Department of Minerals and Energy Pretoria

Capacity Building in Energy Efficiency and Renewable Energy

Report No. 2.3.4 - 03 – Final Report

Title: Energy Efficiency Baseline Study

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OCTOBER 2002

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EXECUTIVE SUMMARY

South Africa would benefit significantly were focus to be placed on energy efficiency. Benefit would be realized in several areas including health, fiscal, environmental and employment. It would also help to relieve the shortage of electricity generating capacity that she will soon be facing. Government encouragement of energy efficiency will assist greatly in promoting energy efficiency. This could occur through the implementing of equipment and building standards, fiscal policies, efficiency targets and agreements, the carrying out of audits and assessments, information dissemination programmes and research and development activities.

Establishing an energy balance and detailed energy consumption for South Africa is integral to defining energy end use and intensity. The balances are compiled from various data sources and integrated into the LEAP energy model.

The approach taken for this study was to:

- Establish a national energy balance,
- Determine detailed consumption statistics, where possible,
- Determine both current and possible future benchmarks, and
- Discuss policy objectives associated with energy efficiency.

The focus of industry in South Africa has shifted from mining to energy intensive manufacturing processes. The major contributors to GDP in South Africa are the Iron and Steel and Chemical and Petrochemical Industries, followed by the mining and pulp and paper industries. There has been little shift towards the production of technically advanced products that have a high value added output with low energy input. This shift should take place in the future and will reduce the overall energy intensity of industry in South Africa.

Benchmarking comparisons performed in the industrial, residential, transport and commercial sectors can be used to highlight areas where potential exists for saving energy. It is important to note that benchmarking can only be used as a rough comparison between sectors in countries as energy use varies widely depending on the product, raw material or process involved. The data for energy use by sectors in South Africa is generally poor and for sub-sectors or industries worse. It is recommended that attention be directed at further studies to determine energy use on a sub-sector by process basis in order to accurately benchmark South African Industries against those of other countries.

Energy intensities in the pulp and paper, chemical and iron and steel industries are typically above those of other first world countries. Iron and steel manufacture has shifted in recent years towards the Corex and Midrex production process. This will lower the energy intensity of this industry significantly, but the lowering is not reflected in the data for this industry. The non-ferrous metals industry is highly energy-intensive, but similar to the energy intensities of other countries. South Africa produces pulp at an energy intensity by gross product output higher than that of other pulp producing countries, but paper is produced at a similar energy intensity to many countries running best practice programmes in this industry.

There is insufficient information available on most sectors to provide an accurate estimate of potential energy savings, however, an attempt has been made to identify areas where savings are possible. There are several standard energy efficiency measures that could be applied to the energy demand sectors to improve the current energy intensities. It is estimated that the potential for improving energy efficiency in the iron and steel, chemical and petrochemical, mining and pulp and paper industries alone through simple one year payback schemes could amount to a large saving of energy.

A key barrier to improving energy efficiency is the lack of knowledge and understanding of energy efficiency, knowledge of what the energy is costing or what the potential savings could be and how to achieve them. Whilst the unit cost of energy is low, and the cost of capital remains high, investments into energy efficient equipment such as motors are often not implemented even though the long term benefits in terms of savings are significant. Projects such as improving lighting efficiency can have pay back periods of longer than 3 years, efficient motor replacement payback period can be up to 4 years. Historically, programmes with payback periods of longer than one and a half years are seldom implemented.

Many countries have successfully encouraged energy efficiency improvements through product labeling schemes. It is suggested that labeling schemes should show the correlation between energy saving and money saving, or include the payback period. Government funded energy audits have proved successful in encouraging energy savings in many countries. In America the payback in terms of additional revenue from taxes after savings has been in excess of the cost of the audits. Training programmes and research in the field of energy efficiency and new technology are also essential. There is a correlation between countries that fund research and development in this area and the energy savings achieved.

Key players to include in an energy efficiency drive are energy users, energy suppliers and distributors, local and national government, educational bodies, associations and NGO’s

PARTICIPANTS

The participation of the following people in the project is gratefully acknowledged.

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Mr Tony Surridge
Mr Johan van Wyk
Ms Janneke Weidema

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LIST OF ABBREVIATIONS

A/C	Air conditioning
BOF	Basic Oxygen Furnace
CDM	Clean Development Mechanism
CEF	Central Energy Fund
CIDA	Canadian International Development Agency
CSIR	Council for Scientific and Industrial Research
DANCED	Danish Cooperation for Environment and Development
DBSA	Development Bank Of South Africa
DME	Department Of Minerals And Energy
DSM	Demand Side Management
DTI	Department Of Trade And Industry
EAF	Electric Arc Furnace
ECN	Energy Research Center of the Netherlands
ESCO	Energy Service Company
ETSU	Energy Technology Support Unit
EU	European Union
FCO	British Foreign Commonwealth Office
FFF	Fossil Fuel Foundation
FGD	Flue Gas Desulpherisation
GDP	Gross Domestic Product
HVAC	Heating, Ventilation And Cooling
I/O	Input / Output
IEA	International Energy Agency
IEP	Integrated Energy Plan
IFC	International Finance Corporation
IRP	Integrated Resource Approach
ISEP	Integrated Strategic Energy Planning
JICA	Japan International Co-operation Agency
kWh	Kilowatt-hour
LEAP	Long Range Energy Alternative Planning Systems
MARKAL	Market Allocations
NGO	Non Government Organisation
NORAD	Norwegian Agency For Development Cooperation
NOVEM	Netherlands Agency For Energy and the Environment
PCF	Prototype Carbon Fund
PJ	Petajoule
ppp	Purchasing Power Parity
RDP	Rural Development Planning
SABS	South African Bureau Of Standards
SEC	Specific Energy Consumption
SIC	Standard Industrial Classification
SIDA	Swedish International Development Cooperation
Sqm	Square Meter
TJ	Terajoule
USAID	United States AID
VSD	Variable Speed Drive

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1. INTRODUCTION

This project funded by the Danish Cooperation for Environment and Development (DANCED), forms part of the Capacity Building in the Department of Minerals and Energy (DME) in Energy Efficiency and Renewable Energy. It has been coordinated by COWI and the Department of Minerals and Energy in South Africa. The aim is to enhance the DME's capacity and performance and create a more sustainable energy sector in South Africa.

Improving energy efficiency in South Africa will benefit both the residents and the economy bringing financial, environmental, health and employment benefits.

Developing baselines of energy end-use in South Africa is a first step towards identifying the energy intensity of the economy and sectors with high energy intensities relative to those of other countries. Data for these baselines, amongst developing countries including South Africa, is often poor and historically inaccurate, and attempts are made in this research to establish baselines with greater accuracy with the help of the energy modelling programme LEAP.

Benchmarking of the industrial sub-sectors with those of other countries, is performed on an energy consumption per value added, gross value of output, and mass of product basis. The similarity of manufacturing process, raw materials and final product of an industry affect the energy consumption of manufacture. Energy consumption by product output where input and output are the same gives a good indication of the energy intensity of the process and can be used to assess where improvements in energy efficiency can be made. Benchmarking of sub-sectors by industrial process has been completed where information is available.

The drive, world wide, to improve energy efficiency has resulted in a large collection of information on possible energy efficiency improvements by industry. Many countries such as Denmark, United Kingdom, United States of America, and the Netherlands have successfully implemented best practice and energy auditing programmes. These are reviewed including suggestions regarding possible government bodies, training centres, Energy Service Company (ESCOS) and Non Government Organisation (NGO's) to include in future energy efficiency development initiatives.

Section 2 – contains a detailed methodology. Section 3 - Energy Balances, gives the overall energy consumption and detailed consumption balances for South Africa. It also lists possible measures for improving energy efficiency and the potential savings that could result. Section 4 - Benchmarking, covers South Africa's energy use, relative to that of other countries, by sub-sector and industry. It also lists areas where potential savings in energy could be made and the extent of savings that could be achieved through implementing simple energy efficiency measures. Barriers to energy efficiency in South Africa and benchmarking are included in this section. Section 5 - lists organisations that should be involved in promoting energy efficiency. Section 6 - gives an overview of policy aspects to consider when implementing energy efficiency policies and the key players to involve in the formulation of future policies.

2. METHODOLOGY

The baseline study is based on information from existing reports, statistics and information obtained form organisations, companies and persons involved in the energy sector. Where data on consumption in residential areas is not available, terms of reference are provided to facilitate establishing this data.

2.1 Objective

The objective of the baseline study is to provide a platform for the development of a strategy for improved energy efficiency in South Africa as well as for the initiation of future demonstration projects within this field.

This necessitates carrying out a number of activities which are listed below.

- Compilation of information regarding the actual energy consumption in the major energy consuming sectors such as the industrial sector, the domestic sector, the commercial sector, the public sector and transportation sector and establishing an overall energy balance for South Africa.
- Compiling an overview of previous as well as ongoing projects and activities in the field of energy efficiency in all sectors including parties that are or were involved in the projects.
- Clarification of which public and government bodies are key players in the field of energy efficiency and should be included in future activities within energy efficiency in technical as well as policy and strategy development.

2.2 Output and scope of work

2.2.1 Energy consumption

Energy consumption balances are used to assess what sectors to address and how to achieve the best cost/ benefit ratios.

2.2.1.1 Overall energy balance

The overall energy balance for South Africa is clarified in terms of

- Imported and own produced energy and fuels,
- Overall power balance,
- Power production and fuel consumption by power plants,
- Power production by wind mills, solar power and hydro power.

This section expands upon previous studies of energy consumption and possible efficiencies.

2.2.2 Final energy consumption

A breakdown of final energy consumption is included to clarify which sectors are the greatest users of energy. Data for the period 1996-2000, is presented in aggregate national figures and provincial figures.

2.2.3 Benchmark of energy consumption in main sectors

The energy balances are is used to benchmark South Africa's energy use against that of other countries.

Sub –sector data is compared with that of other countries in terms of
- Number of companies,
- Value added in the sub-sector,
- PJ in relation to value added,
- PJ/ sqm of building,
- Number of people employed,
- PJ/ tonne where appropriate,
- PJ/ per person where appropriate.

Where necessary different benchmark countries have been used for different sub-sectors. It should be emphasized that benchmarking can only be used for rough comparisons, energy use in industry varies greatly depending on the process used.

2.2.4 Previous and ongoing projects within energy efficiency

A detailed overview of previous and ongoing projects is carried out to establish which organisations to include in future activities within energy efficiency. Barriers facing energy efficiency are investigated to assist the planning of information campaigns and dissemination of information.

National and foreign institutes or organisations and donors currently involved in research in the energy field are listed including; the extent of funding, project duration and a brief project description.

2.2.5 Policy aspects within energy efficiency

The third area of importance in the baseline study deals with political measures that could be used to improve energy efficiency.

Key players to include in policy work are identified and suggestions are made as to how the responsibilities could be divided between them.

2.3 <u>Data for the energy balances</u>

The data balance builds on work in the national energy outlook [Howells et al 2002]. Data from the outlook has been extrapolated to include anticipated sector growth (accounting for intensity changes) and normalized with known electricity growth for the sector concerned. The data sets generated in this study have been compared with industry data, such as ESKOM [Prinsloo 2001], association data such as South African Petroleum Industry Association [SAPIA 2002] and the latest statistics being compiled by the Department of Minerals and Energy [Pouris 2002].

The data generated was then further verified using sector studies, for example de Villiers 2001, [de Villiers & Matimbe 2001], [Voest 1997], [Trollip 1994].

Energy consumed by transformation technologies are calculated from the electricity sent out by power stations [McFadzean 2002], and the plant efficiency. Efficiencies for hydro and nuclear were assumed to be 100%, and pumped storage (storing electricity) 78%. Also included in the energy transformation section is biomass used for electricity generation in the Paper and Pulp and Food and Tobacco industries. While not currently generally the case, this electricity will in future be eligible for sale to the national grid.

3. ENERGY BALANCE

Table 1 below, shows South Africa's energy balance for the year 2000. Balances over the period 1996-2000 have been estimated, and are included in Appendix A. A detailed discussion of the data sources for all sectors is included in Appendix C. Important sources are referenced in the footnotes.

Under transformation, positive values indicate the energy output from the transformation process, negative values are the source or input energy required for the transformation process.

Table 1: South African Energy balance for 2000

Year 2000 Energy Balance– see Appendix C for details

Figures in PJ	Hard coal	Coking coal	Bituminous coal	Coke oven coal	Coal gas	Coke oven gas	Blast furnace gas	Solid biomass	Natural gas	Crude and NGL feed-stocks	Crude oil	Natural gas liquids	Syn-crude	LPG	Avgas[1]	Petrol	Jet fuels	Other kerosene	Diesel	Residual fuels	White spirits	Lubricants	Bitumen	Paraffin	Other petroleum products	Nuclear[2]	Hydro	Electricity[3]	Others	TOTAL
Production	6,000	0	6,000	0	0	0		0	58		0			0		0			0	0				0						6000
Imports	0	0	0	0	0	0		0			852			0		6			6	0				0		34	25			991
Exports	-2,621	0	-2,621	0	0	0		0	0		0			0		-28			-70	-14				-9				-16		-2758
Marine Bunkers	0	0	0	0	0	0		0	0		0			0		0			0	-123				0						-123
Total Primary Supply	**3,379**	**0**	**3,379**	**0**	**0**	**0**	**0**	**0**	**58**	**0**	**852**	**0**	**0**	**0**		**-22**	**0**	**0**	**-64**	**-137**	**0**	**0**	**0**	**-9**	**0**	**34**	**25**	**-16**	**0**	**4,110**
Electricity plants	-1,852	0	-1,852	0	0	0		-2	2		0			0		0			0	0				0		-34	-25	734		-1187
Petroleum refineries	-463	0	-463	0	0	0		0	-52		-805			14		378			301	159				110						-358
Own use	0	0	0	0	0	0		0	0		0			0		0			0	0				0				0[4]		0
Distribution losses	0	0	0	0	0	0		0	0		0			0		0			0	0				0				-98		-98
Total Transformation	**-2,422**	**-122**	**-2,484**	**62**	**36**	**60**		**415**	**-54**		**-805**			**14**		**378**			**301**	**159**				**110**		**-34**	**-25**	**637**		**-1362**
Agriculture[5]	9	0	9	0	0	0		10	0		0			1		3			53	0				3				21		100
Transport[6]	1	0	1	0	0	0		0	0		0			0		352	69		147	0								12		581
Other	37	0	37	0	5	0		0	0		0			2		0			6	1				0				0		51
Commerce[7]	15	0	15	0	1	0		0	0		0			2		0			1	2				0				57		78
Residential[8]	58	0	58	0	0	0		89	0		0			5		0			0	0				25				106		283
Industry[9]	633	0	571	62	30	60		85[10]	0		0			5		0			30	19				4				406		1272
Non Energy	205	0	205	0	0	0		231	0		47			0		0			0	0				0				0		483
Total Demand	**957**	**0**	**895**	**62**	**36**	**60**		**415**	**0**		**47**			**14**[11]		**356**[12]			**237**[13]	**145**[14]				**102**[15]				**603**		**2972**

[1] Aviation gasoline totals are included under petrol.

[2] Imported nuclear fuel of an embedded energy value of 34PJ is converted in Electricity plant (Koeberg) at an assumed 100% efficiency resulting in a total transformation of 34PJ, marked as negative here as it is being consumed in electricity plant to be converted to electricity

[3] Demand data is taken from ESKOM [Prinsloo 2002].

[4] Included in distribution losses and plant efficiency.

[5] Energy Outlook 2002 [Howells et al 2002].

[6] Energy Outlook 2002 [Howells et al 2002].

[7] Energy Outlook 2002 [Howells et al 2002] and de Villiers [de Villiers 2001].

[8] Energy Outlook 2002 [Howells et al 2002] and EDRC [Trollip 1994 and de Villiers and Matimbe 2001].

[9] Energy Outlook 2002 [Howells et al 2002] and Cooper [DME 2002].

[10] Energy Outlook 2002 [Howells et al 2002].

[11] SAPIA 2002.

[12] SAPIA 2002.

[13] SAPIA 2002.

[14] SAPIA 2002.

[15] SAPIA 2002.

Table 2: Detailed consumption balance for 2000[16]

Figures in PJ		Hard coal	Coking coal	Bituminous coal	Coke Oven coal	Coal gas	Coke oven gas	Blast furnace gas	Solid biomass	Natural gas	Crude & NGL feedstock	Crude oil	Natural gas liquids	Syncrude	LPG	Petrol	Avgas	Petrol	Jet fuels	Other kerosene	Diesel	Residual fuels	White spirits	Lubricants	Bitumen	Paraffin	Other petroleum products	Nuclear	Hydro	Electricity	Others	TOTAL
Indus	Iron & Steel	197.4	53.9	143.5		10.1	59.9															8.9								86.9		363.2
	Chemical & Petrochemical	230.4		230.4		2.6																0.5								49.4		282.9
	Non-ferrous metals	1.5		1.5		1.4																								61.		63.9
	Non-metallic minerals	33.6		33.6		6.6																3.5								19.9		63.6
	Transport equipment[17]					0.22																										0.22
	Machinery[18]					5.91																								0.55		6.46
	Mining & quarrying	17.2		17.2		0.6									0.1						17.7	0.6				0.4				114.3		150.9
	Food & Tobacco	48.9		48.9		0.9			49.5													1.3								12.6		113.2
	Paper, pulp & print	51.8		51.8		0.4			34.7																					26.3		113.2
	Wood & wood products																															
	Construction[18]														0.07	0.16		0.16			10.15					0.17				1.97		12.52
	Textile & leather[19]	9.3		9.3											0.31						0.04	2.23				0.03				1.97		13.88
	Others	42.9	8.2	34.7		2.38			0.4						4.22						1.92	1.67				3.1				31.21		87.79
Transport	Aviation																1.1		68.9													70
	Road															350.7		350.7			139.											489.7
	Rail	0.6		0.6																	8.1									12.3		21.
	Pipeline transport																															
	Internal navigation																															
	Others																									0.4						0.4
Commerce & public																																
Building	Public buildings[20]	7.99		7.99		0.43									0.91						0.59	1.13				0.05				30.48		41.58
	Commercial buildings[20]	6.91		6.91		0.37									0.79						0.51	0.97				0.05				26.32		35.92
	Residential - urban[21]														2.91															72.17		72.17
	Residential – rural[21]	9.8		9.8					69.58						0.68											6.33				6.62		94.15
	Residential – townships[21]	24.33		24.33					13.43						0.77											14.09				12.63		66.53
	Residential - low cost[21]	23.87		23.87					2.79						0.24											4.88				14.99		47.25
	Residential - others																															
Farming	Commercial farming	8.6		8.6											0.7						52.7	0.1				2.8				21.2		86.1
	Subsistence farming[22]																															
	Other																															
TOTAL		715.1	62.1	653		31.91	59.9		170.4						11.7	350.86	1.1	350.86	68.9		230.7	20.9				32.3				602.8		2296.56

[16] Only data from which additional data was drawn not mentioned in the supply and demand balance are mentioned here.

[17] Projected from Cooper and Pouris [DME 2002] using global GDP growth.

[18] Projected from Cooper and Pouris [DME 2002] and Prinsloo [2002] using global national GDP growth.

[19] Projected from an industry market survey [Voest 1997] using global national GDP growth.

[20] South African Property Association [SAPOA 2002], [Department of Public Works 2002] & Eta resources [de Villiers 2001]. This assumes an equal energy intensity per square meter for both private and government buildings.

[21] Statistics South Africa [StatsaSA 2002], Department of Housing [DOH 2002], Biomass Initiative [Williams et al 1996] and EDRC [Trollip 1994].

[22] Consumption data in this section is included in rural household energy demand.

