Government of Republic of South Africa
Department of Trade and Industry
Department of Science and Technology

The Study on Energy Efficiency in South Africa

Final Report

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JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

THE INSTITUTE OF ENERGY ECONOMICS, JAPAN
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ABBREVIATIONS

AEE	Association Energy Efficiency
AM	Amorphous Metal
AMDT	Amorphous Metal Distribution Transformer
BAU	Business As Usual
BEE	Black Economic Empowerment
BEMS	Building Energy Management System
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Dioxide Capture and Storage
CEM	Clean Energy Ministerial
COP	Coefficient of Performance
CRGO	Cold Rolled Grain Oriented Electrical Steel
CSIR	Council for Scientific and Industrial Research
CSP	Concentrated Solar Power
DANIDA	Danish International Development Agency
DBSA	Development Bank of Southern Africa
DEA	Department of Environmental Affairs
DEAT	Department of Environment Affairs and Tourism
DME	Department of Minerals and Energy
DMR	Department of Mineral Resources
DOE	Department of Energy
DoH	Department of Health
DOT	Department of Transport
DPE	Department of Public Enterprise
DSM	Demand Side Management
DST	Department of Science and Technology
DT	Distribution Transformer
DTI	Department of Trade and Industry
EEDSM	Energy Efficiency and Demand Side Management
EETMS	Energy Efficiency Target Monitoring System
EnMS	Energy Management System
EPWP	Expanded Public Works Program
ESCO	Energy Service Company
EV	Electric Vehicle
FBC	Fluidized Bed Combustion
FEMS	Factory Energy Management System
GDP	Gross Domestic Product
GEEF	Green Energy Efficiency Fund
GEF	Global Environment Facility
IDC	Industrial Development Corporation
IDM	Integrated Demand Program

IEA	International Energy Agency
IEP	Integrated Energy Plan
IGCC	Integrated coal Gasification Combined Cycle
IGCS	Intelligent Grid Control System
IPAP	Industrial Policy Action Plan
IPEEC	International Partnership of Energy Efficiency and Conservation
IRP	Integrated Resource Plan
JPOI	Johannesburg Plan of Implementation
KfW	German Development Bank
LTMS	Long Term Mitigation Scenarios
M & V	Measurement & Verification
MCEP	Manufacturing Enhancement Competitiveness Program
MEPS	Minimum Energy Performance Standard
NBI	National Business Initiative
NCPC	National Cleaner Production Centre
NCSD	National Committee on Sustainable Development
NEEA	National Energy Efficiency Agency
NEES	National Energy Efficiency Strategy
NER	National Energy Regulator
NERSA	National Energy Regulator of South Africa
NFSD	A National Framework for Sustainable Development in Souse Africa
NGP	New Growth Path
NPC	National Planning Commission
NRCS	National Regulator for Compulsory Specification
NSSD1	National Strategy for Sustainable Development and Action Plan
OLS	Ordinary Linear Square Method
PBMR	Pebble Bed Modular Reactor
PDCA	Plan Do Check Action
PPC	Pretoria Portland Cement Company Limited
PV	Photovoltaic
S ＆ L	Standard & Labeling
SABS	South African Bureau of Standards
SADC	Southern African Development Community
SAEE	South African Association of Energy efficiency
SALGA	South African Local Government Association
SANAS	South Africa National Accreditation System
SANEDI	South African National Energy Development Institute
SANERI	South African National Research Institute
SANRAL	South African National Road Agency Limited
SANS	South African National Standards
SAQA	South African Qualification Authority
SDC	Swiss Agency for Development and Co-operation

SEER	Seasonal Energy Efficiency Ratio
SOP	Standard Offer Program
SWH	Solar Water Heating
TC	Technical Committee
TOU	Time of Use
TPES	Total Primary Energy Supply
TSL	Two Step Loan
UCG	Underground Coal Gasification
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
VRF	Variable refrigerant flow
WG	Working Group
WS	Workshop
WSSD	World Summit on Sustainable Development

1 Introduction

1.1. Background of Study

The Republic of South Africa (hereinafter "South Africa") previously provided electricity at exceptionally low and stable prices rarely seen in other countries by taking advantage of abundant coal resources available in the country. However, since the introduction of a democratic government system in 1994, the country has been experiencing an increasingly tight supply-demand balance of energy due to rapid electrification and high economic growth since 2000. In particular, South Africa was forced to implement rolling blackouts in 2007 and early 2008 because power demand exceeded supply, dealing a serious blow to its main industries, including the mining industry. The country is currently building infrastructure under an action plan (2011/2011-2012/2013) with a view to achieving an optimum supply-demand balance of energy by 2013. Nevertheless, to secure sufficient energy supplies and achieve the country's economic growth targets, the government needs to incorporate an energy-efficiency initiative into the next action plan. Meanwhile, in a series of investigations, including its project study "A Basic Study on Energy Efficiency Improvement" (first edition in November 2008 and second edition in January 2009) and "Preliminary Investigation for Cooperation in Energy Efficiency Improvement in the Republic of South Africa" (July 2009), JICA has confirmed the need to support the South African government in compiling an energy conservation and development plan.

Under these circumstances, this study project was carried out by the Japanese government at the request of the South African government to comprehensively measure and predict demand-supply patterns of energy and, based on the patterns, to assist the country in formulating an energy conservation and development plan.

1.2. Objectives of Study

This study aims to propose a system, framework, and policies for improving the efficient use of resources and energy in the energy sector, and offer assistance for efforts to develop competent human resources by building an energy supply-demand forecast model based on South African industry development policies, progress of comprehensive energy-conservation initiatives, and development programs for new energy sources and renewable energy.

1.3. Structure of Study

The purpose of this Study will be fulfilled when the study plan shown in Figure 1.1-1 has been implemented and when the planned workshop is held. The study has the following process:

(1) Collecting data and information,

(2) Formulating energy supply and demand forecast model,

(3) Reviewing energy conservation policy,

(4) Setting scenarios,

(5) Assessing and analyzing impacts on society and economy, and

(6) Evaluating analytic results and making proposals.

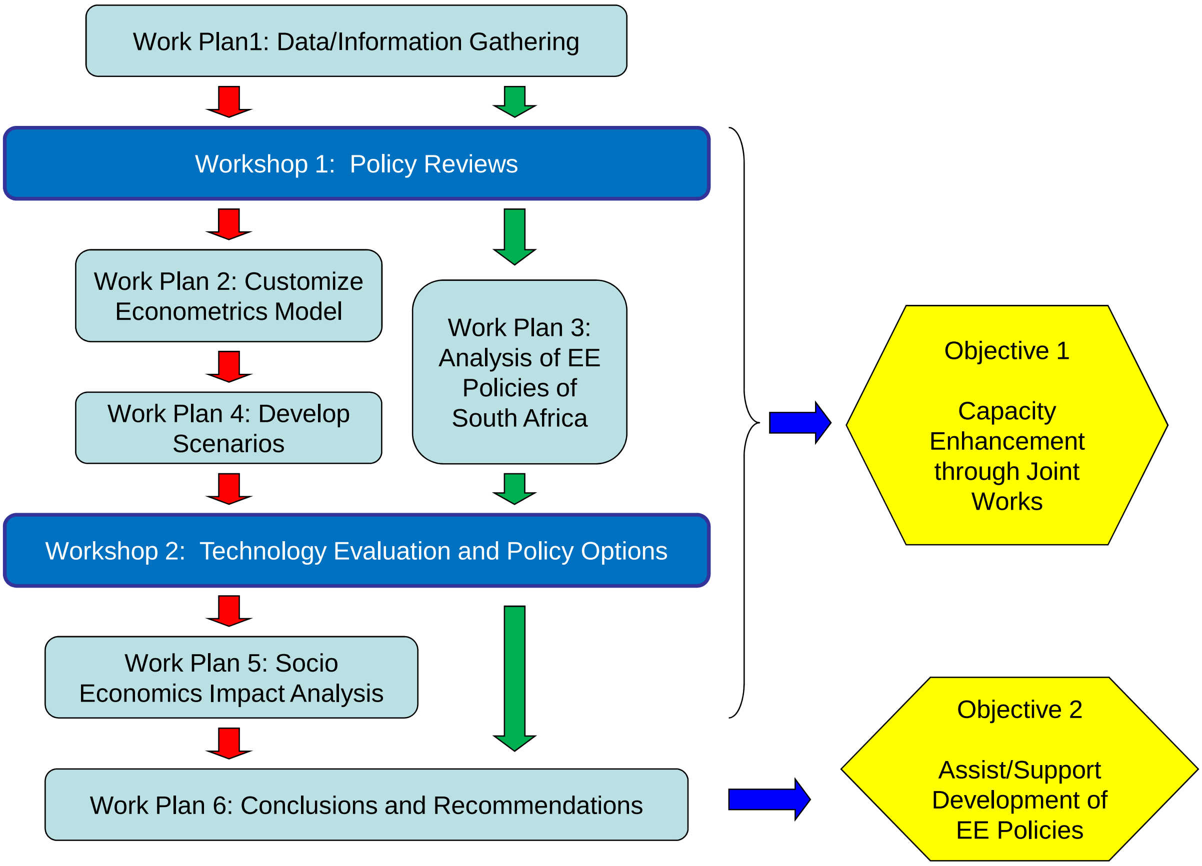


Figure 1.1-1 Study Flow

1.4. South African Counterparts

Department of Trade and Industry (DTI)

Department of Science and Technology (DST)

1.5. Study Period

December 2011 to January 2013

2 Energy and Economy

2.1. Economic Conditions

The Republic of South Africa, having a land area of 1.22 million square kilometers and a population of 49.99 million, recorded an economic growth rate of 3.1% and nominal GDP of 2.9 trillion rand (USD 408.2 billion) for 2011. Its major industries are agriculture and stock farming (corn, citrus fruits, other fruits, wheat, sugar, wool, and leather), mining (gold, diamond, platinum, uranium, iron ore, coal, copper, chrome, manganese, and asbestos), and manufacturing (food, iron making, chemistry, textiles, and automobiles). While nominal GDP per capita reached 8,066 dollars in 2011, there are wide income gaps among population segments, so the government provides financial support to lower income groups. Because the unemployment rate is high at 25.7%, the government is struggling hard to create jobs. Although exports, mainly composed of natural resources, increased 20.1% from a year earlier in 2011, imports increased 24.7%, or more rapidly than exports. The trade balance swung into deficit after 2010. China is the biggest trading partner of the country for both exports and imports.

