National Accounts

Environmental Economic Accounts

Energy Accounts for South Africa: 2002–2009

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List of abbreviations and acronyms

CDM	Clean Development Mechanism
DoE	Department of Energy (Department of Minerals and Energy prior to July 2009, President's Minute No. 690)
Eskom	Electricity Supply Commission of South Africa
FIFA	Fédération Internationale de Football Association
GDP	Gross domestic product
GWh	Gigawatt-hour
IEA	International Energy Agency
kW	Kilowatt
kWh	Kilowatt-hour
LPG	Liquefied petroleum gas
m^2	Square metre
MJ	Megajoules
MW	Megawatt
NNR	National Nuclear Regulator
PetroSA	Petroleum, Oil and Gas Corporation of South Africa
PJ	Petajoules
PV	Photovoltaic
Sasol	South African Coal and Oil
SAPP	South African Power Pool
SEEA	System of Integrated Environmental and Economic Accounting
SI	International System of Units
Stats SA	Statistics South Africa
TJ	Terajoules
UNSD	United Nations Statistics Division
W	Watt

Executive summary and key findings

The South African economy depends heavily on energy resources provided from coal[1]. Coal is dominating primarily because it is abundant and relatively cheap by international standards. South Africa's coal mining is 47% underground mining and 53% opencast mining operations. Many of the deposits can be exploited at extremely favourable costs, and as a result a large coal mining industry has developed. In 2008 there was 121 years left to depletion, given current rates of extraction and proven resources at 30 408 million tonnes.[2] South Africa exports 29% of produced coal to most of Europe and the Far East, through the Richards Bay coal terminal, making South Africa the fifth largest coal exporting country in the world.

Oil and gas explorations are limited in South Africa. Small oil and gas fields are situated off the south coast of Mosselbay. Due to limited oil fields in the country, the bulk of crude oil is imported from the Middle East and Africa (Saudi Arabia, Iran, Kuwait, Yemen, Qatar, Iraq, Nigeria, Egypt and Angola). The small gas fields in South Africa supply Mossgas, a project started in 1987 to exploit offshore gas deposits.

Other energy resources in South Africa include biomass (such as wood and dung), natural gas, hydropower, nuclear power, solar power, wave power and wind power.

South Africa has large coal and uranium reserves. In 2009, South African mines produced 251 million tonnes of coal. Of this figure, 185 million tonnes was used locally, at a value of R34 billion, with export sales totalling 60 million tonnes at a value of R31 billion. South Africa has approximately 30 billion tonnes of proven coal reserves.[2, 3] Recoverable uranium reserves were estimated at 341 kilotonnes. Limited reserves of hydropower exist. South Africa has a huge potential for developing solar power, especially in the Northern Cape, with considerable potential for wind power existing in the coastal regions.[1, 4]

Energy is a key driver of South Africa's economy and the energy intensity (refer to Glossary) as a measure of gross domestic product (GDP) is above average, with only 10 other countries having higher commercial primary energy intensities. It is largely as a result of the economy's structure, with dominating large-scale, energy intensive primary mineral beneficiation and mining industries. Coal, as the major indigenous energy resource, is relied on for the generation of most of the country's electricity and a significant proportion of its liquid fuels. Diversification of the primary energy mix, the bulk of which comprises coal, is especially challenging.[1, 4]

In 2010, the Department of Energy (DoE) was mandated to draft and publish the Integrated Energy Planning Strategy that led to the development of the Integrated Energy Plan, as envisaged in the National Energy Act, 2008 (Act No. 34 of 2008). Part of this legislation focuses on ensuring availability of a diversity of energy resources and its sustained use. In order to achieve government's efficiency target of 15% energy efficiency for the industry and 12% nationally by 2015, there are a number of initiatives in place. These energy efficiency initiatives include the Working for Energy Programme, projects under the Clean Development Mechanism, The Carbon Dioxide Geological Storage Atlas, the implementation of new national building standards and regulations, monitoring building efficiency, the development of solar and wind-electricity generation through the Electricity Supply Commission of South Africa (Eskom), and the Darling Wind Farm to name a few. The liquid-fuels sector is providing investment opportunities at the Coega Industrial Development Zone in the Eastern Cape and the new pipeline between Durban

and Johannesburg will increase petroleum carrying transport capacity. Cross-border gas trade agreements between Mozambique and Namibia should increase the primary energy supply with the contribution of natural gas to the energy mix.[4]

Looking at the Supply and Use Tables presented in the Energy Account for South Africa 2002–2009, the following trends could be observed (also refer to Figure 1 below):

Coal resources

Coal supplied for domestic energy production in 2002 amounted to 5.6 million terajoules (TJ). The amount of energy generated from coal remained fairly steady around 5.8 million TJ from 2003 to 2006, rising to 5.9 million TJ in 2007, then dropping slightly to 5.1 million TJ in 2008 and 5.0 million TJ in 2009. Coal imports for energy supply were negligible. The main industrial demand for energy produced from coal was electricity production, followed by manufacturing. The amount of energy from coal resources for electricity production ranged between 2.4 million TJ in 2002 to 2.7 million TJ in 2009. The manufacturing industry used energy from coal at 1.4 million TJ from 2002 to 2007, and 0.4 and 0.6 million TJ in 2008 and 2009 respectively. Coal exports for energy production were between 1.9 and 2.0 million TJ from 2002 to 2007, 1.6 million TJ in 2008 and 1.5 million TJ in 2009.[5]

Crude oil

Domestic energy production from crude relied largely on imports for energy generation. Imports of crude oil for energy generation fluctuated between 1.4 million TJ in 2002, 0.7 million TJ in 2003, 1.0 million TJ in 2004, 0.8 million TJ in 2005, 0.9 million TJ in 2006, 2007 and 2008, and 1.1 million TJ in 2009. The industrial sector that used crude oil for energy was manufacturing (in the sub-sector chemical and petrochemical for refining and further distribution) ranging from 1.5 million TJ in 2002, 0.7 million TJ in 2003, 1.2 million TJ in 2004, 1.1 million TJ in 2005, 1.2 million TJ in 2006, 0.8 million TJ in 2007, 0.9 million TJ in 2008, and 1.1 million TJ in 2009. Exports of crude oil for energy were negligible.[5]

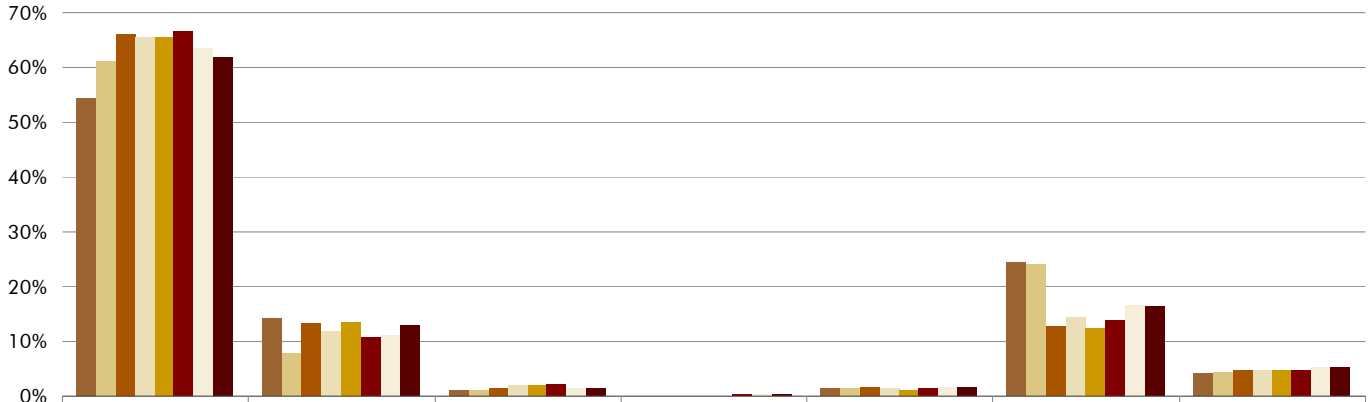
Gas

Domestic gas production as an energy source remained stable around 0.1 million TJ from 2002 to 2009 with slight fluctuations between those years. Gas imports for energy were negligible. The main users of energy from gas production were electricity production and the manufacturing industry. Electricity production from gas was negligible. The manufacturing industry used energy from gas resources ranging from less than 0.1 million TJ in 2002 to 2006, and 0.1 million TJ in 2007 to 2009.[5]

Hydroelectric, nuclear and renewable energy

Hydroelectric, nuclear and renewable energy sources form a small part of the domestic energy production. Hydroelectricity provided less than 1% of the primary energy supply from 2002 to 2009. Nuclear energy provided between 1.3% and 1.7% of the primary energy supply from 2002 to 2009. Renewable energy contributed 4.2% in 2002, 4.5% in 2003, 4.8% from 2004 to 2007, and 5.3% in 2008 and 2009. The amounts of hydroelectric and nuclear energy that were used were negligible. Renewable energy to generate electricity for use was stable at 0.2 million TJ from 2002 to 2009. Renewable energy used for private consumption, ranged from 0.2 million TJ between 2002 and 2009.[5]

Figure 1: Percentage supply of primary energy* (in terajoules) by source in South Africa, 2002–2009



	Coal	Crude oil	Gas	Hydro	Nuclear	Petroleum products	Renewables and waste
2002	54.5%	14.3%	1.2%	0.1%	1.3%	24.4%	4.2%
2003	61.2%	7.7%	1.0%	0.0%	1.4%	24.1%	4.5%
2004	66.0%	13.5%	1.4%	0.0%	1.6%	12.7%	4.8%
2005	65.5%	11.8%	1.9%	0.0%	1.4%	14.5%	4.8%
2006	65.6%	13.6%	2.0%	0.1%	1.2%	12.6%	4.8%
2007	66.6%	10.7%	2.1%	0.2%	1.4%	14.0%	4.8%
2008	63.5%	11.1%	1.5%	0.2%	1.7%	16.6%	5.3%
2009	61.8%	13.2%	1.5%	0.2%	1.7%	16.3%	5.3%

*Excludes electricity production.
Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2002–2009.

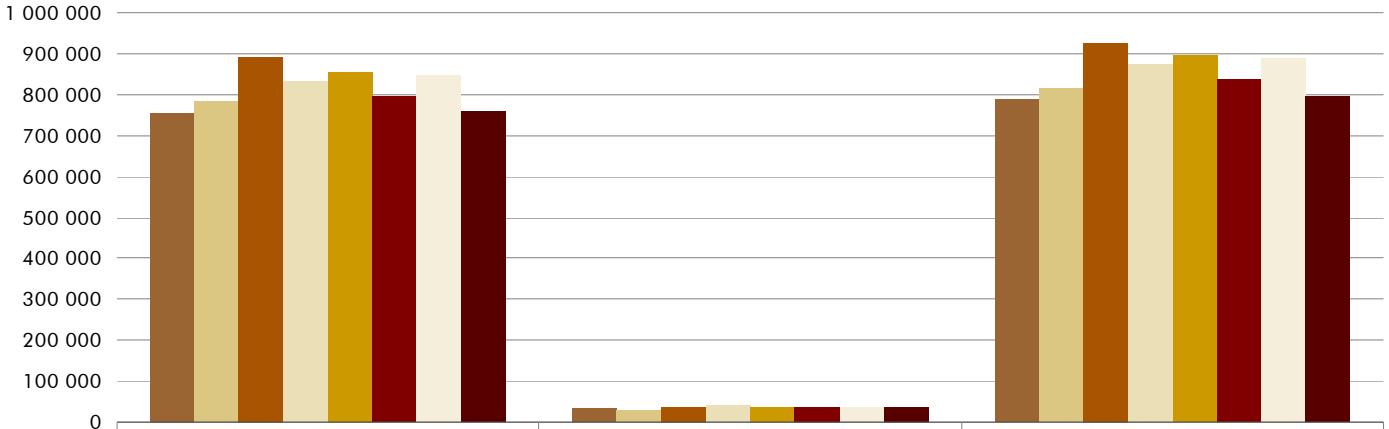
Petroleum products

Domestic production of energy from petroleum products was 2.4 million TJ in 2002, 2.3 million TJ in 2003, 1.1 million TJ in 2004, 1.2 million TJ in 2005, 1.0 million TJ in 2006, 1.1 million TJ in 2007 and 2008, and 1.0 million TJ in 2009. The imports of petroleum products for energy production were negligible. The main users of petroleum products for energy in 2002 and 2003 were manufacturing, followed by transport, storage and communication. From 2004 to 2007 no petroleum products for energy were used by the manufacturing industry. Manufacturing used petroleum products for energy ranging from 1.2 million TJ in 2002 to 1.1 million TJ in 2003. The transport, storage and communication industry group used petroleum products for energy between 0.6 million TJ in 2002 to 0.7 million TJ in 2006, 0.8 million TJ in 2007, 0.9 million TJ in 2008 and 2009. Exports of petroleum products for energy ranged between 0.5 million TJ in 2002 to 0.1 million TJ in 2009.[5]

Electricity

Electricity is a secondary energy supplier that relies on the primary resources of coal, crude oil, gas, hydroelectric, nuclear, petroleum, and renewable energy as inputs to the production process. It needs to be excluded when comparing primary energy resources to avoid double counting. Domestic production of electricity remained steady between 0.8 million TJ to 0.9 million TJ from 2002 to 2007, 0.8 million TJ in 2008 and 2009. Imports of electricity were negligible (refer to Figure 2 below). The main user of electricity was the manufacturing industry with 0.3 million TJ in 2002 and 2003, 0.4 million TJ in 2004, and 0.3 million TJ in 2005 to 2009. The domestic sector's use of electricity was 0.1 million TJ in 2002, 0.2 million TJ in 2003 to 2006, and 0.1 million TJ between 2007 and 2009.[5]

Figure 2: Total electricity supply (in terajoules) in South Africa, 2002–2009



	Domestic production	Imports	Total supply
2002	752 919	34 186	787 105
2003	784 879	29 498	814 378
2004	890 631	35 345	925 976
2005	832 538	39 884	872 422
2006	856 008	38 246	894 255
2007	796 827	38 246	835 073
2008	849 193	38 246	887 439
2009	758 867	38 246	797 113

Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2002–2009.

1. Introduction

The main aim of environmental accounts is to collect qualitative and quantitative information on both the state of natural resources and their progression within a consistent framework. The majority of economic and social activities towards income may lead to the degradation and depletion of natural resources and it is of utmost importance that such activities be managed in order to accomplish sustainable development.

Environmental economic accounts help by providing policy-makers with an information base on natural resources, thereby contributing to general knowledge on environmental issues at each level of decision-making, and to enhance the general awareness level of the public.

Energy accounts provide information on the levels of direct energy consumption by industries in relation to their production processes; and consumption by private households. These accounts can also provide information on changes in the energy requirements of particular industries in relation to their output. This shows the macro-level impacts of new technologies and eco-efficiency measures and behavioural changes. They are also an indispensable prerequisite for reliable estimates of air emissions related to energy consumption.

The aim of this discussion document is to present and discuss the updated energy Supply and Use Tables for South Africa from 2002 to 2009.