Table 3: Total consumption balance for 2000 by province[23]

Figures in PJ	Hard coal	Coking coal	Bituminous coal	Coke oven	Coal gas	Coke oven gas	Blast furnace	Solid biomass	Natural gas	Crude and	Crude oil	Natural gas	Syncrude	LPG	Petrol	Avgas	Petrol	Jet fuels	Other	Diesel	Residual fuels	White spirits	Lubricants	Bitumen	Paraffin	Other	Nuclear	Hydro	Electricity	Others	TOTAL
Western Cape	49.38	11.79	37.59			11.38		3.58						1.93	68.86	0.22	68.86	13.52		43.31	3.92				3.65				90.12		289.86
Eastern Cape	58.56	4.83	53.72			4.66		25.37						1.22	20.18	0.06	20.18	3.96		15.92	1.59				4.69				43.98		180.19
Northern Cape	5.83	0.33	5.49			0.32		0.65						0.21	7.89	0.02	7.89	1.55		7.62	0.16				0.64				10.78		35.67
Free State	38.30	3.04	35.26			2.93		4.66						0.72	14.91	0.05	14.91	2.93		14.89	1.05				2.66				38.31		121.4
KwaZulu Natal	169.28	11.63	157.65		5.60	11.22		102.54						1.96	50.87	0.16	50.87	9.99		29.46	3.65				6.00				84.97		475.7
North West	28.84	1.67	27.18			1.61		3.95						0.68	11.84	0.04	11.84	2.33		16.66	0.80				2.58				61.89		131.2
Gauteng	275.98	21.55	254.43		26.31	20.78		7.83						3.31	155.25	0.49	155.25	30.49		75.97	7.22				7.19				172.99		783.82
Mpumalanga	73.27	6.42	66.85			6.19		6.36						0.97	12.28	0.04	12.28	2.41		17.35	2.11				2.49				69.66		193.14
Northern Province	15.67	0.83	14.83			0.80		14.67						0.69	8.78	0.03	8.78	1.72		9.53	0.40				2.40				30.11		84.79
Total for all provinces	715.11	62.09	653	0	31.91	59.89	0	169.61	0	0	0	0	0	11.7	350.86	1.11	350.86	68.9	0	230.71	20.9	0	0	0	32.3	0	0	0	602.81	0	2295.77

[23] Only data from which additional data was drawn not mentioned in the supply and demand balance are mentioned here.

3.1 Energy consumption and efficiency measures

The detailed consumption balance, shown in Table 2 above, on page 6, was compiled from macro data statistics and sectoral studies. A detailed description of data sources and methodology for the data included in this section can be found in Appendix C.

Computational modelling was carried out to estimate energy consumption in commercial, public and private buildings and different household types.

This data was further broken down into an estimate of energy consumption by province. This was done by assuming a fixed energy intensity per sector, and by multiplying the energy consumption by the fraction of that sector in each province. Several other assumptions were made while compiling the estimates. These are noted below:

- Bagasse is used mainly in KwaZulu Natal,
- Hydrogen rich gas is used mainly in Gauteng,
- Methane rich gas is shared equally between Gauteng and KwaZulu Natal,
- No other provinces use synthetic gas other than Gauteng and KwaZulu Natal,
- The Western Cape is 75% less coal intensive[24] per sector than Gauteng,
- And 80% of industrial wood use is in KwaZulu Natal.

Little comprehensive provincial data is available, and the assumptions made to generate these demand balances should be refined during future work. As a consequence of the broad brush attempt to generate these balances, they should be viewed only as indicative. A better estimate could be generated after market surveys of the major consumers involved. In the case of buildings, consumption should be linked to temperature differences and the effect of this on heating, ventilation and cooling requirements. An important point to note is that detailed SIC, GDP breakdown by province will only be available from Statistics South Africa later this year. With this available manufacturing sub-sectors could be better defined by province.

Data accuracy for this energy balance exercise is difficult to establish, and it is therefore recommended, that this be subject to a review, beyond the scope of this work, which will involve re-establishing contact with some of the ‘base data’ sources. The following comments, however apply:

- Biomass totals for residential consumption are very uncertain.
- Coal and petroleum products, by sub-sector, while based on work from several authors, is difficult to establish as, sales are not always made directly to, or easily tracked to the consumer.
- Coal totals are also difficult to establish due to conflicts in official data, however current studies by the DME [Prevost 2002] are likely to reduce uncertainties.
- Liquid fuels totals are likely to be accurate, and are consistent with industry estimates.
- Electricity data is considered to be fairly accurate, as this is well tracked by ESKOM. However, use in residential and commercial sub sectors is based on estimates. Totals are consistent with ESKOM statistics.

[24] Due the distance from the mines, Western Cape coal costs are high.

Table 3, page 7, gives the first-pass provincial sector balance estimates for 2000. Complete Provincial balances for the years 1996-2000 can be found in Appendix B.

In order to obtain an indication of the potential for savings through improving energy efficiency, energy demand projections were made in the LEAP energy model using adjusted data. The process followed is described below.

Standard efficiency measures were chosen to be included in the model. Many of the measures chosen could be encouraged and implemented through policy, such as equipment or building standards. Many measures inspired by voluntary behaviour changes are difficult to quantify and put into effect and therefore these are not modelled in this exercise. A detailed description of the measures modelled is included in Appendix C and H. Table 4 summarises:

- The measures,
- Their potential for energy saving,
- The least cost timing for the option,
- And an estimate of the job creation potential for industrial electricity efficiency options implemented over a ten year period with:
  - a local content of 80%, and
  - a local content of 20%.

The measures selected were implemented to about 50% of their market potential in order to keep the target easily realisable.

The scenario chosen for this work is consistent with the ‘business as usual’ baseline scenario for South Africa modelled as part of the National Integrated Energy Plan (IEP).

The national IEP was produced by the Energy Research Institute with ESKOM (the national utility) and the National Department of Minerals and Energy (DME). It was sponsored by ESKOM and the DME. The work was developed using variants of two scenarios for the energy sector in South Africa. One based on the ‘business as usual’ practice which focused on current least cost practice, derived from an integrated resource approach (IRP), and another which was biased against coal. The business as usual scenario was called the ‘baseline simulated’ scenario and, much like current greenhouse gas mitigation studies, focused on each fuel (or resource) and sector individually. ‘Least cost futures’ were then reconciled into a single scenario.

The general assumptions and the assumptions that constituted the baseline simulated scenario are given below.

General Assumptions:

- Twenty year planning period (2001 to 2020).
- Process performance data and costs and commodity prices at 1 January 2001 values $1 = R8 (1 Jan 2001).
- Net discount Rate: 11%.
- Population Growth: 2000 = 44 Million, 2010 = 50 Million (1.3% p.a.).
- GDP Growth: 2.8% average annual growth over period.

- Gas generally available from SA, Namibia and Mozambique at $2.5 / GJ escalating at South African Producer Price Index.
- 20% coal price increase for Sasol from 2008.
- At least 15% Sasol coal/liquid process replaced by gas/liquid process by 2015.
- Coal supplied to industrial and other processes, except electricity generation, at R 6/GJ.

Modelling Assumptions:

General
- Business as usual - external costs excluded
- No regional co-operation
- Passive energy efficiency

Electricity
- Coal continues to dominate
- Mothballed coal fired power stations brought back into operation
- New coal fired stations without flue gas desulphurisation (FGD)
- Some combined cycle gas turbine
- New pumped storage and gas turbines for peaking power

Liquid Fuels
- Keep existing sulphur levels
- Mossgas ends 2008
- New refineries built to meet demand, if necessary

Natural Gas
- No increase in use except for electricity generation

Residential Sector
- Current trends continue

Commercial Sector
- No increase in energy efficiency

Transport
- No taxi recapitalisation

An important point about all of the assumptions, used to structure the computer program based models, is that they are realisable and represent an economically viable future scenario that can be achieved with relatively little policy intervention.

The results are illustrated in the figures 1 and 2. Using baselines developed in the Energy Outlook [Howells et al, 2002] and the modest efficiency improvements listed in Appendix C, estimates can be derived for future energy use and intensities. The savings in energy that can be achieved through implementing each measure are listed in Appendix H. The savings that can be achieved by implementing all measures on a sector by sector basis can be found in Section 4.2.

Table 4: Summary of easily implemented energy efficiency improvements

Measure	**Fuel affected**		**Fuel Saving potential**	**Fraction of total for that fuel (Industry)**	**When economic[25]?**	**Assumed payback period**	**Jobs-years over a ten year period: note this is *indicative only.* Assumptions are stated in Appendix: D, I/O model for industry electricity options.**	
							80% local	20% local
VSD	Electricity		30%	(<1%)	2000-2010	4 year	3700	-1500
Motors	Electricity		5%	1% (2%)	2006-2010	5 year	7600	-1300
Comp air	Electricity		20%		Immediately	1 year	7500 (100% local)	
Lighting	Electricity		35%	2% (1%)	2002-2006	3 year	3200	900
HVAC includes some VSDs	Electricity		25%	0.5% (0.1%)	2002-2010	3 year	270	60
Energy Star Equipment	Electricity		30%	0.1 (2%)	Immediately			
Commercial building design	Electricity[26]		40%	<1%(3%)[27]	Immediately[28]			
Thermal Fuel: Industry, Agriculture and commerce.	Solid	Bagasse	15%	8%	Immediately			
		Coal		7%	Immediately			
		Vegital waste		10%	Immediately			
		Wood		1%	Immediately			
	Liquid	HFO	13%	5%	Immediately			
		LPG		3%	Immediately			
		Kerosene		0.5%	Immediately			
	Gas		11%	3%	Immediately			
	Electricity		10%	1%	Immediately	6-9month	4400	3200
(Electricity to coal)			55% system efficiency		Immediately			
(Electricity to natural gas)			61% system efficiency		2006-2012			
(Electricity to LPG)					Not economic			
Household CFL use	Electricity		65%	1% (6%)	2002-2010			
Efficient stoves	Coal		30%	1% (8%)	Immediately			
	Wood			<1% (7%)	Immediately			
Electricity to LP gas	Electricity		50% system efficiency.		Immediately			
Solar hot water heater (residential)	Electricity		75%[29]	<1% (3%)	2002-2010[30]			
Geyser insulation	Electricity		5%	<1%(1%)	2002-2010[31]			
Add ceilings to RDP houses and insulation to existing houses.	Thermal fuels		15-40% (15%)[32]	<1% (1%)	Immediately[33]			

25 These results are very sensitive to initial assumptions. A range has therefore been suggested.

26 Affects other fuels, but the primary effect is for electricity.

27 Assuming moderate growth as in the IEP, by 2020, 42% of the commercial buildings will be built after 2002. It is assumed that half of these could be efficient due, and this value represents a moderate 2020 potential.

28 Authors estimate. This has not yet been modelled in the MARKAL IEP model.

29 Proponents claim 90% saving of electricity.

30 Authors estimate. This has not yet been modelled in the MARKAL IEP model.

31 Authors estimate. This has not yet been modelled in the MARKAL IEP model.

32 It was assumed that only 50% of households had significant winter heating requirements. A total penetration of 30% was assumed.

33 Authors estimate. This has not yet been modelled in the MARKAL IEP model.

Figure 1 shows that a moderate decrease in energy intensity (baseline energy/GDP) is possible for the economy as a whole and close to seven percent for industry compared to the baseline where no energy efficiency measures are implemented. This potential would increase were energy efficiency to be strongly supported by government through regulations or standards, fiscal policies, reporting and benchmarking initiatives, facilitating energy audits, information and awareness campaigns and research and development programmes.

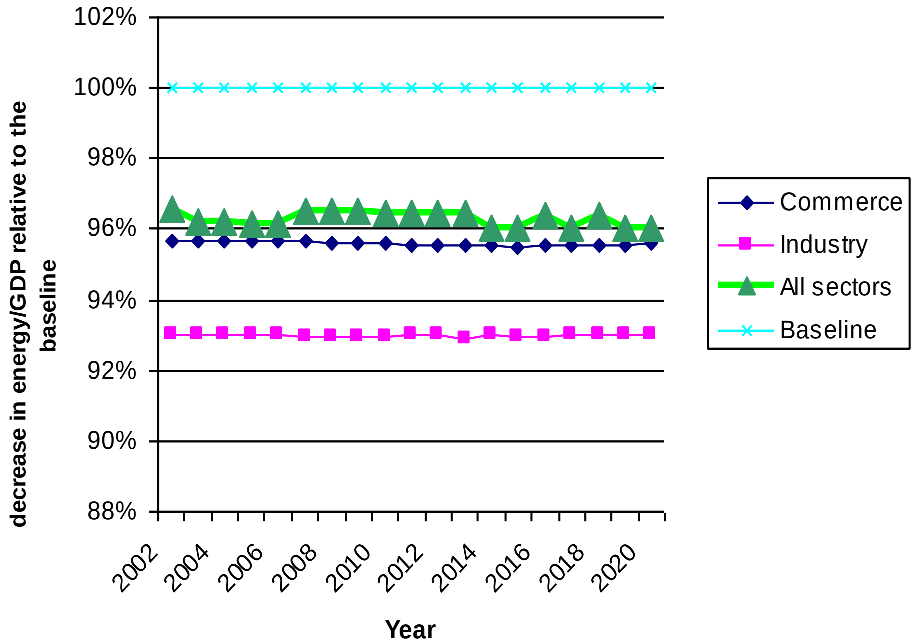


Figure 1: Energy intensity (energy/GDP index) relative to the baseline for the period

It is useful to show energy intensity a function of population in the residential sector.

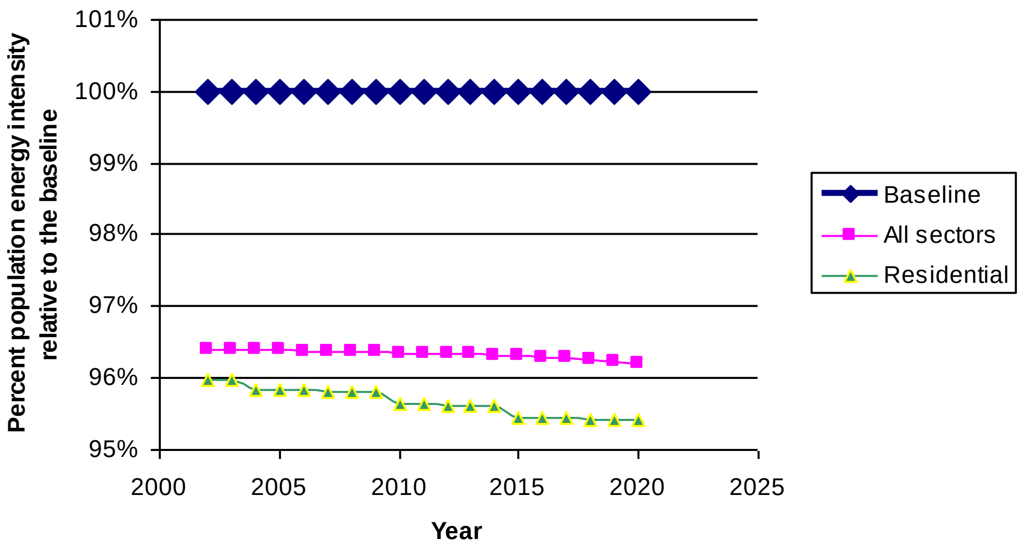


Figure 2: Energy intensity (energy/population index) relative to the baseline

Figure 2, above, shows that there is significant potential for decreasing energy demand in the residential sector relative to the baseline demand.

3.2 Discussion

The development of a database for energy efficiency has essentially begun through the initiation of the IEP modelling and other DME initiatives, such as the residential energy use database. Little information and effort would be required to maintain an energy efficiency equipment database that would feed into a targeted energy efficiency roll out plan.

3.2.1 Energy database

It is suggested that an energy information system should be constructed for the Department of Minerals and Energy. The following aspects should be considered (see Appendix G):

- A simplified data-capturing database, which can be maintained by the DME, with standardised key outputs.
- A simplified methodology to use the database outputs for Integrated Energy Planning models to run efficiency scenarios and simulate the effect of possible measures.
- Scanning and cataloguing of existing, and new studies with relevant data, this should be linked with initiative of the energy regulators, energy supply and use groups.
- Periodical data gathering and suggested
  - Standardised energy auditing reporting,
  - Standardised residential household data collection, and
  - Integration of existing ESKOM demand side management initiatives.

It was suggested by Cooper [Cooper 1998] that the energy efficiency database be hierarchical in order to correctly map the effects of individual interventions, and to target these appropriately.

Starting from the top, the following categories were suggested for the collection of energy data:

(i) Total national requirements
(ii) Sector
(iii) Sub-sector
(iv) Individual users
(v) Process – thermal, mechanical etc.
(vi) Equipment – physical characteristics

These are then further defined in terms of time of data collection and location. This is suggested, as the most appropriate method for collection, however, the following should be noted:

- The database could be designed so that regional data collected could be fed into the main database from regional offices.
- Data collection need not be as intensive as suggested by Cooper above. Comprehensive information of a previous category is not always needed to undertake a meaningful analysis of a subsequent category. For example, equipment standard measures can be approximated without data on an individual user basis.
- It would be useful to include electricity demand profiles for sub-sectors, as this will help evaluate other energy management techniques and measures on an economic basis.

This includes fuel switching, strategic energy demand growth and electricity load shifting. (This data can be obtained from the load research programme).

- Initial data for a national database has been collected during work undertaken for the DME's integrated energy planning process. This could be migrated into an easy to use and update interface.

3.2.2 Future work

This study has identified potential energy efficiency 'interventions' which will have a positive effect in terms of the key government objectives of:

- minimising the cost of the energy system ,
- decreasing environmental pollution, and therefore health impacts,
- improving job creation prospects,
- and decreasing water consumption.

Future work can now be focused on developing the key quantitative figures needed to develop a national energy efficiency strategy. For this the following steps are suggested:

- the development of a dynamic database for the DME's information,
- training of DME staff to maintain this database,
- evaluation of existing local data sets to migrate into the database,
- coordinate the data collection and reporting by bodies such as Statistics South Africa with regard to current energy auditing and other government surveys, annual reporting of companies, and the imports, exports and production of local equipment stock,
- the setting up of a steering committee to provide and review this data,
- based on the data collection, tools be developed to establish:
    - the cost saving of the measure to be implemented,
    - the environmental and health effects,
    - effects on job creation,
    - effects on the macro economy,
    - social indicators, such as access to clean energy.

4. BENCHMARKING

Benchmarking is the comparison of shared information. This information is then used to improve the performance of the sector or industry over time. With regard to energy use, benchmarking comparisons between the industrial, transport, agricultural, commercial and residential sectors of countries highlights the energy intensive sectors. Benchmarking between industries has been used very successfully to estimate efficiency and determine where a reduction in energy use can be achieved.

Benchmarking the energy intensity of economic sectors and sub-sectors within countries on an energy per unit output (specific energy), value added or population basis allows us to compare their performance and identify the most energy intensive sectors. In this way efforts to improve energy efficiency can be focussed on sectors in South Africa that have a high energy intensity relative to those of other countries. Benchmarking sub-sectors and industries can also be used to highlight the relationship between plant energy use and productivity. It allows companies to set practical goals for improving energy efficiency by tracking their energy use over time. Benchmarking is a low cost first measure of energy performance. It addresses the efficiency, operating cost, maintenance and competitiveness of one company against another.

It is important when benchmarking the use of energy in industries to benchmark against other industries with a similar input (raw material) and output (product). Where these are the same, manufacturing process and the type of fuel used should also be considered as these will also affect the final energy consumption. An example is the cement industry where it is not uncommon for energy consumption to double when a different process is used. For these reasons benchmarking comparisons can only be used for rough comparisons of energy efficiency between different international sectors.

In South Africa manufacturing processes have often been chosen in the past with little regard to energy end use. The choice of manufacturing process has been governed mainly by capital expenditure. Also, the low unit cost of energy has made it possible for several energy intensive industries to remain profitable in South Africa, and has attracted these industries into the economy.

In Figure 3 and Figure 4 below, South Africa's energy consumption per Gross Domestic Product (purchasing power parity), (GDP (ppp)), and energy consumption per person is compared to that of several other countries. South Africa's energy use per capita is low compared to that of other countries, but her energy intensity in terms of GDP is high compared to that of developed countries. This phenomena is due to the low income per capita, low energy intensity of the transport and residential sectors and the energy intensive nature of mining and minerals processing.