Table 2.1-1 Economic Indicators of South Africa

Items	2010	2011
GDP		
Real GDP Growth Rate (%)	2.9	3.1
Nominal GDP (million Rand)	2,661,435	2,964,261
Nominal GDP (million US$)	363,523	408,237
Nominal GDP per Capita (US$)	7,271	8,066
CPI		
CPI Growth Rate (%)	4.3	5
CPI (2008=100)	111.7	117.3
Unemployment Rate (%)	25.3	25.7

Source: JETRO

2.2. Energy Programs

The Government of South Africa compiled a report entitled “White Paper on the Energy Policy of the Republic of South Africa,” and indicated the direction of future energy policies of the country. The White Paper states that the main objective of the government is to expand access to energy in rural districts and also to the segment of the population that is impoverished, whose access to energy has been limited thus far, and indicates issues and policies of South Africa on both the energy demand side and the energy supply side as shown in Table 2.2-1.

Table 2.2-1 Direction of Energy Supply and Demand of South Africa

Demand Side	Supply Side
● Household Sector: To expand access to electricity to the impoverished population. ● Mining/Manufacturing Sector, and Commercial Sector: To improve energy efficiency by 10-20% and to promote cleaner use of energy. ● Transport Sector: To diversify fuel types, to achieve appropriate pricing, and to improve fuel efficiency. ● Agricultural Sector: To improve energy efficiency of commercial farmers, and also to improve access to energy by conventional farmers.	● Electricity: To reform the domestic electricity market, and strengthen governance by the government. ● Nuclear: To ensure the safety of the Koeberg Nuclear Power Plant, to reorganize the Atomic Energy Corporation (AEC), and to formulate policies for nuclear waste treatment/disposal. ● Exploration and production of petroleum and gas: To formulate appropriate rules within the current system concerning off-shore petroleum and gas exploration. ● Liquid fuel: Ultimately, to completely liberalize the market, thus promoting internationally competitive industries. ● Gas: To promote a competitive gas industry and draw up related rules. ● Coal: To proceed with monitoring the coal industry, use clean coal technologies, and explore coal bed methane. ● Renewable energy: To use solar power and heat, and use solar power for rural electrification.

Source: DME (1998), “White Paper on the Energy Policy of the Republic of South Africa”

Furthermore, the White Paper lists the following ten cross-sectoral issues that are required to be resolved.

- Formulating “Integrated Resource Plan” (IRP)
- Improving statistics
- Improving energy efficiency
- Responding to environmental problems, and securing health and safety
- Research and development
- Fostering human resources
- Providing information and promoting public awareness
- Removing barriers for exports/imports of energy
- Appropriate energy prices
- Enhancing governance of energy policies

The White Paper establishes five objectives of energy policy, and enumerates the following short-term and mid-long term approaches.

Table 2.2-2 Direction of Energy Policies of South Africa

Objectives	Short-term Approaches	Mid- to Long-term Approaches
1. To increase access to energy by the household sector at reasonable prices	● Improve energy services such as electricity in the household sector ● Promote electricity provision from sources other than power grids	● Introduce new and reusable energy sources ● Introduce improved firewood-type stoves
2. To improve governance on energy issues by the government	● Improve governance capabilities of the government ● Improve process of formulating energy policies	● Improve energy R&D strategies ● Reconstruct national energy properties ● Formulate energy efficiency program
3. To promote economic development	● Promote entrepreneurship in the energy sector ● Remove barriers to energy trading ● Improve investment environment of the energy sector.	● Introduce principle of competition in the energy market ● Review profitability of electricity tariff system ● Promote energy efficiency in all sectors ● Introduce voluntary S&L policies
4. To control environmental impacts of energy-related issues	● Improve atmospheric conditions of residential areas ● Reduce use of candles and paraffin through electrification. ● Introduce safety standards for paraffin stoves	● Establish nuclear waste management policy ● Assess clean energy technologies ● Examine option of not using coal ● Countermeasures against climate change
5. To secure energy security by diversifying energy sources	● Develop electricity pooling system in South Africa ● Promote international cooperation ● Promote cooperation on energy in local areas	● Introduce integrated resources plan ● Reassess coal resources and introduce other primary energy resources

Source: DME (1998), “White Paper on the Energy Policy of the Republic of South Africa”

After compiling the White Paper on Energy Policy, DME drew up the “Integrated Energy Plan” (IEP). The IEP envisages the energy supply and demand situation through 2020, based on energy resources existing in South Africa in 2000, energy supply capabilities such as power generation capacity and petroleum refining capacity, and final energy demand in each sector. Then, the direction of energy policies is presented based on forecasts of energy demand and supply in 2020 under various scenarios.

According to the forecast of the IEP through 2020, future energy demand is expected to continue to increase 3% per year on average, although there are some differences in final energy demand depending on the scenario. Therefore, it is necessary to add an energy supply capability, and the IEP is examining the best scenario for the future composition of energy sources, in particular.

In South Africa, about 90% of all energy sources are provided by coal, and the entire supply is covered by domestically mined coal. However, the Energy White Paper issued in 1998 states that diversification of energy sources needs to be promoted. A controversial point is also what to do with the future ratio of coal in the composition of power resources, taking into account atmospheric pollution from gases emitted from power plants, energy security, countermeasures against climate change, etc. Consequently, costs of various energy sources such as Pebble Bed Modular Reactor (PBMR), hydro power plant, Fluidized Bed Combustion (FBC), Combined Cycle Gas Turbine (CCGT), coal-fired power plant, etc., were examined, and to what extent coal-fired power plants should be replaced with other energy sources was studied.

As a result, the following energy plan was proposed, based on examinations of future energy supply and demand using energy models.

- For the coming 20 years, coal is to be used as the main energy source.
- Energy sources will be diversified to include natural gas and renewable energy.
- Nuclear will be maintained as an option for future energy sources.
- Energy management and use of energy-efficient technologies will be promoted.
- Utilization factor of power generation facilities will be maximized and life-cycle costs will be reduced.
- Domestic petroleum and gas resources will be explored to reduce dependence on imports.
- Production of synthetic fuels will be continued, and natural gas will supplement raw materials for industrial purposes.
- While coal is positioned as the main energy source, hydro, natural gas, and nuclear will also be developed.
- Due consideration for the environment will be given at each phase of energy supply, conversion, and consumption.
- Access to clean and suitable energy sources for homes will be promoted, while maintaining good coordination with local integrated development programs.
- Institutional design will be drawn up to promote renewable energy and energy efficiency.
- Provision of energy-related data will be obligated.
- The IEP will be reviewed periodically.

However, during deliberations on energy policies under the IEP, it was acknowledged that there are deficiencies in aspects of governance of policies, data collection, modeling, assessment of environmental externalities, etc., and these issues have been pointed out as matters to be resolved in the future.

While studies on the future energy plan proceeded domestically, the government of South Africa at the same time ratified the United Nations Framework Convention on Climate Change in 1997 and the Kyoto Protocol in 2002. Consequently, the government of South Africa deliberated with domestic stakeholders (governmental agencies, private companies, NGOs, etc.) on future reductions of GHG emissions.

As a result of such deliberations, "Long-term Mitigation Scenarios" (LTMS) were drawn up, considering various options for future climate change policies and calculating their impacts. In the LTMS, the amounts of emissions until 2050 based on the BAU Scenario were forecasted, and a wide range of issues, such as introduction costs and total costs of renewable energy/energy efficiency measures, corresponding to the Scenario, and impacts on electricity prices and the economy, etc., were examined. In this study, it is pointed out that because the ratio of coal in the composition of power sources is high, it is important for South Africa to reduce the ratio to below 50%, in order to proceed with emissions reductions. To achieve that target, it is necessary to improve energy efficiency, to popularize renewable energy sources, to develop CCS, and to examine the Nuclear option.

Knowledge obtained from the LTMS program is reflected in the reduction target shown in the "Naturally Appropriate Mitigation Actions," which was drawn up based on the Copenhagen Accord at COP15 held in 2009[1]. In this program, targets are set to reduce the GHG emissions in 2020 by 34% and that in 2025 by 42%, compared to the BAU Scenario.

Given a situation where formulation of an energy policy and a climate change policy proceed simultaneously, the DOE drew up the "Integrated Resource Plan" (IRP) 2009 based on the Electricity Regulation Act of 2006. This is a long-term, power-source development plan for the coming 20 years. The IRP is to be reviewed every two years, or as appropriate. In the IRP 2010 announced in 2011, power demand until 2030 is estimated and a power sources development scenario based on this IRP is formulated.

In the IRP 2010, parameters such as GDP growth rates, future power demand, power resources development plan, energy conservation by DSM, carbon tax, etc., are assumed, and the following four policy issues are examined.

[1] United Nations Framework Convention on Climate Change
http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/southafricacphaccord_app2.pdf

(1) Nuclear option:

To end dependence on fossil fuels, construct (put into operation) one or two nuclear reactors during the period between 2022 and 2024, after evaluating related costs.

(2) Emissions reduction target:

To comply with the emissions reduction target, examine until when to continue operation of coal-fired power plants.

(3) Imports of electricity:

Amount of electricity imported

(4) Energy efficiency:

Amount energy demand is reduced by Energy Efficiency and Demand Side Management (EEDSM)

In the power development plan based on these examinations, priority is given to power sources to be developed in the future so that development can proceed as planned. According to the power development plan, the composition of power sources in 2030 is set at 65% for coal-fired power plants, 20% for nuclear, and 20% for renewables. As can be seen here, diversification of energy sources is expected to advance in the future, and the following six points are listed as issues to be examined in the IRP 2012.

(1) Decentralized power sources, Smart Grids, and off-grid power generation
(2) Development of domestic coal resources (UCG, CCS)
(3) Research to quantify risks involved in drawing up a plan
(4) Long-term energy supply and demand outlook, prospects for emissions, drawing up an energy industry plan (establishment of Vision for 2050)
(5) Closure of power plants and treatment of nuclear waste
(6) Deepening research on technologies such as small-scale hydro power, bio mass, storage batteries, EEDSM, etc.