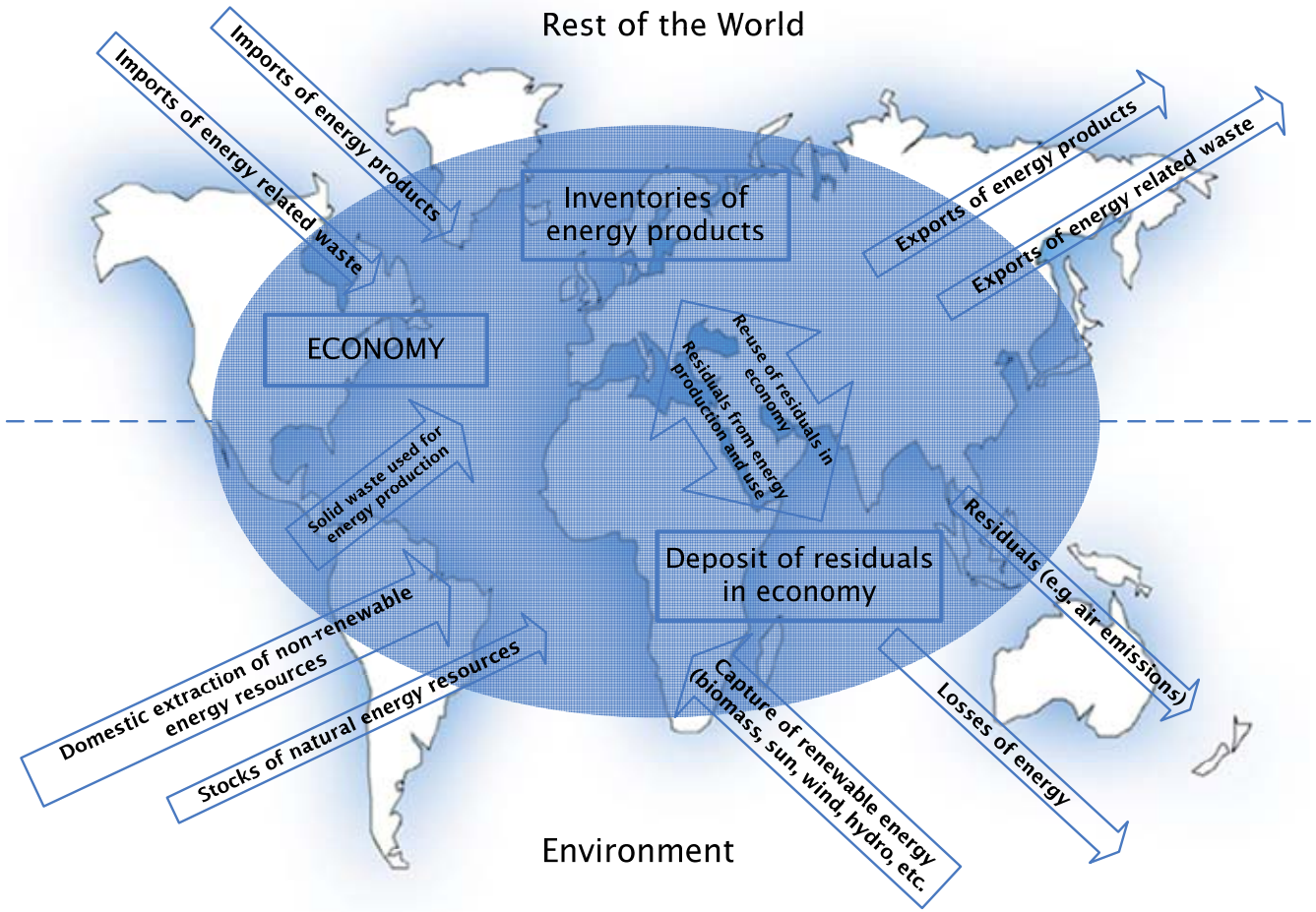
2. Energy and the interaction between the environment and the economy

Figure 3 below schematically outlines the exchange of energy resources, energy products and energy related air emissions and other residuals. The exchange is made between the environment, the economy in focus, and the rest of the world economies represented as one overall group.

For this discussion document it is sufficient, although not entirely correct, to think of the economy as essentially the economic activities taking place within the geographical territory of South Africa. Similarly, the 'rest of the world' could be considered to constitute all economic activities of countries other than South Africa.

There are two main gateways through which energy enters the economy. One is through the extraction of fossil and nuclear energy resources from the stocks deposited in the environment or through the capture of energy from renewable resources. Once the energy resources have entered the economy they become energy products, which may be the subject of economic transactions, just like any other products. The other is through imports of energy products from the rest of the world. Once an energy product has entered the economy, it may be used directly for fuels, it could be converted into other energy products (e.g. crude oil is converted into petrol or diesel) or it can be exported to the rest of the world. In some cases, energy products may be used to produce non-energy products, e.g. plastics or bitumen. Similarly, some energy products accumulated in a previous period may be taken out from inventories to be used in the economy or for exports.

Figure 3: Energy related stocks and flows



Source: Statistics South Africa, 2011. Adapted from the SEEA-Energy Framework, United Nations Statistics Division.

Energy products, which are used for fuels, together with the air used for the combustion, are transformed into heat or electricity accompanied by an output of residuals in the form of solid waste like fly ash and slag, emissions of greenhouse gases and other gases, and evaporation of water, etc.

The solid waste from energy combustion is used either as inputs into the production of products (e.g. fly ash used for production of plasterboards) or it is accumulated in waste disposal sites. In some cases, part of the waste is exported to other countries, just

as some may be imported into the economy in focus. Another type of residual, which flow from the economy to the environment are losses of energy. Typical examples are electricity and heat, which are lost from the distribution network into the environment. Other more peripheral, but not necessarily unimportant, energy-related flows exist. For example, the production of certain types of energy requires use of huge amounts of water for cooling. This non-consumptive use of water might affect eco-systems because of the change of the temperature in the water. With regard to the extraction of natural energy resources the extraction process involves extraction of large amounts of associated materials, which at some stage are relocated or removed from the 'pure' energy product. The latter type of flows are the subject of economy-wide material flow accounting, and is not within the scope of the SEEA-E and are therefore not shown in the above diagram.[6]

3. South African classifications and methodology

The Energy Accounts for South Africa follows the System of Integrated Environmental and Economic Accounts (SEEA) 2003 developed by the United Nations Statistics Division (UNSD). The SEEA 2003 has been adapted to South African circumstances. All the data used in the energy account are from the DoE.

3.1 Energy resources

The main energy resources in the South African economy are coal, oil, gas, nuclear power, hydropower and renewable sources such as wind, solar, biomass and wave power. Figure 1 gives the distribution of primary energy supply by source in South Africa from 2002 to 2009.

The sources that supplied energy to South Africa from 2002 to 2009 were predominantly electricity that relied on coal, followed by petroleum products and crude oil with gas, hydro, nuclear power, and renewable energy contributing less than 10% of the total energy mix. Renewable energy includes resources such as biomass, wave, wind and solar power.

3.1.1 Coal

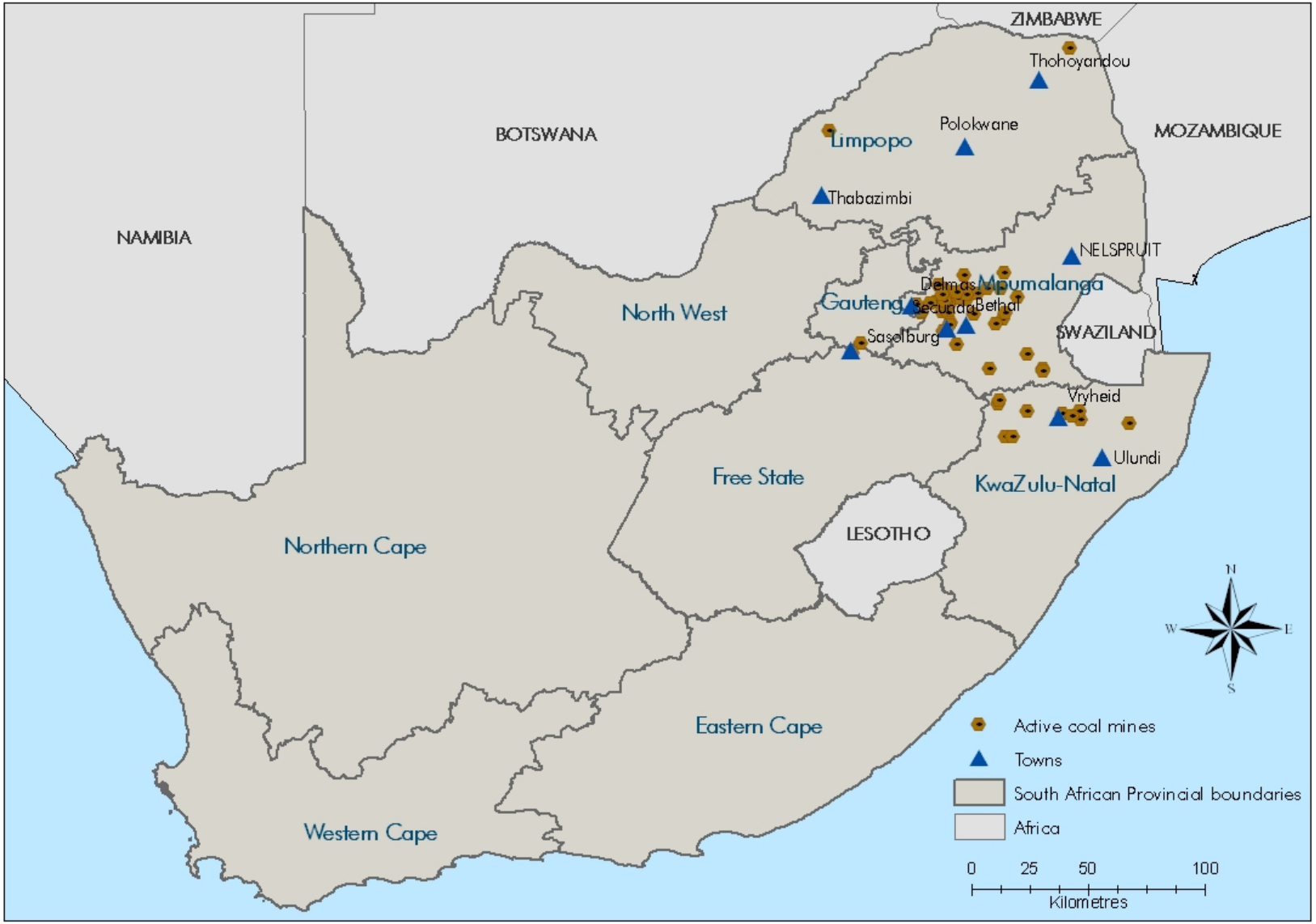
The South African energy sector is dominated by coal, and it is expected to remain the major overall electricity generator until 2020. In 2009, South African mines produced 251 million tonnes of coal. Of this figure, 185 million tonnes was used locally, at a value of R34 billion, with export sales totalling 60 million tonnes at a value of R31 billion. South Africa has approximately 30 billion tonnes of proven coal reserves.[2, 3]

In 2002, South Africa's coal reserves were estimated at 55 billion tonnes with almost 200 years of coal supply left, estimated at current rates of extraction and proven resources. According to the latest mineral accounts for South Africa, in 2008 there was 121 years left to depletion, given current rates of extraction and proven resources at 30 408 million tonnes.[2]

In South Africa, for the years 2002 to 2009, the bulk of the primary energy needs were provided for by coal, which made it the most widely used primary fuel. This is unlikely to change significantly in the next decade, due to the relative lack of suitable developed alternatives to coal as an energy source. South Africa's coal production feeds the various local industries, with the bulk used for electricity generation.

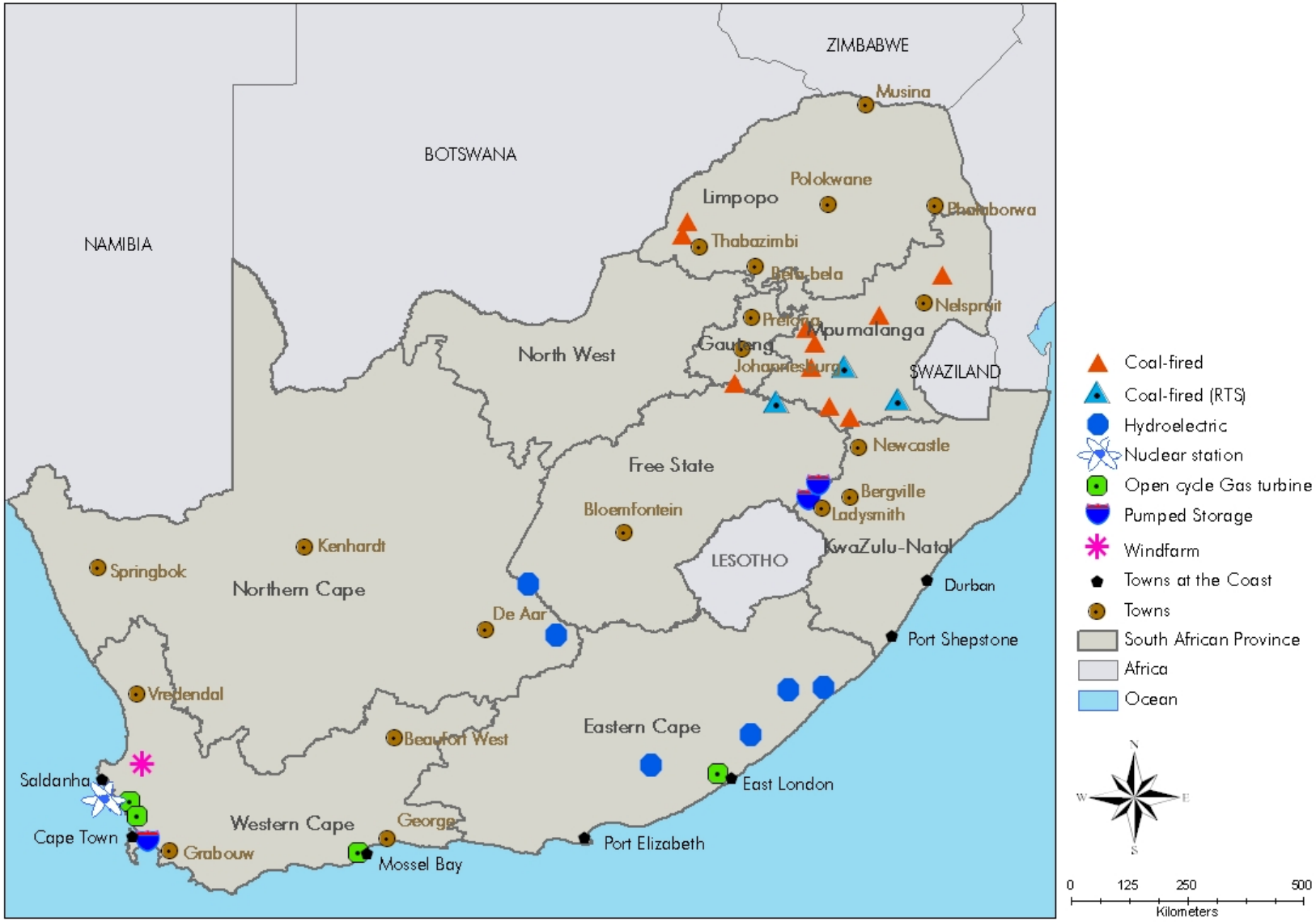
The advantages of coal power for South Africa are that our country has abundant coal reserves, coal-fired power stations are a reliable part of existing infrastructure to generate electricity and coal power is well established. The disadvantages are that coal has the most severe waste problems of all energy sources. Building coal-fired power stations is a long and expensive process and South Africa's coal fields are concentrated in Mpumalanga, which limits the location options for power stations (refer to Maps 1 and 2 below). Figure 4 below shows the flow of coal from production to consumers.[1, 4]