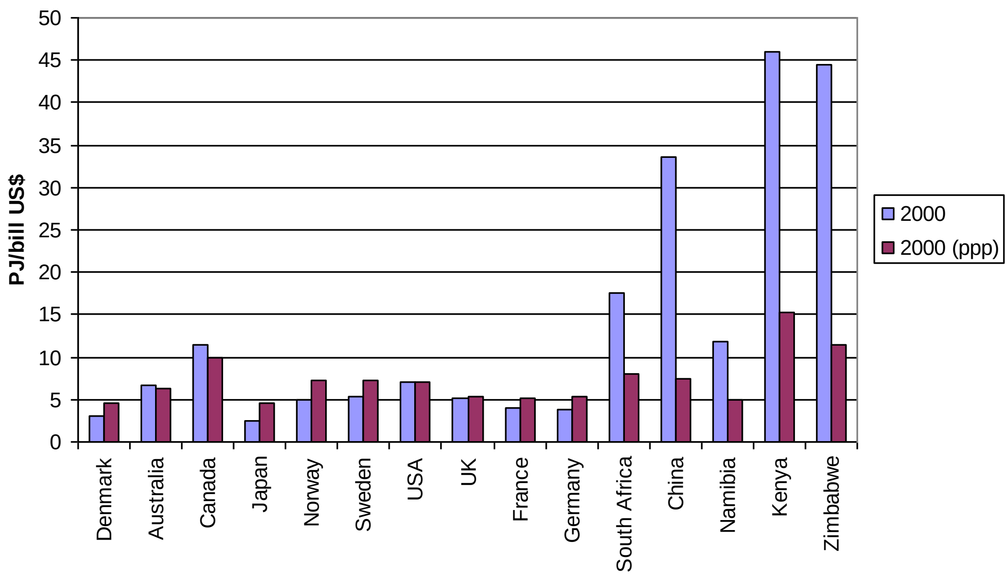


Figure 3: Energy consumption per GDP(ppp)1995$ and GDP 1995$ [IEA 2002]

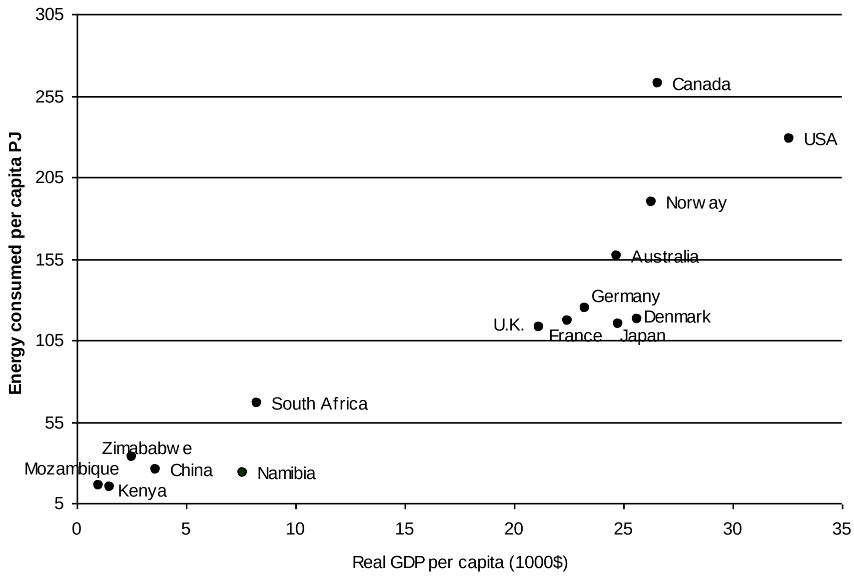


Figure 4: Final energy demand per capita (2000) [IEA 2002]

In Table 5 South Africa's energy consumption by sector, as a percentage of total end use energy, is compared with that of developed and developing countries. This gives an indication of the sectors with high energy demand but does not give any indication of the energy efficiency of these sectors. South Africa does not have accurate current data of the energy consumed by the machinery, wood and wood products and textile sector (these are included under other).

The countries used as benchmarks are chosen according to data availability and the size of the industry in that country. Where possible countries using similar processes and with similar products or output are used.

Table 5: Percentage of total energy use by sector in selected countries (2000)

	Industry	Transport	Agriculture	Residential	Commercial and Public	Other
Denmark	19.56	32.40	6.72	27.41	11.91	2.00
Australia	34.29	39.30	2.25	12.67	7.05	4.44
Canada	36.76	27.78	2.20	16.05	13.96	3.25
Japan	39.56	27.14	2.85	14.75	12.90	2.81
Norway	40.61	22.72	3.70	18.43	10.74	3.79
U.S.A.	23.98	40.71	0.95	17.68	12.92	3.75
U.K.	25.57	32.61	0.69	26.66	10.65	3.82
France	27.50	31.27	1.84	22.87	13.09	3.43
Germany	30.95	27.45	1.12	25.07	9.27	6.13
South Africa	42.75	19.56	3.35	9.55	2.61	22.19
Mozambique	23.41	4.33	0.07	71.60	0.39	0.20
Namibia	4.39	40.02	11.78	17.27	0.30	26.25
Kenya	9.42	12.34	6.47	70.21	0.76	0.79
Zimbabwe	14.41	9.12	10.04	61.34	3.55	1.55

[IEA 2002]

South African industry is still dominated by processes that require a high input of energy per value added of output, or higher energy requirement per contribution to GDP. The aluminium smelting industries have benefited from low energy costs and there has been little shift in manufacturing towards industries and processes that are less energy intensive e.g. light manufacturing and advanced technologies. If industry in South Africa was to shift from domination by heavy industry towards light manufacture there would be a shift in energy consumed per Rand of GDP.

Figure 5 below shows the final energy demand in final energy units for the sub-sectors of the industrial sector between the years 1996 and 2000. The largest consumers of energy in the industrial sub-sector are the Iron and Steel industry, the chemical industry, paper and pulp and mining.

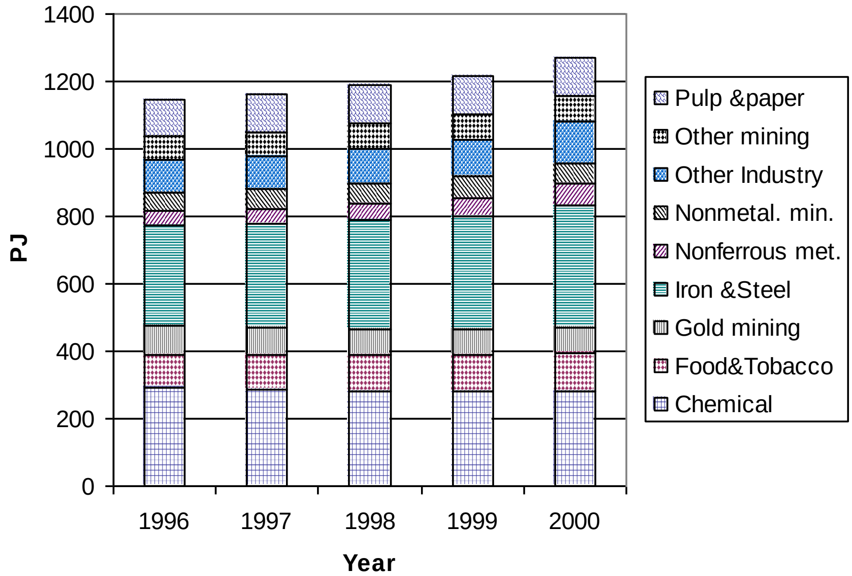


Figure 5: Baselines - final energy demand in final energy units industry

4.1 <u>Indices</u>

There are several indices commonly used to define the energy intensity of specific sectors and sub-sectors of the economy. These are generally energy per unit of value added, energy per employee and energy per unit of product output. Tables for Denmark, Norway, Japan, USA, UK and South Africa, covering energy use by industry persons employed, value added and gross output in monetary terms are given in Appendix E. Industrial sub-sectors have been further disaggregated where information is available. Information for several of these disaggregated sub-sectors of South African industry is not available, and requires further investigation.

Energy per value added and energy per value of gross output do not always give a good indication of the energy efficiency of a process. This is because the cost of a product is also affected by the cost of labour, materials, capital expenditure, maintenance etc. For these reasons, the trend of energy intensity in industry over time is often very different when considering either energy per value added or energy per physical product output. If an industry changes its product or the output of the industrial sector changes over time, the energy intensity could increase or decrease without any relation to a change in energy efficiency.

Energy consumed per unit of product output is also referred to as specific energy consumption or SEC. SEC provides a clear indication of the level of energy efficiency if the input (raw materials), output (product) and process are the same. Where product input and output differ, adjustments should be made to the SEC for comparative purposes. An example of process affecting energy intensity is found in the clay brick industry where bricks made using clamp kilns with coal as fuel have very different average energy intensity per ton of product output to those made in non clamp kilns.

The specific energy consumptions of products in the mining, paper and pulp, non – ferrous metals and chemical sectors are often compared in terms of GJ/ tonne of output. Textile energy intensity is given in GJ/m^2 or GJ/t, refineries in GJ/m^3, transport sector comparisons are made in a GJ/km, GJ/per person, GJ/passenger km and GJ/vehicle engine size. Commercial and public sector buildings are benchmarked by GJ/m^2, GJ/activity (e.g. education, hospital) and GJ/employee. Residential buildings are compared in GJ/household or GJ/population, when benchmarking buildings degree days should be taken into account. Degree days are a measure of the difference in average temperature over time relative to a fixed base temperature.

The following section covers the processes used in the iron and steel, pulp and paper, non-ferrous metals, non metallic minerals, chemical and textile sub-sectors. It gives a general overview of the sub-sector, a description of the manufacturing processes commonly used and provides comparisons of energy intensities in South Africa with that of other countries. It covers key areas for improving energy efficiency and gives an estimate of the overall potential for energy efficiency improvements in that sub sector where data is available. These are based on the assumptions covered in Section 3.1.

4.2 Sectoral energy intensity

The sectors discussed below in terms of energy intensity are the industrial, residential, commercial and transport sectors. The industrial sector includes mining and manufacturing and excludes oil refineries and power stations and other transformation sub-sectors. The industrial sector is the sector with the highest energy consumption in South Africa.

4.2.1 Industrial sector

For the purpose of benchmarking, the industrial sector is divided into sub-sectors. These sub-sectors are further divided into industries that have similar raw materials and products. The sub-sectors covered in this section are the iron and steel, pulp and paper, non-ferrous metals, non-metallic minerals, chemical, textile and food and beverage sub-sectors.

Shown below in Figure 6 is South Africa’s energy consumption by sub-sector for the industrial sector. The sub-sectors with the highest energy consumption in the industrial sector in South Africa are the Iron and Steel industry, chemicals and petrochemicals and mining industries. Manufacturing processes used in these industries in South Africa are described along with energy intensity comparisons and suggested potential energy savings.

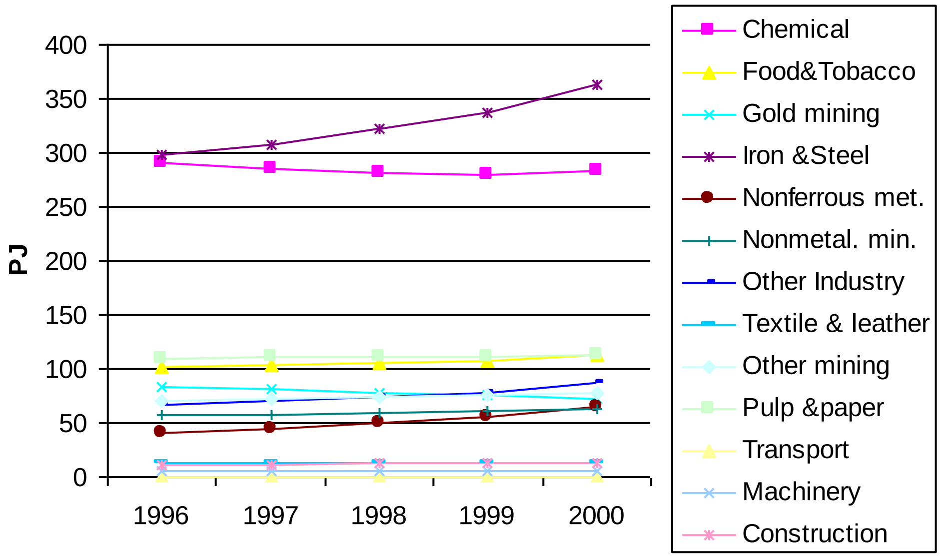
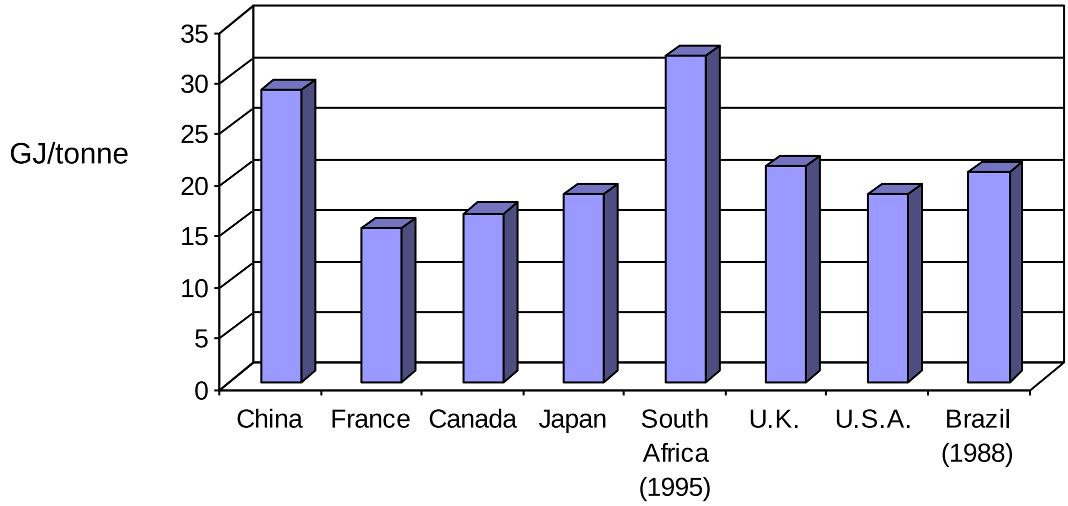


Figure 6: Energy consumption in sub-sectors of industry 1996-2000

4.2.1.1 Iron and steel

World production of raw steel in 2001 was 845 mmt, with the USA producing 90.1 mmt, Japan 102.9 mmt, China 148.9 mmt and South Africa 8.8 mmt. Iron and steel production is very energy intensive, and was 28% of South Africa's industrial energy consumption in 2000 providing 1.15% of her GDP.

The energy intensity in PJ/ tonne of production of raw steel is decreasing around the world. This is largely due to improved technologies. Energy intensity of China, France, Canada, Japan, South Africa, the United Kingdom, the United States and Brazil per tonne of crude steel is shown below in Figure 7.



[ODYSSEE, Granville 1993, Energetics 2000, CIEEDAC].

Figure 7: Energy intensities in the Iron and Steel industry 1998 (GJ/t)

Iron ore is reduced to iron by removing the oxygen. Coke absorbs the oxides from the iron ore, creating a liquid iron feedstock and carbon monoxide gas. Steel is then made from the iron by removing impurities and adding carbon and other elements. The reduction of iron ore to liquid iron or directly reduced iron has a high energy intensity. In the past, four processes were used to produce steel from iron ore; blast furnace and open hearth furnace, blast furnace and basic oxygen furnace (BOF), direct reduction furnace and electric arc furnace (EAF) and electric arc furnace using scrap metal as the raw material. Blast furnaces rely on coke to remove oxygen from the iron ore. There is a shortage of good quality coking coal in South Africa, as a result we have moved to the Midrex and Corex process. The combination of the Midrex and Corex processes has an energy intensity for liquid steel production of 16.2 GJ/ton of liquid steel [Granville, A, 1993].

Around the world steel production is dropping because steel is being replaced by plastics and other materials. South Africa also produces ferrochrome, ferrosilicon and ferromanganese. These are also energy intensive processes. Ferrochrome is used in stainless steel production, Ferrosilicon on ferromanganese are used in carbon steels. Coke energy use in steel making is likely to drop as the use of blast furnaces decreases. Electricity consumption will increase as electric arc furnace use increases. Bitumous coal use in the Corex and Midrex process will increase as production by these processes increases.

Finishing involves heating, rolling, and coating. The initial phase of finishing is hot rolling, it requires heat and mechanical force, this is followed by cold rolling and finally coating.

The high energy intensity in South Africa compared to other countries has several causes. The raw materials although plentiful are of poor quality. The iron ore has a high alkali content, there is a low portion of sinter and no pellets in blast furnaces and a large portion of steel is produced directly from reduced iron and not from scrap metal. EAF steel making is typically half as energy intensive as the blast furnace – BOF method. It would be natural to assume therefore that countries shown in table 6 to produce a high percentage of steel by the EAF process would have lower energy intensities, this is not always the case. The percentage of crude steel production by BOF and EAF process for selected countries is shown below in Table 6.

Table 6: Crude steel production by process (2001)

	BOF	**EAF**	**Mmt**
China	57.7	24.2	148.9
Japan	72.4	27.6	102.9
Canada	58.5	41.5	15.3
France	57.4	42.6	19.3
South Africa	55.6	44.4	8.8
U.K.	75.9	24.1	13.7
U.S.A	52.6	47.4	90.1

[Canadian steel producers association – www.canadiansteel.ca]

The USA has a relatively low energy intensity in its iron and steel industry. The energy intensities of production from iron ore and scrap in the USA are recorded below in Table 7 for benchmarking purposes. The theoretical lowest energy demand of steel production from scrap is given as 3.4 GJ/t and from iron ore as 6.6 GJ/t [Beer, 1998].

Table 7: Energy Intensity in the USA in Integrated and EAF-based Steelmaking

	Integrated Steelmaking	EAF-Based Steelmaking
	MJ/tonne	MJ/tonne
Sintering	316.5	N/A
Coke making	3534.25	N/A
Pulverized coal injection	10.55	N/A
Iron making	11320.15	N/A
BOF Steelmaking	928.4	N/A
EAF Steelmaking	N/A	5538.75
Vacuum Degassing and Ladle Metallurgy	654.1	1128.85
Continuous Casting	305.95	305.95
Ingot Casting	2932.9	N/A
Slab Mill	2869.6	N/A
Hot Rolling	2426.5	3724.15
Hot Dip Galvanneal	4483.75	3101.7
Tempering and Finishing	443.1	337.6
Cold Rolling (cleaning and annealing)	1688	1023.35
Tempering and Finishing (cold rolling)	1403.15	337.6

[Energetics, Incorporated, 2000]

Energy saving opportunities in the Iron and Steel Industry are:

- Heat recovery,
- Cogeneration,
- Improved compressor efficiency,
- Technology improvements, such as and switching to EAF,
- High efficiency motors and variable speed drives, and
- Lighting efficiency

The expected saving in energy efficiency in the Iron and Steel industry resulting from improving thermal efficiency, compressed air, lighting and motor efficiency and the use of variable speed drives is shown below in Table 8. The measures are implemented over five years beginning in the year 2002. Savings amount to 13% of the total energy used in iron and steel production.

Table 8: Potential energy savings in the Iron and Steel industry (PJ)

PJ	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lighting	0	0	0.2	0.3	0.4	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9
Motors	0	0	0.1	0.2	0.3	0.4	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7
VSD	0	0	0	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Compressed air	0	0	0.2	0.4	0.5	0.7	0.9	0.9	0.9	1	1	1	1.1	1.1	1.1
Thermal measures	0	0	5.4	11.1	16.9	22.9	29.1	29.9	30.7	31.7	32.6	33.5	34.3	35.2	36.7
Total	**0**	**0**	**5.9**	**12.1**	**18.2**	**24.8**	**31.6**	**32.4**	**33.3**	**34.4**	**35.3**	**36.3**	**37.3**	**38.2**	**39.7**

4.2.1.2 Pulp and paper

Pulp and paper is the 4th highest industrial consumer of energy in South Africa. When comparing energy intensity in the pulp and paper process it is important to consider the raw material input, the product output and manufacturing process. South Africa produces 316 000 tons of newsprint and 970 000 tons of printing and writing paper per year [Kenny, 2002]. Both hardwood (Eucalyptus) and soft wood (pine) are used as a raw material. The bark of soft wood is removed at the factory, and the recovered bark is used as fuel in boilers to produce steam. Debarking of hardwood is done in the plantation. Fuels used in the pulp and paper process are coal, electricity and biomass. Biomass includes bark and residue from the pulping process. Mills that make paper from pulp do not have access to this biomass and are thus more reliant on other fuels for steam generation. Electricity is needed for motors, process heat, direct heat, light and a few other minor uses.

The paper production line flows from debarking to pulping, bleaching, rolling and lastly drying. Debarking of soft wood on site is done mechanically. Pulping technology is now diverse due to technical improvements and the different qualities of pulp required. Pulp is extracted mechanically, thermally or chemically. South Africa produces 370 000 tons of mechanical wood pulp, and 150 000 tons of chemical wood pulp per year [L Heyl 1997]. Mechanical pulping relies on electricity either generated onsite or from the grid and is an energy intensive process. Bleaching uses oxygen or chlorine, but environmental concern and market demand for chlorine free products is forcing manufacturers to use alternatives to chlorine in the bleaching process. The most energy intensive sub-processes in the pulp and paper industry are fibreline, papermaking and the recovery plant. South Africa uses on average of 20-30% more energy per unit of product output than other countries. Recycling of paper reduces the final energy demand in proportion to the amount of recycled paper used.

A comparison of energy intensities in the pulp and paper industry by tonne of output is shown in Table 9.