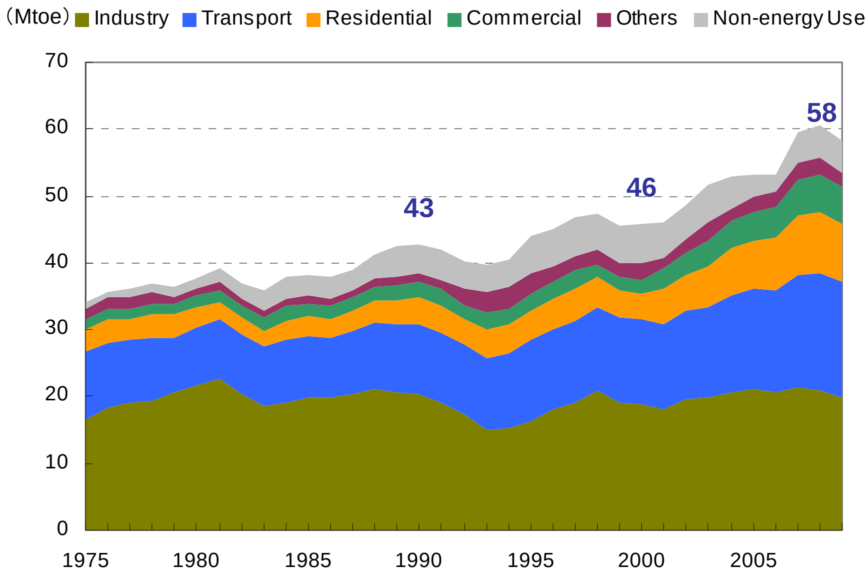
South Africa is to draw up a new Integrated Energy Plan (IEP) in 2013. This Plan will be the basis for future energy policies of South Africa, and will include energy supply and demand forecasts and composition of power sources until 2030.

2.3. Energy Supply and Demand

2.3.1. Final Energy demand

Final energy consumption (excluding non-commercial biomass) increased at an annual rate of 1.7%

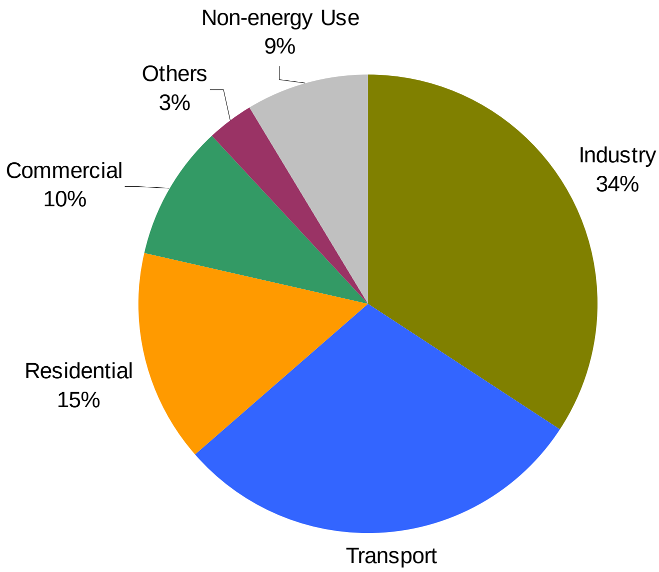
from 43 Mtoe in 1990 to 58 Mtoe in 2009. Between 1990 and 2009 final energy consumption by the industry remained almost flat. During the period 1990-2009, energy consumption increased at an annual rate of 4.6% in the business sector, 4.1% in the household sector, and 2.7% in the transport sector. Throughout the same period, the share of the industry sector of energy consumption decreased 15%, while the business and household sectors each increased their shares by 5%. In 2009, the share of energy consumption was 34% for industry, 29% for transport, 15% for households, and 10% for business, with other sectors accounting for 3% and the non-energy sector for 9%.



	Growth rate (%/year) 1990~2009	Share 1990	Share 2009
Total	1.7%	100%	100%
Industry	-0.1%	49%	34%
Transport	2.7%	29%	29%
Residential	4.1%	10%	15%
Commercial	4.6%	5%	10%
Other	2.3%	5%	3%
Non-energy use	0.9%	3%	9%

Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

Figure 2.3-1 Final Energy Demand by Sector

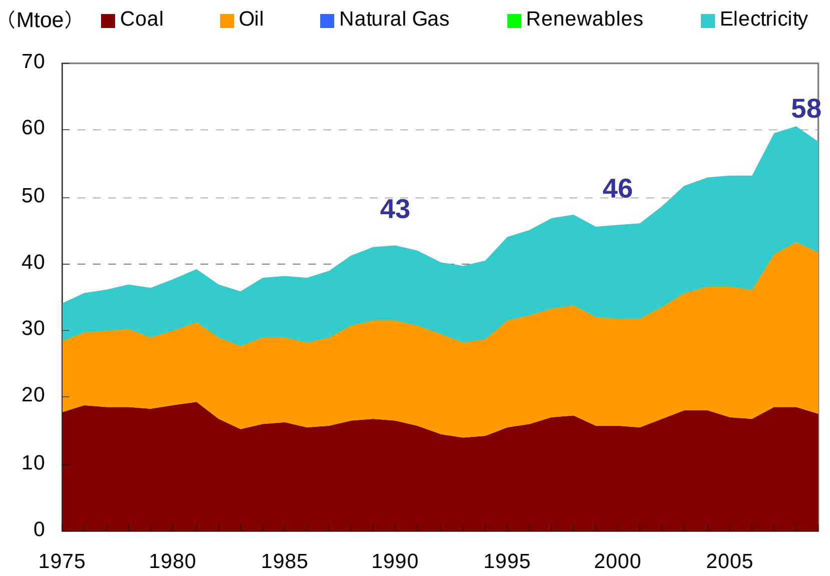


Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

Figure 2.3-2 Breakdown of Final Energy Demand by Sector (2009)

By energy source, the share of coal of energy consumption decreased from 39% to 30% during the period 1990-2009, while the share increased from 35% to 41% for petroleum and from 26% to 28% for electricity.

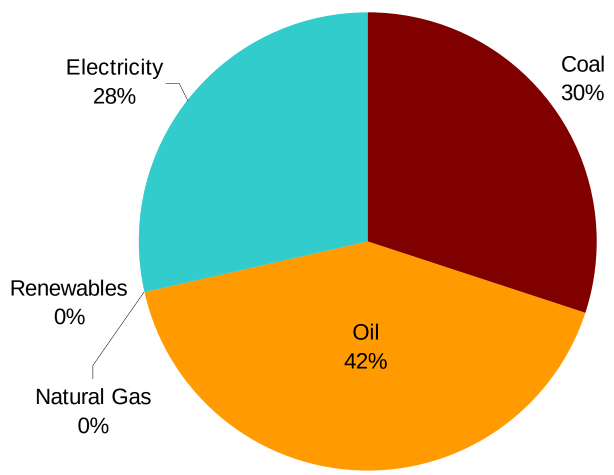
In 2009, the share of energy consumption in the industry sector was 45% for coal, 6% for petroleum, and 50% for electricity. In the transport sector, petroleum accounted for 98% of total energy consumption. In the household sector, coal represented 54%, petroleum 7%, and electricity 39%. In the business sector, coal accounted for 43%, petroleum 13%, and electricity 44% of total energy consumption.



	Growth rate (%/year) 1990~2009	Share 1990	2009
Total	1.7%	100%	100%
Coal	0.3%	39%	30%
Oil	2.5%	35%	41%
Natural Gas	-	0%	0%
Renewables	-	0%	0%
Electricity	2.1%	26%	28%

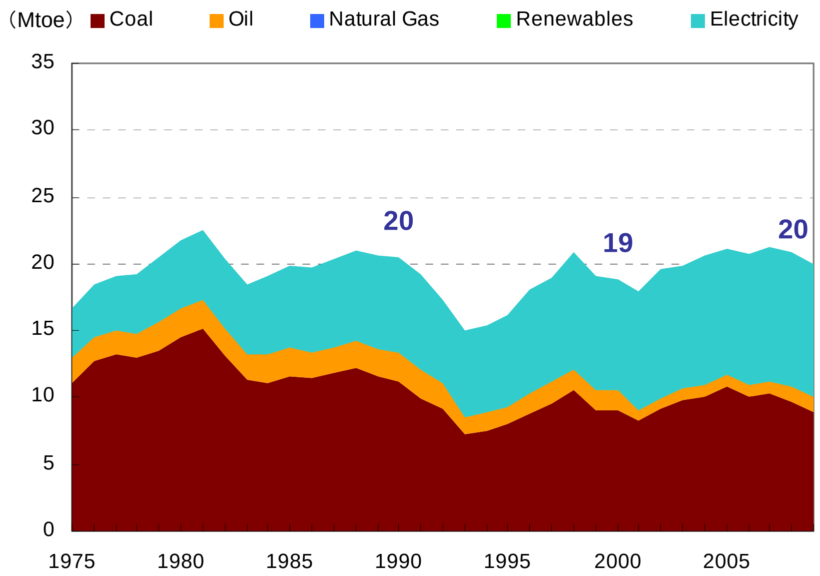
Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

Figure 2.3-3 Final Energy Demand by Energy Source



Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

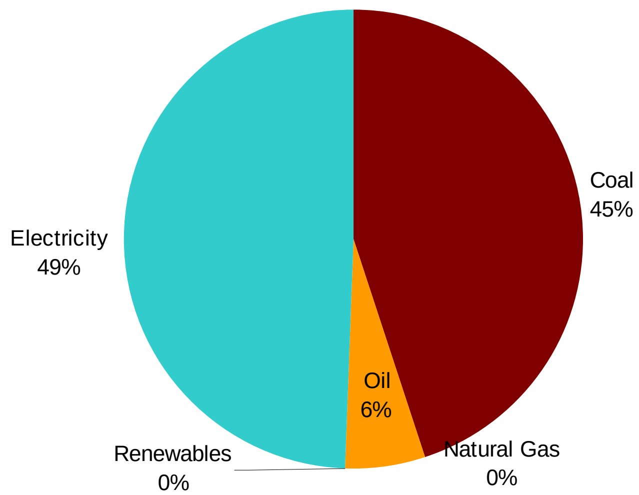
Figure 2.3-4 Breakdown of Final Energy Demand by Energy Source (2009)



	Growth rate (%/year) 1990~2009	Share 1990	2009
Total	-0.1%	100%	100%
Coal	-1.2%	55%	45%
Oil	-3.5%	11%	6%
Natural Gas	-	0%	0%
Renewables	-	0%	0%
Electricity	1.8%	35%	50%