Map 1: Location of coal mines in South Africa



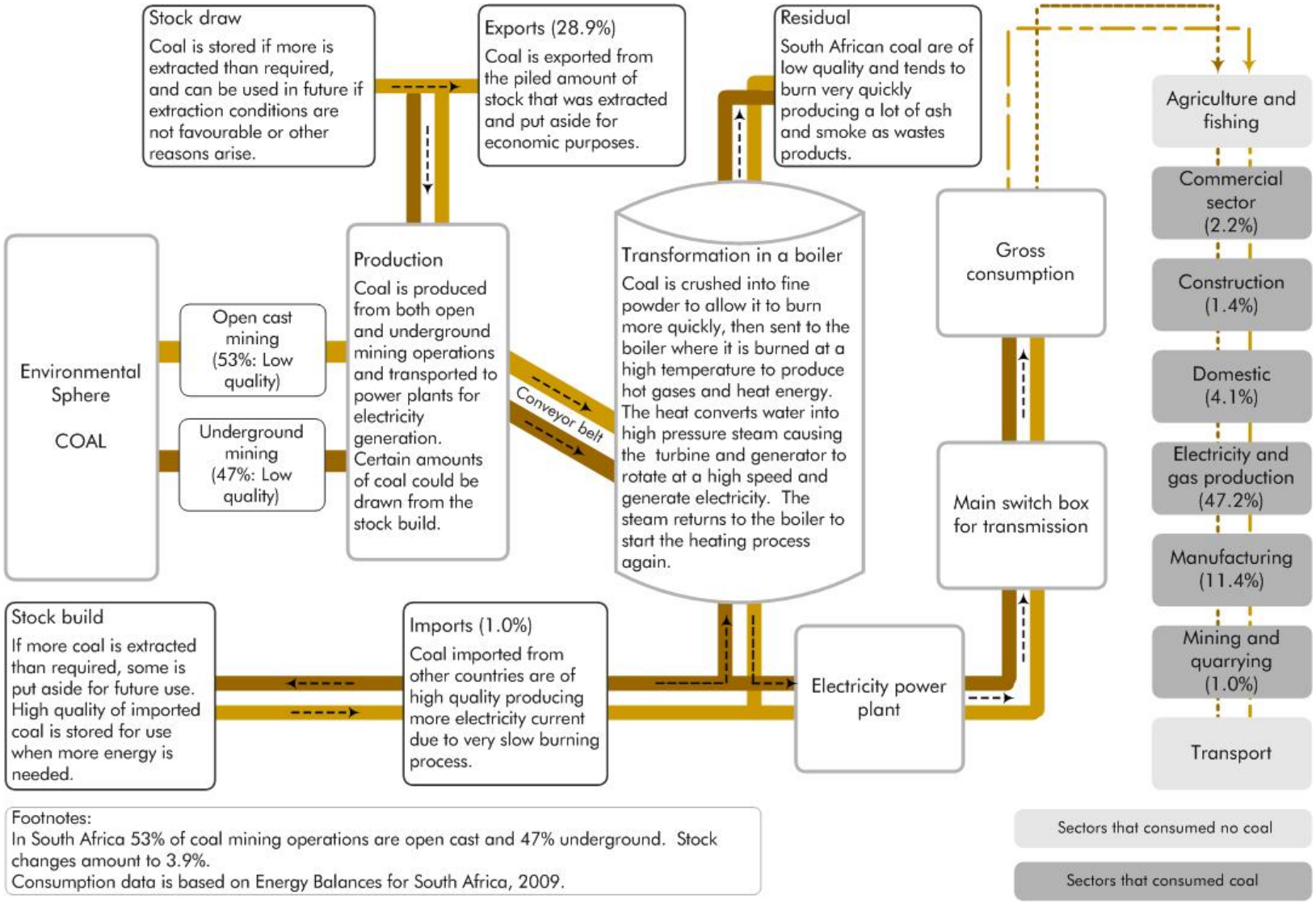
Source: Statistics South Africa, 2011.

Map 2: Location of power stations in South Africa



Source: Statistics South Africa, 2011.

Figure 4: Flow diagram for coal, 2009



Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

3.1.2 Crude oil and petroleum products

South Africa has very limited oil reserves and the bulk of its crude oil requirements are met by imports from the Middle East and Africa (Saudi Arabia, Iran, Kuwait, the United Arab Emirates, Yemen, Qatar, Iraq, Nigeria, Egypt and Angola).

Refined petroleum products such as petrol, diesel, residual fuel, oil, paraffin, jet fuel, aviation gasoline, liquefied petroleum gas (LPG) and refinery gas are produced by the following methods:

- Crude oil refining (oil refineries);
- Coal to liquid fuels and gas to liquid fuels (South African Coal and Oil (Sasol)); and
- Natural gas to liquid fuels (Petroleum, Oil and Gas Corporation of South Africa (PetroSA)).

The South African liquid-fuels sector presents a number of opportunities for investment. In 2010 PetroSA concluded a feasibility study on a 400 000 barrels-a-day refinery at the Coega Industrial Development Zone in the Eastern Cape. The proposed Mthombo oil refinery (completion is estimated in 2015) will save energy costs. A new R15 billion pipeline to transport petroleum from Durban to Johannesburg is under construction for completion in 2012. The DoE promulgated regulations for the retail price of LPG supplies to households in 2010. Two pilot projects for the use of LPG by households for space heating and cooking are undertaken by the DoE.

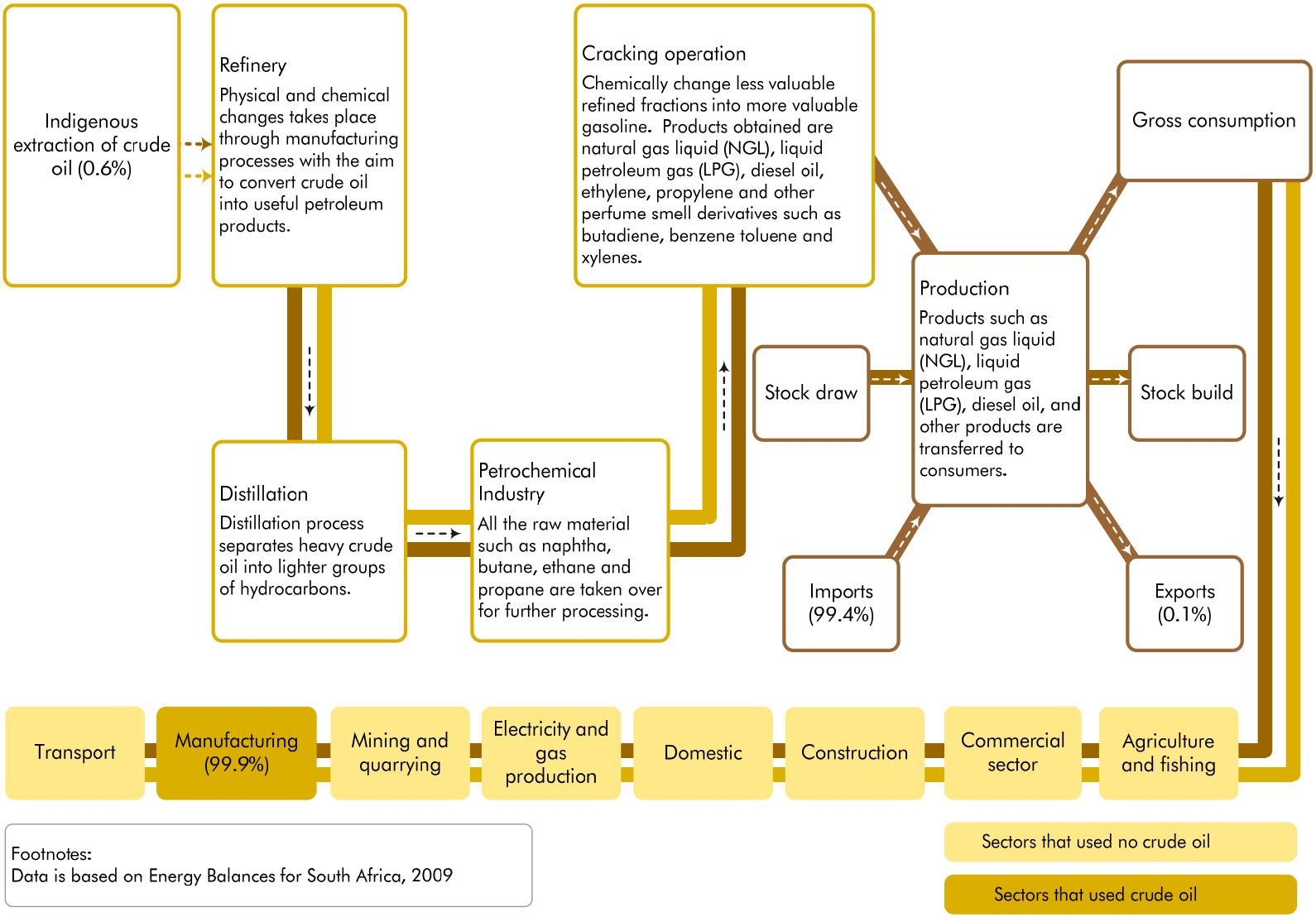
Figures 5 and 6 below show which sectors are the main users of crude oil and petroleum products.[1, 4]

3.1.3 Gas

Limited natural gas reserves exist around the South African coast. PetroSA exploits the reserves off the coast of Mosselbay, where the Mossgas plant converts the gas into liquid fuels. Sasol produces gas from coal and is researching prospects to import gas from Namibia. Even though gas consumption has increased in recent years, the importance of gas in the South African energy economy is still low compared with other countries. Cross-border gas trade agreements have been signed with Mozambique and Namibia to facilitate the movement of gas across international borders. The contribution of natural gas to the primary energy supply is expected to increase when the new Mozambique-South Africa gas-transmission pipeline reaches maximum capacity. The South Africa-Nambia Gas Commission addresses harnessing the natural gas reserves in the Kudu Gas Field.[1, 4]

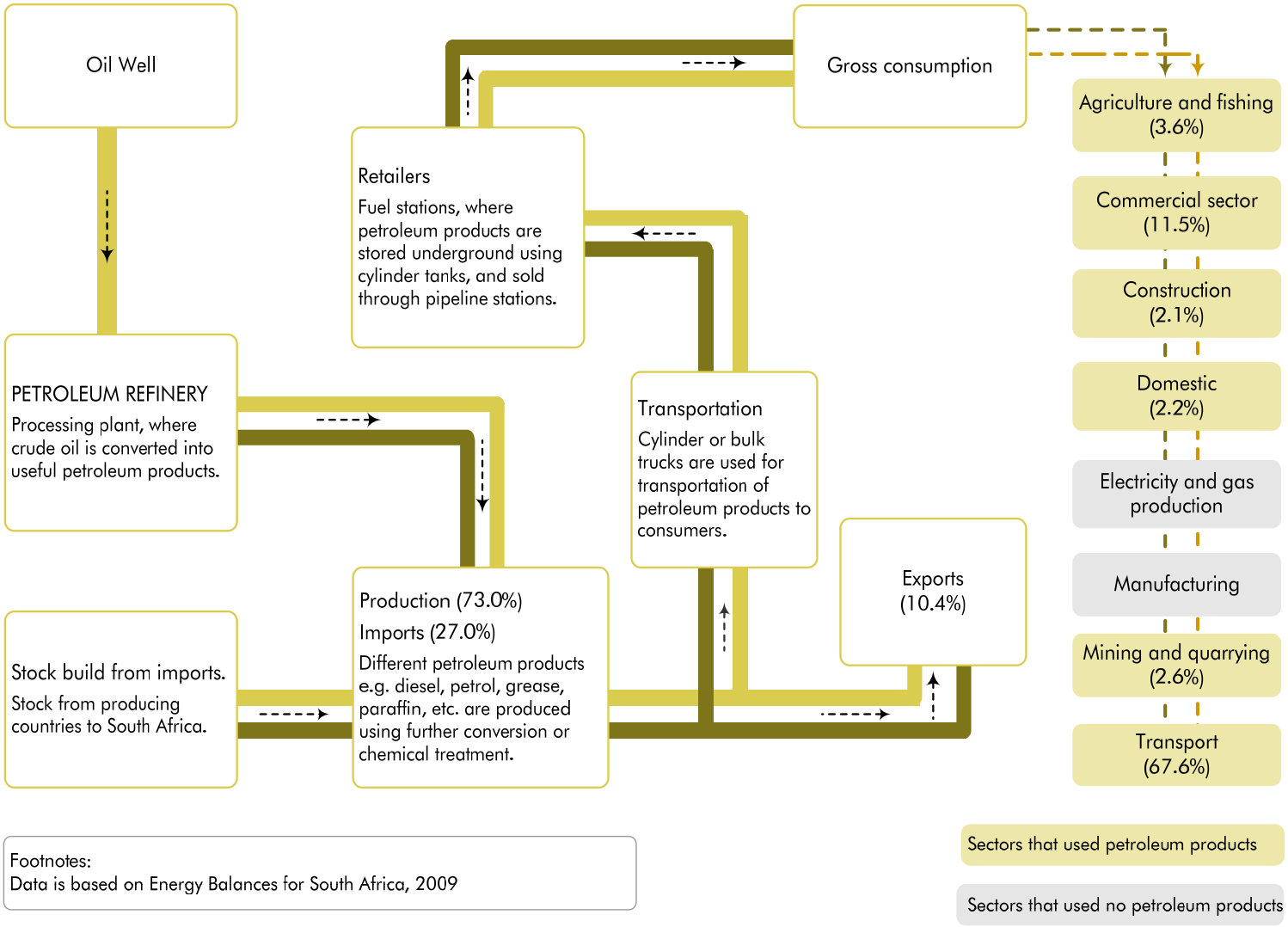
Figure 7 below show which sectors are the main users of gas.

Figure 5: Flow diagram for crude oil, 2009



Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

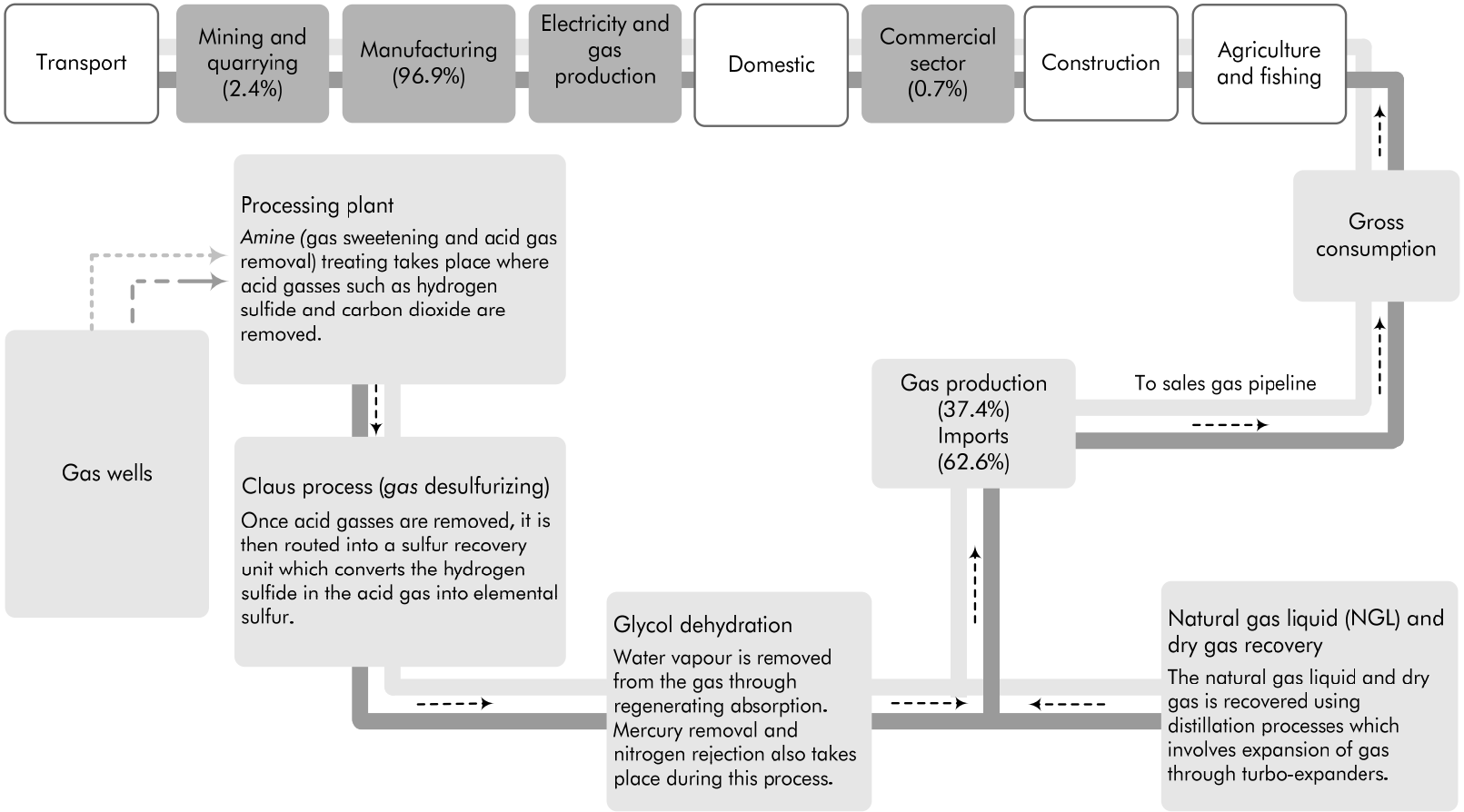
Figure 6: Flow diagram for petroleum products, 2009



Footnotes:
Data is based on Energy Balances for South Africa, 2009

Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

Figure 7: Flow diagram for gas, 2009



Foot notes:
South Africa has small oil and gas fields situated south off the coast of Mosselbay, at Oribi, Oryx as well as Sable. Limited oil and gas is supplied by these fields while the majority is imported and the small gas fields supply the Mossgas. Condensate wells produce raw natural gas along with a very low density liquid hydrocarbon called *natural gas condensate*.
Data is based on the Energy Balances for South Africa, 2009

Sectors that used gas energy

Sectors that used no gas energy

Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

3.1.4 Renewable energy

In 2010, the DoE was mandated to draft and publish the Integrated Energy Planning Strategy that led to the development of the Integrated Energy Plan, as envisaged in the National Energy Act, 2008 (Act No. 34 of 2008). Part of this legislation focuses on ensuring availability of a diversity of energy resources and its sustained use. In order to achieve government's efficiency target of 15% energy efficiency for industry and 12% nationally by 2015, there are a number of initiatives in place. Renewable energy sources, other than biomass, have not yet been exploited optimally in South Africa (refer to Figure 8). Some of the current initiatives that contribute to the National Energy-Efficiency Strategy are[4]:

- The World Bank has secured a US$3.75 billion loan to Eskom to fund solar and wind-electricity generation, with construction commencing in 2011.