Table 9: Energy intensity in the Pulp and Paper industry

	GJ/tonne	Pulp production Ktonne	Paper Production Ktonne
South Africa	34.13[a]	2138[f]	2226[f]
USA	26.36[b]		
UK	26[d]	743[g]	4824[g]
Brazil	20[c]		
Sweden	23.5[d]	10215[h]	8419[h]
Canada	29.21[e]	9756[e]	25971[e]

<u>Notes</u>:
([a]) (1995) Trikam 2002.
([b]) (1997) N. Martin 2000.
([c]) (1988) ETSU 1999 AEAT-4450.
([d]) (1998) AEA Technology 2000.
([e]) (1999) CIEEDAC.
([f]) (1999) www.Mbendi.com.
([g]) europa.eu.int.

Energy efficiency can be improved in the pulp and paper industry through:

- Reducing electric consumption with high efficiency motors, efficient lighting and by decreasing pumping losses and replacing pneumatic chip conveyers with belt conveyers,
- Use of recovery boilers,
- Waste heat recovery and turbine generators where there are steam pressure drops should be utilised,
- Increasing thermodynamic efficiency,
- Reducing losses along with waste recovery and re-use where possible, and
- Increasing personal awareness.

There is scope for alternative fuel use and demand side management options in the pulp and paper process.

The possibility for improving energy efficiency in the pulp and paper industry in the area of more efficient motors, lighting, compressed air, variable speed drives and thermal measures is shown in Table 10. These are scaled in over 5 years beginning in 2002, it indicates a potential energy saving of 8%. Best practice for Pulp and Paper industries in countries producing pulp and paper in ratio of 1:1 is given as being between 21 and 24 GJ/tonne. This indicates a potential for energy saving in the South African pulp and paper industry of up to 30%. Energy saving is likely to be less than this due to the age of machinery.

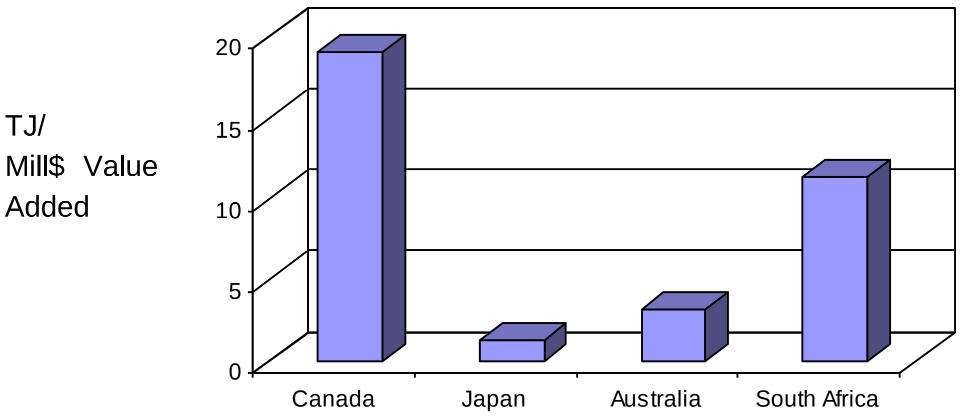
Table 10: Potential energy savings in the Pulp and Paper industry (PJ)

PJ	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lighting	0	0	0.1	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Motors	0	0	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
VSD	0	0	0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Compressed air	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Thermal measures	0	0	1.6	3.1	4.5	6	7.4	7.4	7.4	7.5	7.5	7.5	7.5	7.6	7.6
Total	**0**	**0**	**1.8**	**3.7**	**5.3**	**6.9**	**8.5**	**8.5**	**8.5**	**8.6**	**8.6**	**8.7**	**8.7**	**8.8**	**8.8**

4.2.1.3 Mining (metallic and non-metallic)

In 2000, the mining sector used 11.8% of the energy consumed by the industrial sector in South Africa. This was accompanied by a rise in the contribution of mining to GDP from 6.5% to 10% [Kenny, 2002]. Gold is the largest consumer of energy in this sub-sector and uses more energy than all other mining combined. The Gold mines are deep and cooling, lifting and transport consumes a lot of energy. Gold mining consumed 72.8 PJ of energy in 2000, all other mining combined including coal consumed 78.1 PJ. Electricity is the largest source of energy in mining.

Figure 8 below shows the energy intensity in the mining sector in Canada, Japan, Australia and South Africa in TJ/mill $ value added.



[Data extracted from Appendix E]

Figure 8: Energy intensity in the Mining sector TJ/mill $ value added

Opportunities for increasing energy efficiency in South Africa are centred in mining and other energy-intensive sub-sectors. The largest demand for electricity lies in electrical motor-driven equipment.

Opportunity exists to save energy by:

- Increasing motor efficiency,
- Increasing cooling and ventilation efficiency, and
- Replacing noisy and inefficient pneumatic drills with hydraulic drills or new technology electric drills.

Table 11 below shows the 5% anticipated decrease in final energy use to be gained by improving energy efficiency through the use of high efficiency motors, variable speed drives, efficient lighting, compressed air and thermal measures. These measures are implemented over a five year period, with 2002 being the base year.

Table 11: Potential energy savings in the Mining Sector (PJ)

PJ	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
lighting gold mining	0	0	0.1	0.3	0.4	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5
lighting other mining	0	0	0.1	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6
VSD gold	0	0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
VSD other	0	0	0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Compressed air gold	0	0	0.6	1.2	1.7	2.2	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5
Compressed air other	0	0	0.5	1	1.4	1.9	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.7
Thermal measures gold	0	0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Thermal measures other	0	0	0.3	0.6	1	1.3	1.7	1.7	1.8	1.8	1.9	1.9	2	2	2.1
motors gold mining	0	0	0.3	0.7	1	1.4	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6
motors other mining	0	0	0.3	0.6	0.9	1.2	1.5	1.5	1.5	1.6	1.6	1.6	1.7	1.7	1.7
Total	**0.0**	**0.0**	**2.4**	**4.9**	**7.2**	**9.5**	**11.5**	**11.5**	**11.7**	**11.8**	**11.9**	**11.9**	**12.2**	**12.2**	**12.4**

4.2.1.4 Chemicals

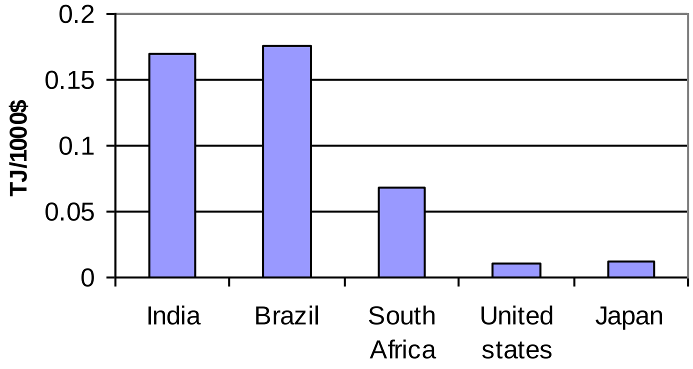
The chemical sector is a substantial consumer of energy and provider of GDP in South Africa. The major developments in the synfuel sector of the chemical industry occurred when two large oil-from-coal plants were commissioned in the 80's. These plants are a major source of chemical feedstock and other products. South Africa's energy intensity in the chemical and petrochemical industry was estimated to be 13.03 GJ/t in 1995 [Trikam 2002].

The chemical industry in South Africa covers a broad range of products. These can be divided into four major groups; firstly base chemicals such as ethylene, propylene, butadiene, benzene, toluene, xylenes and methanol also inorganic chemicals such as ammonia, caustic soda, chlorine, sulphur etc. Intermediate chemicals production includes ammonia, waxes, solvents, plastics, tars and other products. Chemical end products include plastics, paints, explosives and fertilizers, and lastly the speciality chemical products such as pharmaceuticals, agrochemicals, biochemicals, food and fuel and plastic additives. Recent developments in the chemical market in South Africa have led it away from synfuels production towards the higher value chemical products. In 1999 Sasol began expanding its Xenon and Cryptonite facilities and future capacity will be enough to supply up to half the demand for Xenon and Cryptonite gas in the world.

Syngas is produced from coal or methane. Currently coal is being used, but natural gas from Mozambique could be used in the future. Methane use is cheaper and cleaner and also more efficient. 33 percent of the coal is needed to supply steam to the process, the remainder is converted into syngas by combining coal with oxygen and steam. The process has a high energy intensity. The oxygen used in the process is separated from air using cryogenics the remaining nitrogen is used to make ammonia.

Syngas is used for a variety of chemicals. Products include diesel, petrol, waxes, ethylene, polyethylene, propane, butane and many others, these are made by joining the carbon atoms together into chains.

The energy intensity of the chemical industry in terms of GDP is shown in Figure 9. Table 12 gives the estimated final energy intensity by products in the USA chemical sector. This shows that energy intensity in value added terms varies greatly according to the complexity of products produced. In this Sub-sector it is more an indication of the technical expertise required to produce a product than the energy efficiency of the process. Therefore to compare the energy intensity of production, energy consumption data for the chemical sector in South Africa should be disaggregated further into groups of similar product output.



[Data extracted from Appendix E]

Figure 9: Energy intensity of petrochemical and chemicals 1999 TJ/1000$ value added

Table 12: Estimated final energy intensity (GJ/tonne) USA 1994

Product	**Estimated final energy intensity (GJ/tonne) USA 1994**
Ethylene	67.5
Methanol	38.4
Polyethylene	9.3
Polypropylene	10.5
Polyvinyl Chloride	11.6
Polystyrene	9.3
Nitrogen	1.8
Oxygen	1.8
Ammonia	39.8
Urea	2.8
Chlorine	19.2

[Worrell, E, 2000]

Opportunities for improving energy efficiency in the chemical industry lie in:

- Improved process-related technologies,
- Improved catalysts and product removal and syngas recovery,
- Fuel switching from coal to natural gas,
- Further process integration for extraction of other chemicals,
- Heat recovery for all processes,
- Compressed air system and steam system maintenance and efficiency,
- Motor efficiency, variable speed drives and soft starters, and
- Better control of refrigeration.

The opportunity for saving energy in the chemical industry through improving the efficiency of lighting, compressed air, air conditioning, motors and using variable speed drives is shown below in Table 13.

Table 13: Potential energy savings in the Chemical and Petrochemical Sector (PJ)

PJ	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lighting	0	0	0.1	0.2	0.3	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7
HVAC	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Motors	0	0	0.2	0.5	0.8	1.1	1.4	1.4	1.5	1.5	1.5	1.6	1.6	1.7	1.7
VSD	0	0	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4
Compressed air	0	0	0.5	0.9	1.3	1.7	2.2	2.2	2.3	2.4	2.4	2.5	2.6	2.6	2.7
Thermal measures	0	0	4.6	9.3	14.3	19.6	25.1	26.1	27.2	28.3	29.5	30.7	31.9	33.1	34.2
Total	**0**	**0**	**5.5**	**11**	**17**	**23.2**	**29.7**	**30.7**	**32**	**33.2**	**34.4**	**35.8**	**37.3**	**38.6**	**39.8**

4.2.1.5 Non – metallic minerals

Non metallic minerals include cement, lime, bricks and glass. The largest consumption of energy in this sub-sector is in the cement making industry. The average energy intensity of the non-metallic minerals sector in South Africa is 4.246 GJ/t [Trikam, 2002].

The potential for energy savings from improved lighting and motor efficiency, making use variable speed drives and thermal measures and improving compressed air efficiency is shown below in Table 14. The overall savings in this sub-sector that could be realised within 5 years were these measures to be implemented over 5 years after 2002 is 20%.

Table 14: Potential energy savings in the non-metallic minerals Sector (PJ)

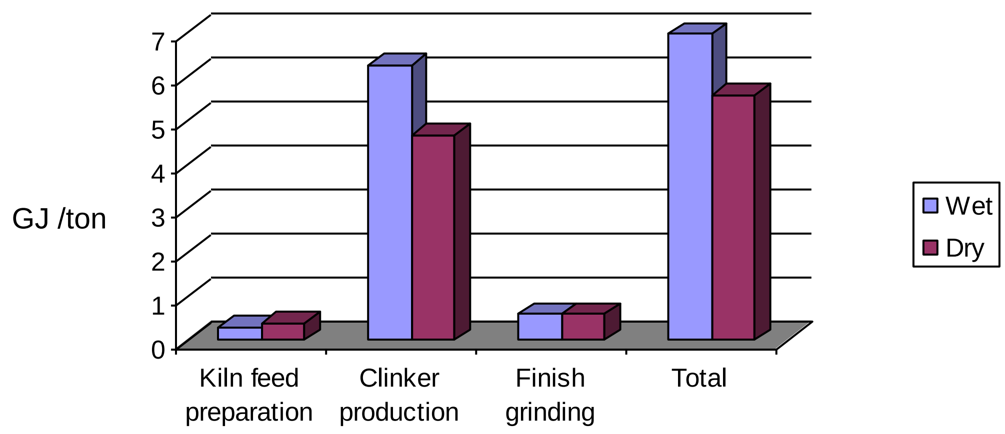
PJ	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lighting	0	0	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5
Motots	0	0	0.1	0.1	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5
VSD	0	0	0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
Compressed air	0	0	0.2	0.4	0.6	0.8	0.9	1	1	1	1.1	1.1	1.1	1.1	1.2
Thermal measures	0	0	0.8	1.7	2.5	3.4	4.4	4.5	4.6	4.8	4.9	5.1	5.2	5.3	5.6
Total	**0**	**0**	**1.2**	**2.5**	**3.6**	**5**	**6.3**	**6.5**	**6.6**	**6.8**	**7.1**	**7.4**	**7.5**	**7.7**	**8.1**

4.2.1.6 Cement

There is little or no import or export of cement in South Africa and growth in this sub-sector is linked to GDP. Cement manufacture occurs in 3 stages. The first stage involves the preparation of raw materials (prior to kiln), then clinker production, the final stage is finishing (after kilns). During the preparation of raw materials, mined raw materials are ground to a fine powder. Grinding is completed either dry or with water. South African kilns tend to use the modern dry method for manufacture which is a more energy efficient process. Adding water during grinding affects the energy intensity of the process and benchmarking of energy intensity is thus divided into the dry and wet process. Figure 10 shows the difference in the average energy intensity of cement production using either the wet or dry process recorded in the USA in 1994.

During clinker production the mixture is passed through the kiln and exposed to heat (up to 1400°C). This evaporates the water and disassociates CO_2 from Calcium carbonate. The output must be cooled rapidly to prevent further chemical changes. The energy required for evaporation is 2.09 GJ/ tonne [IEA, 1991]. Clinker production is extremely energy intensive.

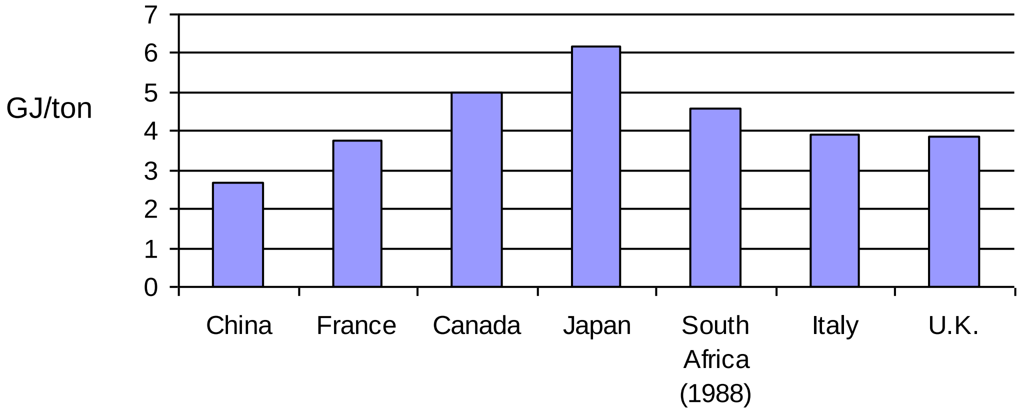
Cement is produced by grinding clinker with additives such as calcium sulphate, ash fly and other components. The grinding of raw materials and cement is electrically intensive. It is expected that future energy intensity of cement making will be 2.93-3.35 GJ/tonne.



[Worrell, E., 1999]

Figure 10: Intensity of the wet and dry process in cement production in the USA (1994)

Figure 11 below shows the energy intensity of cement production in GJ/ton for China, France, Canada, Japan, Italy and the U.K.



[AEA Technology, 2000, ODYSSEE, ETSU 1999]

Figure 11: Energy intensity of cement production

The theoretical potential energy intensity of cement production by the dry process is 2.1 GJ/t and the wet process is 3.34 GJ/t [IEA 1991]. Another theoretical minimum of 1.86 MJ/ton of clinker is suggested by de Villiers [de Villiers, M.G., 1994].

Measures in the cement industry to reduce fuel consumption per unit of output;

- Make use of high efficiency fans, variable speed drives and motors,
- Reduce kiln dust wasting,
- Insulation,
- Reduce compressed air losses,
- Maintenance,
- Technical process improvements,
- Heat recovery from cogeneration especially during clinker cooling,
- Use classifiers to separate finely and coarsely ground particles,
- Fluidised bed kilns (these have a lower temperature and NOx output, they are also smaller and have a lower capital cost and can operate on a wider variety of fuels,
- Roller presses for grinding and packing,
- Improved control of the semi wet and dry kilns, and
- Change from wet to dry process.

4.2.1.6.1 Clay brick

The clay brick industry in South Africa has a high energy intensity in terms of rands per value added. Energy is used in the production phase to dry and fire the bricks. The energy used for drying and firing in South Africa consumes up to 90 percent of the energy used during production. Clay is mixed with water to facilitate extrusion. Most factories extrude and wire cut the bricks, but in some factories the bricks are dry pressed. Formed bricks are then dried and baked in kilns. Drying is done naturally or with hot circulated air. Clay bricks are fired in clamp and non-clamp kilns between 900 and 1200°C. Clamp kiln firing is an intermittent process, whereas non-clamps use a continuous process. Energy use per kg of product output differs between clamp and non-clamp kilns. Clamp kilns typically consume 5.83 MJ/kg and non clamp kilns 3.19 MJ/ kg bricks [Dutkiewicz, 1994]. Non-clamp kilns have a greater electricity consumption due to greater automation.

In clamp kilns or batch kilns, bricks are stacked around coal and the stack is set alight. It is an open uncontrolled process affected by the weather. It produces bricks of varying quality and has a high scrap rate. Non-clamp kilns are enclosed kilns. They fire continuously with either the bricks or the kiln moving. Temperature is more evenly controlled resulting in higher quality bricks. Clamp kilns are typically transverse arch, Hoffman or tunnel kilns. Seventy percent of bricks produced in South Africa are produced in clamp kilns or batch kilns [Dutkiewicz, 1994]. These kilns are labour intensive, energy intensive and highly polluting.

Below, Table 15, gives a comparison of specific energy consumption for South Africa, India, Germany and Ireland. There is significant scope for improvement of the energy intensity in this industry in South Africa. Direct specific energy comparisons betweens countries are difficult because energy consumption is affected by clay quality, climatic conditions and the standards and strength of bricks. Mechanised kilns require more electricity and different continuous kiln designs fire at different temperatures. South Africa also uses clamp kilns that are prevented by legislation in several countries due to pollution.

Table 15: Energy intensity in the clay brick industry

	SEC (MJ/kg)
India	2.8
South Africa	3.42
Germany	1.94
Ireland	1.97

[Dutkiewicz et al, 1994]

The target energy consumption for clamp and non-clamp kilns is 2.4 MJ/kg and 1.8 MJ/kg respectively. The potential for energy savings in clamp kiln production is 40 percent and 38 percent for non-clamp kilns [Dutkiewicz, 1994].

Energy saving opportunities:

- Electricity: power factor corrections,
- Coal: automatic kiln stokers will ensure optimum feed rate, unburned coal and excess ash left in the kiln after firing it can cover the bricks forming and insulating layer around them, this causes under firing,
- Compressed air: ensure that inlet air to compressor is dust free, and as cool as possible, inspect filters regularly,
- Install and maintain water traps,
- Leaks in a compressed air system are costly,
- Insulation: insulate ducts and fans,
- Shape of brick affects energy efficiency. Perforations in bricks reduce the volume and mass and increase the surface area. This speeds up the drying process,
- Additives can be included in bricks to reduce water content and firing temperature and extrudability. Increasing extrudability allows the water content to be reduced. Reducing the water content lowers the energy needed for firing,
- Reduce scrap,
- The industry is fragmented and research and support could be provided through the Clay Brick Association, and
- Improved process control in tunnel kilns.

