StatsSA (2008b).

6 Impact on Industry

This section examines the potential effect of C&S on South African industries. Section 6.1 provides an overview of energy consumption and CO2 emissions, and projects the immediate costs of emissions under C&S, for the major sectors of the economy. Section 6.2 discusses some of the anticipated second order impacts. Section 6.3 addresses the issue of international competitiveness, specifically for South Africa's energy intensive export industries.

6.1 Energy use, emissions and CO2 costs by major sector

Table 21 shows the consumption of fossil fuels and electricity in four main sectors in 2005. Agriculture consumes a relatively small amount of energy, mainly petroleum and electricity. Industry accounts for the largest share of energy consumption (42%), followed by transport (31%). The residential sector (14%) and commercial and public services (9%) consume relatively small amounts of energy. The CO2 emissions are a direct multiple of the energy consumption figures since the latter are given in common units (kilotonnes of oil equivalent).

Table 21: Energy consumption and CO2 emissions by sector in 2005

Sector	Coal	Oil	Gas	Electricity	Total	Share
			Energy consumption (ktoe)			
Agriculture	9	1,126	0	475	1,610	3%
Industry	8,881	874	1,861	9,448	21,064	42%
Transport	0	15,254	0	468	15,722	31%
Residential	3,151	817	0	3,179	7,147	14%
Com & Pub Services	1,576	480	7	2,331	4,394	9%
TOTAL	13,617	18,551	1,868	15,901	49,937	100%
			CO2 emissions (kt)			
Agriculture	26	3,220	0	1,359	4,605	3%
Industry	25,400	2,500	5,322	27,021	60,243	42%
Transport	0	43,626	0	1,338	44,965	31%
Residential	9,012	2,337	0	9,092	20,440	14%
Com & Pub Services	4,507	1,373	20	6,667	12,567	9%
TOTAL	38,945	53,056	5,342	45,477	142,820	100%

Notes:

- *ktoe = kilotonnes of oil equivalent; kt = kilotonnes.*
- *Com & Pub Services = commercial and public services.*
- *The emissions factor is 2.86 tonnes of CO2 per tonne of oil equivalent.*

Source: IEA (2008) and own calculations.

Table 22 presents estimates of the costs of CO2 emissions by sector for various CO2 price levels. As could be expected, the impact relative to gross value added in the sector is highest in the case of transport and lowest in the case of commercial and public services.

Table 22: Cost of CO2 emissions by sector in 2005

	CO2 price				
Euro/tonne	25	50	100	200	400
Rand/tonne	300	600	1200	2400	4800
Sector	**Cost of CO2 emissions (R million)**				
Agriculture	1,381	2,763	5,526	11,051	22,102
Industry	18,073	36,146	72,292	144,583	289,167
Transport	13,489	26,979	53,958	107,916	215,832
Residential	6,132	12,264	24,529	49,057	98,114
Com & Pub Services	3,770	7,540	15,080	30,160	60,321
Total	42,846	85,692	171,384	342,768	685,535
Sector	**Cost as a % of sectoral gross value added**				
Agriculture	3.7	7.4	14.8	29.7	59.3
Industry	4.3	8.5	17.1	34.2	68.3
Transport	10.1	20.1	40.3	80.5	161.0
Residential	n/a	n/a	n/a	n/a	n/a
Com & Pub Services	0.5	1.0	1.9	3.9	7.8
Total	3.1	6.2	12.5	25.0	50.0

Notes:

- *The IEA uses different sectoral classifications from the SA National Accounts, so it is not possible to obtain the precise gross value added for the above. The percentage figures are approximations based on the nearest fit between the two sectoral classification systems.*

Source: Own calculations based on IEA (2008) and SARB (2008).

Clearly, the more energy intensive a sector or firm's production process is, the more it will have to pay to purchase CO2 emission permits and therefore the higher will be its production costs. The higher costs may to some extent erode profits, although this depends on the extent to which producers can pass on their high costs to their customers (ultimately consumers). In South Africa, many industries are highly concentrated, which confers considerable pricing power on firms.

6.2 Second order effects

However, if higher costs resulting from C&S are passed on to consumers, this will bring about changes in demand – so-called second order effects. In general, consumers are likely to purchase fewer carbon intensive goods (and services). Companies that are more energy efficient – or more labour intensive – will in general become more competitive and gain larger market shares. The introduction of C&S would favour traditional over commercial agriculture since the latter is far more energy intensive and would therefore face higher costs when CO2 emissions are restricted and traded. Some commercial farmers might shift over to organic production methods which utilise less fossil energy.