- A climate change mitigation project worth R120 million between the DoE and the Swiss Agency for Development and Cooperation has been launched to fund climate-change mitigation. Part of the project will be to monitor the energy-efficiency targets in the public buildings of five municipalities, i.e. Sol Plaatje, Polokwane, King Sabata Dalindyebo, Rustenburg and Mbombela. The aim of the project is to contribute towards a significant reduction in energy consumption in the building sector through enhanced energy efficiency in the full life cycle of buildings.

- New national building standards was launched in 2010, regulating energy-efficiency for residential and commercial buildings, places of learning and worship, certain medical clinics and other categories of buildings in its design and construction that will facilitate energy saving on the electricity supply grid.

- The South African Centre for Carbon Capture and Storage was established in March 2009. The Carbon Dioxide Geological Storage Atlas was released in 2010. This atlas will assist with the capture and storage of carbon in South Africa.

- Through clean energy research, the DoE invested in an electric car and the prototype of a hybrid e-bike developed at the Tshwane University of Technology in 2010 (the hydrogen-fuelled bike is called 'hi Fambeni' that means 'let's go' in Tsonga).

- As a signatory to the Kyoto Protocol, the development of the Clean Development Mechanism (CDM), 'green' premium, etc.) 10 000 Gigawatt-hour (GWh) low-cost renewable energy technologies and applications are to be implemented, based on the level of commercialisation of the technology and the natural resource availability. These technologies include:

  - Sugar cane bagasse for co-generation (59%);
  - Landfill gas extraction (6%);
  - Mini-hydroelectric schemes (10%);
  - Commercial and domestic solar water heaters (23%);
  - Wind energy (1%); and
  - Biomass pulp and paper (1%).[4]

Biomass power

Renewable energy comprises biomass and natural processes that are replenishable as an energy source. Biomass is used commercially in pulp and paper mills and sugar refineries by burning bulk from logs, black liquor and bagasse to produce process heat. The energy produced is used by those industries to meet their needs. In future, some of this energy could be sold to the national grid (depending on electricity prices and environmental regulations). In households, biomass is used for cooking and heating. In 2010 the DoE launched the Working for Energy Programme, with the primary objective of using the feedstock created from clearing alien biomass vegetation to produce power. By mid-2010 the Industrial Development Corporation has committed R800 million for the development of bio-ethanol production.[1, 4]

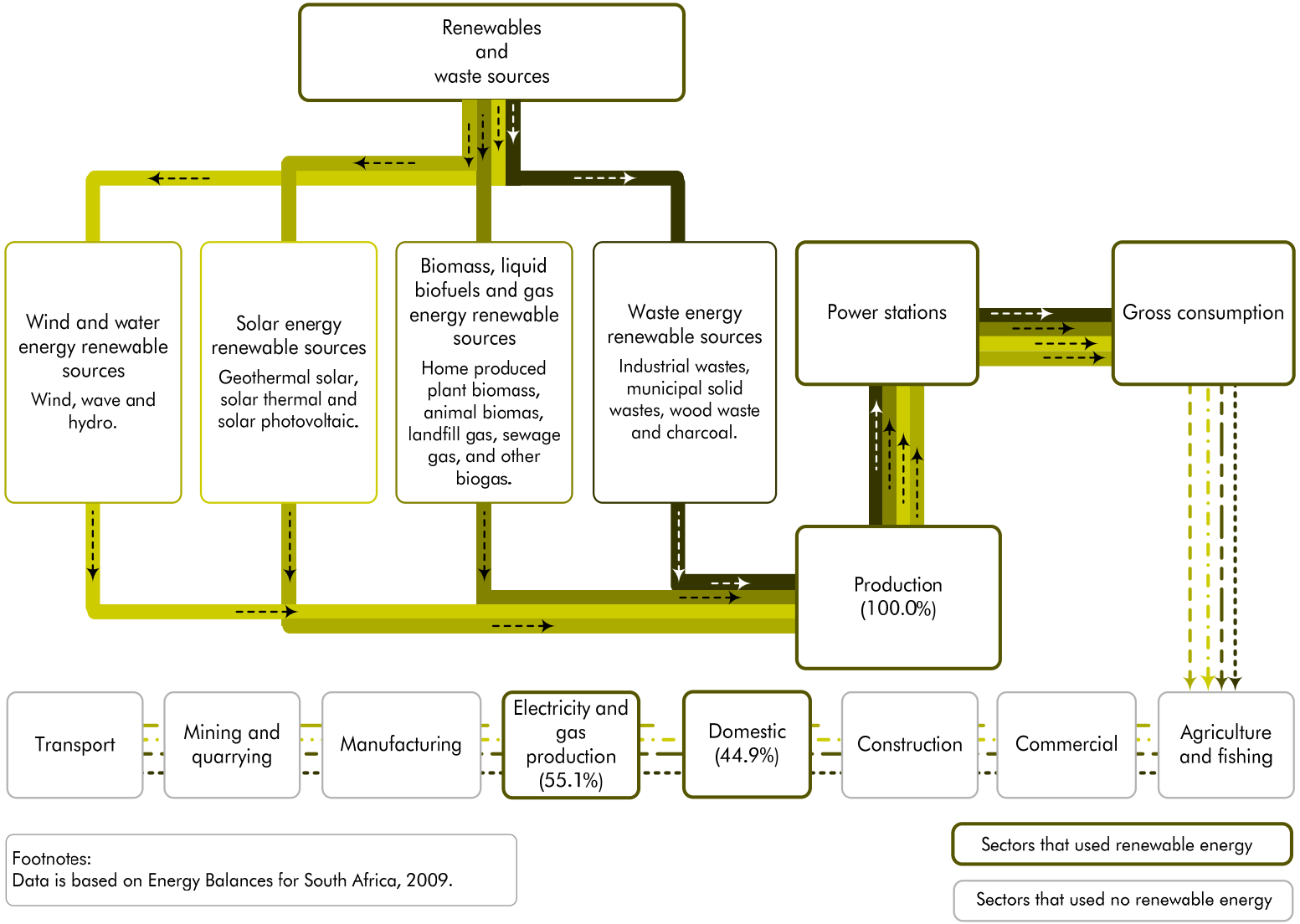
Solar power

Most areas in South Africa average more than 2 500 hours of sunshine per year, and average daily solar radiation levels range between 4.5 and 6.5 kilowatt-hour per square metre (kWh/m^2). The southern African region, and in fact the whole of Africa, is well endowed with sunshine all year round. The annual 24-hour global solar radiation average is about 220 watt per square metre (W/m^2) for South Africa, compared with about 150 W/m^2 for parts of the United States of America, and about 100 W/m^2 for Europe and the United Kingdom. South Africa has the potential for 36 217 GWh solar-thermal power generation per year. This makes the local resource one of the highest in the world. The solar resource is the most readily accessible in South Africa. It lends itself to a number of potential uses. The country's solar equipment industry is developing. Annual photovoltaic (PV) panel assembly capacity totals 5 MW, and a number of companies in South Africa manufacture solar water heaters. Solar power is increasingly being used for water pumping through the rural water provision and sanitation programme of the Department of Water Affairs. Low cost housing could be made 'energy smart' by using elementary solar-passive building designs, which could significantly benefit household energy costs. The national Solar Water-Heating Programme was launched in 2010 in the Winterveldt, aiming to contribute to the installation of at least one million solar water-heaters by 2014 to reduce the water-heating load on the national grid.[4]

Wave power (ocean energy)

Ocean energy could potentially be derived from the various characteristics of the sea. For example, the rise and fall of the waves could be converted into hydraulic pressure by mechanical compression devices. Such pressure could drive a turbine generator to produce electricity, while the tidal variation, sea current and different thermal layers in the ocean could also be used. The main reason why this energy resource is not currently being harnessed is that no reliable technology exists that can generate electricity from this resource. Various companies are testing systems internationally to develop technically viable solutions. Once technical reliability has been proven, cost effectiveness in relation to other solutions will have to be established. Eskom has continued with resource surveys of the Agulhas current on the east coast of South Africa and of wave energy, in partnership with the Department of Environmental Affairs (Oceans and Coasts Branch), and the Bayworld Centre for Research and Education. Results have proved the technical feasibility of extracting significant large-scale renewable energy from the current.[4]

Figure 8: Flow diagram for renewable energy, 2009



Footnotes:
Data is based on Energy Balances for South Africa, 2009.

Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

Wind power

Eskom's Klipheuwel, just north of Cape Town, is the first large wind turbine facility in sub-Saharan Africa. The pilot phase of the Klipheuwel research and demonstration project ran from August 2002 to the end of 2005. During that time, the Klipheuwel pilot wind farm generated more than 12 GWh of electricity, reducing carbon dioxide emissions by 11 000 tonnes. The three wind turbines operated at an average availability of 90%. The project's research phase has been completed and this pilot wind farm will be operated commercially for its anticipated 20-year lifespan as calculated from 2006.

In August 2006, the City of Cape Town signed a 20-year agreement to buy 'clean' electricity from the Darling Wind Farm. Local and foreign investors, government and the community of Darling, a small town north-west of Cape Town, will collaborate to make South Africa's first commercial wind-farm venture operational. The R75 million pilot project for generation of commercial wind energy started its operations in 2007. The Darling Wind Farm is feeding the national power grid by using four giant wind turbines to generate 5.2 GWh of green-energy per year. The City of Cape Town has signed a power purchase agreement granting them the entire production for 20 years at a negotiated tariff. The city will use half for its own needs and sell the remaining power to individuals and companies supporting green electricity generation.

The environmental benefits of the Darling Wind Farm are:

- Avoiding the release of carbon dioxide into the atmosphere;
- Avoiding the release of other pollutants into the atmosphere as is the case with coal power generation;
- Saving of fossil fuel and water; and
- Health impacts, job creation, and tourism attraction.[7]

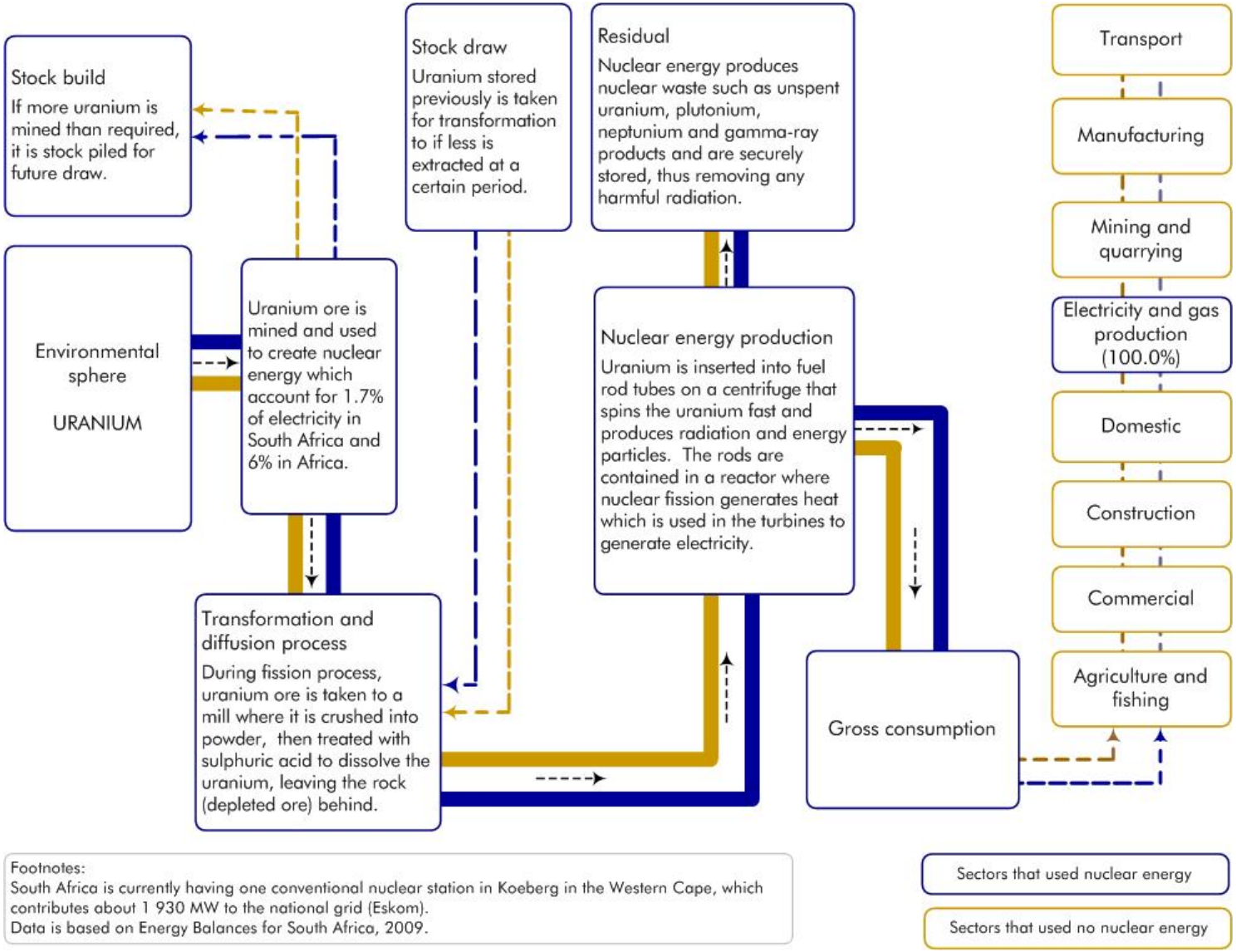
In 2010 a commercial wind farm was launched at the Coega Industrial Development Zone in Port Elizabeth. This wind farm has a generation capacity of 57.5 MW, which is roughly 10% of the Nelson Mandela Bay electricity consumption, and can power 80 000 homes with green energy.[4]

3.1.5 Nuclear power

The nuclear sector in South Africa is mainly governed by the Nuclear Energy Act, 1999 (Act No. 46 of 1999), and the National Nuclear Regulator (NNR) Act, 1999 (Act No. 47 of 1999). The DoE administers these acts. The Department of Health administers the Hazardous Substances Act, 1973 (Act No. 15 of 1973), related to groups III and IV hazardous substances.

The long-term vision is for South Africa to become globally competitive in the use of innovative technology for the design, manufacture and use of state-of-the-art nuclear energy systems and power reactors as part of the energy mix, as well as the deployment of nuclear fuel cycle systems to ensure security of supply. These nuclear reactors will play a role in mitigating climate change by reducing greenhouse gas emissions. Eskom is investigating the possibility of generating up to 20 000 MW of new nuclear power capacity by 2025. The South African Nuclear Energy Corporation is doing research and development in the fields of nuclear energy and its applications. The Koeberg Nuclear Power Station, the only nuclear power station on the African continent, generates about 2% of total electricity in South Africa and about 6% of total electricity in Africa. (Refer to Figure 9).[4]

Figure 9: Flow diagram for nuclear power, 2009



Footnotes:
South Africa is currently having one conventional nuclear station in Koeberg in the Western Cape, which contributes about 1 930 MW to the national grid (Eskom).
Data is based on Energy Balances for South Africa, 2009.

Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

3.1.6 Hydroelectric power

An assessment conducted by the DoE, the Baseline Study on Hydropower in South Africa, indicated that specific areas in the country show significant potential for developing all categories of hydropower in the short and medium terms. The Eastern Cape and KwaZulu-Natal are endowed with the best potential for developing small, i.e. less than 10 MW hydropower plants. The advantages and attractiveness of these plants are that they can either be stand-alone or can exist in a hybrid combination with other renewable energy sources. Advantages can be derived from the association with other uses of water (e.g. water supply, irrigation, flood control, etc.), which are critical to the future economic and socio-economic development of South Africa.

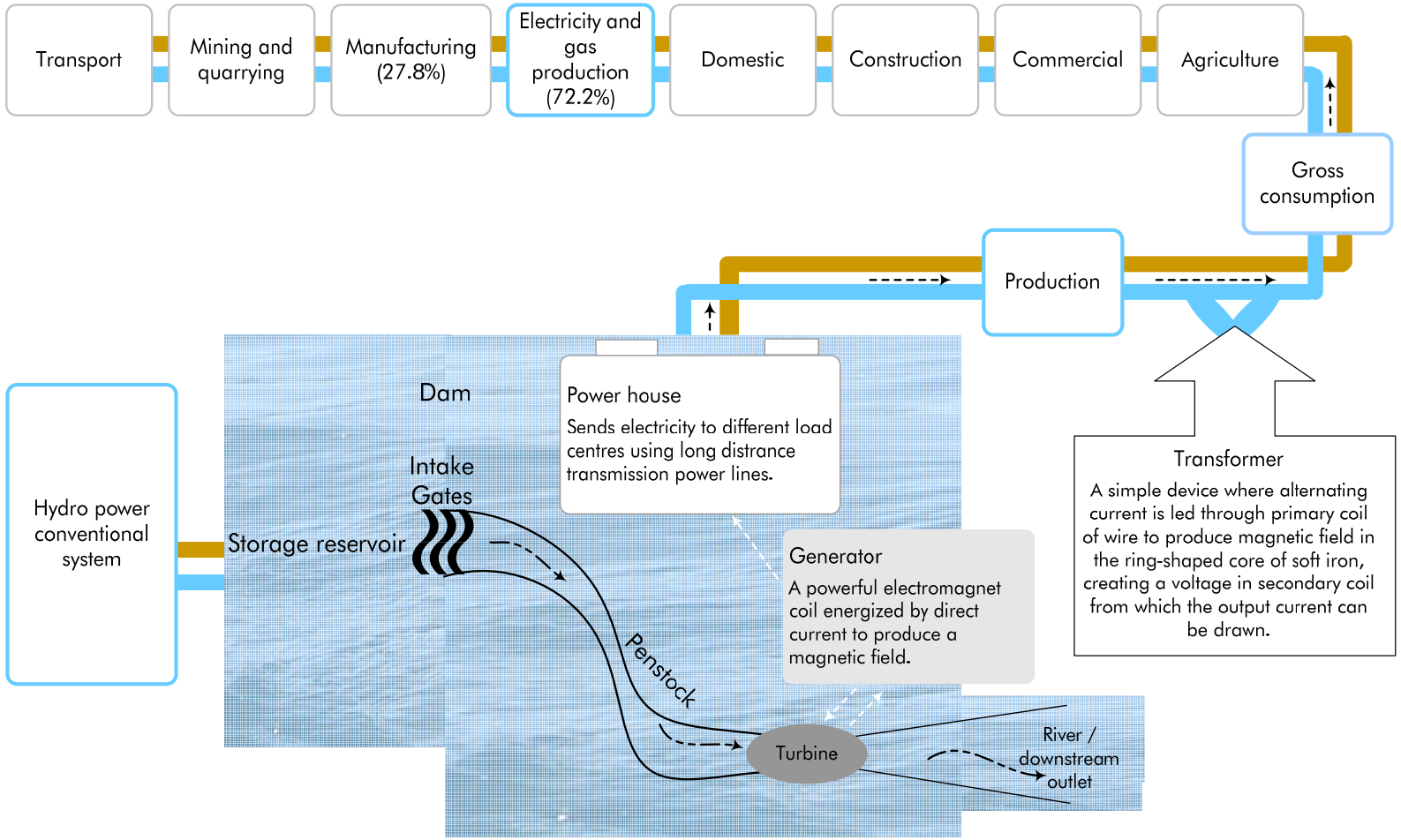
Eskom has started the construction of the Ingula pumped storage scheme (1 332 MW) near Van Reenen, KwaZulu-Natal. It is expected that the first unit will be operational in 2013. Preliminary work for the design and construction of a second pumped storage scheme in Mpumalanga has commenced. As peak demand for electricity continues to grow, Eskom will continue to explore the development of new hydroelectric and pumped storage schemes.

The South African Power Pool (SAPP) allows for the free trading of electricity between members of the Southern African Development Countries, providing South Africa with access to the vast hydropower potential in the countries to the north, notably the significant potential in the Congo River (Inga Falls). The main project outside South Africa's borders is Westcor. It entails a five-way intergovernmental memorandum of understanding signed between the utilities of the Democratic Republic of Congo, Angola, Namibia, Botswana and South Africa. Westcor will tap into some of the potential in the Democratic Republic of Congo. The first project is Inga III, a 3 500 MW hydro plant on the Congo River.

At the same time, the countries to the north could benefit through access to the coal-fired power resources in the south. Such an arrangement should stabilise the energy requirements of the region well into this century. Exploitation of the vast hydropower resources will constitute a significant infusion of renewable energy resources into the energy economy of the region over the medium to long term. The Lesotho Highlands Water Project can contribute some 72 MW of hydroelectric power to the system in the short term.

Global pressures regarding the environmental impact and displacement of settlements by huge storage dams are likely to limit the exploitation of hydropower on a large scale. Irrespective of the size of installation, any hydropower development will require authorisation in terms of the National Water Act, 1998 (Act No. 36 of 1998). (Refer to Figure 10).[1, 4]

Figure 10: Flow diagram for hydroelectric power, 2009



Footnotes:
South Africa has two hydro power systems in operation, i.e. the conventional system and the pumped storage systems.
Data is based on Energy Balances for South Africa 2009.

Sectors that used hydropower

Sectors that used no hydropower

Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

3.2 Sectors concerned with energy use

For the purpose of energy use, the South African economy can be divided into the following sectors: industrial (including commercial and agricultural sectors), residential and transport. Each of these sectors is discussed in more detail below.

The table below shows the main users of electricity, excluding electricity and gas production.

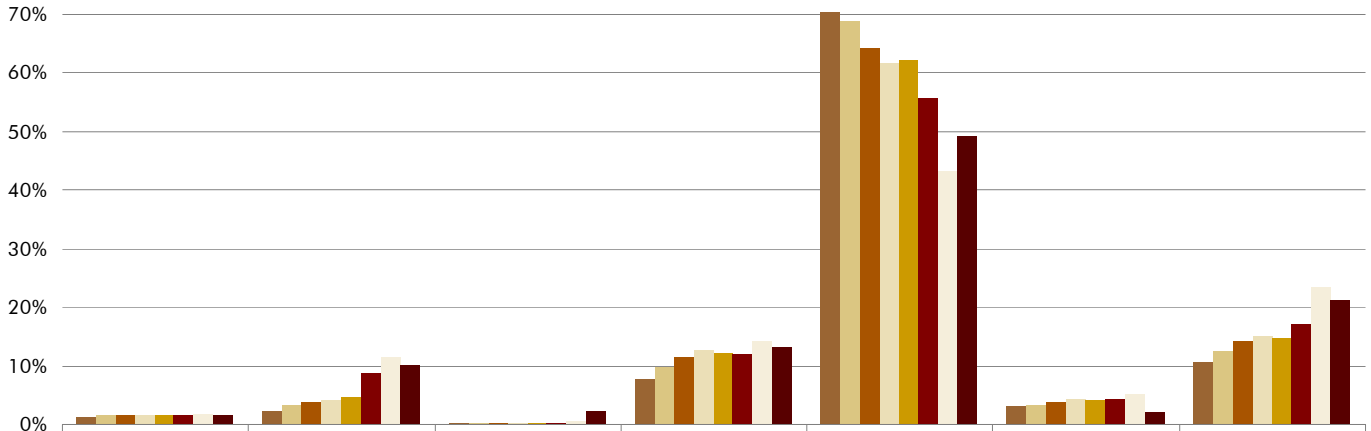
Table 1: Main users of energy in South Africa, 2002–2009

Intermediate consumption by main users	2002	2003	2004	2005	2006	2007	2008	2009
				Terajoules				
Agriculture and fishing	72 904	74 998	77 988	71 534	70 385	71 441	70 241	69 242
Commercial	143 597	171 599	194 992	197 644	224 133	420 637	459 064	437 245
Construction	15 816	16 939	15 982	16 535	15 665	17 302	25 344	96 916
Domestic	459 920	510 980	552 888	592 930	601 305	567 418	580 124	570 769
Manufacturing	4 462 893	3 602 037	3 109 626	2 888 487	3 036 673	2 619 092	1 732 371	2 103 786
Mining and quarrying	183 795	180 699	190 274	204 592	201 982	206 350	211 374	88 804
Transport, storage and communication	636 332	656 520	698 552	710 943	726 596	803 918	942 397	914 885
Total sector use in TJ	5 975 257	5 213 772	4 840 301	4 682 665	4 876 738	4 706 158	4 020 915	4 281 647

Intermediate consumption by main users	2002	2003	2004	2005	2006	2007	2008	2009
				Percentage (Terajoules)				
Agriculture and fishing	1.2%	1.4%	1.6%	1.5%	1.4%	1.5%	1.7%	1.6%
Commercial	2.4%	3.3%	4.0%	4.2%	4.6%	8.9%	11.4%	10.2%
Construction	0.3%	0.3%	0.3%	0.4%	0.3%	0.4%	0.6%	2.3%
Domestic	7.7%	9.8%	11.4%	12.7%	12.3%	12.1%	14.4%	13.3%
Manufacturing	74.7%	69.1%	64.2%	61.7%	62.3%	55.7%	43.1%	49.1%
Mining and quarrying	3.1%	3.5%	3.9%	4.4%	4.1%	4.4%	5.3%	2.1%
Transport, storage and communication	10.6%	12.6%	14.4%	15.2%	14.9%	17.1%	23.4%	21.4%
Total sector use (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Due to rounding, discrepancies may appear in totals.
Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

Figure 11: Percentage distribution of energy to the main users in South Africa, 2002–2009



	Agriculture and fishing	Commercial sector	Construction	Domestic	Manufacturing	Mining and quarrying	Transport, storage and communication
2002	1.2%	2.4%	0.3%	7.7%	74.7%	3.1%	10.6%
2003	1.4%	3.3%	0.3%	9.8%	69.1%	3.5%	12.6%
2004	1.6%	4.0%	0.3%	11.4%	64.2%	3.9%	14.4%
2005	1.5%	4.2%	0.4%	12.7%	61.7%	4.4%	15.2%
2006	1.4%	4.6%	0.3%	12.3%	62.3%	4.1%	14.9%
2007	1.5%	8.9%	0.4%	12.1%	55.7%	4.4%	17.1%
2008	1.7%	11.4%	0.6%	14.4%	43.1%	5.3%	23.4%
2009	1.6%	10.2%	2.3%	13.3%	49.1%	2.1%	21.4%

Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

3.2.1 Residential sector

The residential or domestic sector used less than 15% of electricity from 2002 to 2009 (see Figure 11). The sector is subdivided into urban and rural areas. Different types of households use energy mainly for cooking, water heating, space heating as well as lighting. Most people in urban areas rely on the use of electricity; however, residents in rural areas might use mainly wood for their energy source. Residential energy falls into three categories:

- Traditional fuels, consisting of wood, dung and bagasse;
- Transitional fuels, consisting of coal, paraffin and LPG; and
- Modern fuels, consisting of electricity.

It is expected that in the future the trend from traditional fuels through transitional fuels to electricity is likely to continue, based on previous experiences. Electricity allows for more efficient energy use than coal, wood and paraffin although more energy can get consumed for water heating. It is also expected that there will be a growth in demand for energy for non-essential appliances such as televisions. Residential energy use is expected to grow at the same rate as the population.[1, 4]

3.2.2 Industrial sector

In South Africa, the industrial sector is the largest user of energy at slightly over 65% in 2009. The sector is divided into various sub-sectors, namely the manufacturing industry, the commercial sector, agriculture and mining (see Figure 12 below).

3.2.2.1 Manufacturing

The manufacturing industry, which includes various sub-groupings such as iron and steel, chemicals, non-ferrous metals, non-metallic minerals, pulp and paper, food and tobacco, and other non-specified industries, is the largest consumer of energy at 49% in 2009. The sub-group that uses the most energy is the iron and steel industry, followed by non-specified industries and the third largest use of energy is the chemical and petrochemical industry.[1]

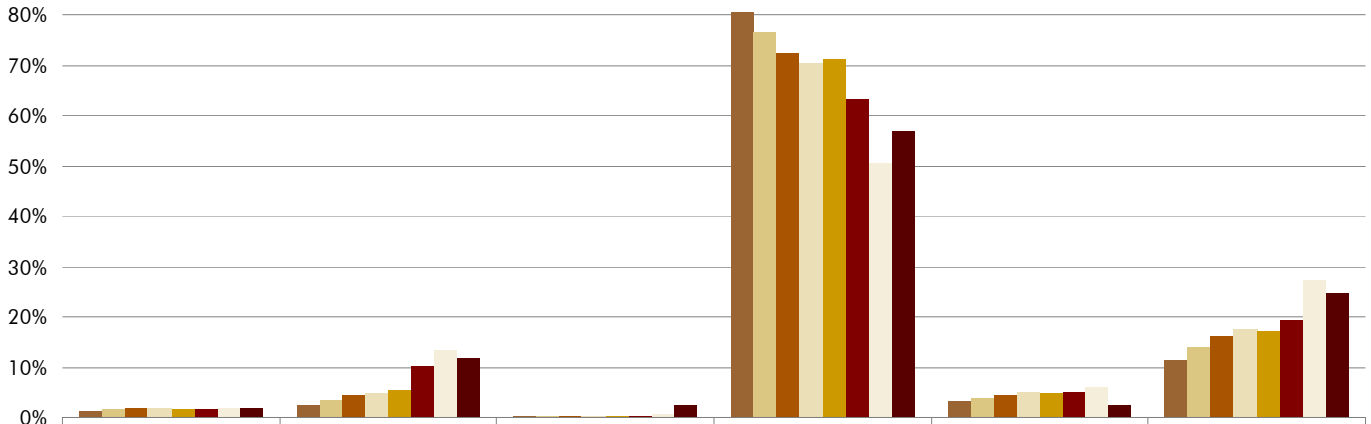
3.2.2.2 Commerce

The commercial sector (including public services) is very small, even though it is growing at a fast rate with energy use of just obove 10% in 2009. This sector consists of government, office buildings, financial institutions, shops, and recreation and education. Energy in this sector is used mainly for lighting, heating and air-conditioning but, office machines such as computers, fax machines and printers are starting to play a bigger role as energy users. Electricity contributes the most to the commercial sector's energy use. Electricity is likely to take an even bigger share of energy for this sector in future.[1]

3.2.2.3 Agriculture

The agricultural sector is smaller than the commercial sector in terms of energy consumption and the energy use was less than 2% in 2009. The fuels used in the agricultural sector included electricity, petroleum and gas. As economies mature, agriculture forms a smaller share of the national employment, large farms replace smaller ones and agriculture produces a smaller fraction of GDP. However, with land reform, many new small farms are likely to arise, and these will almost certainly use traditional farming methods on small plots, including the use of vegetable wastes for energy. On the other hand, globalisation and commercialisation of farming are likely to lead to fewer commercial farmers with bigger farms and increased exports and imports. This will lead to a search for more energy efficiency. The latter trend is almost certain to prevail for agricultural energy demand and it is expected that the importance of diesel and electricity will increase, while that of vegetable wastes will decline.[1, 4]

Figure 12: Percentage distribution of energy to the industrial sub-sectors* in South Africa, 2002–2009