4.2.1.6.2 Glass

To produce glass, the raw materials, sand and recycled glass are melted in a furnace. Melted glass flows from the furnace through forehearths into forming machines before it is cooled. Forming causes temperature gradients in the glass, which results in stresses that crack the glass if it is allowed to cool naturally. Cooling and forming are often done with compressed air and this forms a large part of the energy demand of the process. The techniques used to form the glass are product dependent. Glass has a high energy intensity on average, however it differs considerably depending on the product produced and the amount of recycled glass available. The Specific energy intensities measured in glass manufacture in the European Union is given below in Table 16.

Table 16: Specific energy intensity of glass production

	GJ/t
Germany	3.02
Austria	3.37
France	12.2
UK	7.11

[AEA Technology 2000]

Energy efficient technologies:

- Forced cooling in Lehrs,
- Replacement of compressors by servos,
- Waste heat recovery on glass tanks, and
- Other energy efficiency improvements include; insulation, lighting, kiln efficiency, waste recovery and alternative fuel use.

4.2.1.7 Non ferrous metals

The non-ferrous metal industry consumed 63.9 PJ of energy in 2000. Non –ferrous metals include aluminium, platinum, titanium, zink, nickel and copper. Of these the production of aluminium is the most energy intensive and accounts for about half of the energy used in this sector in South Africa. The energy intensity in the non-ferrous metal sector of South Africa in 2000 was 24.3 GJ/ [Trikam 2002]t.

Table 17 below shows the estimated potential savings in the non – ferrous metals sector that can be achieved through thermal measure, installing variable speed drives, efficient motors, lighting and improving compressed air efficiency. The savings implemented over 5 years amount to 13% of the total energy used in this sub sector.

Table 17: Potential energy savings in the non- ferrous metals Sector (PJ)

PJ	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lighting	0	0	0.1	0.2	0.4	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Motors	0	0	0.1	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
VSD	0	0	0	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Compressed air	0	0	0.1	0.3	0.4	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8
Thermal measures	0	0	0.5	1.1	1.7	2.2	2.8	2.9	2.9	3	3	3.1	3.1	3.1	3.2
Total	**0**	**0**	**0.8**	**1.9**	**2.9**	**3.9**	**4.8**	**5**	**5**	**5.1**	**5.1**	**5.3**	**5.3**	**5.3**	**5.4**

4.2.1.7.1 Aluminium

Aluminium smelting is very energy intensive. In 1998 the energy intensity of the Billton Hillside smelter in Richards Bay was 48.2 GJ/ton which is among the best in the world [Kenny, 2002]. The industry average in 1991 was 67 GJ/ton, the USA consumed 50.4 GJ/ton in 1999. A theoretical future minimum of 22.89 GJ/ton is suggested for Aluminium smelting [International

Aluminium Institute]. Ninety percent of the energy used to smelt aluminium is electricity and the industry relies on the low cost of electricity to survive. South Africa's aluminium plants are world leaders in a growing market.

South Africa imports aluminium ore (bauxite) in the form of alumina. Alumina is converted to aluminium using the Hall–Heroult process. The Hall-Heroult process uses electrolysis to isolate the aluminium after it has been dissolved in molten sodium fluoride. About 14 kWh is required to produce 1kg of aluminium. The total production capacity in South Africa currently is 670 kt/year. When aluminium is recycled, 90 percent of the energy required to make metal from bauxite is saved.

South Africa has extensive reserves of low grade bauxite but due to the large availability of bauxite in the world, it is not commercially attractive to use this.

4.2.1.7.2 Titanium

This is the second largest consumer of electricity in the non-ferrous minerals sector. South Africa has the largest reserves of titanium. South Africa produces titanium dioxide slag, and is the second largest producer after Australia. The production of titanium slag is energy intensive requiring about 20 GJ/tonne, with 55% of the process energy being electricity, and the rest anthracite [Kenny, A.R. 2002].

4.2.1.8 Textiles and textile products

The textile industry includes wool, cotton, man-made fibres and a variety of different fabrics and finished products. The process involves fibre production, non-wovens, yarn processing (spinning, weaving, tufting, knitting), dying and finishing. Estimated energy consumption in the textile sector in 2000 was 13.9 PJ, the main source of energy is electricity. Energy consumption by sector activity per month in South Africa is given below in Table 18. The market survey of the textile industry lists energy consumption in Zambia as being 14.5 GJ/tonne and in South Africa 16.2 GJ/tonne [De Voest, 1997]. The potential for energy savings in the textile industry identified by ETSU in 1999 was 35% [ETSU 1999].

Table 18: Energy consumption by process in the textile industry in South Africa

Process		PJ/month	Major energy carrier		Yardsticks for industrial production GJ/ton
Fibre production		259.73	Electricity	51.8%	12.04
Fibre processing	- non wovens	49.95	Electricity	43.1%	10.44
	- spinning	206.93	Electricity	71.4%	16.64
Yarn conversion	- weaving, knitting, tufting	138.43	Electricity	84.2%	6.86
Dying and finishing		722.07	Coal	65.9%	59.19
Total		1427.11	Coal	48.1%	56.19

[de Voest, 1997]

Below in Figure 12 the specific energy consumption of countries (calculated from Appendix E) is shown. The values given for South Africa are an estimate.

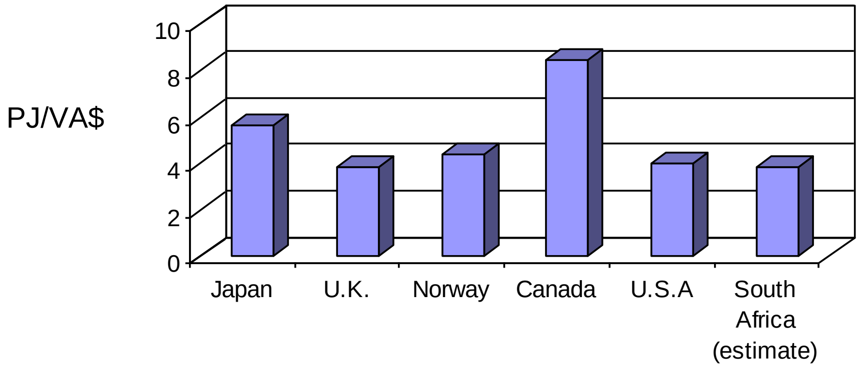


Figure 12: Energy intensity in the textile industry (PJ/$VA)

The potential for energy savings in the textile industry are system efficiency improvements 10%, heat recovery and insulation 5%, energy carrier efficiencies 5%. [J.A. de Voest, 1997]

Opportunities for improving energy efficiency in the textile industry lie in:

- Improving the manufacturing process, modernisation and more efficient technologies for stenters, dryers and looms, change dying from cold water process to “cold pad batch dyeing”,
- Improving the efficiency in the utility plant, boiler steam and compressors,
- Heat recovery systems, dual fuel systems,
- Space heating and ventilation systems,
- Reducing scrap rates,
- Efficient lighting,
- Insulation of dying vessels, building insulation,
- Economisers for boiler feedwater,
- Improve condensate return,
- Inverter drives on machines, large machines stopped when not needed,
- Power factor correction, and
- Good housekeeping.

Table 19 below shows the energy that could be saved through implementing measures to improve thermal efficiency, improving the efficiency of compressed air, motors and lighting. The measures are implemented over a 5 year period with 2002 being the base year.

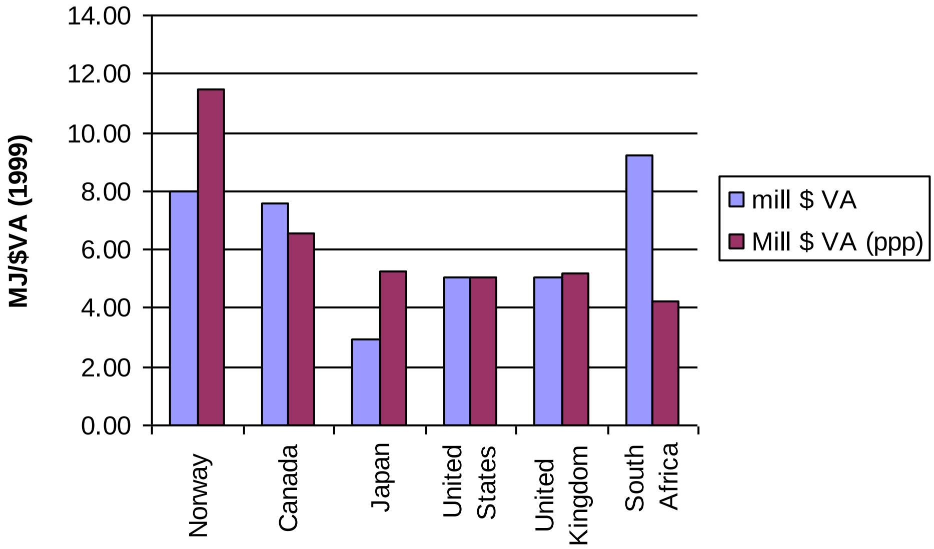
Table 19: Potential energy savings in the Textile and Textile products sector (PJ)

PJ	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Thermal	0	0	0	0	0.2	0.5	0.8	1.1	1.3	1.4	1.4	1.5	1.5	1.5	1.6	1.6
Comp air	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Motors	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Lighting	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	**0**	**0**	**0**	**0**	**0.2**	**0.5**	**0.9**	**1.3**	**1.6**	**1.7**	**1.7**	**1.8**	**1.8**	**1.8**	**1.9**	**1.9**

4.2.1.9 Food, beverages and tobacco

The food and tobacco industry consumed 113.2 PJ of energy in South Africa during 2000, 9% of the energy consumed by the industrial sector. Of this only 11% was in the form of electricity, the rest is made up of coal, biomass and a small portion of other fuels.

The food and beverage sector is diverse in terms of products and manufacturing processes. The energy intensity of the food and beverage sector of selected countries is shown below in Figure 13. It is often useful in this sector to benchmark in terms of steam usage.



[Data extracted from Appendix E]

Figure 13: Energy intensity of the food and beverage sector

The food and beverage industry is not often targeted when energy efficiency improvements are considered because of the low energy intensity of production, energy costs typically form less than 10% of production costs. It is still possible, however, to realise improvements in energy use. Potential savings that could be achieved through improved lighting, motor and compressed air efficiency, the use of variable speed drives and introduction of thermal measures are listed below in Table 20. Energy audits conducted in this sector in South Africa recognised the potential for savings of between 8 and 32 % [M.G. de Villiers 1994].

Table 20: Potential energy savings in the Food and Tobacco Sector (PJ)

PJ	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lighting	0	0	0.1	0.1	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5
Motors	0	0	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
VSD	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1
Compressed air	0	0	0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Thermal measures	0	0	2	4.1	6.3	8.5	10.8	11.1	11.4	11.8	12.1	12.5	12.8	13.1	13.7
Total	**0**	**0**	**2.2**	**4.4**	**6.8**	**9.2**	**11.7**	**12**	**12.3**	**12.8**	**13.1**	**13.5**	**13.8**	**14.1**	**15**

4.2.2 Commercial sector

Energy audits in the commercial sector in South Africa have identified considerable opportunity for energy savings. Recent audits on the Old Mutual building in Cape Town and Megawatt Park in Gauteng, have resulted in savings of millions of rands with Megawatt Park using 40 percent less electricity in 1999 than it used in 1991 [Grobler, 2001]. This sector uses mainly electricity, and consumes 2.5% of the energy consumed in South Africa providing 43% of the GDP.

Energy use in commercial buildings in the U.S.A., UK and South Africa are listed below in Table 21 and Table 22. Energy intensity is measured on a per person and per square meter basis and differs depending on geographical region (which affects space heating and cooling) and the size of the building.

Table 21: Energy consumption MJ/m^2 floor area in commercial buildings in the U.S.A. and South Africa

	MJ/m^2
U.S.A.	
Northeast	989.1335
Midwest	1186.733
South	917.5888
West	1069.763
South Africa	1082

[www.eia.doe.gov]

Table 22: Energy consumption MJ/m^2 floor area in commercial buildings in the U.K.

Naturally ventilated cellular		**Naturally ventilated open plan**		**A/C Standard**		**A/C Prestige**	
Typical	Good practice	Typical	Good practice	Typical	Good practice	Typical	Good practice
738	403	849	478	1454	810	2045	1253

[Association for the conservation of energy, www.ukace.org]

Table 23 below shows the potential for energy savings in the commercial sector that can be achieved through introducing thermal measures, efficient lighting, air conditioning and improving commercial building design. The total savings amount to 24% of energy use.

Table 23: Potential energy savings in the Commercial Sector (PJ)

PJ	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Commercial building design	0	0	0.2	0.3	0.5	0.7	0.9	1.1	1.3	1.6	1.8	2.1	2.3	2.6	2.9
Lighting	0	0	0.6	1.2	1.8	2.3	2.9	2.9	3	3.1	3.2	3.2	3.3	3.4	3.5
HVAC	0	0	0.7	1.3	2	2.6	3.3	3.4	3.4	3.5	3.6	3.7	3.8	3.9	4
Thermal measures	0	0	0.6	1.1	1.7	2.3	2.9	3	3.1	3.1	3.2	3.3	3.4	3.4	3.6
Total	**0**	**0**	**2.1**	**3.9**	**6**	**7.9**	**10**	**10.4**	**10.8**	**11.3**	**11.8**	**12.3**	**12.8**	**13.3**	**14**

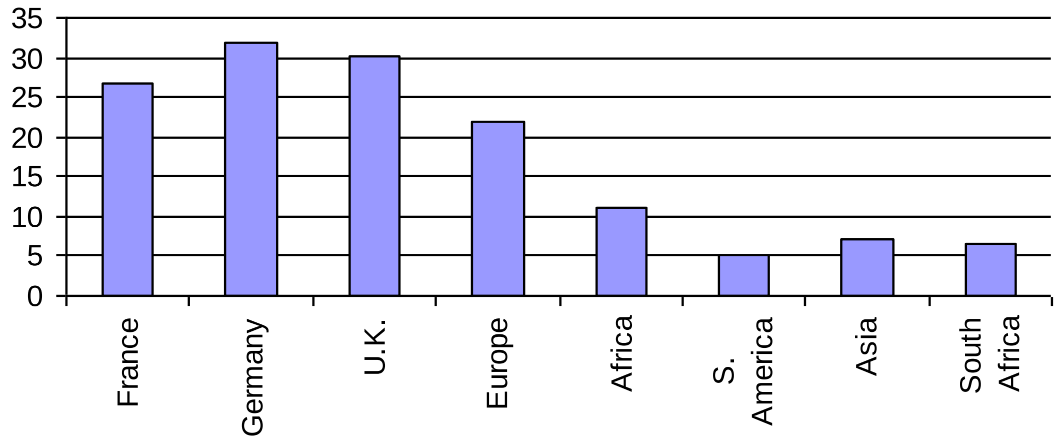
Energy saving potential in the commercial sector exists in the following areas:

- reduction of light levels to match the task, replace existing lights with magnetic ballasts with fluorescent T8's with electronic ballasts,
- switch off lights when they are not needed, this can be automated, sectioning of lighting and dampers,
- power factor correction,
- adjust air conditioning to level that is required, automate time of use, variable air speed, insulation, remove central air conditioning where single load is needed, type of coolant affects energy requirement and filter, install variable speed drives on fans ,
- shield windows with blinds, curtains, overhangs or tinted windows and angled shutters,
- install pre heat solar hot water systems,
- reheat hot water using waste flues, and
- Building design.

4.2.3 Residential sector

Residential energy efficiency and fuel use differs widely between affluent and poor households in South Africa. Affluent households use electricity as a primary fuel, townships and RDP houses use kerosene and coal as primary fuel and rural households use wood as primary fuel.

South Africa has a low energy intensity per household, of the energy that is used a large proportion is renewable. Figure 14 below shows South Africa's energy intensity against that of Africa, South America, Asia and Europe. A key determinant of household energy demand in the residential sector is disposable income.



[Chipman et al, 1999, IEA statistics 2002]

Figure 14: Residential energy intensity (GJ/person)

Opportunities for increasing energy efficiency in residential energy use in South Africa lie in increasing the energy efficiency of appliances that are found in the home and those that are outside the house itself. These are discussed by appliance below. There is also opportunity for energy savings in housing design and materials.

Hot water cylinders consume up to 40 percent of urban household energy, these can be better insulted, controllers can be added to switch them on and off as needed, restrictors can be added to limit the volume of hot water used. Water can be preheated with solar energy prior to entering the cylinder.

Technology improvements in refrigeration have reduced running costs considerably. Savings in energy in refrigeration have been achieved by increasing insulation and the thermal capacity of the evaporator and condenser. Cleaning of heat exchangers improves efficiency and refrigerators that are designed to keep the surfaces of the exchangers clean have a higher long term efficiency. Regular defrosting of a freezer unit, closing the doors, maintaining seals, not placing the fridge near the stove or washing machines or other hot appliances and not placing hot food in the fridge will increase energy efficiency. Refrigerator freezer combinations that are above each other consume less electricity than those that are side by side. Chest freezers are more efficient than upright freezers.

Dishwashers, tumble dryers and washing machines. It is best to use units that allow temperature to be adjusted to what is required. These appliances should be cleaned regularly and used at capacity.

Lighting, compact fluorescents can significantly reduce the energy required to light a building, they are costly but this is balanced by a longer life expectancy. Lighting levels should match the need. Electrification of lower income households is increasing electric lighting demand. Lights must be switched off when not needed.

Space heating and air conditioning. Improved heat pump technology could improve energy efficiency in this field considerably. The need for space heating is affected by climate, the thermal efficiency of the building, the design of the building (a lower square meter area of outside walls to inside floor area, maximise the amount of passive solar heating, shade windows during summer, face the house in the correct direction). Heating and air conditioning can be made more energy efficient by using heat pumps, ceiling insulation (this can prevent as much as 84% of heat from escaping in winter, and entering in summer), prevention of draughts, only heating the space in use, using radiant not convective heat as this is more efficient, installing curtains over windows (glass is poor insulator) and only heating or cooling locally.

Thermal efficiency of the home. South African homes are not built to be thermally efficient, and there are no regulations to encourage thermal efficiency when building.

Cooking efficiency is improved by using microwave ovens, gas cookers, solar cookers and efficient wood stoves.

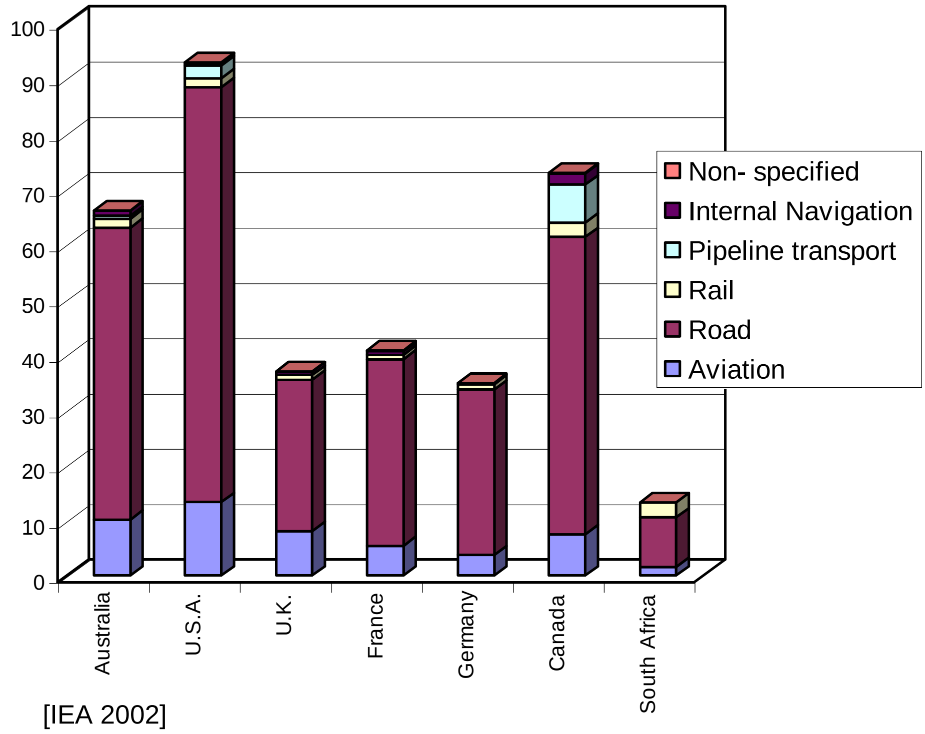
Table 24 below shows the potential for energy savings in the residential sector that can be achieved through including ceilings in buildings, using solar hot water heaters, insulating geysers and making use of efficient lighting and stoves.