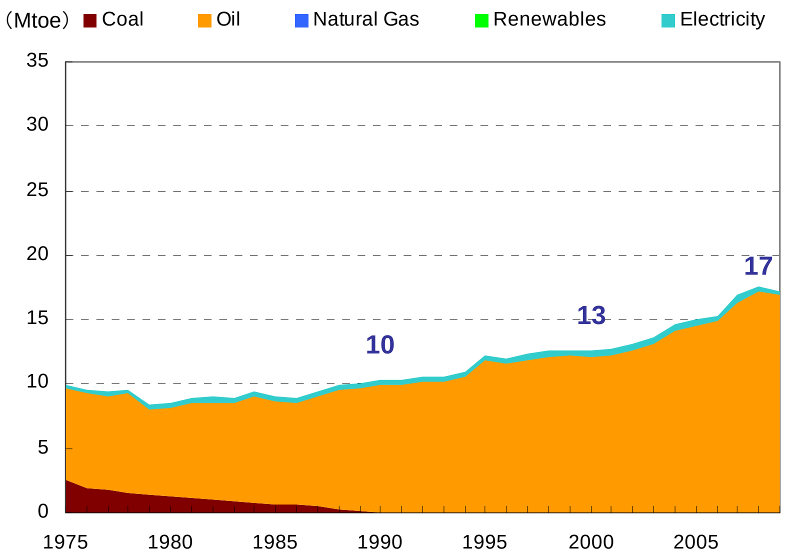
Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

Figure 2.3-5 Final Energy Demand in the Industrial Sector by Energy Source



Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

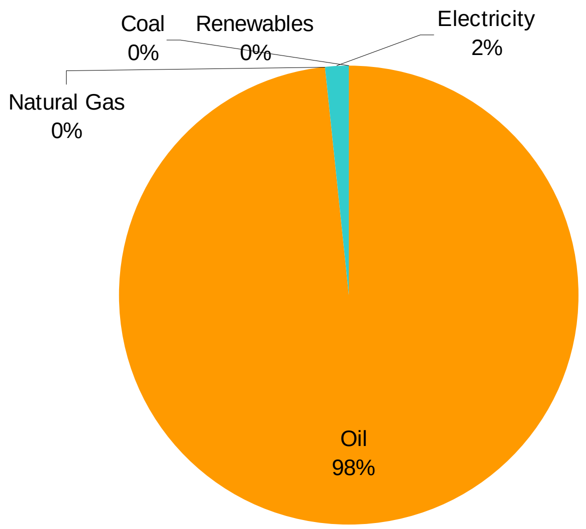
Figure 2.3-6 Breakdown of Final Energy Demand in the Industrial Sector (2009)



	Growth rate (%/year) 1990~2009	Share 1990	Share 2009
Total	2.7%	100%	100%
Coal	-100.0%	0%	0%
Oil	2.8%	96%	98%
Natural Gas	-	0%	0%
Renewables	-	0%	0%
Electricity	-0.6%	3%	2%

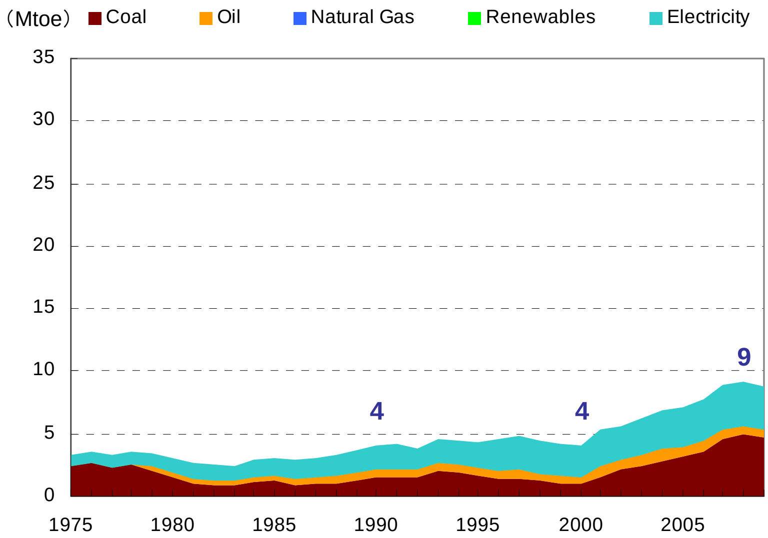
Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

Figure 2.3-7 Final Energy Demand in the Transport Sector by Energy Source



Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

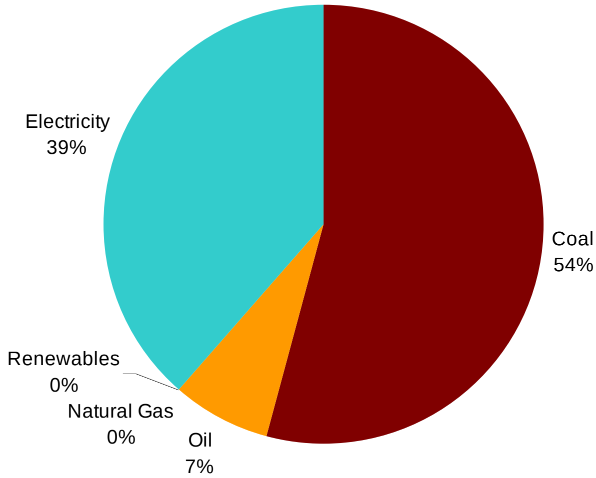
Figure 2.3-8 Breakdown of Final Energy Demand in the Transport Sector (2009)



	Growth rate (%/year) 1990~2009	Share 1990	Share 2009
Total	4.1%	100%	100%
Coal	6.3%	37%	54%
Oil	0.1%	16%	7%
Natural Gas	-	0%	0%
Renewables	-	0%	0%
Electricity	3.0%	48%	39%

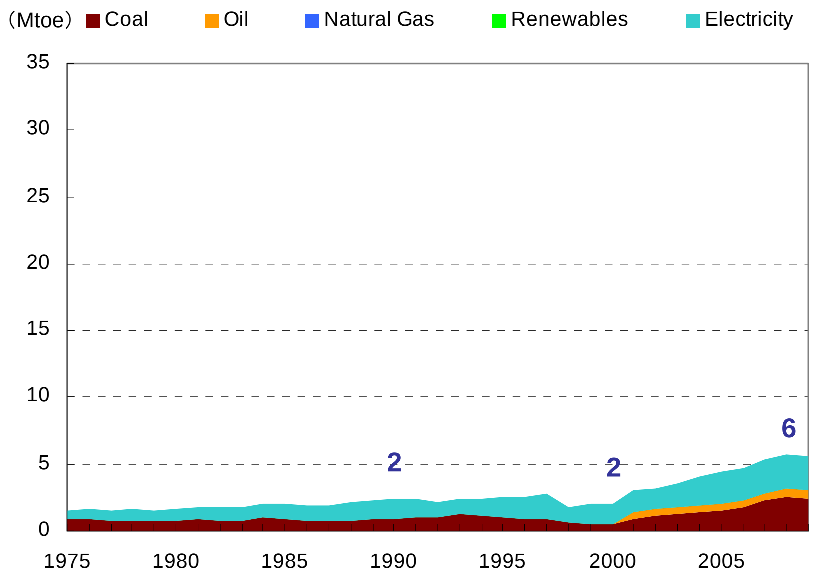
Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

Figure 2.3-9 Final Energy Demand in the Residential Sector by Energy Source



Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

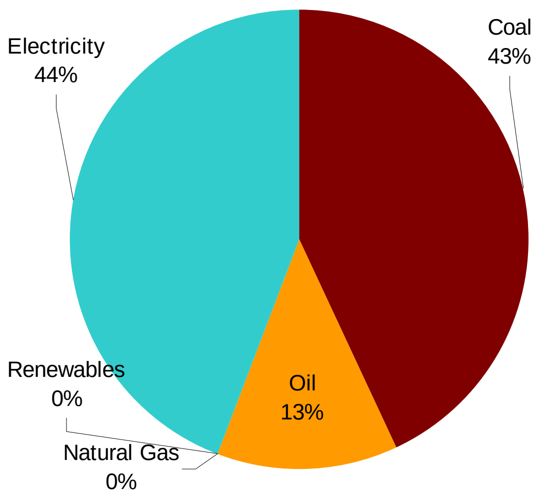
Figure 2.3-10 Breakdown of Final Energy Demand in the Residential Sector (2009)



	Growth rate (%/year) 1990~2009	Share 1990	2009
Total	4.6%	100%	100%
Coal	5.2%	38%	43%
Oil	-	0%	13%
Natural Gas	-	0%	0%
Renewables	-	0%	0%
Electricity	2.8%	62%	44%

Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

Figure 2.3-11 Final Energy Demand in the Commercial Sector by Energy Source

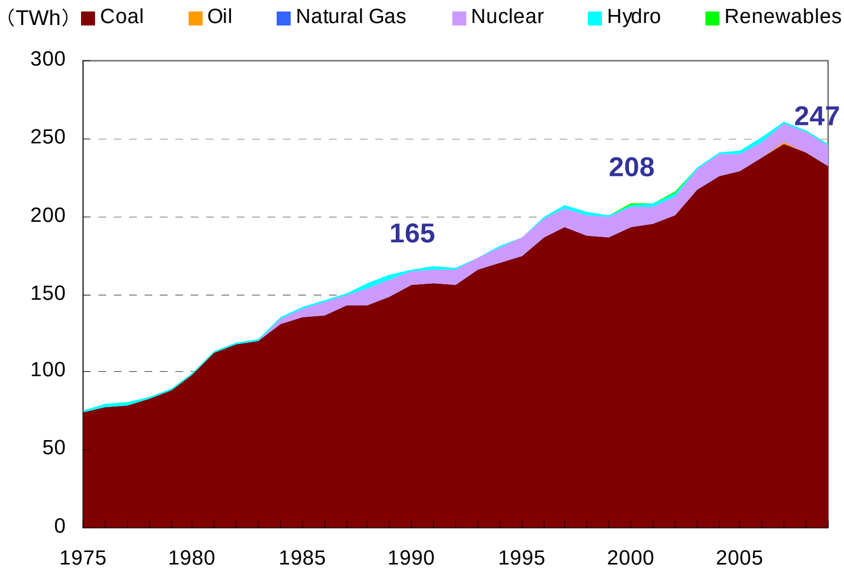


Note: Non-commercial biomass is not included
Source: IEA Energy Balance Table

Figure 2.3-12 Breakdown of Final Energy Demand in the Commercial Sector (2009)

2.3.2. Power Generation

During the period 1990-2009, power generation increased at an annual rate of 2.1% to 247.0 billion kWh. The shares of total power generation remained almost unchanged at 94% for coal and nuclear generation for 5%.