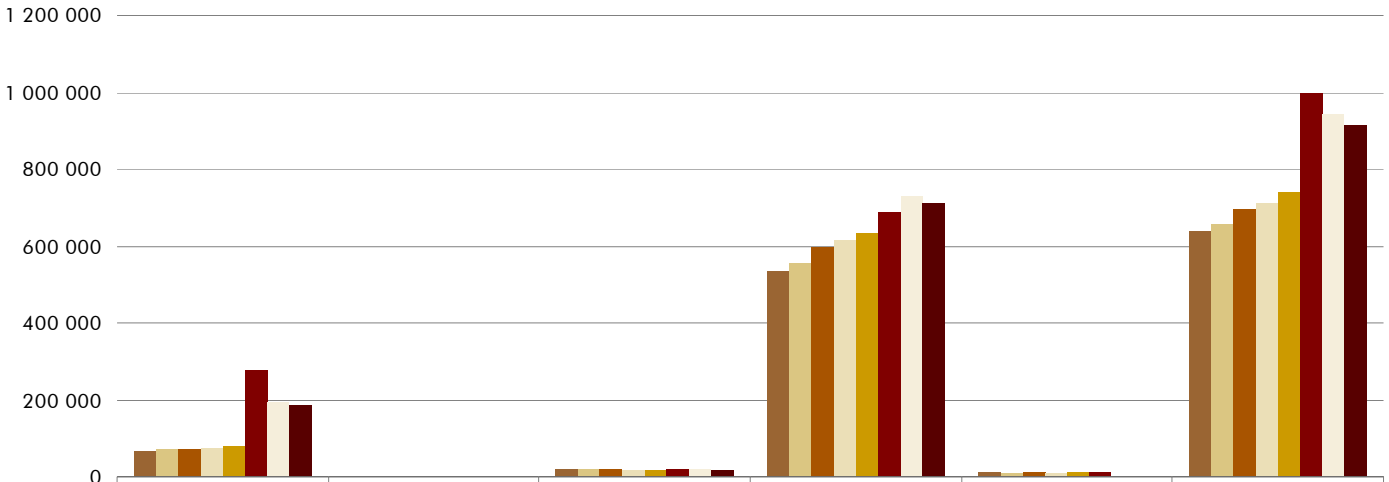
	Agriculture and fishing	Commercial sector	Construction	Manufacturing	Mining and quarrying	Transport, storage and communication
2002	1.3%	2.6%	0.3%	80.9%	3.3%	11.5%
2003	1.6%	3.6%	0.4%	76.6%	3.8%	14.0%
2004	1.8%	4.5%	0.4%	72.5%	4.4%	16.3%
2005	1.7%	4.8%	0.4%	70.6%	5.0%	17.4%
2006	1.6%	5.2%	0.4%	71.0%	4.7%	17.0%
2007	1.7%	10.2%	0.4%	63.3%	5.0%	19.4%
2008	2.0%	13.3%	0.7%	50.3%	6.1%	27.4%
2009	1.9%	11.8%	2.6%	56.7%	2.4%	24.7%

*Excluding domestic.
Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

3.2.2.4 Mining

The energy required to extract gold has increased due to the depth of extraction and processing more ore for each tonne of gold. Electricity contributes 56% to mining's energy use mix. Coal, petroleum products, and gas provide the other sources of direct energy to the mining industry. The mining and quarrying sector's energy use was just obove 2% in 2009.

Figure 13: Energy consumption in terajoules per transport sub-sector, 2002–2009



	Air	Transport via pipeline	Rail	Road	Non-specified	Total transport
2002	68 517	221	21 340	536 128	10 126	636 332
2003	72 615	278	20 667	555 363	7 596	656 520
2004	72 323	290	19 726	596 076	10 136	698 552
2005	75 931	284	14 726	612 564	7 439	710 943
2006	79 049	284	14 702	632 560	12 154	738 749
2007	277 685	318	18 350	689 566	12 154	998 073
2008	193 743	339	18 776	728 225	1 314	942 397
2009	186 958	355	14 265	711 450	1 856	914 885

Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

3.2.3 Transport

The transport sector deals with transport of people and goods by land, sea and air. Energy for transport is completely dominated by liquid fuels, such as petrol, diesel and jet fuel. It is very difficult to switch from fossil fuels to other sources of energy in this sector. Land transport is dominated by petrol and diesel with some electricity used by trains. Air transport uses jet fuel for gas turbine engines and aviation gas for piston engines. There are however, very few piston engines in the air these days. On the other end marine engines are nearly entirely diesel. Figure 13 below shows the energy consumption by various sub-sectors in the transport sector. Energy use by the transport sector was more than 21% in 2009.[1, 4]

4. Energy supply and use tables for South Africa, 2002–2009

Physical energy accounts should be constructed as extended supply and use tables. Usually the energy supply and use accounts will include both the monetary as well as the physical units. The energy accounts for South Africa are only presented in physical units at this time, the reason being that the accounts are based on the Energy Balances compiled by the DoE and are presented in physical units only. The DoE follows the International Energy Agency (IEA) framework when compiling the Energy Balances. According to the Energy Statistics Manual (2005), the main aim of the Energy Balances (measured in physical units) is to serve as indicators of energy consumption and energy efficiency. This is done at a national level for every energy commodity in use, with the aim to make international comparisons. The IEA framework uses the International System of Units (SI) (i.e. modern metric system) that is used by all countries compiling Energy Balances. The SI converts to one unit of measure, e.g. terajoule, to energy commodities which makes it easy to understand and comparable, especially if correct conversions are applied. This section presents the energy supply and use accounts for South Africa from 2002 to 2009.

The main energy resources used in South Africa are listed in the columns and the sectors are given in the rows of the tables. Energy supply has to equal energy use in the column totals in order for the accounts to balance. All of the resources used are expressed in terajoules (TJ).

Supply of products is defined as domestic production plus import of the various energy commodities, whereas total product use is defined by the intermediate use by industries, household consumption, inventory changes and exports. The use table shows the use of natural resources, for example the use of coal, gas and oil extracted by the mining industries.

An important distinction has to be made between primary energy sources, classified into fossil fuels and renewable energy sources (such as water power and solar energy), and secondary energy sources such as electricity and refined petroleum products which have been produced from the transformation of a primary energy source. Use of a product refers to the consumption of the product by various industries and households. Exports, losses in distribution and statistical differences are included in the use table.

One should keep in mind that the energy accounts should include both primary and secondary energy sources. There is thus double counting in the sense that both primary energy (e.g. coal) and the converted energy (e.g. electricity produced by coal and other primary resources) are included. This is not different from other monetary and physical supply and use tables for products in which both raw materials and finished products appear. Tables 2 to 17 are the supply and use tables that include data from the Energy Balances, 2002–2009.[8]

Table 2: Energy supply table for South Africa, 2002

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nu clear	Petroleum	Renewable energy and waste	Total energy supply
					Terajoules				
a. Domestic production	5 515 609	10 589	752 919	127 137	8 485	130 811	2 428 027	426 467	9 400 045
b. Imports	49 054	1 447 465	34 186	0	0	0	67 946	0	1 598 650
c. Total supply (a+b)	5 564 663	1 458 054	787 105	127 137	8 485	130 811	2 495 973	426 467	10 998 695

Source: Department of Energy, *Energy Balances, 2002*.

Table 3: Energy use table for South Africa, 2002

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy use
					Terajoules				
a. Intermediate consumption by industries	3 513 139	1 453 533	567 234	127 137	8 485	130 811	1 957 354	236 067	7 993 761
Agriculture and fishing	*2 455*	*0*	*16 719*	*0*	*0*	*0*	*53 730*	*0*	*72 904*
Commercial	*45 524*	*0*	*65 618*	*293*	*0*	*0*	*32 162*	*0*	*143 597*
Construction	*0*	*0*	*415*	*0*	*0*	*0*	*15 401*	*0*	*15 816*
Electricity, gas and steam production	*2 015 364*	*0*	*3 933*	*83 764*	*8 485*	*130 811*	*0*	*236 067*	*2 478 424*
Manufacturing	*1 410 577*	*1 453 533*	*342 132*	*42 636*	*0*	*0*	*1 214 014*	*0*	*4 462 893*
Mining and quarrying	*39 218*	*0*	*115 933*	*412*	*0*	*0*	*28 231*	*0*	*183 795*
Transport, storage and communication	*0*	*0*	*22 485*	*31*	*0*	*0*	*613 816*	*0*	*636 332*
b. Inventory changes	21 216	0	0	0	0	0	0	0	21 216
c. Private consumption, total	89 564	0	144 048	0	0	0	35 909	190 400	459 920
Heating, use of electricity, etc.	*89 564*	*0*	*144 048*	*0*	*0*	*0*	*35 909*	*190 400*	*459 920*
d. Exports	1 940 743	4 520	26 071	0	0	0	502 711	0	2 474 046
e. Losses in distribution	0	0	49 752	0	0	0	0	0	49 752
f. Total use (a+b+c+d+e)	5 564 663	1 458 054	787 105	127 137	8 485	130 811	2 495 973	426 467	10 998 695

Note: Due to rounding, discrepancies may appear in totals.
Source: Department of Energy, *Energy Balances, 2002*.

Table 4: Energy supply table for South Africa, 2003

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy supply
					Terajoules				
a. Domestic production	5 796 818	5 144	784 879	99 062	2 890	138 142	2 255 901	430 427	9 513 263
b. Imports	49 171	732 330	29 498	0	0	0	41 398	0	852 397
c. Total supply (a+b)	5 845 989	737 474	814 378	99 062	2 890	138 142	2 297 299	430 427	10 365 660

Source: Department of Energy, *Energy Balances, 2003*.

Table 5: Energy use table for South Africa, 2003

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy use
					Terajoules				
a. Intermediate consumption by industries	3 689 010	737 455	548 539	99 062	2 890	138 142	1 908 121	240 027	7 363 246
Agriculture and fishing	*3 322*	*0*	*18 515*	*0*	*0*	*0*	*53 162*	*0*	*74 998*
Commercial	*52 259*	*0*	*75 856*	*95*	*0*	*0*	*43 389*	*0*	*171 599*
Construction	*0*	*0*	*479*	*0*	*0*	*0*	*16 460*	*0*	*16 939*
Electricity, gas and steam 0production	*2 214 718*	*0*	*14 460*	*50 218*	*2 890*	*138 142*	*0*	*240 027*	*2 660 454*
Manufacturing	*1 381 877*	*737 455*	*308 339*	*46 415*	*0*	*0*	*1 127 950*	*0*	*3 602 037*
Mining and quarrying	*36 835*	*0*	*110 857*	*2 334*	*0*	*0*	*30 673*	*0*	*180 699*
Transport, storage and communication	*0*	*0*	*20 034*	*0*	*0*	*0*	*636 486*	*0*	*656 520*
b. Inventory changes	49 346	0	0	0	0	0	0	0	49 346
c. Private consumption, total	103 027	0	177 915	0	0	0	39 637	190 400	510 980
Heating, use of electricity etc.	*103 027*	*0*	*177 915*	*0*	*0*	*0*	*39 637*	*190 400*	*510 980*
d. Exports	2 004 606	19	36 947	0	0	0	349 541	0	2 391 112
e. Losses in distribution	0	0	50 976	0	0	0	0	0	50 976
f. Total use (a+b+c+d+e)	5 845 989	737 474	814 378	99 062	2 890	138 142	2 297 299	430 427	10 365 660

Note: Due to rounding, discrepancies may appear in totals.
Source: Department of Energy, *Energy Balances, 2003*.

Table 6: Energy supply table for South Africa, 2004

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy supply
					Terajoules				
a. Domestic production	5 840 254	206 292	890 631	120 862	2 890	145 801	1 058 263	430 427	8 695 420
b. Imports	52 106	1 006 341	35 345	6 981	0	0	82 675	0	1 183 446
c. Total supply (a+b)	5 892 359	1 212 633	925 976	127 842	2 890	145 801	1 140 938	430 427	9 878 867

Source: Department of Energy, *Energy Balances, 2004*.

Table 7: Energy use table for South Africa, 2004

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy use
					Terajoules				
a. Intermediate consumption by industries	3 919 385	1 212 607	661 668	127 842	2 890	145 801	819 042	240 027	7 129 263
Agriculture and fishing	*3 155*	*0*	*22 172*	*0*	*0*	*0*	*52 661*	*0*	*77 988*
Commercial	*60 791*	*0*	*89 963*	*310*	*0*	*0*	*43 928*	*0*	*194 992*
Construction	*0*	*0*	*187*	*0*	*0*	*0*	*15 796*	*0*	*15 982*
Electricity, gas and steam production	*2 360 170*	*0*	*15 790*	*77 172*	*2 890*	*145 801*	*0*	*240 027*	*2 841 850*
Manufacturing	*1 456 283*	*1 212 607*	*392 687*	*48 049*	*0*	*0*	*0*	*0*	*3 109 626*
Mining and quarrying	*38 987*	*0*	*118 180*	*2 312*	*0*	*0*	*30 795*	*0*	*190 274*
Transport, storage and communication	*0*	*0*	*22 689*	*0*	*0*	*0*	*675 863*	*0*	*698 552*
b. Inventory changes	-53 861	0	0	0	0	0	0	0	-53 861
c. Private consumption, total	121 581	0	197 629	0	0	0	43 278	190 400	552 888
Heating, use of electricity etc.	*121 581*	*0*	*197 629*	*0*	*0*	*0*	*43 278*	*190 400*	*552 888*
d. Exports	1 905 254	25	47 714	0	0	0	278 618	0	2 231 611
e. Losses in distribution	0	0	18 965	0	0	0	0	0	18 965
f. Total use (a+b+c+d+e)	5 892 359	1 212 633	925 976	127 842	2 890	145 801	1 140 938	430 427	9 878 867

Note: Due to rounding, discrepancies may appear in totals.
Source: Department of Energy, *Energy Balances, 2004*.

Table 8: Energy supply table for South Africa, 2005

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy supply
					Terajoules				
a. Domestic production	5 793 803	282 359	832 538	124 505	4 199	123 193	1 190 715	430 427	8 781 738
b. Imports	57 616	772 180	39 884	45 383	0	0	102 500	0	1 017 563
c. Total supply (a+b)	5 851 419	1 054 539	872 422	169 888	4 199	123 193	1 293 215	430 427	9 799 301

Source: Department of Energy, *Energy Balances, 2005*.

Table 9: Energy use table for South Africa, 2005

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy use
					Terajoules				
a. Intermediate consumption by industries	3 516 383	1 054 319	587 528	169 888	4 199	123 193	821 749	240 027	6 517 286
Agriculture and fishing	*379*	*0*	*19 871*	*0*	*0*	*0*	*51 284*	*0*	*71 534*
Commercial	*68 155*	*0*	*97 572*	*326*	*0*	*0*	*31 592*	*0*	*197 644*
Construction	*0*	*0*	*188*	*0*	*0*	*0*	*16 347*	*0*	*16 535*
Electricity, gas and steam production	*1 962 168*	*0*	*14 988*	*82 976*	*4 199*	*123 193*	*0*	*240 027*	*2 427 551*
Manufacturing	*1 428 615*	*1 054 319*	*321 523*	*84 029*	*0*	*0*	*0*	*0*	*2 888 487*
Mining and quarrying	*57 066*	*0*	*113 425*	*2 557*	*0*	*0*	*31 543*	*0*	*204 592*
Transport, storage and communication	*0*	*0*	*19 961*	*0*	*0*	*0*	*690 982*	*0*	*710 943*
b. Inventory changes	197 741	0	0	0	0	0	0	0	197 741
c. Private consumption, total	135 343	0	227 766	0	0	0	39 420	190 400	592 930
Heating, use of electricity etc.	*135 343*	*0*	*227 766*	*0*	*0*	*0*	*39 420*	*190 400*	*592 930*
d. Exports	2 001 951	219	48 319	0	0	0	432 045	0	2 482 535
e. Losses in distribution	0	0	8 809	0	0	0	0	0	8 809
f. Total use (a+b+c+d+e)	5 851 419	1 054 539	872 422	169 888	4 199	123 193	1 293 215	430 427	9 799 301

Note: Due to rounding, discrepancies may appear in totals.
Source: Department of Energy, *Energy Balances, 2005*.