6.3 Export industries and international competitiveness

Firms producing for the export market face similar issues to producers of non-tradable goods and services, although the context is obviously the global economy. Faced with cost increases when CO_2 permits have to be purchased, exporting firms will pass on those extra costs to their consumers to the extent that they can. Again, this depends on their market power, which in general will tend to be smaller than that of domestic firms in the non-tradable sector given the extent of international competition. Of critical importance for such firms will be their relative carbon intensity as compared with their competitor firms.

According to the DME (2002: i), South African firms' "[e]nergy intensities in the pulp and paper, chemical and iron and steel industries are typically above those of other first world countries." The energy intensity of the non-ferrous metals and paper industries is similar to that of other countries, while the intensity of pulp is substantially higher. Further details are provided in Appendix B. In general, low energy costs have for many years been viewed as a competitive advantage of South African firms, but this has contributed to energy inefficiency and high energy intensity and will thus work against these firms under a C&S scheme.

Over time, all carbon-intensive exporters are likely to see demand patterns shift away from their products to some degree as consumers respond to higher energy prices. Domestically, greater possibilities for import substitution are likely to arise considering the CO_2 emissions from freight transport, which will add to the costs of imported products. Products that are bulkier and heavier will tend to be traded less. Intra-industry trade in particular is likely to contract more than other types of trade because of its inherent energy inefficiency.

In considering the potential impact of C&S on industries, it is perhaps worth noting Article 4.8 of the United Nations Framework Convention on Climate Change (UNFCCC), which states the following:

> "In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures, especially on: …
> (h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products".

7 Opportunities for Renewable Energy

One of the key aims of placing a price on CO_2 emissions is to alter the balance of incentives between fossil fuels and renewable energy sources such as solar and wind. Table 23 provides a comparison of electricity generation costs for coal, wind and solar energy sources. Current costs are compared with those for coal under the various benchmark CO_2 price levels. Although solar and wind powered electricity is at least twice as expensive as coal-fired electricity currently, this picture changes dramatically under C&S. Even at the lowest CO_2 price level, solar becomes more competitive than coal, while from R600/tonne upwards the cost of coal power becomes much more expensive than renewables.

Table 23: Comparison of electricity generation costs under C&S

			CO2 price				
		Euro/tonne	25	50	100	200	400
		Rand/tonne	300	600	1200	2400	4800
		Rand/kg	0.3	0.6	1.2	2.4	4.8
Energy source	**Current cost**			**Cost including CO2**			
Coal	0.23	R/kWh	0.53	0.83	1.43	2.63	5.03
Solar	0.46	R/kWh	0.46	0.46	0.46	0.46	0.46
Wind	0.56	R/kWh	0.56	0.56	0.56	0.56	0.56

Source: IOL (2008), Eskom (2007) and own calculations.

By putting a price on carbon emissions, C&S will also incentivise greater efficiency in the use of energy that is derived from fossil fuels. Given the history of low electricity (and to some extent liquid fuel) prices in South Africa, there is plenty of scope for efficiency gains. Those sectors and households that invest earlier in conservation and efficiency measures will be relative gainers while those that are slow to adapt will be net losers.

8 Summary and Conclusions

This study sought to identify the initial impact that a global Cap and Share scheme might have on South Africa, based on a set of limiting assumptions. In particular, it attempted to quantify the immediate impact – i.e. before behavioural responses take effect – on energy prices, the macro economy, household expenditure and income, industries and the competitiveness of renewable energy sources. The main findings are summarised as follows.

South Africa is considerably more carbon-intensive than the world average in both per capita and per economics output terms. Emissions are dominated by those from coal, and have been on a rising trend for decades.

Putting a price on CO2 emissions would have a major impact on the price of electricity, a notable impact on the price of coal, and a lesser relative impact on the prices of liquid fuels in South Africa. Higher energy prices would also feed through into higher producer and consumer prices given that energy is embodied in the production process for many goods, and many goods and services have a transport cost component.

Because of South Africa's high energy intensity relative to the world average, the net impact of C&S, taking into account the total cost of emission permits after adjusting for the balance of emissions embodied in trade as well as national income from PAPs, is a substantial, negative percentage of GDP. This might make the adoption of C&S by the South African government politically difficult if there is no compensation for South Africa's developing country status.

At the household level, C&S would effect a substantial degree of income redistribution within South Africa given the existing extent of inequality in energy consumption and income. In particular, the richest three income deciles are net losers from C&S while the bottom seven deciles are net winners. In proportional terms, C&S has a progressive impact on inequality. Any policy intervention that produces winners and losers is bound to encounter political obstacles, and in this case the hurdles are likely to be substantial given that the elite have the most to lose. However, the adoption of C&S could assist the South African government's commitment to poverty alleviation.