	Growth rate (%/year) 1990~2009	Share 1990	2009
Total	2.1%	100%	100%
Coal	2.1%	94%	94%
Oil	-	0%	0%
Natural Gas	-	0%	0%
Nuclear	2.2%	5%	5%
Hydro	1.9%	1%	1%
Renewables	-	0%	0%

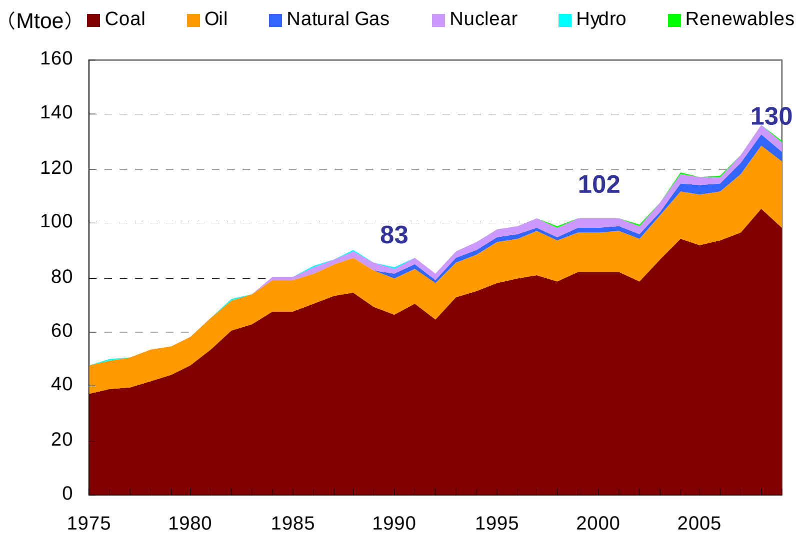
Source: IEA Energy Balance Table

Figure 2.3-13 Power Generation by Energy Source

2.3.3. Primary Energy Supply and CO_2 Emissions

During the period 1990-2009, primary energy supply increased at an annual rate of 2.4%, reaching 130 Mtoe in 2009. The share of coal of energy supply decreased from 80% to 76% during the same period, while petroleum increased its share from 16% to 19%, and natural gas from 2% to 3%.

During the period 1990-2009, CO_2 emissions increased at an annual rate of 2.4%, reaching 457 Mt-CO_2 in 2009. The share of coal-derived energy sources, although decreasing slightly, accounted for 84% in 2009.

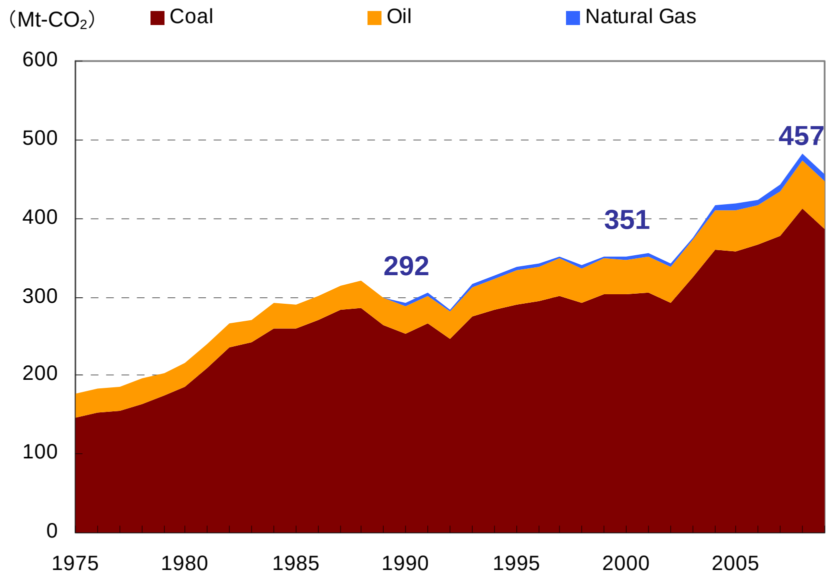


	Growth rate (%/year) 1990~2009	Share 1990	2009
Total	2.4%	100%	100%
Coal	2.1%	80%	76%
Oil	3.3%	16%	19%
Natural Gas	4.9%	2%	3%
Nuclear	2.2%	3%	3%
Hydro	1.9%	0%	0%
Renewables	-	0%	0%

Note: Non-commercial biomass is not included

Source: IEA Energy Balance Table

Figure 2.3-14 Primary Energy Supply by Energy Source



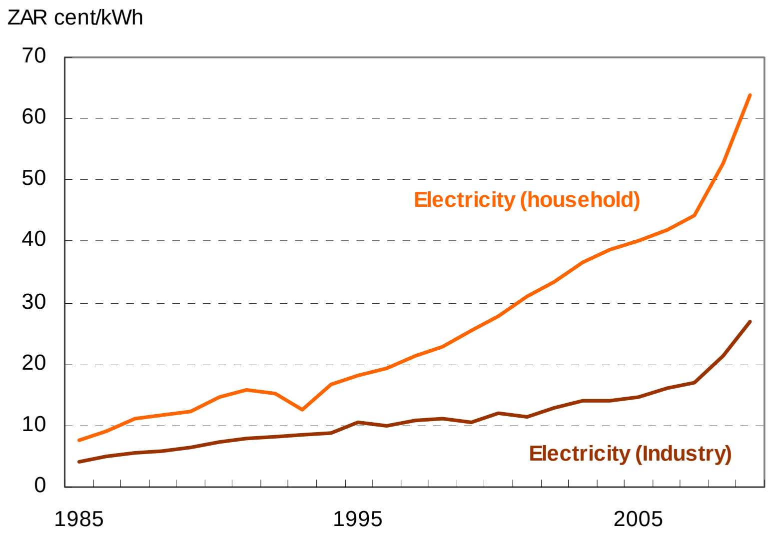
	Growth rate (%/year) 1990~2009	Share 1990	Share 2009
Total	2.4%	100.0%	100%
Coal	2.2%	86.4%	84%
Oil	3.0%	12.4%	14%
Natural Gas	4.9%	1.2%	2%

Source: IEA Energy Balance Table

Figure 2.3-15 CO_2 Emissions by Energy Source

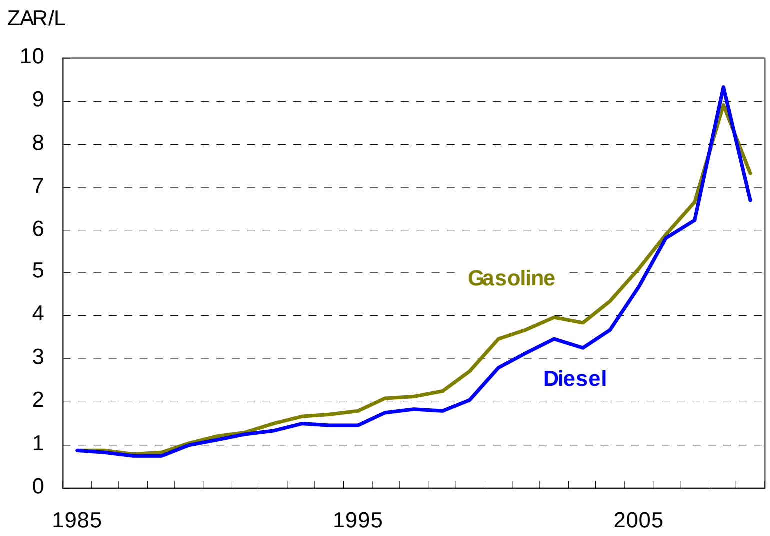
2.4. Energy Prices

During the period 1990-2009, electricity prices increased from 0.07 to 0.27 ZAR/kWh for the industry sector and from 0.15 to 0.64 ZAR/kWh for households. Specifically, there has been a sharp price increase since 2007. During the same period, prices rose from 1.2 to 7.3 ZAR/L for gasoline and from 1.1 to 6.7 ZAR/L for diesel fuel.



Source: IEA Energy Prices and Taxes

Figure 2.4-1 Trends of Electricity Prices by sector



Source: IEA Energy Prices and Taxes

Figure 2.4-2 Trends of Gasoline and Diesel Prices

3 Approaches to Energy Conservation

3.1. National Target for Energy Conservation

South Africa aims to improve energy efficiency 12% by 2015. This target is set for each sector, and the Energy Efficiency Target Monitoring System (EETMS) to monitor achievement of the target is to be developed by 2014.

In the "White Paper on the Energy Policy of the Republic of South Africa" drawn up by the Department of Minerals and Energy (DME) in 1998, the importance of each sector efficiently using energy; i.e. Industrial Sector, Household Sector, Commercial Sector, and Transport Sector, is stated. As background therefore, the White Paper points out the situation where as much as 15% of the GDP of South Africa is allocated for energy-related items, and a larger share of the income of those in poverty in particular is spent on energy. The White Paper mentions that improving energy efficiency needs to be examined within the framework of the energy policy, and points to the necessity of introducing the following measures in the future.

- Introducing energy efficiency standards for commercial buildings.
- Promoting energy auditing, providing information, and training personnel in industries,
- Introducing energy efficiency standards for industrial facilities.
- Introducing an energy efficiency program to reduce energy consumption by the public sector.
- Increasing public awareness of the household sector, and introducing/promoting building standards to improve the energy efficiency of residences.
- Providing enhanced education to the household sector to improve energy efficiency.
- Introducing a labeling program.

The "Energy Efficiency Strategy of the Republic of South Africa" was subsequently approved by the cabinet in 2005, and a target to improve energy efficiency by 12% (compared to the BAU case) by 2015 was indicated. At the same time, measures to achieve this target were presented. Among the objectives to be attained, the following were also enumerated: (i) improve health of the nation; (ii) create jobs; (iii) mitigate energy poverty; (iv) alleviate environmental pollution; (v) reduce CO_2 emissions; (vi) enhance competitiveness of industry; (vii) strengthen energy security; and, (8) lessen need to augment power generation capacity. Meantime, the White Paper mentions the following five obstacles facing South Africa as it proceeds with improving energy efficiency.

- Energy prices are too low.
- Lack of understanding and knowledge about energy efficiency.
- Lost opportunity to improve energy efficiency.

- Uncertainty about the investment environment when introducing high-efficiency equipment.
- Lack of information and knowledge when purchasing equipment.

The numerical targets put forward by the above-mentioned Strategy are allocated to sectors as follows.

- Commercial and Public buildings: -15%
- Industry and Mining: -15%
- Household: -10%
- Power generation: -15%
- Transport: -9%

To grasp progress towards achieving these targets, the Strategy plans to introduce a monitoring and verification system within the DME.

The Strategy aims to achieve the established targets by 2015, and divides the period until that point into three phases; i.e., Phase 1 from March 2005 through February 2008, Phase 2 from March 2008 through February 2011, and Phase 3 from March 2011 through February 2015. Achievement of targets and progress of policies is to be assessed at the end of each Phase.