Table 10: Energy supply table for South Africa, 2006

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy supply
					Terajoules				
a. Domestic production	5 788 411	287 766	856 008	125 797	9 895	109 375	991 004	430 427	8 598 682
b. Imports	57 428	926 356	38 246	52 202	0	0	135 264	0	1 209 496
c. Total supply (a+b)	5 845 839	1 214 122	894 255	177 998	9 895	109 375	1 126 267	430 427	9 808 178

Source: Department of Energy, *Energy Balances, 2006*.

Table 11: Energy use table for South Africa, 2006

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy use
					Terajoules				
a. Intermediate consumption by industries	3 568 553	1 193 284	601 218	177 998	9 895	109 375	853 589	240 027	6 753 939
Agriculture and fishing	*763*	*0*	*21 029*	*0*	*0*	*0*	*48 592*	*0*	*70 385*
Commercial	*76 399*	*0*	*103 798*	*864*	*0*	*0*	*43 071*	*0*	*224 133*
Construction	*0*	*0*	*194*	*0*	*0*	*0*	*15 470*	*0*	*15 665*
Electricity, gas and steam production	*2 032 129*	*0*	*14 766*	*72 314*	*9 895*	*109 375*	*0*	*240 027*	*2 478 506*
Manufacturing	*1 405 978*	*1 193 284*	*335 491*	*101 920*	*0*	*0*	*0*	*0*	*3 036 673*
Mining and quarrying	*53 282*	*0*	*113 412*	*2 900*	*0*	*0*	*32 388*	*0*	*201 982*
Transport, storage and communication	*0*	*0*	*12 527*	*0*	*0*	*0*	*714 069*	*0*	*726 596*
b. Inventory changes	197 741	0	0	0	0	0	424	0	198 165
c. Private consumption, total	152 604	0	219 435	0	0	0	38 867	190 400	601 305
Heating, use of electricity etc.	*152 604*	*0*	*219 435*	*0*	*0*	*0*	*38 867*	*190 400*	*601 305*
d. Exports	1 926 942	20 838	48 920	0	0	0	233 387	0	2 230 088
e. Losses in distribution	0	0	24 682	0	0	0	0	0	24 682
f. Total use (a+b+c+d+e)	5 845 839	1 214 122	894 255	177 998	9 895	109 375	1 126 267	430 427	9 808 178

Note: Due to rounding, discrepancies may appear in totals.
Source: Department of Energy, *Energy Balances, 2006*.

Table 12: Energy supply table for South Africa, 2007

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy supply
					Terajoules				
a. Domestic production	5 862 309	7 680	796 827	143 778	21 041	123 458	949 373	430 427	8 334 892
b. Imports	55 280	942 360	38 246	45 383	0	0	295 408	0	1 376 677
c. Total supply (a+b)	5 917 588	950 040	835 073	189 162	21 041	123 458	1 244 781	430 427	9 711 570

Source: Department of Energy, *Energy Balances, 2007*.

Table 13: Energy use table for South Africa, 2007

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy use
					Terajoules				
a. Intermediate consumption by industries	3 648 792	820 023	643 337	189 162	21 041	123 458	1 008 948	236 272	6 691 034
Agriculture and fishing	*530*	*0*	*21 029*	*0*	*0*	*0*	*49 882*	*0*	*71 441*
Commercial	*106 578*	*0*	*180 418*	*864*	*0*	*0*	*132 777*	*0*	*420 637*
Construction	*0*	*0*	*281*	*0*	*0*	*0*	*17 020*	*0*	*17 302*
Electricity, gas and steam production	*2 103 791*	*0*	*0*	*67 732*	*21 041*	*123 458*	*0*	*236 272*	*2 552 294*
Manufacturing	*1 381 236*	*820 023*	*300 166*	*117 665*	*0*	*0*	*0*	*0*	*2 619 092*
Mining and quarrying	*53 067*	*0*	*117 147*	*2 900*	*0*	*0*	*33 235*	*0*	*206 350*
Transport, storage and communication	*3 590*	*0*	*24 295*	*0*	*0*	*0*	*776 034*	*0*	*803 918*
b. Inventory changes	197 741	0	-33 646	0	0	0	-14 747	0	149 348
c. Private consumption, total	193 338	0	142 815	0	0	0	37 109	194 155	567 418
Heating, use of electricity etc.	*193 338*	*0*	*142 815*	*0*	*0*	*0*	*37 109*	*194 155*	*567 418*
d. Exports	1 877 716	130 016	48 920	0	0	0	213 470	0	2 270 123
e. Losses in distribution	0	0	33 646	0	0	0	0	0	33 646
f. Total use (a+b+c+d+e)	5 917 588	950 040	835 073	189 162	21 041	123 458	1 244 781	430 427	9 711 570

Note: Due to rounding, discrepancies may appear in totals.
Source: Department of Energy, *Energy Balances, 2007*.

Table 14: Energy supply table for South Africa, 2008

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy supply
					Terajoules				
a. Domestic production	5 088 065	6 603	849 193	121 430	14 514	141 862	1 069 894	432 267	7 723 828
b. Imports	74 547	898 740	38 246	0	0	0	276 653	0	1 288 187
c. Total supply (a+b)	5 162 613	905 344	887 439	121 430	14 514	141 862	1 346 547	432 267	9 012 015

Source: Department of Energy, *Energy Balances, 2008*.

Table 15: Energy use table for South Africa, 2008

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy use
					Terajoules				
a. Intermediate consumption by industries	3 128 395	904 801	662 058	121 430	14 514	141 862	1 198 043	238 112	6 409 214
Agriculture and fishing	*1 444*	*0*	*21 029*	*0*	*0*	*0*	*47 651*	*116*	*70 241*
Commercial	*116 917*	*0*	*180 418*	*864*	*0*	*0*	*160 865*	*0*	*459 064*
Construction	*0*	*0*	*274*	*0*	*0*	*0*	*25 070*	*0*	*25 344*
Electricity, gas and steam production	*2 544 287*	*0*	*29 764*	*0*	*14 514*	*141 862*	*0*	*237 996*	*2 968 423*
Manufacturing	*408 862*	*904 801*	*301 042*	*117 665*	*0*	*0*	*0*	*0*	*1 732 371*
Mining and quarrying	*51 383*	*0*	*116 280*	*2 900*	*0*	*0*	*40 812*	*0*	*211 374*
Transport, storage and communication	*5 502*	*0*	*13 251*	*0*	*0*	*0*	*923 645*	*0*	*942 397*
b. Inventory changes	197 741	0	0	0	0	0	0	0	197 741
c. Private consumption, total	211 749	0	142 815	0	0	0	31 404	194 155	580 124
Heating, use of electricity etc.	*211 749*	*0*	*142 815*	*0*	*0*	*0*	*31 404*	*194 155*	*580 124*
d. Exports	1 624 727	543	48 920	0	0	0	117 101	0	1 791 291
e. Losses in distribution	0	0	33 646	0	0	0	0	0	33 646
f. Total use (a+b+c+d+e)	5 162 613	905 344	887 439	121 430	14 514	141 862	1 346 547	432 267	9 012 015

Note: Due to rounding, discrepancies may appear in totals.
Source: Department of Energy, *Energy Balances, 2008*.

Table 16: Energy supply table for South Africa, 2009

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy supply
					Terajoules				
a. Domestic production	4 998 412	6 603	758 867	76 046	15 097	139 702	972 049	432 267	7 399 043
b. Imports	47 967	1 068 203	38 246	45 383	0	0	359 112	0	1 558 912
c. Total supply (a+b)	5 046 379	1 074 807	797 113	121 430	15 097	139 702	1 331 161	432 267	8 957 955

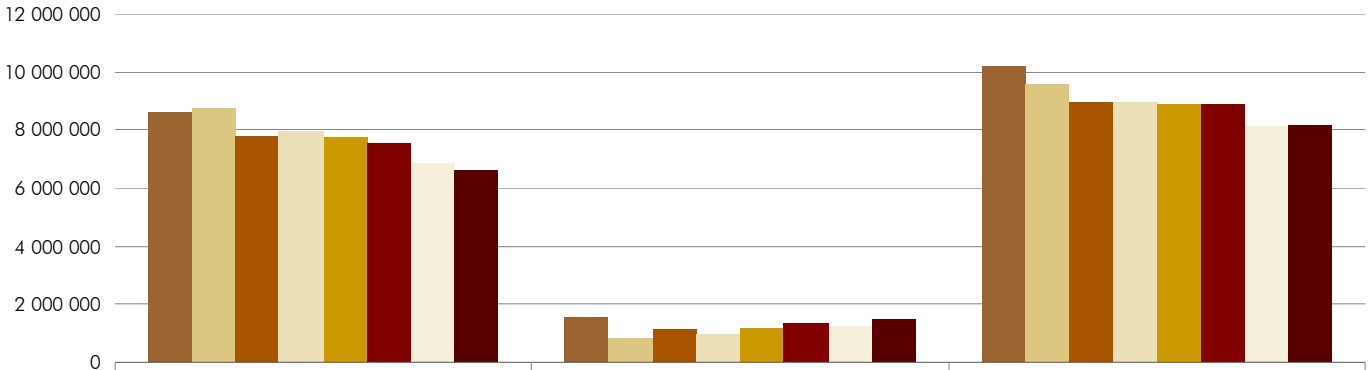
Source: Department of Energy, *Energy Balances, 2009*.

Table 17: Energy use table for South Africa, 2009

	Coal	Crude oil	Electricity	Gas	Hydroelectric	Nuclear	Petroleum	Renewable energy and waste	Total energy use
					Terajoules				
a. Intermediate consumption by industries	3 186 534	1 074 149	571 731	121 430	15 097	139 702	1 163 613	238 112	6 510 368
Agriculture and fishing	*679*	*0*	*21 029*	*0*	*0*	*0*	*47 418*	*116*	*69 242*
Commercial	*110 280*	*0*	*172 385*	*864*	*0*	*0*	*153 716*	*0*	*437 245*
Construction	*68 426*	*0*	*325*	*0*	*0*	*0*	*28 165*	*0*	*96 916*
Electricity, gas and steam production	*2 381 125*	*0*	*29 764*	*0*	*10 903*	*139 702*	*0*	*237 996*	*2 799 490*
Manufacturing	*572 827*	*1 074 149*	*334 950*	*117 665*	*4 194*	*0*	*0*	*0*	*2 103 786*
Mining and quarrying	*51 161*	*0*	*112*	*2 900*	*0*	*0*	*34 631*	*0*	*88 804*
Transport, storage and communication	*2 035*	*0*	*13 165*	*0*	*0*	*0*	*899 684*	*0*	*914 885*
b. Inventory changes	197 741	0	0	0	0	0	0	0	197 741
c. Private consumption, total	204 902	0	142 815	0	0	0	28 896	194 155	570 769
Heating, use of electricity etc.	*204 902*	*0*	*142 815*	*0*	*0*	*0*	*28 896*	*194 155*	*570 769*
d. Exports	1 457 203	657	48 920	0	0	0	138 651	0	1 645 431
e. Losses in distribution	0	0	33 646	0	0	0	0	0	33 646
f. Total use (a+b+c+d+e)	5 046 379	1 074 807	797 113	121 430	15 097	139 702	1 331 161	432 267	8 957 955

Note: Due to rounding, discrepancies may appear in totals.
Source: Department of Energy, *Energy Balances, 2009*.

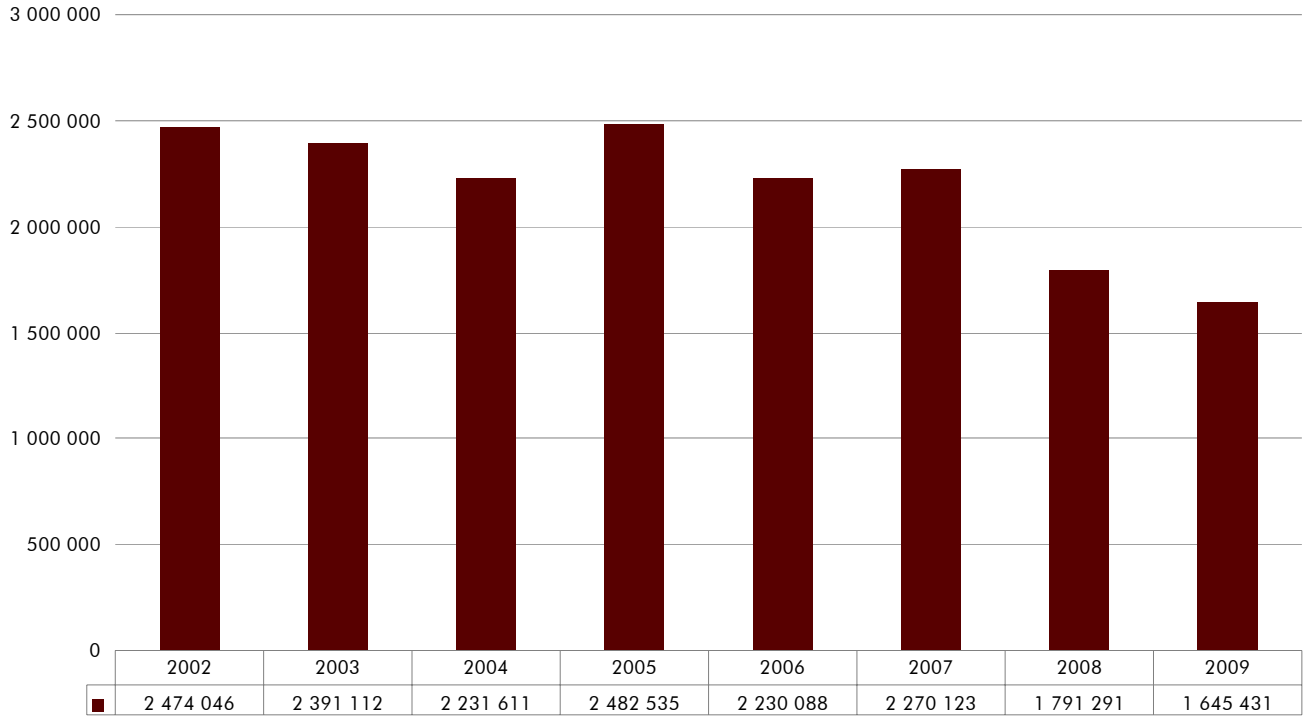
Figure 14: Total primary* energy supply in South Africa in terajoules, 2002–2009



	Domestic production	Imports	Total supply
2002	8 647 126	1 564 465	10 211 590
2003	8 728 384	822 899	9 551 282
2004	7 804 789	1 148 102	8 952 891
2005	7 949 201	977 679	8 926 879
2006	7 742 673	1 171 250	8 913 923
2007	7 538 066	1 338 431	8 876 497
2008	6 874 635	1 249 941	8 124 576
2009	6 640 176	1 520 666	8 160 842

*Electricity production as a secondary supplier is not included.
Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

Figure 15: Total energy exported from South Africa in terajoules, 2002–2009



Source: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2009.

5. South Africa's energy intensity and economic growth

South Africa's economic growth as measured by the GDP was 4.1% for the period 2002 to 2009. The total primary energy supply decreased from 8 647 petajoules (PJ) in 2002 to 6 683 PJ in 2009 – a decrease of 22.7% over the seven years. The energy intensity for the individual years is shown in Table 18 and Figure 16.