Certain energy-intensive industries would be hard hit in terms of their international competitiveness, especially manufacturing which relies heavily on coal-powered electricity. Other energy-intensive industries, such as mining and metal production, have similar energy-intensities to their direct competitors in other countries, but could lose out to less energy-intensive competitors where those exist. Over time there is likely to be a relative decline in long-distance international trade so that opportunities for import substitution will improve.

Renewable sources of energy become much more cost competitive than coal-fired electricity even at moderate CO2 price levels. This suggests that C&S would help to kick-start a domestic renewable energy industry.

In sum, this report has indicated that C&S would have a substantial impact on the South African economy and society, even in immediate terms. This exploratory study has hopefully demonstrated that more extensive research and analysis into the potential impacts of C&S is worth undertaking. For instance, more complex economic modelling could be applied to estimate some of the dynamic responses of industrial sectors and households to higher energy prices.

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10 Appendix A: Fossil Fuel Scarcity Rents[7]

Cap and Share was designed to share out the scarcity rent that arises from restrictions on fossil energy use, regardless of whether these restrictions arise because of the increasing difficulty of supplying fuel as a result of resource depletion, under-investment by the fuel producers, or restrictions on the use of fossil fuels in response to climate change. It was not intended, however, to capture all of the scarcity rent for distribution to consumers. Feasta points out that a portion of the rent has to accrue to the fuel producers if only to make it financially worthwhile for the governments of net fuel exporting countries to co-operate with the Global Climate Trust (GCT), the organisation Feasta proposes should be responsible for making C&S work. Securing this co-operation is important because, if the GCT introduced C&S without the fuel exporters' agreement, they could simply refuse to ship more fuel until C&S was dropped or their share of the rent was increased to an acceptable level. This does not mean, however, that the exporters will demand to retain all the scarcity rent because they have a lot to lose if C&S is not put into use. The reasons they will wish to compromise include:

1. It is as important for them as it is for everyone else that climate stability is achieved.
2. If they insist on retaining all the scarcity rent due to resource depletion or underinvestment but are unable to recycle it in ways which return it, directly and indirectly, to the people from whom it came, those people will not be able pay as much for their fuel the following year. Their purchases will fall, their economies will go into recession and the price of fuel will slump, possibly staying low for a decade or more. This would not only reduce the fuel exporters' earnings below what they would have been had they agreed to give up part of the scarcity rent. It would also damage their extensive investments in their customers' countries.
3. If the exporters agree to let the GCT cut their output faster than they would otherwise be forced to do by depletion, it will enable them to stay in production for longer. Moreover, if the GCT offers to increase year by year their share of the total amount paid for their fuel and for the emissions permits required for its sale, they ought to be happy to agree to do so if the return they received from keeping the fuel in the ground was greater than they could obtain from selling it immediately and investing the proceeds.

How high is scarcity rent at present?

The total amount of scarcity rent that fossil fuel producers have received since oil prices began their climb has been substantial. Most currently-active oilfields were developed on the assumption that the price of oil would be about $20 a barrel, the long-run average price between the early 1980s and the early 2000s. If one increases that figure to $30 to allow for inflation, more than half of the $1,975 billion paid for oil in 2007 when oil averaged $64.20 a barrel, was actually scarcity rent. It amounted to around $1,000 billion, roughly 2% of gross world product. Coal and gas producers also received scarcity rental payments but the oil part alone works out at $151 for everyone on Earth.

[7] This Appendix was provided by Feasta.

For the purposes of this paper, it is assumed that the oil producers come to an agreement with the Global Climate Trust to accept a price made up of their actual average production cost, which is assumed to be $30 in the first year in which C&S operates, and a share of the scarcity rent. The table shows the scarcity rental shares for each oil price which have been taken as the outer bounds of the range of possibilities at which an agreement might be struck.