The first follow-up of the Energy Efficiency Strategy was published in June 2009, and the target to improve energy use efficiency by 12% was redefined to the effect that the amount of final energy demand should be reduced by 12% by 2015 compared to baseline demand. In line with this redefinition, the numerical targets of sectors were also changed as follows:

- Industry and mining: To reduce final energy demand by 15% by 2015.
    - Iron & steel: To improve energy intensity by 1% every year.
    - Chemical: To improve energy intensity by 1% every year.
    - Mining: To reduce final energy demand by 10% by 2015.
    - Paper & pulp: To improve energy intensity by 2% every year.
    - Cement: To improve energy intensity by 2% every year.
- Power generation: To reduce power consumption within power stations by 15% by 2015.
- Commercial and public buildings: To reduce final energy demand by 20% by 2015.
- Household: To reduce final energy demand by 10% by 2015.
- Transport: To reduce final energy demand by 9% by 2015.

The monitoring and verification system, which was scheduled to be introduced, was in fact established in the DME, following enactment of the Energy Act in 2008. This system is used to assess the achievement of targets by collecting energy data within South Africa and monitoring compliance with policies.

Following the announcement of this first follow-up, the second follow-up is scheduled to be announced. As of May 2012, public comments were collected and the second follow-up was scheduled to be announced in June at the latest, but it has not yet been announced as of today.

3.2. Energy Conservation-related Organizations

Major governmental Departments and other organizations related to energy conservation in South Africa are as follows:

- Department of Science and Technology (DST)
  - Council for Scientific and Industrial Research (CSIR)
- Department of Trade and Industry (DTI)
  - South African Bureau of Standards (SABS)
  - National Regulator for Compulsory Specification (NRCS)
  - National Cleaner Production Centre (NCPC)
- Department of Energy
  - South African National Energy Development Institute (SANEDI)
  - （Independent Agency） National Energy Regulator of South Africa (NERSA)
- Other Departments
  - Department of Transport (DOT)
  - Department of Environmental Affairs (DEA）
- Other organizations
  - Development Bank of Southern Africa (DBSA)
  - Eskom
  - National Business Initiative (NBI)
  - Industrial Development Corporation (IDC)
  - Universities, research institutions, etc.

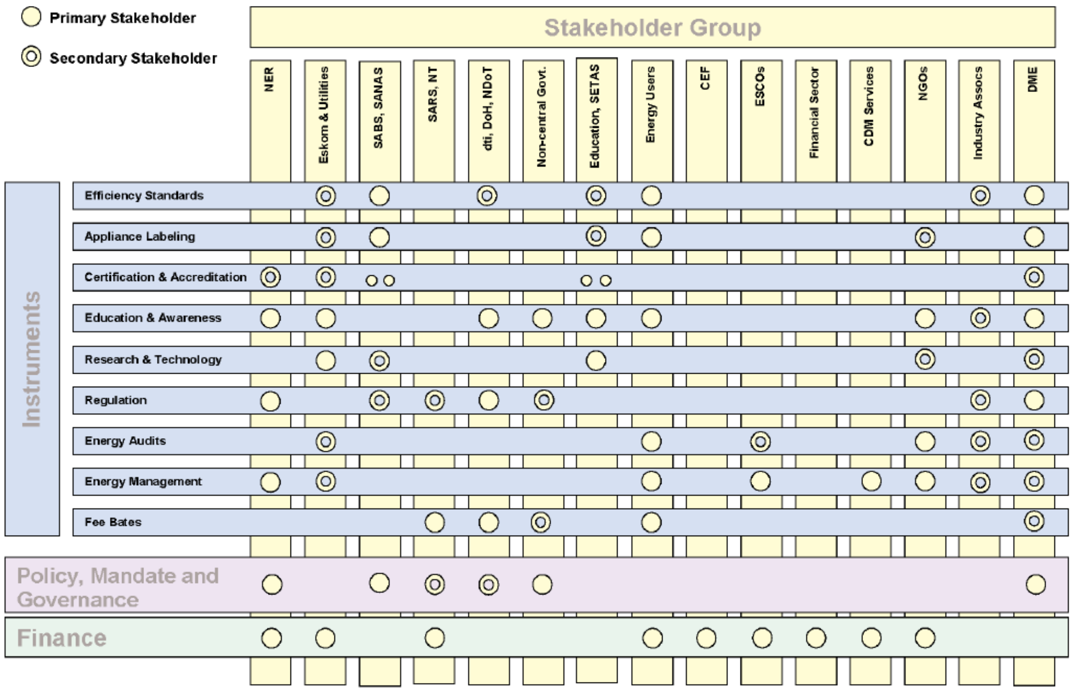
The major roles of each Department/organization are shown in Table 3.2-1. Although the roles of individual organizations are set forth, it is necessary to take interdepartmental and intersectoral approaches, in order to proceed concretely with energy conservation. Accordingly, collaboration and cooperation among different organizations have also been undertaken in South Africa in line with the contents of tasks.

However, when the number of organizations involved is increased, coordination among different organizations becomes necessary, and delays consequently occur.

Table 3.2-1 Roles of Various Organizations Related to Energy Conservation in South Africa

Department of Science and Technology (DST)		DST is in charge of scientific and technological research and development. DST implements R&D on energy conservation, renewable energy technologies, and international cooperation.
	Council for Scientific and Industrial Research (CSIR)	CSIR is a research organization for scientific and technological R&D, Its Model and Digital Science Section is in charge of developing energy models.
Department of Trade and Industry (DTI)		DTI is in charge of industrial policies. DTI establishes energy conservation standards, and implements energy conservation support measures. DTI is responsible for South Africa National Accreditation System (SANAS), which accredits measurement and verification (M&V) experts related to energy use in factories, etc.
	South African Bureau of Standards (SABS)	SABS is an implementing agency regarding the establishment of standards for equipment and products, as well as quality assurance.
	National Regulator for Compulsory Specification (NRCS)	NRCS is an agency for administering, supervising, and operating laws and regulations. In respect of energy conservation, NRCS implements operational administration of standards, labeling, monitoring, etc. of S&L.
	National Cleaner Production Center (NCPC)	NCPC is a program jointly established by DTI and DANIDA. NCPC provides support aiming at making chemical products, automobiles, etc., clean.
Department of Energy		DOE is the main agency handling energy conservation policies. Within its organization, DOE has a section overseeing energy conservation. National Energy Act (which stipulates national strategies concerning energy) is within the jurisdiction of DOE.
	South African National Energy Development Institute (SANEDI)	SANEDI undertakes energy conservation-related technology development and makes policy recommendations. It approves, supervises, and accredits energy conservation plans from companies based on the Energy Efficiency Tax Incentive Regulation.
	(Independent Agency) National Energy Regulator of South Africa	NERSA is the regulatory agency for energy sources such as electricity, gas, and petroleum. Although NERSA is obliged to report to the DOE, it is established as an independent organization from the viewpoint of neutrality.
Other Departments		
	Department of Transport (DOT)	DOT is the competent authority for traffic and transport.
	Department of Environmental Affairs (DEA)	DEA is the competent authority for environmental protection.
Other organizations		
	Development Bank of Southern Africa (DBSA)	DBSA is a development bank that financially supports economic development.
	Eskom	Eskom is the largest power company in South Africa. It conducts DSM activities and projects to promote energy conservation.
	National Business Initiative (NBI)	NBI is a voluntary industrial group. It was established to promote development and sustainable growth of South Africa. NBI shares information on energy conservation experiences, etc.
	Industrial Development Corporation (IDC)	IDC was established by the Economic Development Department. IDC financially supports the introduction of renewable energy and energy conservation facilities/equipment.
	Universities, research institutions, etc.	The University of Cape Town independently collects data related to energy.

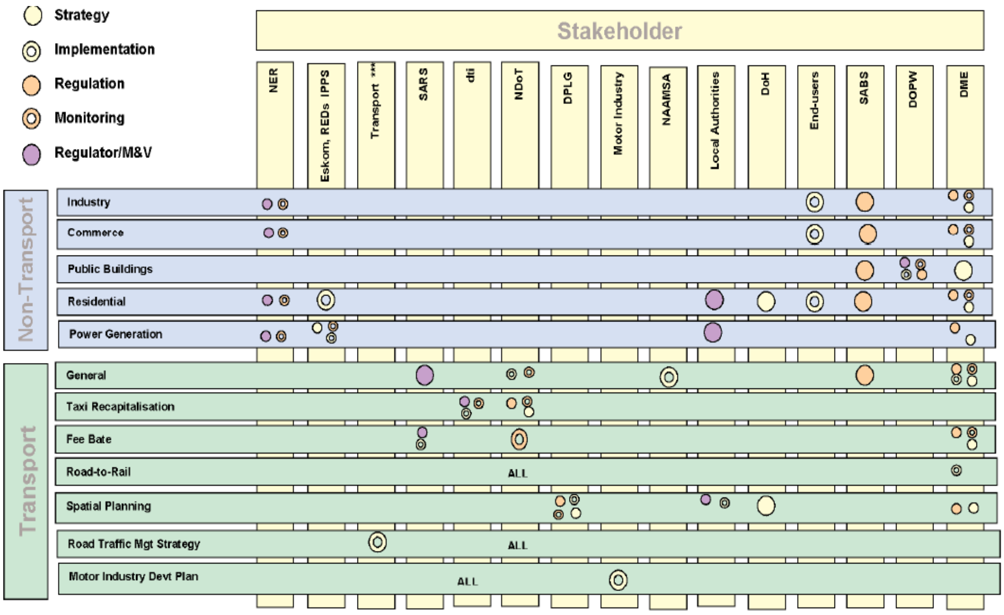
The National Energy Efficiency Strategy of South Africa shows some examples of relations among various organizations as indicated in Figure. 3.2-1 and Figure. 3.2-2.



NER : National Energy Regulator, SABS : South Africa Bureau of Standards, DTI : Department of Trade and Industry, DoH : Department of Health, DOT : Department of Transport, DME : Department of Minerals and Energy

Source: Energy Efficiency Strategy of the Republic of South Africa（2009）

Figure 3.2-1 Various Organizations Involved in Energy Policies in South Africa (1)



Source: Energy Efficiency Strategy of the Republic of South Africa（2009）

Figure 3.2-2 Various Organizations Involved in Energy Policies in South Africa (2)

3.3. Present Status of Policies and Systems for Energy Conservation

3.3.1. Data Collection System

(1) Data on Energy

Energy data in South Africa were formerly controlled by the Department of Minerals and Energy (DME), but since this Department was reorganized into the Department of Energy (DOE) and the Department of Mineral Resources (DMR), data have been controlled by the DOE. However, energy data held by the DOE have not necessarily been collected chronologically and statistically, and the contents are limited.