Table 24: Potential energy savings in the Residential Sector (PJ)

PJ	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lighting	0	0	1.1	2.3	3.5	4.8	6.1	6.2	6.3	6.4	6.5	6.6	6.6	6.7	6.8
Insulated geysers	0	0	0.7	1.4	2.1	2.9	3.6	3.7	3.8	3.8	3.9	3.9	4	4	4.1
Solar hot water heaters	0	0	0.7	1.4	2.1	2.9	3.6	3.7	3.8	3.8	3.9	3.9	4	4	4.1
Efficient stoves	0	0	0.7	1.5	2.2	3	3.8	3.9	3.9	4	4.1	4.1	4.2	4.2	4.3
Ceiling options	0	0	0.7	1.5	2.2	3	3.8	4.6	5.4	6.2	7.1	7.9	8	8.1	8.1
Total	**0**	**0**	**3.9**	**8.1**	**12.1**	**16.6**	**20.9**	**22.1**	**23.2**	**24.2**	**25.5**	**26.4**	**26.8**	**27**	**27.4**

4.2.4 Transport sector

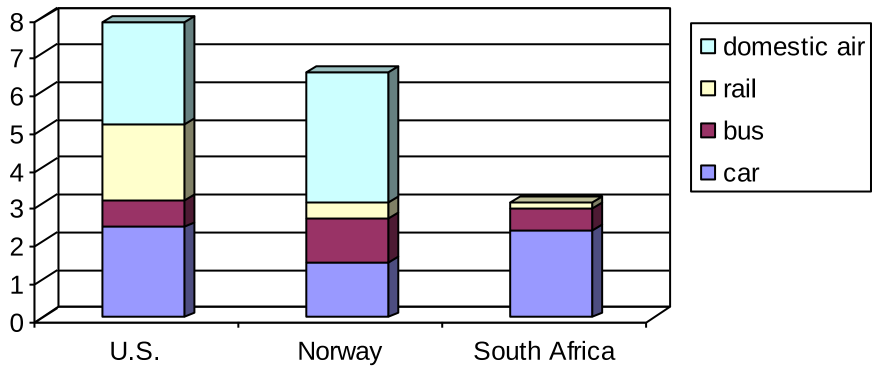
South Africa is experiencing increasing road congestion and pollution. Public transport by trains and buses is limited and hindered by urban sprawl (low density outlying urban areas) thus the majority of commuters are reliant on private vehicles and the minibus Taxi industry that has developed. The number of private vehicles is growing (proportionally with population growth and faster than the GDP) [Howells et al, 2002]. The need in business to move smaller quantities of goods quickly and conveniently has made freight transport by road increasingly popular. Transport sector energy intensities are shown below in Figure 15 in PJ/person and in Figure 16 MJ/passenger kilometer.



[IEA 2002]

Figure 15: Transport sector energy intensity 2000 MJ/person

Transport related pollution in South Africa is higher than that of developed countries, with emissions from the transport sector currently accounting for about 23% of TFC CO_2 emissions [Howells et al, 2002]. Second hand vehicles are relatively inexpensive and the lack of any enforcement of emissions control means that inefficient and badly tuned vehicles are not kept off the road. There is a strong link between vehicle population, energy demand and pollution. The energy drivers in the transport sector are the number of vehicles, the average trip lengths and efficiency.



[Western Cape Metropolitan Council (2002)]
[Norway odyssee database (1999)]
[USA www.publicpurpose.com, transport factbook (1999)]

Notes:
Values for South Africa are for the Western Cape, no values were available for domestic air.

Figure 16: Energy intensity in the transport sector MJ/passenger kilometer

There are many areas in which transport, public, private and freight, can be made more efficient. Examples are encouraging car pooling, using alternative fuels in cars and taxis, smaller vehicles, emissions testing, a more reliable and safe public transport system.

4.3 Future energy efficiency

Lack of knowledge is a key focus area that must be addressed if energy efficiency is to improve in South Africa.

To implement an energy efficiency programme, the potential for energy efficiency improvements must be identified. Efficiency improvements must be monitored on an ongoing basis. This is a continuous process that needs to be repeated regularly.

Energy efficiency programmes must create an awareness of the benefits of energy efficiency and highlight simple cost effective methods of achieving energy savings as well as savings through improved technology and research.

Education and training in the area of energy efficiency is essential. Training programmes should be accessible and understandable to all. Sectors and industry have different potential for energy savings and levels of management in industry and commercial sectors are likely to be driven to achieve energy efficiency by different concerns. Management must be made aware of the economic benefits of energy efficiency as well as CDM and DSM opportunities.

4.3.1 Residential sector

Energy efficiency amongst affluent households will increase with good housekeeping practices. Currently with the low cost of electricity in the affluent areas (often lower than in low income areas) there is no need to reduce energy use and energy reduction is often done due to concern for the environment and not concern for final energy use. Energy efficiency campaigns and labeling of products are needed to create an awareness of products that reduce energy consumption and the environmental benefits associated with reduced energy consumption. In this sector, capital cost is less of a driver, but is still a concern, technologies for decreasing energy use are costly and payback is often more than 2 years. Educational programmes and labeling of appliances will improve energy efficiency.

Thermal efficiency in low cost housing is a concern. Traditional thatch houses were well insulated, corrugated iron roofed houses have little thermal insulation. Fuels used to improve heat affect the health of the occupants. Barriers to energy efficiency here are additional costs of supplying insulation and chimneys.

Opportunities for improving energy efficiency in the residential sector lie in efficient lighting initiatives, residential hot water heating, low cost refrigeration, sustainable homes, insulation, improved space heating and efficient wood or electric stoves, these are covered in detail in Section 4.2.3.

4.3.2 Commercial sector

There is currently little drive for energy efficiency existing in the commercial sector. However there is significant scope for energy savings. These are often overlooked because they rely on changing behavioral patterns or have payback periods of up to 3 years (due to the high cost of capital). Once implemented savings must be monitored regularly and maintained. Energy bills are often not scrutinized, if companies want to make savings they look elsewhere. Energy is seen as being a fixed cost.

4.3.3 Industrial sector

Modernization of manufacturing processes is an important step towards improving energy efficiency. Optimization of existing processes, regular maintenance, good housekeeping and the adoption of new technologies as they become available will improve energy efficiency significantly. Energy efficiency will also improve with process improvements and a reduction in the defective articles and waste.

Barriers to energy efficiency in industry are:

The unit energy cost in South Africa is significantly below that of most other countries. An overall saving of thousands of rands in the motor industry may amount to only a few rands per car, and companies tend to concentrate on improving output or product quality, cutting material and labour costs as this is where they see the money going and what has been done in the past. Low energy costs limit the interest in energy efficiency even though many energy efficiency opportunities remain cost effective.

The high cost of capital prevents projects that could increase energy efficiency but require large capital expenditure from being followed through. Due to the decreasing value of the rand, and the low cost of energy, imported energy saving technologies often have a pay back period beyond the lifetime of the equipment and are not feasible. The longer the payback period the less likely a product is to be implemented.

Electricity prices have remained low while there has been a surplus of electric generating capacity, and a surplus of coal. By the next decade there will no longer be a surplus of electric generating capacity, South Africa will shortly be experiencing a shortage, this along with increasing environmental pressure will focus attention on the need for greater energy efficiency as a solution to both issues.

Although the government has funded and participated in several energy efficiency studies and work groups it is not a priority as a result there is limited knowledge, resources and training available in the area of energy efficiency.

Policy decisions that could potentially be addressed, and should be investigated, in the area of energy efficiency are equipment standards, labels, building codes, promotion of ESCO's, audit and best practice schemes and developing efficiency targets and agreements. Many countries encourage energy efficiency by facilitating energy audits that allow companies and commercial industries to identify areas where energy can be saved without an initial outlay of capital on their side.

4.3.4 Barriers to benchmarking

The barriers to benchmarking are founded in a lack of awareness and understanding of benchmarking and the failure to realise that energy efficiency improvements are needed. Companies are unwilling to supply the information needed for benchmarking due to a lack of trust in what the information will be used for, the belief that they know their business best, a lack of knowledge or understanding of the indices used and the belief that their product or processes are unique and therefore comparisons are worthless. Managers and technical staff need to realise that these views are not conducive to improving energy efficiency and that the experience of outside experts in this field is invaluable in assisting them to improve their energy efficiency.

These barriers are not unique to South Africa, in a Benchmarking Symposium held at the office of the National Environmental Trust in Washington in June 2001, several speakers highlighted similar experiences.

5. ORGANIZATIONS INVOLVED IN PROMOTING ENERGY EFFICIENCY

This section briefly discusses organizations that should be included in energy efficiency promotion in South Africa. They are:

- Local Government,
- National Government,

- Associations,
- NGOs,
- Universities, and.
- Foreign Donors.

5.1 Government objectives surrounding energy efficiency

The commitment of government to energy efficiency is clearly stated in the Energy White Paper 1998. Specific reference is made to governments aims for promoting industrial, commercial and residential energy efficiency.

In the field of industry and commerce, government undertakes to

- "*Promote an energy efficiency awareness amongst industrial and commercial energy consumers and encourage the use of energy-efficient practices by this sector"*
- *"Establish energy efficiency norms and standards for commercial buildings"*
- *"promote the performance of audits, demonstrations, information dissemination, sectoral analyses and training programmes"*
- *"establish energy efficiency standards for industrial equipment"*
- *"implement an energy efficiency programme to reduce consumption in its installations"*

with regard to efficiency in households government will:

- "*promote energy efficiency awareness in households and will facilitate the establishment of relevant standards and codes of practice for the thermal performance of dwellings, the inclusion thereof in the national building codes and will promote their implementation through appropriate measures"*
- *government is committed to a programme of education for decision makers such as "designers, financiers builders and home owners dealing with the costs and benefits of building dwellings with good thermal performance".*
- *"government will promote the introduction of domestic appliance labelling"*
- *"government will seek as a matter of priority, to mitigate the negative environmental and health effects of air pollution from coal and wood use in household environments"*

in terms of future capacity
"government will further investigate the establishment of appropriate institutional infrastructure and capacity for the implementation of energy efficiency strategies

Excerpt from the Bill of Rights in South Africa's New Constitution Environment

24. Everyone has the right -

a. to an environment that is not harmful to their health or well-being; and

b. to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that -

i. prevent pollution and ecological degradation;

ii. promote conservation; and

iii. secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development. [IIEC 2002]

5.1.1 Greenhouse gas mitigation

South Africa is not an Annex 1 country in terms of the Kyoto Protocol and therefore does not yet have commitments to the reduction of greenhouse gases. However, South Africa is obliged to monitor and report on its emissions of greenhouse gases. This will require a national inventory of greenhouse emissions, which will have to be kept up to date.

At this stage it is not advisable for South Africa to introduce any new acts or regulations on greenhouse gas emissions. However it is important for emissions to be carefully monitored. Education on how to reduce emissions should be encouraged as a matter of policy, new methods and technologies of reducing emissions should be investigated and it should be continually emphasised to all interested parties that energy efficiency reduces emissions.

5.1.2 Poverty eradication and health improvements

According to Eberhard and van Hooren [Eberhard and van Hooren 1995], the second highest cause of infant mortality in South Africa is respiratory illness, the major cause of which is indoor air pollution associated with poor fuel use. Many energy efficiency interventions will co-incidentally reduce indoor air pollution, due to better ventilation and more complete combustion. Most pollution levels also decrease with decreased fuel consumption associated with efficiency interventions.

The Department of Health aims to meet the following goals:
"Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature." [WHO 2002]

The department has recently carried out a national campaign to stop smoking in public areas, citing the hazards associated with passives smoking as a primary driver. Therefore there may be significant potential for DOH involvement in the adoption of household energy efficiency measures associated with wood, coal and paraffin usage.

5.1.3 Access to basic services

The rational is similar to the previous section. Where fuels are not accessible or affordable, situations of fuel poverty exist. Energy efficient practice can increase access to energy by extracting maximum use from the limited energy supply that is available, or affordable.

Indoor household pollution is high in many poor communities and certain energy efficiency interventions hold the potential to reduce both energy consumption and pollution levels. The following is taken from a government review document (bold and italics from the author):

"The level and nature of expenditure allocations, to sectors of government concerned with human development, are an important indicator of whether or not government expenditure is likely to lead to a reduction in poverty and inequality. There is a strong correlation between ***poverty and lack of access to basic services*** in South Africa. Therefore, one of the first steps, to remedy poverty, is to ***ensure that adequate resources are allocated to those sectors of government which provide basic services***. In many cases, social sector services often require government intervention public expenditure allocation because of the existence of market failures, particularly the positive externalities accrued by society.” [National Government 1998]

5.1.4 Water saving

Water saving often occurs when energy efficiency measures are implemented. The following examples illustrate this:

- At a national level
  - Any reduction in national energy consumption results in less energy being transformed. Most energy transformation including: electricity generation, liquid fuels conversion, coal mining and beneficiation require process water. Much of this process water is evaporated in cooling towers or polluted, requiring clean up. Therefore a reduction in energy demand, due to energy efficiency, will lead to a reduction in water consumption or pollution.
- At end use level
  - The following large scale energy efficiency measures in industry are generally associated with reducing water consumption:
    - Reducing compressed air consumption. (Reduced cooling results in less heat exchange with water).
    - Boiler and steam system efficiency improvements. (The less steam that is required by a system, and the more condensate returned, the lower the water consumption necessary).

5.1.5 Local environment improvement

Fuel burnt in cooking and heating devices contributes to local environmental degradation. Energy efficient practice in industry and in households can help reduce this, both because less fuel is burned and, in the case of households, combustion conditions are generally better controlled resulting in a lower release of particulate matter. Various government departments seek to improve local environmental conditions. Improved energy efficiency offers a way of achieving this.

The ministry of the Department of Health recognises that “Human beings are at the centre of concerns for sustainable development. They are entitled to ***a healthy*** and productive life in harmony with nature.” [WHO 2002] The levels of pollution amongst the urban poor is particularly noted by the Department of Environment and Tourism which comments on the following in its white paper of 1998. [DEAT 1998]

“The highest levels of air pollution at ground level are found in black townships. ***The use of coal stoves for cooking and heating in these areas causes air pollution well above safety levels***.”

The DEAT seeks to promote a goal which could be well served by appropriate energy management practice namely,
‘To promote holistic and integrated pollution and waste management through pollution prevention, minimisation at source, impact management and remediation***.’***

Other local environmental effects of energy use which can be mitigated through good energy management practice include:

- Land scarring and local dust pollution due to coal mining, and
- Deforestation due to harvesting of wood fuel.

5.1.6 Energy service companies (ESCO's) and small medium and micro enterprise (SMME) development

Energy service companies assist with energy efficiency improvements. These companies provide the following services:

- Implement an industrial or commercial energy saving plan and share the savings that accrue.
- or provide an energy service, such as steam or air conditioning, to industrial or commercial institutions.

As small service providers, ESCO's fit within the goals of government to develop business initiatives.

The Department of Trade and Industry is dedicated to the following goals [DTI 2002]:

- Providing support to existing small businesses and micro-enterprises in particular, taking into account the specific factors that underline the difficulties and weaknesses that limit their growth,
- Tailoring delivery and support mechanisms to the differentiated requirements of small business, and
- Providing an effective and localized supply infrastructure

5.1.7 Technology and technology transfer

The use of sub-standard technology and bad practice results in poor energy management. The use of more efficient technologies such as heat pump systems can be economic, but are not widely implemented. The following is stated as a government objective for technology and development:

According to the white paper drawn up by the Department of Arts, Culture, Science And Technology, [DACST 1998] the following are "fundamental to the expression of a sound S&T policy:

- Promoting competitiveness and employment creation,
- Enhancing quality of life,
- Developing human resources,
- Working towards environmental sustainability,
- Promoting an information society."

Many energy efficiency technologies fit these criteria.

5.1.8 Trade balance improvement and inflation reduction

Energy efficiency has the effect of reducing energy intensity. Oil a fuel widely used in South Africa, is derived from imported crude. Due to increases in the crude price, but more importantly the weakening rand/dollar exchange, the cost of liquid fuels has been increasing. This has several complex and related effects two, of importance to government are:

- Loss of revenue from South Africa,
- And increased inflation. Freight transport is heavily reliant on diesel and to a lesser extent on petrol. As the price of oil goes up, so do the price of goods, and so does the consumer price index (CPI).

It is the stated goal of government to keep inflation levels low, according to the national macro economic strategy. GEAR [GEAR 2002] notes the importance of countering inflation:
‘The danger of an increase in the rate of inflation, reinforced by a wage-price spiral, is a constant threat to the expansion anticipated by the strategy.’

It is also the goal of government to improve the balance of payments, again noted by GEAR [GEAR 2002]:
“growth path is linked to an improved balance of payments situation, which eases the major constraint on medium term economic growth”.

5.1.9 Efficiency in transport

While not considered in detail in this work, due to the complex effect of behaviour patterns, there is significant technical scope to reduce greenhouse gas emissions. The Department of Transport makes explicit reference to this.

The following are goals stated by the Department of Transport (DOT 2002):

- Regulate the transport system to ensure efficiency.
- To provide, amongst others, public transport.

The latter is generally more efficient than private motor vehicle transport, in terms of energy use per passenger per kilometre travelled.

5.1.10 Job creation

Studies show that jobs can be created by the spill-over effects of appropriate implementation of energy efficiency [Laitner 2000].

This is a clear objective of government, as indicated by the Department of Works [DOW 1007] White paper, which states:
“Socio-economic objectives. By virtue of its functions, DPW is in a position to make specific contributions to overall government objectives, in large part by including socio-economic factors in cost-benefit analyses related to departmental operations for the first time. These factors include ***job creation***, Human Resources Development; redistribution of income; support for SMMEs, cooperatives and NGOs; new production regimes that stress labour-intensity for workers and community participation and control for beneficiaries; promotion of employment

equity and affirmative action; environmental protection; energy conservation; better access to buildings for disabled South Africans, along lines suggested in the Integrated National Disability Strategy; and increased (appropriate) public access to South Africa's natural and built heritage. Each objective will be considered."

Other issues with the DME as lead agent include:

- Increased energy security,
- Least cost energy system, and
- Access to energy.

5.2 Local Government

Several councils have environmental officers with an interest in energy efficiency, but there is no specific energy portfolio or representative in local government. The initiative to improve energy efficiency by local government would rest mainly on improving residential, commercial and transport efficiency and controlling industrial pollution.

Links to the metropolitan councils of Benoni, Cape Town, Ceres, Dorea, Durban, Hermanus, Johannesburg, Petersberg, Rustenberg, Sasolburg can be found in www.dplg.gov.za, the website of the Department of Provincial and Local Government. A comprehensive list of all local governments with contact person and phone number can be found at www.dplg.gov.za/municipalities%20of%20the%20RSA.pdf. The list is dated 19 February 2002.

Major industrial municipal areas are listed below. Additional information including contacts and municipal profiles can be viewed on www.demarcation.org.za.

Name of Municipality	Municipal manager	City	Telephone
City of Johannesburg	Mr P. Moloi	Johannesburg	011 407 7308
Ekurhuleni Metropolitan Municipality	Mr. P.M. Maseko	Germiston	011 820 4004
Sedebeng District Municipality	Mr. T. Mkaza	Vereeniging	016 4503092
Emfuleni Local Municipality	Mr N. Shongwe	VanderbijlPark	016 950 5044
West Rand District Municipality	Mr. MMJ Mohlakoane	Randfontein	011 411 5000
Eastvaal District Municipality	Mr S. Sewnarian	Secunda	017 631 1181
Nkangala District Municipality	Mr TC Makola	Middelberg	013 243 1441
Ehlanzeni District municipality	Mr FT Mashiane	Nelspruit	013 755 2580
Durban Metropolitan Council	Mr F Dlamini	Durban	031 311 2000
UGU District Municipality	Mr KE Mpungose	Port Shepstone	039 682 1150
Umgungundlovo District Minicipality	Ms NH Ally	Pietermaritzburg	033 394 5561
Amajuba District Municipality	Mr WJM Mngomezulu	Newcastle	034 314 3759
Jozini Local Municipality	Mr SP Magwaza	Richards Bay	035 789 1404
King Shaka District	Mr BH Pretorius	Durban	031 569 3277
Greater Kokstad Local Municipality	Mr LL Barnard	Kokstad	039 7273133
City of Cape Town Metropolitan Municipality	Mr R Maydon	Cape Town	021 400 1335
West Coast District Municipality	Mr W Rabbets	Morreesburg	0224 332 380
Swartland Local Municipality	Mt CFJ Van Rensburg	Malmesbury	0224 822 935
Mossel Bay Local Municipality	Mr TI Lotter	Mossel Bay	044 691 2920

Oudtshoorn Local Municipality	Mr R Butler	Oudtshoorn	044 272 2221
Bojanala Platinum District Municipality	Mr R Ramatlhape	Rustenburg	014 597 3024
Southern District Municipality	Mr L Ralekgetho	Klerksdorp	018 464 9020
Frances Baard District	Mr Thabo Nosi	Kimberley	053 838 0911
Motheo District Municipality	Mr G Ramathebane	Bloemfontein	051 409 4600
Matjhabeng Municipality	Mr S Sesele	Welkom	057 391 3237
Northern Free State District Municipality	Mr B Molotsi	Sasolburg	016 976 0765
Western District Municipality	Mr B Gxilishe	Port Elizabeth	041 508 7111
Amatole District Municipality	Ms P Yako	East London	053 701 4000
Chris Hani District	Mr MA Mene	Queenstown	046 838 1556

5.3 National Government Bodies

Much has been said recently about creating a national energy efficiency agency, funded by government, to carry out energy efficiency programs and act as a technical support unit for industry. There are however several structures already in place that could be used to carry out programs that government wish to implement.