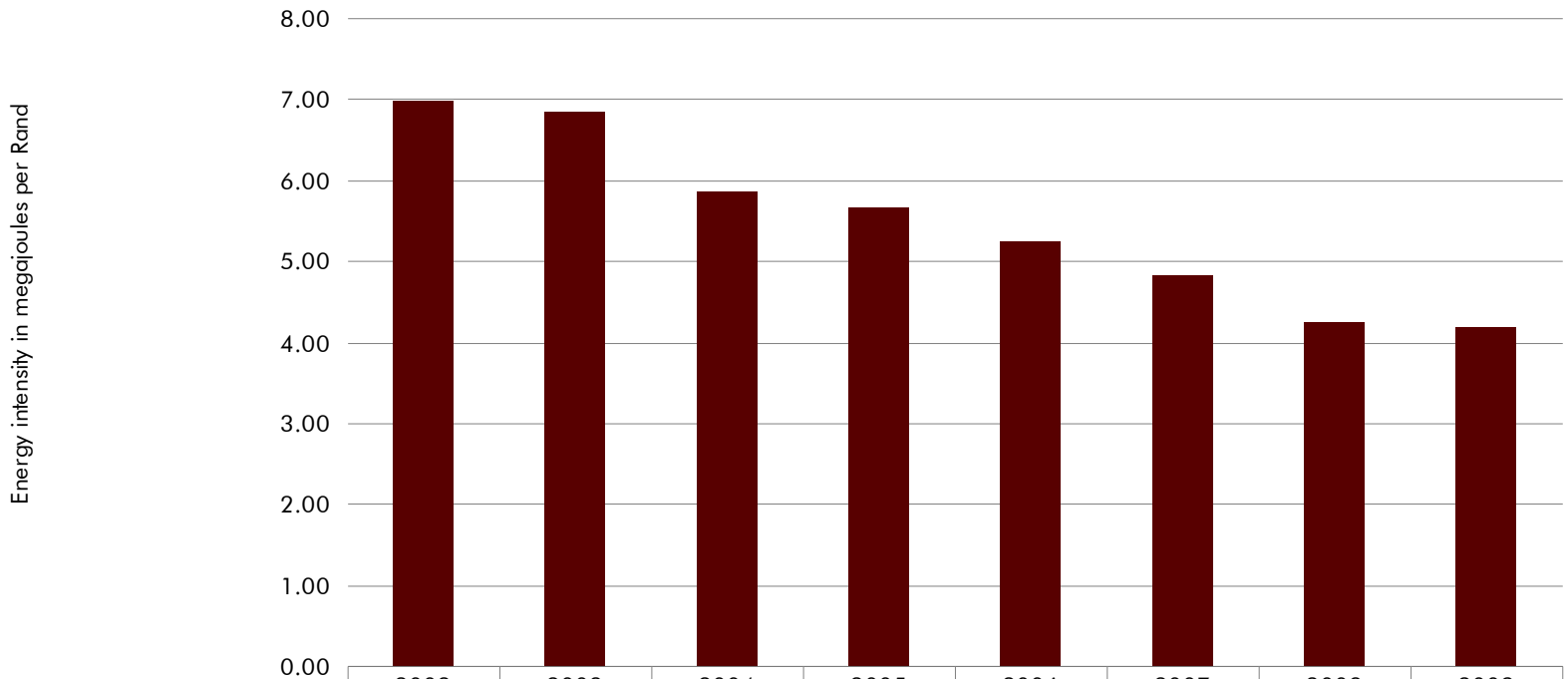
The ratio of aggregate energy use to GDP, often called 'energy intensity' or the 'energy ratio', is not an ideal indicator of energy efficiency, sustainability of energy use, or technological development. The aggregate ratio depends as much on the structure of the economy as on the energy intensities of sectors or activities, and changes in the ratio over time are influenced almost as much by changes in the structure of the economy as by changes in sector energy intensities. Measurement and interpretation of energy intensities are complicated by differences among products within a category, such as size (automobile weight or refrigerator capacity), features (power steering and automatic transmission in cars, freezer compartments in refrigerators), and utilisation (hours per year a stove is used, and vehicle occupancy if passenger-km is the measure of output). Total energy use should ideally be disaggregated into components, by sector (manufacturing, transportation, residential, commercial/services, industry, agriculture, construction, etc.) or sub-sector. For each sector or sub-sector, energy use can be related to a convenient measure of output to provide sector or sub-sector energy intensity. Examples include energy use for steel-making relative to tonnes of steel produced; energy consumption by passenger vehicles relative to passenger-kilometres or vehicle-kilometres; energy consumption in buildings relative to their floor area. The energy intensity of a process (energy consumed per unit of output) is the inverse of the 'energy efficiency' of the process (output per unit energy consumed). Due to resource constraints, this energy measurement would only be incorporated in future energy accounts. High energy intensities indicate a high price or cost of converting energy into GDP. Low energy intensities indicate a lower price or cost of converting energy into GDP. Since 2002 the price of converting energy into GDP has steadily decreased. The lower energy intensities could thus be an indicator of higher economic productivity.[5, 9, 10]

Table 18: Energy intensity per gross domestic product, 2002–2009

Year	Gross domestic product at 2005 constant prices (R millions)	Primary energy supply in Terajoules*	Energy intensity in Megajoules per Rand
2002	1 236 270	8 647 126	6.99
2003	1 273 129	8 728 384	6.86
2004	1 330 390	7 804 789	5.87
2005	1 401 067	7 949 201	5.67
2006	1 478 492	7 742 673	5.24
2007	1 561 076	7 538 066	4.83
2008	1 619 738	6 874 635	4.24
2009	1 597 860	6 683 347	4.18

*Excludes imports and electricity; includes coal, crude oil, gas, hydro, nuclear, petroleum products, and renewables and waste.
Sources: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2002–2009. Statistics South Africa, *Quarterly Gross Domestic Product, Third quarter: 2011*, Statistical release P0441.

Figure 16: Energy intensity in megajoules per rand, 2002–2009



	2002	2003	2004	2005	2006	2007	2008	2009
Energy intensity in megajoules per Rand	6.99	6.86	5.87	5.67	5.24	4.83	4.24	4.18

Sources: Statistics South Africa, 2011. Energy Supply and Use Tables for South Africa, 2002–2009. Statistics South Africa, *Quarterly GDP, Third quarter: 2011*, Statistical release P0441.

6. Conclusion

The main energy resources in the South African economy are coal, oil, gas, nuclear power, hydropower and renewable sources such as wind, solar, biomass and wave power. The South African economy, for the purpose of the country's energy accounts, is divided into six sub-sectors, namely the:

- Residential sector;
- Commercial sector;
- Agricultural sector;
- Transport sector;
- Industrial sector; and
- Other sectors.

The environmental economic accounts are crucial in a sense that they reflect how significant our environment is as a provider of resources in the economy. In South Africa, energy is sourced from the natural resources such as coal, therefore the supply and use (in physical units) of energy should be reflected in a way that is understandable from its raw production to the residuals.

The energy supply and use tables can therefore provide us with answers to the following questions:

- What is the level of energy consumption?
- What is the level of energy input (both direct and indirect) into the various categories of final demand (private household consumption, exports, etc.)?
- What is the energy intensity of particular industries, taking into account both direct and indirect energy inputs?

For the sake of future predictions, these accounts can also provide information on changes in the energy requirements of particular industries in relation to their output. These accounts will be updated annually, based on data availability from Energy Balances compiled by the DoE. It will be important to publish future energy accounts as official statistics and for the DoE and Statistics South Africa (Stats SA) to embark on the process of verification of input data into the energy balances. Once the SEEA-Energy manual is released, the monetary accounts for energy will be developed.

7. Glossary

Term	Description
Anaerobic digesters	Anaerobic digestion is a series of processes in which micro-organisms break down biodegradable material in the absence of oxygen. It is widely used to treat wastewater sludges and organic waste because it provides volume and mass reduction of the input material. As part of an integrated waste management system, anaerobic digestion reduces the emission of landfill gas into the atmosphere. Anaerobic digestion is a renewable energy source because the process produces a methane and carbon dioxide rich biogas suitable for energy production helping replace fossil fuels. Also, the nutrient-rich solids left after digestion can be used as fertiliser. The digestion process begins with bacterial hydrolysis of the input materials in order to break down insoluble organic polymers such as carbohydrates and make them available for other bacteria. Acidogenic bacteria then convert the sugars and amino acids into carbon dioxide, hydrogen, ammonia, and organic acids. Acetogenic bacteria then convert these resulting organic acids into acetic acid, along with additional ammonia, hydrogen, and carbon dioxide. Methanogens are finally able to convert these products to methane and carbon dioxide.
Account	An account is a tool which records, for a given aspect of economic life, (a) the uses and resources or (b) the changes in assets and the changes in liabilities and/or (c) the stock of assets and liabilities existing at a certain time; the transactions accounts include a balancing item which is used to equate the two sides of the accounts (e.g. resources and uses), and which is a meaningful measure of economic performance.
Biomass	Biomass is the quantity of living material of plant or animal origin, present at a given time within a given area.
Biomass power	Biomass is plant material either raw or processed and includes agricultural residues, wood waste, paper trash, municipal solid waste, energy crops and methane captured from landfill sites. Unlike fossil fuels, biomass is renewable in the sense that only a short period of time is needed to replace what is used as an energy source. This biomass can be used to generate electricity, heat or liquid fuels.
Biota	Refers to the flora and fauna of a specific region or country.
Coal	An accumulation of carbonaceous material derived from vegetation.
Consumption	Consumption is an activity in which institutional units use up goods and services. It can be either intermediate or final.
Crude oil	A mineral oil consisting of a mixture of hydrocarbons of natural origins, yellow to black in colour

Term	Description
	and of variable viscosity.
Energy balances	Materials and energy balances are accounting tables that provide information on the material input into an economy delivered by the natural environment, the transformation and use of that input in economic processes (extraction, conversion, manufacturing, consumption) and its return to the natural environment as residuals (wastes). The accounting concepts involved are founded on the first law of thermodynamics, which states that matter (mass/energy) is neither created nor destroyed by any physical process.
Energy intensity	Energy intensity is a measure of the energy efficiency of a nation's economy. It is calculated as units of energy per unit of GDP. • High energy intensities indicate a high price or cost of converting energy into GDP. • Low energy intensity indicates a lower price or cost of converting energy into GDP. Many factors influence an economy's overall energy intensity. It may reflect requirements for general standards of living and weather conditions in an economy. It is not atypical for particularly cold or hot climates to require greater energy consumption in homes and workplaces for heating (furnaces, or electric heaters) or cooling (air conditioning, fans, refrigeration). A country with an advanced standard of living is more likely to have a wider prevalence of such consumer goods and thereby be impacted in its energy intensity than one with a lower standard of living. Energy efficiency of appliances and buildings (through use of building materials and methods, such as insulation), fuel economy of vehicles, vehicular distances travelled (frequency of travel or larger geographical distances), better methods and patterns of transportation, capacities and utility of mass transit, energy rationing or conservation efforts, 'off-grid' energy sources, and stochastic economic shocks such as disruptions of energy due to natural disasters, wars, massive power outages, unexpected new sources, efficient uses of energy or energy subsidies may all have an overall impact on the energy intensity of a nation. Thus, a nation that is highly economically productive, with mild and temperate weather, demographic patterns of work places close to home, and uses fuel-efficient vehicles, supports carpools, mass transportation or walks or rides bicycles, will have a far lower energy intensity than a nation that is economically unproductive, with extreme weather conditions requiring heating and cooling, long commutes, and extensive use of generally poor fuel-economy vehicles. Paradoxically, some activities that may seem to promote high energy intensities, such as long commutes, could in fact result in lower energy intensities by causing a disproportionate increase in GDP output.
Energy sources	Energy sources are all solid, liquid and gaseous fuels; electricity; uranium; steam and hot water; and the traditional fuels such as fuel wood, charcoal, and vegetable and animal wastes.

Term	Description
Energy supply	Total primary energy domestic supply (sometimes referred to as energy use) is calculated by the International Energy Agency as production of fuels + inputs from other sources + imports - exports - international marine bunkers + stock changes. It includes coal, crude oil, natural gas liquids, refinery feed stocks, additives, petroleum products, gases, combustible renewables and waste, electricity and heat. Domestic supply differs from final consumption in that it does not take account of distribution losses. The supply and use of energy commodities are converted to kilogramme oil equivalent using standard coefficients for each energy source.
Environmental accounting	Under the SEEA framework, environmental accounting refers to the combination of natural resource accounts, which consist of stock and flow accounts in physical terms, and the monetary valuation of these accounts.
Gross domestic product	A measure of the total economic activity occurring within the national boundary of a country.
Hydropower	Hydropower is electricity generation using the power of falling water.
Intermediate consumption	Intermediate consumption consists of the value of the goods and services consumed as inputs by a process of production, excluding fixed assets whose consumption is recorded as consumption of fixed capital. The goods and services may be either transformed or used up by the production process. Some inputs re-emerge after having been transformed and incorporated into the outputs. Other inputs are completely consumed or used up. Intermediate consumption includes the rentals paid on the use of fixed assets.
Joules	One joule is the amount of energy required to perform the following physical actions: • The work done by a force of one Newton travelling through a distance of one metre. • The work required to move an electric charge of one coulomb through an electrical potential difference of one volt; or one coulomb volt, with the symbol C·V. • The work done to produce the power of one watt continuously for one second or one watt second (compare kilowatt-hour), with the symbol W·s. Thus a kilowatt-hour is 3 600 000 joules.
Micro-hydropower	Micro-hydropower is a technically and economically feasible remote area power supply technology option at suitable sites. A typical micro-hydropower scheme diverts water from a river using a dam or weir.
Natural gas	Consists mainly of methane occurring naturally in underground deposits. It may be associated or free gas.
Natural resource	An accounting system that deals with stocks and flows of natural assets, comprising biota (produced

Term	Description
accounting	or wild); subsoil assets (proved reserves); and water and land with their aquatic and terrestrial ecosystems. The term is used frequently in distinguishing physical accounting from monetary (environmental) accounting. However, the terms 'natural resource accounting' and 'environmental accounting' are often used interchangeably.
Natural resources	Natural assets (raw materials) occurring in nature that can be used for economic production or consumption.
Non-renewable natural resources	Exhaustible natural resources such as mineral resources (coal or uranium) that cannot be regenerated after exploitation.
Nuclear power plant	A nuclear power plant is a facility that converts atomic energy into usable power. In a nuclear electric power plant, heat produced by a reactor is generally used to drive a turbine which in turn drives an electric generator.
Photovoltaics	Photovoltaics is the field of technology and research related to the application of solar cells for energy by converting sun energy (sunlight or sun ultra violet radiation) directly into electricity.
Physical accounting	Natural resource and environmental accounting of stocks and changes in stocks in physical (non-monetary) units, for example weight, area or number. Qualitative measures, expressed in terms of quality classes, types of uses or ecosystem characteristics, may supplement quantitative measures.
Solar power	Solar radiation exploited for hot water production and electricity generation by: • Flat plate collectors, mainly of the thermosyphon type, for domestic hot water or for the seasonal heating of swimming pools. • Photovoltaic cells. • Solar thermal-electric plants.
System of Environmental and Economic Accounting (SEEA)	The SEEA was developed by the United Nations Statistical Division, as a satellite system to the System of National Accounts (SNA), for the incorporation of environmental concerns (environmental costs, benefits and assets) in the national accounts. The SEEA is intended to be a system with global application and standards, suitable for all countries and all aspects of the environment.
System of National Accounts (SNA)	An international accounting framework consisting of a coherent, consistent and integrated set of macro-economic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules. It provides a comprehensive accounting framework within which economic data can be compiled and presented in a format that is designed for the purposes of economic analysis, and decision and policy-making.

Term	Description
Wave power	Waves are a free and sustainable energy resource created as wind blows over the ocean surface. The greater the distances involved, the higher and longer the waves will be. Energy is stored in this way until it reaches the shallows and beaches of coasts where it is released.
Wind power	Wind power is the conversion of wind energy into a useful form, such as electricity, using wind turbines.

Table 19: International System of Units – multiples for joule

SI multiples for joule (J)					
Submultiples			Multiples		
Value	Symbol	Name	Value	Symbol	Name
10^{-1} J	dJ	decijoule	10^{1} J	daJ	decajoule
10^{-2} J	cJ	centijoule	10^{2} J	hJ	hectojoule
10^{-3} J	mJ	millijoule	10^{3} J	kJ	kilojoule
10^{-6} J	μJ	microjoule	10^{6} J	MJ	megajoule
10^{-9} J	nJ	nanojoule	10^{9} J	GJ	gigajoule
10^{-12} J	pJ	picojoule	10^{12} J	TJ	terajoule
10^{-15} J	fJ	femtojoule	10^{15} J	PJ	petajoule
10^{-18} J	aJ	attojoule	10^{18} J	EJ	exajoule
10^{-21} J	zJ	zeptojoule	10^{21} J	ZJ	zettajoule
10^{-24} J	yJ	yoctojoule	10^{24} J	YJ	yottajoule

Source: Department of Energy, 2009. Digest of South African Energy Statistics, 2009.

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