Besides the DOE, the Department of Trade and Industry (DTI) collects data on the economy (such as the national economy), on the industrial sector, and on trading; Statistics South Africa (Stats SA) compiles and publishes limited energy-related data; the South African National Energy Development Institute (SANEDI) collects data on energy consumption and reports them to the DOE; several universities hold energy data collected from study projects, etc., entrusted by the government; and, Eskom Holdings SOC Limited (Eskom), which engages in power generation, transmission, and distribution in South Africa with a near monopoly, collects and publishes data related to electricity, at its own initiative.

At present, the DOE has the following three energy data collection schemes; i.e. (i) compulsory energy data reporting system, (ii) energy efficiency target monitoring system (Swiss foundation), and (iii) data collection related to household electric appliances. The compulsory energy data reporting system has been administered by the Energy Planning Section of the DOE since March 2012. Under the system, there is an obligation to report energy data (energy by fuel type, such as petroleum and electricity). Each company in the industrial sector is obligated to report its data to the DOE. As regards household electric appliances, it aims to collect data on sales and efficiency distribution, but this is still at the planning stage.

(2) Data on Energy Conservation

With respect to data on energy conservation, a system is to be initiated, under which SANEDI collects data from companies and reports them to the DOE after processing. Although individual companies are expected to submit their data on energy consumption (which each company obtains) to SANEDI, systems at the company side have not yet been well developed, so the disposition of energy management personnel at companies is currently under study. Because such personnel should have professional knowledge, this still presents a problem to be solved in the future. Meanwhile, there has been a requirement since March 2012 for public buildings to submit reports on their energy consumption to Eskom.

3.3.2. Energy Management

(1) Overview

Various standards for energy management have been established, following the National Energy Efficiency Strategy drawn up in 2005 establishing a target for reducing final energy consumption by 12% by 2015. Unlike Japan's Act on the Rational Use of Energy, no law or regulation is enforced in South Africa that comprehensively regulates the use of energy, and voluntary standards based on the international ISO standard are generally adopted as the energy management standard. Binding standards were adopted recently for buildings and some lighting equipment.

As incentives for energy conservation, while the main program is the EEDSM Program led by Eskom (the leading power company in South Africa), certain preferential tax treatment systems based on the Income Tax Act have started to be introduced. Section 12L, under which an applicant can get a tax deductions according to the degree of energy conservation, in particular, is a preferential tax treatment system exclusively focused on energy conservation.

Although this system has not yet been enforced, positive effects are expected when it is implemented.

(2) Regulation

There is no law or regulation on directly controlling energy management in South Africa. Power companies are obligated to undertake a program called "Energy Efficiency and Demand Side Management" (EEDSM) based on "Regulatory Policy on Energy Efficiency and Demand Side Management for the South African Electricity Industry," which National Energy Regulator (NERSA) announced in 2004, and the Energy Regulation Act, which was also promulgated in 2006. Details of EEDSM are described in Item (4) Subsidy system.

(3) Standards

1) Energy management standard (SANS50001)

Following publication in June 2011 of the ISO50001 international standard for the energy management system (EnMS South Africa’s domestic standard SAN50001 based on ISO50001 was announced.

While SANS50001 (ISO50001) does not indicate any technological standard, it shows energy management methods that all entities, regardless of their type or scale, should adopt for continuously improving energy efficiency. The basic philosophy of this standard is to incorporate the PDCA cycle in energy management.

- P (Plan)
  To grasp the current energy consumption of the entity and establish a baseline. To determine energy management objectives and an energy management action plan to achieve objectives.
- D (Do)
  To put into practice the determined energy management action plan.
- C (Check)
  To measure energy performance indicators, and analyze them to see if effects are achieved as planned.
- A (Action)
  To review the energy management action plan.

2) Energy measurement and verification standard (SANS50010)

When conducting energy conservation measures, it is necessary to measure the effects properly and verify them through energy management. For that reason, in September 2011, South African Bureau of Standards (SABS) announced the SANS50010 standard on measurement and verification methods concerning energy conservation.

The principles of the standard are indicated below.

- Energy Conservation = (energy consumption during baseline period) － (energy consumption during reporting period) ± (adjustment)
- The baseline period means the state before measures are taken; the reporting period means the state after measures are taken; and, adjustment means a value to adjust the difference in conditions between the two periods.

While SANS50001 stipulates the general energy management method, SANS50010 supplements the measurement method.

3) Energy standard for buildings

In South Africa, SANS204 (Energy Efficiency in Building) was drawn up in 2009 as a voluntary energy standard for buildings. Thereafter, the same standard was made binding and put into force in November 2011. Newly designed and built buildings are covered by this standard, and existing buildings are not. The main items are described below. Allowance values are designated for each item.

- Buildings subject to the standard: Apartment houses, entertainment facilities, schools, offices, lodging facilities, hospitals, nursing homes, etc. (Newly built ones only)
- Area classification: The country is divided into six areas, according to weather conditions.
- Direction building faces
- Opacity, eaves
- Thermal insulation of the floor, outer walls, and roofs
- Layout of windows, heat transmission coefficient
- Energy consumption of air-conditioners
- Ventilation system
- 50% or more of the hot water supply needs to be provided by heaters not using electric resistance (such as solar heat, heat pump, waste heat recovery). Solar heat needs to comply with SANS1307 or SANS6211.

Management of conformance is administered by inspectors of municipalities, and if a building does not confirm to the standard, no construction permit is issued. Inspections are carried out even after a building is completed.

There exists no subsidy system or certification system at present.

4) Consumer electrical appliances
As regards consumer electrical appliances, the voluntary standard SANS941 was announced by SABS in March 2012. Items covered by this standard are air-conditioners, refrigerators, plasma TV sets, dish washers, electric ovens, etc. The three main requirements of the standard are as follows:

- Power factor is to be 0.85 or more.
- Standby mode electricity is to be 1 W or less.
- Visible energy labels is to be displayed.

Regarding lighting equipment, a binding standard VC9091 for CFL was put into force in 2010. Minimum requirements for the durability, efficiency, and intensity of illumination are stipulated, and equipment not meeting the requirements may not be sold. Both domestically manufactured and imported equipment are subject to the standard, and it is necessary to attach a document to the equipment showing the results of performance tests, and authentication by SABS or a competent international organization is required for the sales of the equipment.

A draft regulation has also been prepared for old-style electric bulbs, and it will be published in the future, most probably around November 2013.

(4) Subsidy system

1) EEDSM

As stated previously, power companies are obligated to undertake a program called Energy Efficiency and Demand Side Management (EEDSM). EEDSM is a system whereby business operators or ESCO companies can recover expenses required to reduce power consumption, as a rebate per unit of reduced power. The main program under EEDSM is called the Standard Offer Program, which is implemented through the following procedures.

- Minister of Energy establishes a power reduction target based on EEDSM.
- NERSA determines and publishes conditions for program application and the amount of rebate under SOP (rand/kWh- reduction amount).
- Each business operator or ESCO company draws up a power consumption reduction plan and submits it to the Development Bank of South Africa (DBSA). DBSA carried out an examination to verify if the submitted plan satisfies application conditions. The plan is also required to meet the provision for cost-effectiveness.
- Each business operator implements its reduction project and submits a performance report to DBSA. The reduction of power consumption is calculated in accordance with an established methodology.
- At the request of DBSA, an M&V organization authorized by NESA examines performance to verify if it satisfies SOP’s requirements based on “International Performance Measurement and Verification Protocol” (IPMVP).
- NERSA notifies Eskom of the amount of the rebate to be paid to each business operator.
- Eskom pays the rebate to each business operator or ESCO company. The rebate is paid from power rates in accordance with the power-rate decision process.

According to material from Eskom, the power consumption reduction program based on EEDSM is divided into several categories: (i) ESCO Model is applied to demand reduction projects with a scale of 1 MW or above per project; (ii) SOP is applied to projects with a peak cut of 50 kW to 5 MW per project; (iii) Performance Contracting is applied to large energy conservation projects that reduce 30 GWh or more per project over three (3) years; and, (iv) Standard Product is applied to energy efficient products whose reduction amount is 100 kW or less per product.

As regards solar water heaters, a rebate program is applied for replacing low-efficiency equipment with high-efficiency equipment.

2) 12I

As a subsidy system currently applied to energy conservation projects, besides the above-mentioned EEDSM, there is a preferential tax system called 12I based on the Income Tax Act implemented in

1962.

- Projects covered by this system: Large-scale industrial projects (in the case of the manufacturing industry, a project with development costs of 500 million rand or more.)
- Application conditions: Projects that can achieve energy conservation of 10% or more, and that meet established conditions regarding Black Economic Empowerment (BEE) and employment promotion.
- Date commenced: 2009

3) 12L

As in the case of 12I, this is a preferential tax system based on the Income Tax Act implemented in 1962. 12L is scheduled to be put into force within this year. Unlike 12I, this is a preferential tax treatment system exclusively focused on energy conservation, and qualification for the system is to be examined based on SANS50001. The present contents of the system (draft) are as follows:

- Each company submits an application to SANEDI based on the expected energy conservation effects of a relevant project.
- SANEDI examines the energy conservation effects of project based on SANS500001 and SANS50010.
- Based on approval by SANEDI, the applicant can receive a tax deduction of 15 cents/kWh, according to the degree of energy conservation.

3.3.3. Energy Audit System

(1) Overview

At present, two different energy audit systems are offered. One is conducted by Eskom as part of the EEDSM Program, and the other is a free energy audit conducted by the National Cleaner Production Centre (NCPC), which is an organization under the DTI. The main difference between the two is that the audit by Eskom covers introduction of relevant facilities under the EEDSM Program, whereas that by NCPC is just a proposal and business operators themselves need to select manufacturers, etc., The two audit systems are outlined below.

(2) Free energy audit system by NCPC

NCPC is a governmental organization of South Africa, which has been providing energy audit services free of charge. NCPC is a subordinate organization of the DTI and is carrying out an energy efficiency improvement project called the Industrial Energy Efficiency Improvement Project. This Project has been operated with cooperation from the DTI and also other organizations such as the DOE, UNIDO, Federal Department of Economic Affairs of the Swiss government, and UKaid.

The Project is operated with the DTI’s budget, and offers free energy audits for companies and buildings. The geographical areas covered by this Project are the three Provinces of Gauteng, Durban, and Cape Town.

Businesses covered by this Project mainly belong to eight fields (energy, water, raw materials, waste use, pulp, commercial buildings, tourism, etc.) nominated by the DTI as targets under the "Industrial Policy Action Plan." NCPC conducts assessments of not only energy conservation but also of environmental impacts such as reduction of CO_2 emissions, management of atmospheric pollution, and water quality control, in collaboration with the DEA.