The following section discusses government bodies which could play a role in the promotion of energy efficiency.

Government Department	Contact Person	Email	Telephone
Department of Transport	Mr Mike Mabasa	mabasam@ndot.pwv.gov.za	(021) 309 3131
Department of Trade and Industry	Ms Manana Makhanya	makhanya@dti.pwv.gov.za	(012) 310 9581
Department of Environmental Affairs and Tourism	Mr Blessing Manale	bmanale@ozone.pwv.gov.za	(012) 310 3457
Department of Water	Mr Themba Khumalo	bdj@dwaf.pwv.gov.za	(012) 336 8270
Department of Health	Ms Samantha Bloem	bloems@health.gov.za	(012) 312 0853
Department of Provincial and Local Government	Mr E. I. Africa	lizette@dso.pwv.gov.za	(012) 334 0830

5.3.1 The Department of Minerals and Energy (DME)

The DME's primary role is to legislate and determine policy for the energy sector. It has facilitated several studies in the area of energy efficiency. Projects to improve public awareness of energy efficiency that have been carried out in the last few years include conferences, the compilation of an industrial guidebook to promote energy efficiency, feasibility studies, awareness campaigns (this includes two energy efficiency weeks), and the development of energy efficiency branding.

The DME has also over the years funded studies of several energy intensive industries. There are very few recent studies most were completed prior to 1994. In the area of energy auditing, the DME has funded projects to identify the methodology to establish a national energy audit scheme, including what funding should be made available. They have recently commissioned an energy audit of the NER and DME buildings in Pretoria.

Much attention has been placed on residential energy efficiency, studies in Durban have attempted to identify the use of energy in high and low income households, energy week was aimed at lowering residential energy by increasing the awareness amongst adults and children of ways in which to be more energy efficient. The DME has also focused some attention on energy efficient cooking in low income households. In 1997 a project was commissioned to create a strategy for establishing an energy performance contracting industry. The ESCO would provide services and funding to companies wishing to improve their energy efficiency, this is paid back by a portion of the savings. Other projects funded by the DME lie in the area of primary and tertiary education. Most projects have been of an exploratory nature. A detailed overview of projects completed by the DME is included in Appendix F.

Progress has been severely hampered by a lack of capacity, with very few members of the DME assigned to energy efficiency. This has changed recently with funding from the Danish government and a DME drive to develop energy efficiency and increase capacity in this area.

5.3.2 Central Energy Fund (CEF)

The CEF (Pty) Ltd is the South African government's holding company in the petroleum industry. CEF is mandated by the state to engage in the acquisition, exploitation, generation, manufacture, marketing and distribution of energy and to engage in research relating to the energy sector. There is potential for the CEF to roll out energy efficiency programs on behalf of the Department of Minerals and Energy, by shifting its role from one that is heavily focused on petroleum, it may become an important instrument in the future.

5.3.3 Development Bank of South Africa (DBSA)

Essentially the DBSA provides low interest loans which could be used to promote government objectives and sustainable development. Therefore, energy efficiency service suppliers or companies (ESCO’s), could be offered low interest loans. Sensible criteria for energy efficiency investments first need to established, to satisfy governance and the goals of the Bank.

5.3.4 Legislature

The legislature is responsible for implementing the legal framework of government. This body would be used to enforce equipment standards or other energy efficiency measures.

5.3.5 The South African Bureau of Standards (SABS)

The responsibility of the South African Bureau of Standards lies primarily in the development and publication of standards for products and services. The SABS is responsible for research relating to standards, and should be included in the development of energy efficiency standards and services.

5.3.6 ESKOM

ESKOM is a state owned institution and will shortly be partly sold by the State. The ESKOM Integrated Strategic Electricity planning office, ISEP, has concluded that demand side management and electrical energy efficiency constitutes a least cost pathway to meeting national energy needs. The alternative is building a new power station. Research has been carried out by ESKOM to establish and test this hypothesis. However ESKOM is about to be privatized and in the short term business perspective there is decreasing incentive to dedicate funds to rolling out the energy efficiency initiatives. Where energy efficiency is an expensive option, there is little incentive to roll out any program involving capital outlay until ESKOM's future operating regime is clearly defined.

Energy efficiency implemented to reduce the electrical load at peak times of generation (which is generally expensive to meet as it requires additional generating or storage capacity), will also reduce electricity sales during off peak times. This translates to a loss of revenue. The restructuring of the electricity supply industry in the United Kingdom and America resulted in an increase in the cost of electricity and a decrease in expenditure on research and development.

5.3.7 National Electricity Regulator

The chief role of the regulator is to regulate electricity generation, transmission, distribution, purchases and sales. It does this in the context of an Integrated Resource Plan (IRP), which derived from ISEPs last plan, also suggests that DSM, including energy efficiency is the least cost option to meet growing electricity needs. The regulator however should not 'roll-out' a DSM plan, as this would in effect constitute a conflict of interest,as running a DSM program may also be viewed as running a 'virtual power station' which sells a 'reduction in demand'. The regulator may set tariffs which provide funding for electrical energy efficiency programs. This is currently limited to electricity, however, the latest thinking is that the regulator would in future regulate all energy, in which case this body may be used to help generate funding for all fuel energy efficiency programs.

5.3.8 Statistics South Africa

A database of energy information should be collaborated. Statistics South Africa are ideally placed to host the information collected in the form of detailed energy balances and energy intensity information. Statistics South Africa publishes yearly statistical handbooks and all information is available on a well maintained website.

5.3.9 Other government departments

Other bodies, referred to in this report, which are relevant include the:

- Department of Environmental Affairs and Tourism,
- Department of Transport,
- Department of Public Works,
- Department of Water, and
- the Department of Health.

5.4 Energy Efficiency Associations

5.4.1 South African Energy Management Association (SEMA)

The South Africa Energy management association is a non-profit forum between government and industry. The core objectives are to:

- Raise awareness of energy management ,
- Improve the profitability of industry,
- Conduct basic energy audits,
- Educate energy users,
- Introduce new technology,
- Provide a forum for the exchange of information,
- Help establish dialogue between industry and government, and
- Offer energy service organisations an introduction through its trade directory

It is allied to the Association of energy engineers, but takes a wider role in terms of raising awareness and discussion at the level of decision maker.

5.4.2 South African Association of Energy Engineers (SAAEE)

This association of engineers offers training and certification. The South African chapter was initiated by and has links with the American Association of Energy Engineers.

5.5 NGO's active in the area of energy efficiency

5.5.1 Earthlife Africa

Earthlife Africa is dedicated to proactive environmental practice in all spheres of society. To this end, it is co-ordinating and disseminating information on energy efficiency on both websites and in printed media. The Sustainable Energy and Climate Change Program (SECCP) is a multimillion rand project being co-ordinated by Earthlife Africa, which includes disseminating information via email newsletters and projects. They are currently coordinating a project which considers policies and measures for implementing renewable energy and energy efficiency.

5.5.2 Energy and Development Group (EDG)

Formed in 1992, the energy and development group has been involved in the implementation and development of sustainable energy policies in Southern Africa. Several projects involve an energy efficiency component, and EDG has experience with low-income household energy strategies.

5.5.3 IIEC

The IIEC is a global non-profit organization. The African office of the IIEC seeks to promote energy and transport options that address both the developmental and environmental imperatives of the African continent. The office's primary objectives are to:

- Improve the quality of life for Africa's historically disadvantaged population ,

- Realise energy efficiency opportunities that also address the continent's health and environmental needs ,
- Help build the capacity of local organisations to achieve energy and environmental goals , and
- Promote local economic empowerment through energy efficiency opportunities.

A significant project currently being completed by the IIEC is a low cost energy efficient housing program.

5.5.4 The Minerals and Energy Policy Center (MEPC) and Training Institute (MEETI)

The MEPC and MEETI have been involved with energy efficiency initiatives. MEPC is primarily a policy organization and MEETI, housed by the MEPC, is a training organization. Apart from policy research and training, the MEPC are actively involved in research and information dissemination activities.

5.5.5 The South African National Energy Association (SANEA)

South African National Energy Association is the South African branch of the World Energy Council (WEC). This organization is primarily an association of energy supply companies, and has recently been organized as a non-profit association. The association is involved in various activities including regional meetings of members. WEC activities include a large Southern African energy gathering initiative. SANEA produces and email newsletter for energy professionals and addresses various issues, including energy efficiency.

5.6 <u>Universities active in the area of energy efficiency</u>

5.6.1 University of Cape Town

The University of Cape Town has two energy research organizations. One technically and scientifically orientated the Energy Research Institute (ERI) and one policy orientated the Energy for Development Research Center (EDRC).

5.6.1.1 The Energy Research Institute (ERI)

The ERI is an organization which focuses on three major energy related areas, namely energy management, energy and the environment and integrated energy planning. The ERI has been involved with energy efficiency for several decades. It has produced energy management guidebooks and case studies and disseminated several thousands of copies of both. It also maintains a web-based resources center for energy efficiency from which the material can be downloaded free of charge.

The ERI is a non-profit organization that does not house an energy consultancy. It currently cross subsidizes its funding. It publishes ‘Energy Management News’ a newsletter, which goes to over 1000 recipients in the SADC region.

The ERI is also and accredited Industrial Assessment Centre (a US Department of Energy initiative, of which only eight exist outside of the US.). The ERI is responsible for the activities of SEMA and runs energy management courses.

5.6.1.2 The Energy and Development Research Centre (EDRC)

The EDRC is a policy based group formed to develop policy for South Africa's democratic government. The work has a strong social science emphasis and is concerned with the dynamics of energy with particular focus on the poor. Energy efficiency initiatives are undertaken in their 'Energy Efficiency and Environment Program'. Much research has been performed by the EDRC in the area of household energy efficiency.

5.6.2 University of Potchefstroom

The University of Potchefstroom is involved with energy efficiency programmes, such as the CSIR's 'Green Buildings for Africa' and student training. The university sub-contracts much of this work to a private company responsible for coordinating the activities of the South African Association of Energy Engineers.

5.6.3 University of Pretoria

The University of Pretoria has undertaken energy efficiency work at the household and industrial level. Three areas of specific interest include:

- Electrical energy modelling (in the research group: Electrical, Electronic and Computer Engineering),
- Energy, including extensive work on households (in the research group: Architecture), and
- Energy management systems (in the research group: Electrical, Electronic and Computer Engineering). Significant expertise resides in this group with respect to building practice.

5.7 <u>Other organizations</u>

Other organizations with an interest in energy efficiency include:

- The Sustainable Energy Society of South Africa (SESSA),
- And the South African Wind Energy Association (SAWEA), and
- The National Domestic Energy Efficiency Task Team (NADEE).

5.7.1 Fossil Fuel Foundation (FFF)

The Fossil Fuel Foundation associates itself closely with energy and mining issues in South Africa, which are primarily coal dominated. As such energy efficiency is an issue of interest. The FFF also organizes information dissemination through conferences.

5.7.2 The Centre for Scientific and Industrial Research (CSIR)

The Centre for Scientific and Industrial Research (CSIR) has an interest in several initiatives related to energy efficiency from a household to commercial level. The CSIR has been involved in the field of energy efficiency in buildings, in the Green Buildings for Africa programme. This project, done in collaboration with the University of Potchefstroom, promotes high efficiency commercial building development.

5.8 Foreign donors currently funding projects

Five aspects to keep in mind when considering implementing an energy efficiency strategy are;

1. What capacity is currently available locally and what could be developed?
2. What funds are available for development?
3. What institutions could fund the development of an energy efficiency strategy?
4. What are the objectives of the strategy?
5. And what energy efficiency strategies are possible?

It is also necessary to identify at what level energy efficiency programs need to be supported. These could be summarised as follows:

- Policy development,
- Roll-out / Management, and
- Implementation.

It is in this context that the following short lists have been compiled. The objective however is to identify international donors and where appropriate a preferred implementing body.

5.8.1 Donors to involve in projects:

There is funding available from several sources for the development of national strategies. The list of institutions below is a first pass based partially on evident competency and partially on availability of funding for South Africa. The list has been compiled using the author's experience. Possible sources of funding in loosely defined different categories include:

Efficient motors, compressed air and refrigeration
Department of Energy (USA)
European Union (EU)
British Foreign and Commonwealth Office (FCO)

Benchmarking
British Foreign and Commonwealth Office (FCO)
Dutch government's economic affairs department with NOVEM (Netherlands)
European Union (EU)

Energy Auditing
USAID and the Department of Energy (DOE) with University City Science Centre (USA)
European Union (EU)
Norad (Norway)

Furnaces, boilers and steam
JICA, Japan International Co-operation Agency (Japan)
USAID and University City Science Centre and the Alliance to Save Energy (USA)

Demonstration facilities
JICA, Japan International Co-operation Agency (Japan)

5.8.1.1 Sector studies:

General
Norad (Norwegian Aid Agency)
European Union (EU)

USAID (USA)
Department of Energy (DOE) (USA)

Residential sector
USAID (USA)
Danida (Denmark)
International Institute for Energy Conservation (IIEC) (International)
German Technical Co-operation (GTZ) (German)

Commercial buildings
National Renewable Energy Laboratory (NREL) (USA)
Environmental Protection Agency (EPA) (USA)
British Foreign and Commonwealth Office (FCO) (UK)

Emissions and energy efficiency
World Bank (International) and the

- Global Environmental Forum (GEF)
- Prototype Carbon Fund (PCF)

Norad (Norwegian Aid Agency) (Norway)
German Technical Co-operation (GTZ) (German)

Economics and Energy Efficiency
Environmental Protection Agency (EPA) (USA)
International Energy Agency (International)

- Energy Technology Systems Analysis Program (ETSAP)

ESCO development
USAID (USA)
JICA, Japan International Co-operation Agency (Japan)
British Foreign and Commonwealth Office (FCO) (UK)

DME Staff Capacity Building
JICA, Japan International Co-operation Agency (Japan)
Swedish aid agency (Sweden)
Danida (Denmark)
USAID (USA)

A list of project specific information detailing projects funded by donor organisations follows.

CIDA **Contact**::Tret-da@dfait-maeci.gc.ca

Cida is currently funding an emission reduction programme, information is available from tret_da@dfait-maeci.gc.ca, CIDA could not supply information on the book "Energy and Sustainable development in Africa" funded by DFAIT

TITLE	AGENCY SUPPORTED	CONTRIBUTION	TIMING
Danced - contact: *Mr Jonsson, Peter Olafur,* ***petjon@um.dk***			
1. Danish input into the South African Energy Policy Discussion Document	DME	DKK 161,460	1995
2. Energy Study Tour to Denmark, May 1997.	Various Southern African agencies	DKK 282,555	1997
3. Renewable Energy for South Africa (REFSA) Project	DME & REFSA	DKK 322,920	1996-97
4. The Urban Sustainable Energy, Environment and Development (SEED) Phase I project	The Danish Organisation for Sustainable Energy (OVE) and the Energy and Development Group (EDG)	DKK 5,651,100	1999-2001
5. The Rural Sustainable Energy, Environment and Development (SEED) Phase I project	The Energy and Development Research Centre (EDRC) and the Danish Organisation for Sustainable Energy (OVE)	DKK 3,229,200	1999-2001
6. The Green City Project - Midrand Integrated Environmental Planning (Energy Efficiency in Low Cost Housing Component)	Midrand Metropolitan Local Council (MMLC) and MIDDEV	DKK 11,302,200	1998-2000
7. South African Bulk Renewable Electricity Generation, Wind Energy, Phase I - Wind Resource Assessment	Eskom, Technology Services International (TSI)	DKK 403,555	1999-2000
8. Initial Core Support to the South African Wind Energy Association (SAWEA)	SAWEA	DKK 350,000	1999
9. Research on Independent Power Production (IPP) in South Africa with An Emphasis on Bulk Electricity Generated Through the Harnessing of Renewable Energy Sources	DME	DKK 807,300	2000
10. Environmentally Sound Housing Financing Feasibility	Department of Housing	DKK 201,825	2000
11. Sustainable Energy and Climate Change Partnership: Earthlife Africa	Earthlife Africa	DKK 6,885,547.00	2000 - 2003
12. Support to the South African Department of Minerals and Energy on Renewable Energy and Energy Efficiency	DME	DKK 27, 000, 000	2000-2003
13. Support to Bulk Wind Energy Generation in South Africa Including the Establishment of A National Demonstration Wind Farm in Darling, Western Cape (Phase I - Barrier removal)	DME	DKK 2.260,440	2000-2001
14. Sustainable Energy and Climate Change Advocacy Support	Earthlife Africa Johannesburg	DKK 5,,651,100	2000-2003
15. Support to Bulk Wind Energy Generation in South Africa Including the Establishment of A National Demonstration Wind Farm in Darling, Western Cape (Phase II - Implementation)	DME	DKK 15, 000, 000 Or 25%	2001-2003

16. Lynedoch Development Eco-Efficient Buildings Demonstration Project	Spier Institute	DKK 662, 095	2001
17. City of Johannesburg Sustainable Housing Strategy (Energy Efficiency)	City of Johannesburg	DKK 3, 000, 000	2001-2003
18. Sustainable Energy, Environment and Development Urban SEED II		DKK 5, 460, 781	2001-2003
Prototype carbon fund			
1. Municipality of Durban- Productive use of landfill gas	Municipality of Durban/DSW/Durban Solid Waste	€ 40 000 000	2002 ±2017
EU - Contact: Tren-info@cec.eu.int, Europeaid-info@cec.eu.int			
1. Clean Development Mechanism Capacity Building amongst the Private Sector in Africa: South Africa, Zambia, Botswana, Zimbabwe, Mozambique	Proposer: Institute of Energy Economics and the Rational Use of Energy , Germany	€ 455 722	18 months
2. Cane Resource Network for Southern Africa, Participants: Italy, Zimbabwe, South Africa , United Kindom, Brazil, Greece, India, Botswana, Zambia, Mauritius South Africa is represented by theUniversity of Natal	Sustainable Energy Programme, Stockholm	unspecified	30/10/2002-31/8/2005
3. The Sustainable Energy Policy and Research 'Knowledge Network' on Cost Effective, Ecologically sound & Healthy Energy Alternatives for Low- Income Rural Households Participants: United Kingdom, Germany, Netherlands, Kenya, Nairobi, Uganda, Tanzania, Zimbabwe, Zambia, South Africa. South Africa is represented by Rural Energy Power Solutions	ITDG Operations Energy Unit, United Kingdom	unspecified	01/01/2002-31/12/2004
4. Establishment and operation of an Opet Association in the Southern African Development Community (SADC) region Participants, South Africa, Botswana	Minerals and Energy Policy Centre, Johannesburg	unspecified	26/06/2001-25/06/2002
5. Non-Grid Electrification of Rural Schools	ESKOM	unspecified	Unspecified
6. Renewable Energy Sources For Rural Electrification in South Africa	Garrad Hassan and Partners Limited	€ 177 900	01/02/1997-completed
ECN - Contact: Mr Smekens, Koen, smekens@ecn.nl			
1. Integrated Energy Planning in South Africa with the Markal Family of models	CSIR, under guidance of the DME	Dutch Government€30 900 ECN € 3360 DME € 17 000 (still to be established)	04/01/2001 -end date to be decided
ETSU - Contact: www.etsu.com			
1. Information Dissemination Programmes for EU Energy Efficienct Technologies in South African Industry	AEAT		11/1999-completed
2. Energy Supply and Demand; Kenya, Uganda, South Africa; Addressing Institutional Energy Supply and Demand	EDRC	unspecified	unspecified