Table A1: Allocation of oil scarcity rents

Oil price in USD per barrel	Producers' share of scarcity rent (Max)	Min. rental captured by C&S from oil ($/barrel)	Producers' share of scarcity rent (Min)	Max rental captured by C&S from oil ($/barrel)	Min. price per tonne of CO2	Max. price per tonne of CO2	Income range per person from selling permits for 3.71 tonnes in first year.
$60	100%	0	20%	$24	0	$53	0-$197
$100	90%	$7	17.5%	$58	$16	$128	$59-$475
$150	80%	$24	15%	$90	$54	$200	$200-$742
$200	70%	$51	13%	$148	$113	$329	$419-$1,220
$250	60%	$88	11%	$196	$196	$435	$727-$1,614
$300	50%	$135	9%	$246	$300	$546	$1,113-$2,026
$350	40%	$192	7%	$298	$427	$662	$1,299-$2,456
$400	30%	$259	5%	$352	$575	$780	$2,133-$2,894

450kg of CO2 released/barrel of oil

There is little possibility that the higher oil prices envisaged in the table would apply when C&S was introduced. They are much more likely to arise later when the cap on fossil fuels begins to get very tight and only extremely valuable fuel uses remain economic. In these circumstances, the *per capita* emissions allocation would be quite small. If this assumption turns out to be sound, the value of each person's allocation will never reach the highest figures in the table.

It is interesting to note that the 2007 edition of the OPEC publication, *World Oil Outlook*, which deals with the period up to 2030, builds much lower oil prices than at present into its projections. It states on page 15: “An emerging dominant impression is that in order to finance the necessary investments there appears to be a need for higher prices than previously thought. Indeed, this has become the understanding, tacit or otherwise, of both producing and consuming countries. Bearing these developments in mind, the reference case OPEC benchmark crude price is assumed to remain in the $50–60/bbl range in nominal terms for much of the projection period, rising further in the longer term with inflation. These price levels are, of course, no more than assumptions, and do not reflect or imply a projection of most likely price paths, or of the desirability of any given price.”

The need to reduce the supply of C&S permits more rapidly than the fastest depleting fossil fuel

Assume that the three fossil fuels are initially used in equal proportions in terms of MTOE but that the CO_2 emissions from them are in the ratio 1 for gas, 2 for oil and 3 for coal. Also assume that oil output begins to decline at 8% a year as a result of resource depletion but coal production can increase by 2% p.a. provided enough permits are released to allow this. Gas output is flat. If the Global Climate Trust does nothing, world emissions will therefore fall by

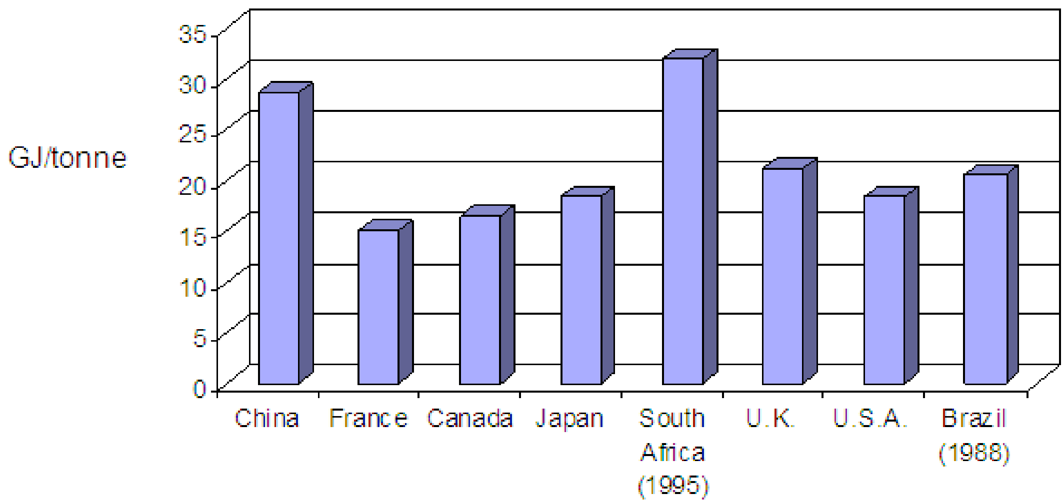
$$\frac{(2 \times 0.08) - (3 \times 0.02)}{0.06} \text{ equals } 1.7\%.$$

At what rate should the Trust reduce the supply of permits? Should it cut their issue by a minimum of 1.7% each year or should it cut by the rate at which output of the fastest depleting fossil fuel is falling? The answer is that if it cuts by less than 8%, all three types of fossil fuel producer will still be able to get a scarcity rent. This is because there will be more demand for oil than the producers can supply. This will push up the price of oil by a scarcity rent element, widening the differential between the price of oil and the prices of other fuels, which will then rise accordingly as demand switches to the cheaper options. Thus, if the aim is to capture all the scarcity rent for the people of the world, the rate at which the GCT cuts the issue of permits has to be at least as great as the rate of decline of output of the fastest depleting fuel. However, a rent-sharing arrangement with the fossil fuel producers would be necessary and cutting by less than the fastest decline rate would be one way of delivering it.