GEF - Contact: www.Gefonline.com			
1. Renewable Energy Enterprise Development	UNEP	Not yet approved	
2. Solar Water Heaters for Low Income Housing in Peri-Urban Areas	UNDP	US$m 0.728	07/01/2000-end date not specified
3. Concentrating Solar Power for Africa	IBRD	US$m 0.230	19/07/1999-end date not specified
4. Pilot Production adn Commercial Dissemination of Solar Cookers	UNDP	US$m 0.8	13/08/2001-end date not specified
NORAD - Contact: Mr Ericson, Jan.ericson@norad.no			
Specific information regarding the funding of projects by NORAD can be obtained from the Norwegian Embassy, this information was not available at time of print, however NORAD funded projects worth NOK126 mill in 2000 and states the following on their website. **Energy** The Norwegian Water Resources and Energy Directorate (NVE) and the Norwegian Petroleum Directorate are participating in legislative reform and human resource development in the energy sector (electricity, petroleum), both in South Africa and in the region as a whole. A more open energy market, cooperation on common standards and greater access to the electricity grid for electricity produced by a variety of energy bearers are important, both for economic development and for environmental reasons. **Environment** Environmental and natural resource management is an important priority area in the bilateral programme. A five-year framework agreement has been entered into with the Department of Environmental Affairs and Tourism (DEAT) in South Africa. The projects that receive funding under this agreement are related biodiversity and water, climate and energy issues, conservation of the cultural heritage and tourism, environmental rights and environmental reporting. Many Norwegian institutions participate actively in this programme. The most important of them have so far been the Ministry of the Environment, the Directorate for Cultural Heritage and GRID-Arendal. A cooperation agreement on fishery management and research has been signed in which the Directorate of Fisheries and the Institute of Marine Research are active partners.			
NOVEM **Contact**: info@novem.nl No information was recieved regarding projects funded by NOVEM			
Prototype carbon fund (World Bank)			
1. Municipality of Durban- Productive use of landfill gas	Municipality of Durban/DSW/Durban Solid Waste	€ 40 000 000	2002 ±2017
SIDA - Contact: Agnetha Danielson, info@sida..se No information was recieved regarding projects funded by SIDA			
World Bank			
1. Energy Use, Energy Supply, Sector reform and Poor	EDRC	US $ 80 000	02/01-unspecified
JICA - Contact: Mr Imamara (012) 346 4493 Jica is currently funding no projects in the energy field in South Africa			
USAID - Contact: Mr Guzman, Sergio sguzman@usaid.gov **Projects outsourced through Megatech** **Average monetary size of projects US $ 80 000**			
TrustUrban Eco-village: demonstration of eco-village concept integrating micro planning for mixed land uses, ecological technologies such as grey waste water treatment, solar water heating, ecological housing, ecological business such as organic gardening, recycling and ecotourism.	Midrand EcoCity	annie@ecocity.org.za	

Rural Energisation: demonstration of an unsubsidised, user-owner model for alternative energy supply to rural households consisting of PV for power and LPG for cooking.	Parallax (Pty) Ltd	info@parallaxonline.net
Renewable Energy Technology Transfer: demonstration of use of solar powered sewing machines in rural areas and how provision of training and other services can remove barriers for the take up and use of renewable energy.	Cape Technikon	uken@ctech.ac.za
Urban Greening and Eco-tourism: involves sustainable greening through tree planting and tourism development in Avalon Cemetry and Morris Issacson High School, places of great historical significance with constant visitor and tourist draw.	Soweto Development Foundation	sdfventure@wspgroup.co.za
Rural Eco-Village: demonstration of eco-housing and village design for rural farmworkers including installation of solar water heaters, LPG stoves, Energy efficient lights, and insulation, as well as community waste collection and recycling.	Lynedoch Development (Section 21 Company)	robspier@iafrica.com
Renewable Energy Markets: demonstration of the technical viability of a "green" electricity market in Southern Africa through supply of "green" electricity to the venues of the WSSD for the duration of the summit.	Agama Energy (Pty) Ltd	glynn@agama.co.za
Renewable Energy Technology: demonstration of 1) prototype farm-scale ethanol production plant produced in modules constructed in 20 ft shipping containers for easy transport to rural areas in RSA and around the world; 2) a prototype of an existing commuter taxi engine modified to run on ethanol/water mixture; and an economic model of an eco-village based on the agri-refinery technology demonstrated	National Development Initiative for Social Welfare (Ndiswe)	aprocot@intekom.co.za
Community-Based Greening, Recyling, Energy Efficiency: Involves constructing a community recycling depot, landscaping including tree planting, and bicycle lanes; as well as development of home insulation kits suitable for informal settlements	EZD and partners	imh@intekom.co.za sowman@enviro.uct.ac.za
Carbon Sequestration and Conservation: Involves establishing sustainable tree farms of indigenous species to substitute for harvesting of mangrove by local communities. This is aimed at conservation of the 150 hectares of mangrove forest in Mngazana Estuary.	Institute of Natural Resources	hay@nu.ac.za eddy.russell@undp.org
Clean Transport: demostration of low-cost, efficient and environmentally sound transport options in at least three pilot municipalities. Includes improved signage, trasport friendly designs for public transport, bicycle infrastructure. Will develop a Blue print plan to be showcased in WSSD.	IIEC - Africa	m.whitehead@iafrica.com

Sustainable Resettlement: demonstration of planning, developing and managing a sustainable rural community resettlement within an ecologically sensitive area. Involves construction of environmentally sustainable housing component, a business development component with a focus on organic agricultural practices, skills training and appropriate technologies	Kranspoort Community	odinp@global.co.za	
Renewable Energy, Greening: demonstration of use of solar power to provide energy services to a rural commuinity. Services to include providing power to a community center, water pumping and purification. Greening activities include planting trees and other vegetation.	Technikon Northern Gauteng	dintchev@icon.co.za	
Rural Energisation: demonstration of possibilities for meeting energy needs of rural communities through use of various renewable energy sources while providing jobs, skills training, and SMME development opportunites.	Nuon RAPS Utility (Pty) Ltd	marius@raps.co.za info@raps.co.za	
Greening, Recycling: involves establishment of plant nurseries, food gardens, planting of trees, waste reclying and manufacture of organic fertilizer	Ndla-Ndlamuka Local Project		
Industrial Energy Efficiency: demonstration of energy monitoring and targeting sytems as a means of saving energy in industry. This can be a useful tool to help small businesses to reduce energy bills.	Enerwise Africa	joasa@mweb.co.za	
Renewable Energy Technology: demonstration of a production plant for clean, efficient fuel for residential use produced by mixing cowdung and paper	ZET Consultancy		
Energy Efficienct Housing: demonstration of thermally efficient and renewable energy solutions in housing.	Buffalo Flats Community Development Trust	bfcdt@iafrica.com	
USAID - Contact: MS Knight, Melissa, mknight@usaid.gov			
Energy Efficiency Workshops: CHF provided a subgrant to Isandla Partners in Development (IPD) to work with various community groups in the Port Elizabeth area to leverage the national housing subsidy. Under the terms of the CHF-IPD agreement IPD was tasked with implementing 4 workshops on housing energy efficiency for community groups as well as for local municipal and housing officials.	Cooperative Housing Association (CHF) in collaboration with Isandla Partners in Development and local Housing Association.	US $ 350 000	07/2000-02/02
Energy Efficiency Awareness; GCDC worked with the CPT Metro and local associations to facilitate the leveraging of national housing subsidies for the community. GCDC also built several model energy efficient homes and carried out an awareness campaign to expose residents to features which homes could have that save on energy.	Gugulethu Community Development Corporation (GCD	$385,000	05/1998- 02/02

Sustainable Homes Initiative; IIEC implements the Sustainable Homes Initiative whereby they work with government bodies, private sector firms and NGOs to build awareness on the importance of energy efficiency in home construction. They have trained Sustainable Homes professionals around the country to provide this assistance	International Institute for Energy Conservation (IIEC)	$520,000	07/00- 12/03
Housing Associations and Community Development; IPD is working with various housing association in the Nelson Mandela Metropole to develop plans for leveraging the national housing subsidy. In 2 developments in the Motherwell area IPD has leveraged subsidies for over 800 homes and contracted for construction of the homes. The physical planning of the construction work is made with energy efficiency in mind. Many of the homes will have north facing windows. Homeowners are also exposed to the benefits of installing energy efficiency features. This is done through workshops and written material.	Isandla Partners in Development (IPD)	$150,000	06/01- 02/03
Retail Water Distribution Project (RWDp); The RWD project is meant to provide local institutions with the training and technical assistance so that they can have the capacity to manage water resources. Part of the assistance focuses on training and assistance to persons responsible for operating and maintaining potable water systems. Under this component leaks are fixed and valves are adjusted so that the appropriate amounts of water is running through the system,. This saves energy costs as energy requirements are diminished through the more efficient use of the water.	Chemonics International with South African partners	$2,900,000	09/00- 05/04
Global Climate Change Awareness; The objective of this activity is to increase public awareness of Global Climate Change (GCC) in South Africa and to assist the South African government to educate students about the importance of GCC. This awareness building and education is meant to lead to demonstration projects such as energy efficiency activities.	Academy for Education Development	$636,000	02/02- 02/03
Southern Africa Solar Water Heating Initiative; aims at promoting solar water heating and creating an interest in solar water heating	Solar Engineering Services	US $ 60 000	03/02-09/02

IFC portfolio of GEF funded projects – Contact: **ifcepu@ifc.org**			
Efficient Lighting Initiative, Argentina, Hungary, Czech Republic, Latvia, Peru, Phillapines and South Africa	Bonesa`	Total value US $ 15 mill	Ends 2003
Renewable energy and energy efficiency fund (REEF) aimed at renewable energy and energy efficiency projects in developing countries		Total value US$ 65 mill	02/02-unspecified

5.8.2 Organizations involved with energy efficiency work in South Africa

Organizations involved with energy efficiency work in South Africa include, amongst others, the following:

- **USAID**
  - Has sponsored several initiates relating to low cost energy efficient housing.
- **ESKOM**
  - ESKOM has funded and co-funded much work in the field of 'demand side management' to reduce electricity demand and to shift electrical demand to off peak times.
- **GEF (Global Environmental Forum)**
  - The primary coordinator of Bonesa, South Africa's efficient lighting initiative.
- **World Bank**
  - Has funded several energy efficiency programs under its prototype carbon fund, including co-generation.
- **US Department of Energy**
  - Funded the development of the Energy Research Institute to become an International Industrial Assessment Centre.
- **US Environmental Protection Agency (EPA)**
  - This organization has provided support for the development of case studies, and the input-output model described in this work.
- **Department of Minerals and Energy**
  - This organization has funded several studies in the area of energy efficiency. They have also held seminars and workshops and conducted awareness campaigns.

The Danish funding agency DANEDA has played an important role for local energy efficiency programs. These have included the some of the following programs:

- Partnership for Sustainable Energy and Climate Change,
- Building energy audits,
- Baseline studies,
- And the SEED program.

5.8.3 Previous donors:

Previous donors have included:

- The Government of the Netherlands
    - Was involved in co-funding an industrial efficiency drive, which is now self-funding.
- The European Union
    - The primary agent in funding industrial energy efficiency programs in South Africa.

Various organizations, mainly energy agencies or non-government organizations, or consultants, of the donor country governments have been active in South Africa in energy efficiency work. These include, amongst others:

- University City Science Centre (USA)
- US EPA (USA)
- Novem (Netherlands)
- And AEAT (UK)

It is suggested that the DME target specific groups to fund research initiatives which it identifies. The DME could act as a facilitator between local partners and international donors to apply for funding for particular projects, identified as important by the DME.

6. POLICY ASPECTS WITHIN ENERGY EFFICIENCY

6.1 Key Players

The key players who should be involved in devising and implementing national policies on energy efficiency may be divided into eight broad groups: (6.1.1) energy users (6.1.2) energy suppliers and distributors (6.1.3) government and administration both local and national (6.1.4) the trade unions (6.1.5) business organisations (6.1.6) educational bodies (6.1.7) the media (6.1.8) energy NGOs.

6.1.1 Energy users

In general large companies are more efficient in their use of energy than small ones, therefore the small ones have greater scope for improvement. However, the large ones have the manpower and better means to implement programmes of energy efficiency and they should be used first in a national policy. Later on the small ones should be encouraged to join and help and advice should be given to them to do so. But initially the policy thrust should be directed at the big companies.

Such big companies in the industrial sector include the mining corporations; iron and steel works, companies smelting and processing metals, such as aluminium smelters; chemical manufacturers; manufacturers of cement, glass and bricks; pulp and paper mills; large manufacturers of motor vehicles, machines, textiles, appliances and other finished goods; large construction companies; and companies making food, beverages and tobacco products.

In the transport sector, all public transport should be included, such as train, bus and airlines. So should large land freight companies.

In the commercial or services sector, the areas of interest are large shops, government buildings, office blocks, theatres, housing development and educational buildings.

Agriculture and the residential sector are composed mainly of a large number of small energy users. These should not be included as primary players in the first thrust of policy but would of course be encouraged by educational programmes to join in the move to improved energy efficiency.

6.1.2 Energy suppliers and distributors

There is a paradox in an energy supplier encouraging energy efficiency and so apparently inviting customers to use less of his product. End users are however more likely to return to a supplier if they are provided with the cheapest alternative to their energy needs. This can be accomplished by promoting energy efficiency on the part of the supplier.

The main energy suppliers are Eskom, municipal electricity generators, the oil refining companies, Sasol and the coal mines. The main energy distributors are Eskom, municipal electricity distributors, the oil companies, and companies distributing coal, gas and paraffin.

Another important group here are those companies making and supplying equipment for the raising of steam, heat and electricity. Most of these are already keenly aware of the need for energy efficiency but they should certainly be included in the energy efficiency policy and are likely themselves to assist it with advice and knowledge.

6.1.3 Government and administration

Central government, notably the Department of Minerals and Energy, and local government, in its provincial and municipal arms, are essential for sanctioning, co-ordinating and giving authority to any national policy on energy efficiency.

6.1.4 The trade unions

The unions, in close contact with millions of workers supplying, distributing and using energy, are key players in helping to make the workforce aware of the need and the possibilities for improved energy efficiency and the ways for achieving it.

6.1.5 Business organisations

Business organisations, such as SACOB will be important in co-ordinating the polices of corporations supplying and using energy, and in disseminating information and advice among them.

6.1.6 Educational bodies

Universities and technical colleges, particularly in their engineering and commerce faculties, should be part of the national policy on energy efficiency. However, schools should be brought in to, just to make every pupil aware that energy is not free and that there of ways of using it less wastefully.

6.1.7 The media

Television, radio, newspapers and magazines are essential in making the public aware of the need, the potential and the benefits of improved energy efficiency. This subject is entirely non-controversial and without any political slant and so it should be relatively easy to persuade all sections of the media to support the policy.

6.1.8 Energy NGOs

Energy NGOs, which are not driven by profit, have an important part to play in advising on policy and co-ordinating and informing interested parties in the energy field.

From these eight broad groups, the task of educating and informing the public and interested parties should be done by the media, the educational bodies, the government, energy NGOs and departments within large corporations. Devising and authorising policy can only be done by the government, although perhaps using the advice of energy suppliers, users and NGOs. Implementing policy should be done national by the government but within corporations by their own departments.

6.2 Policy instruments

The first policy thrust should be directed at implementing existing policy on pollution from combustion such as the black smoke regulation of diesel engines. Enforcing these regulations would make the air cleaner and allow the offenders to get more kilometres for every litre of diesel fuel. This is an increase in energy efficiency.

At this stage it is probably not a good idea to introduce more acts and regulations for improving national energy efficiency because the groundwork has not been laid to support these (this excludes all acts or regulations that are aimed at providing information or awareness such as appliance labelling and the introduction of energy efficiency into curricula 2005). The main policy drive should be awareness and educational: explaining first and foremost that energy efficiency saves money; but that it also improves operations and safety, and of course benefits the environment and reduces the emission of greenhouse gases.

Policy should also be directed at co-ordinating the activities of the various interested parties listed in 6.1 so that the national drive for energy efficiency becomes cohesive and effective.

The Department of Minerals and energy fulfils the role of governing and therefore plays an important role in:

- policy, strategy and legislation,
- coordination,
- enforcement,
- dissemination and reporting of information,
- participation and appeals,
- monitoring, auditing and reviewing policy, and
- capacity building.

Policy measures which promote energy efficiency and could be considered are listed below. These must be investigated individually in terms of meeting the objectives of government:

- Equipment and building standards,
- Appliance labelling,
- Taxation and subsidies,
- Audits and assessments,
- Research and development,
- Reporting the energy and CO_2 intensity of industry,
- Efficiency targets and agreements,
- Information dissemination to, and lobbying of, other government bodies where energy efficient practice meets other objectives and perhaps the co-ordination of cross sector implementation plans such as:
  - Improved health
  - Greenhouse gas and local pollutant mitigation
  - Improved balance of payments
  - Job creation
  - Small medium and micro enterprise development
  - Access to energy
  - Reduction in water demand and pollution
  - Environmental degradation
  - And Technology transfer

It is important that energy efficiency measures are implemented in an integrated way that promotes the goals of government. Cognisance should be taken of the fact that:

- Energy is an important part of the South African socio-economy, and low energy prices sustain intensive industry such as aluminium smelting.
- And because we have intensive industries goals should be set which these industries can reach, rather than importing targets which are not appropriate for South Africa.

6.3 Further research

The effects of improved energy efficiency should be quantified, and appropriate measures identified for South Africa. In this context the following can be quantified through the process of the IEP:

- Water consumption
- Greenhouse gas mitigation
- Local pollutant mitigation

- Effects on balance of payments

Other topics requiring further study include:
- Job creation
- Economic growth
- Specific policies and measures relevant to South Africa

7. CONCLUSION

Energy efficiency in South Africa could improve significantly were a coordinated national strategy to be put in place. Improving energy efficiency in South Africa would result in environmental, health, fiscal and employment benefits. It would also help to relieve the shortage of electricity generating capacity that she will soon be facing.

Government can encourage and promote energy efficiency through the implementing of equipment and building standards, fiscal policies, efficiency targets and agreements with industry, the carrying out of audits and assessments, information dissemination programmes and research and development initiatives.

The South African energy baselines published are inaccurate in both fuel end use by sector and total energy end use. An attempt has been made to supply balances that are more accurate, but division of the sectors into sub-sectors is inherently inaccurate due to the poor quality of data available.

Although the report highlights the energy intensive sectors and industries in the economy, quantifying potential energy savings is hindered by the lack of sector specific and process specific information available detailing energy consumption in South Africa. There have been few studies in recent years that have collected data on industrial energy use and equally few reliable studies relating to residential and transport energy use, studies have centered on policy and education and programme implementation. More effort must be placed on formulating data collection methods, and sub-sector divisions and sub-divisions for collaborating data.

There is significant potential for increasing energy efficiency in many areas of industry, however many of these have long pay back periods. Projects with payback periods of longer than one and a half years are typically not implemented. The long payback periods are a result of the low unit cost of energy, low exchange rate and high cost of capital. Measures could be implemented to encourage the implementation of these. The establishing of ESCO's would also assist in this area.

South African industry is centered around energy intensive industries. These are not necessarily inefficient. They are typically industries that process raw materials, they have a low final value added and high energy input per ton of output. If industry was to move towards high technology and light manufacturing the energy intensity in terms of GDP output would drop.

In order to provide meaningful comparisons of energy efficiency, the raw materials, and final output and process should be the same. South African industrial processes are dominated by those that have a low capital cost and are labour and energy intensive. Investment in research and development initiatives would assist with technological advancement.

Energy efficiency is likely to remain poor whilst the unit cost of energy is low and the capital costs are high. Energy efficiency is a new concept amongst engineers and managers, little is known about the potential for saving energy and even less is done. Benchmarking is an ideal way of developing an interest in energy efficiency and enabling companies to set realistic targets for energy use. Benchmarking and energy auditing go hand in hand. Energy auditing will help to collect more accurate data on energy use and enable companies to identify target areas for energy savings. It is suggested that government support both these initiatives in the future.

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APPENDIX A ENERGY BALANCES 1996-1999

APPENDIX B1: NATIONAL BALANCES 1996-2000

APPENIDX B2: PROVINCIAL ENERGY BALANCES 1996-2000

APPENDIX C ENERGY BALANCES AND EFFICIENCY MEASURES

APPENDIX D INPUT AND OUTPUT ANALYSIS

APPENDIX E COUNTRY BALANCES AND INTENSITIES

APPENDIX F REVIEW OF COMPLETED PROJECTS

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