11 Appendix B: Comparative Energy Intensities of SA Industries

The following figures and tables provide comparative evidence of the energy intensity of certain energy-intensive South African industries relative to those in other countries.

Figure B1: Energy intensity in the iron and steel industry in 1998 (GJ/t)



Source: DME (2002)

Table B1: Energy intensity in the Pulp and Paper industry (GJ/t)

	GJ/tonne	Pulp production Ktonne	Paper Production Ktonne
South Africa	34.13	2138	2226
USA	26.36		
UK	26	743	4824
Brazil	20		
Sweden	23.5	10215	8419
Canada	29.21	9756	25971

Source: DME (2002)

Figure B2: Energy intensity in the mining sector (TeraJoules/million $ value added)

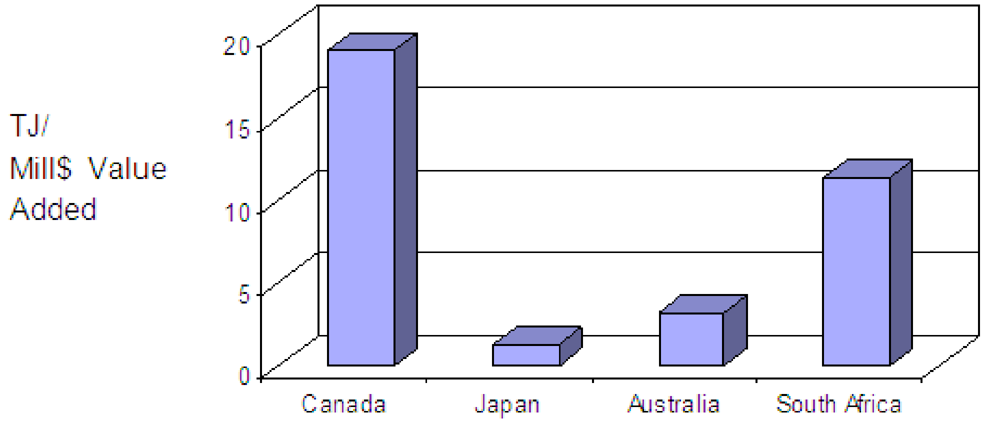


Figure B3: Energy intensity of petrochemical and chemicals, 1999 (TJ/1000$ value added)

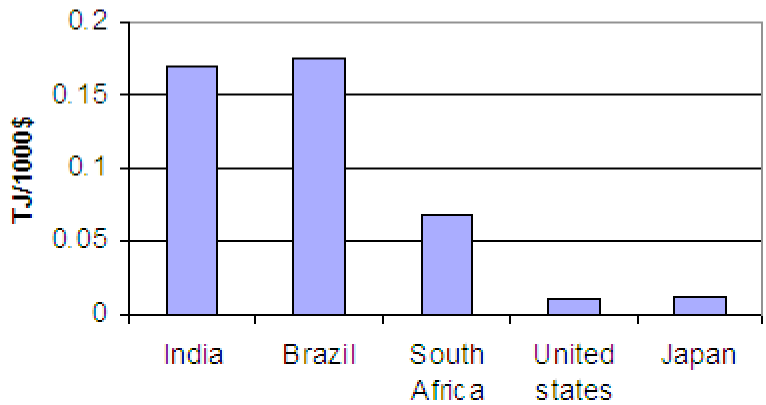
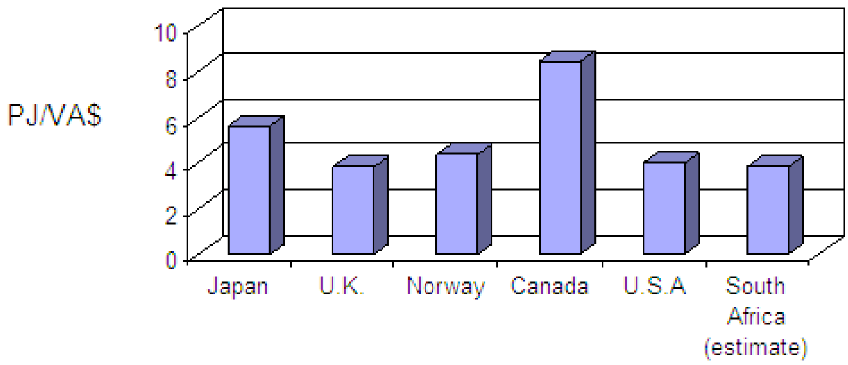


Figure B4: Energy intensity in the textile industry (PJ/$VA)



Source: DME (2002)