The implementation scheme (procedures) of this Project is outlined below.

1) NCPC receives a request for an energy audit from an individual company or owner of a building(s).
2) NCPC requests outside expert(s) on each business segment to conduct an energy audit and bears the costs.
3) Expert(s) performs the energy audit of each company or building free of charge for the company or building owner.
4) Expert(s) reports to the person who made the request on such matters as relevant energy conservation effects, rough cost effectiveness, and available subsidy systems. (NCPC, however, is not involved in the actual introduction of facilities.)

(3) Energy audit by Eskom
Eskom conducts energy audit as part of the EEDSM Program. Private ESCO companies are registered with Eskom, and Eskom performs each energy audit using an ESCO company specialized in each business segment.

Based on the results of the audit, Eskom plans energy conservation projects and implements them under the EEDSM Project.

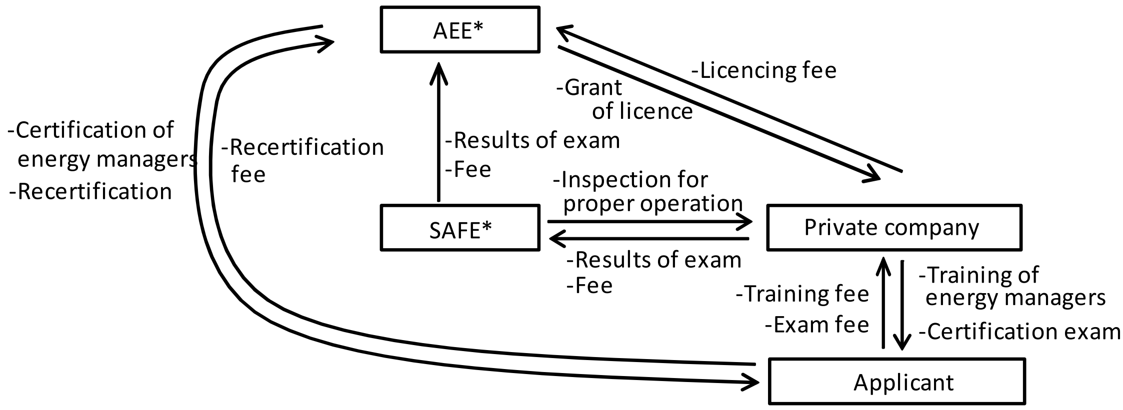
3.3.4. Energy Management Education and Training System

(1) Overview
Although South Africa has its own system operated by the South African Qualification Authority (SAQA) to certify energy managers, a system based on certification by an organization in the United States is more popular among private companies. We describe the situation below.

(2) SAQA
This is a certification organization of South Africa, which is also charged with certifying energy managers. To obtain its certification, an academic degree from a university is required.
(3) Private companies
Private companies train energy managers based on licenses issued by the Association of Energy Engineers (AEE) of the United States. The AEE program is employed by more than 40 countries and

it is necessary to have experience of having worked as an energy management professional and also to pass a four-hour written examination to qualify as a Certified energy manager (CEM), etc.

AEE has a branch office in South Africa: South Africa Association of Energy Engineers (SAEE). At present, there are about 300 AEE certified energy managers in South Africa, and there are also cases of large companies adopting AEE certification.



*AEE: Association of Energy Engineers
*SAEE: South African Association of Energy Engineers

Figure 3.3-1 Licensing Procedures Adopted by SAEE

3.3.5. Energy Efficiency Standard and Labeling Program

(1) Outline

In 1998, the South African government started discussing introduction of an energy efficiency standard and labeling program for electric appliances. In its 1998 report (“The White Paper on Energy Policy Energy Policy”), the Department of Minerals and Energy (DME) pointed out that an energy efficiency standard and a labeling program should be the first policy implemented for improving energy efficiency. In 2003, Eskom conducted a survey of home appliances. In 2004, the US Agency for International Development (USAID) carried out a nationwide consumer survey on energy information labeling. Taking the findings of these surveys into account, DME implemented a voluntary energy grade labeling program in 2005 targeting refrigerators. This labeling program is a slight modification of the EU energy labeling program.

In 2006, DME applied to UNDP/GEF for financial aid[2]. There were few relevant developments in successive years, partly due to a reorganization of DME. In 2008, however, a serious blackout drew close attention to energy efficiency policy. The National Energy Act, enacted in the same year, mandated the establishment of an energy standard and a labeling program for electric appliances.

[2] 「Market Transformation through Energy Efficiency Standards & Labeling of Appliances in South 」

In 2009, the Department of Energy (DOE) confirmed the importance of introducing an energy labeling program, in its review of the national energy strategy. Meanwhile, according to the Industrial Policy Action Plan 2 (IPAP2) compiled by the Department of Trade and Industry (DTI), South African Bureau of Standards (SABS) is to develop South African National Standards (SANS) for energy efficiency by mid-2012 (Q4 of FY2011), and the National Regulator for Compulsory Specifications (NRCS) is to formulate a compulsory standard for home appliances.

In August 2011, DOE and DTI announced a joint action plan—"South Africa Energy Efficiency Action Plan for Home Appliances[3]." This action plan aims, first, to introduce a mandatory labeling program and a minimum energy efficiency standard (Minimum Energy Performance Standard: MEPS) and, second, to improve the technical skills of domestic appliance manufacturers and promote exports to the Southern African Development Community (SADC) and other African regions. The action plan is intended to cover five categories of home appliances, as follows.

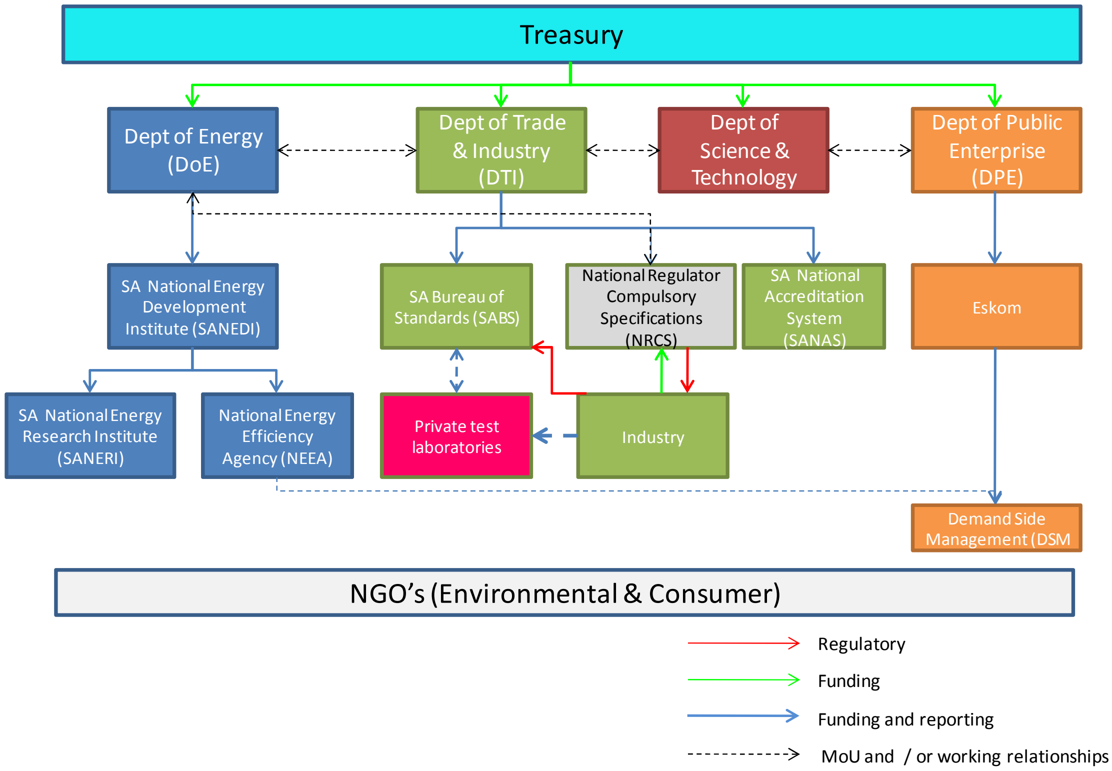
- Air conditioners up to 5 kW, non-ducted air conditioners and heat pumps
- Dishwashers and washing machines
- Electric ovens
- Refrigerators and freezers
- Water heaters/geysers)

In addition to introducing MEPS and a mandatory labeling program, the action plan sets forth a standby power standard for home appliances of up to 1W, implementation of the labeling program by 2013, and revision of the program in 2015.

(2) Related organizations

The figure shows government organizations related to the energy efficiency standard and labeling policy. Basically, the energy efficiency policy should be managed by the Department of Energy. However, since the 2009 reorganization of the Department of Resources and Energy into the Department of Energy, there has been an extended delay in formulating an energy efficiency standard or a labeling policy due to a shortage of human resources. Currently, a policy is being developed jointly by DOE and DTI. DTI is working on the basis of IPAP2. Through consultations with DTI and other government agencies, DOE will develop an overall policy framework for an energy efficiency standard and a labeling policy. An energy efficiency testing standard will be formulated by SABS, an affiliate of DTI. Implementing regulations for a mandatory labeling and an efficiency standard will be developed by NRCS, also an affiliate of DTI. NRCS is also tasked with supervising implementation of, and compliance with, these systems.

3 "South African National Electrical Appliances Energy Efficiency Action Plan," Department of Energy and Department of Trade and Industry, August 2011



Source: UNDP Project Document[4]

Figure 3.3-2 Organizations Related to Energy Efficiency Standard and Labeling Program

(3) Voluntary energy labeling program (from 2005)

As explained previously, the South African government has had a voluntary energy grade labeling program for refrigerators in place since 2005. Formally adopted in May 2004, this program was intended initially for refrigerators and later for washing machines and other products. As of 2012, there are no data available on implementation of the voluntary labeling program. The voluntary labeling program does not require participating companies to make applications or present reports to the relevant government agency. For this reason, even DOE as a government agency does not grasp the status of the program currently in place (including information on equipment and number of participating companies). Experts point out that the energy grade labeling program is a failure because few companies participate in a voluntary program.

The failure of the program can be explained partly by a lack of an energy-conservation incentives among consumers because of low electricity charges, in addition to program defects. Under the voluntary energy grade labeling program, participating companies attach a label to their products on a voluntary basis and do not need to report to the government. In addition, an energy performance testing standard is yet to be established. There are no laboratories in the country for measuring energy efficiency. Under these circumstances, the government has failed to even make compliance

[4] "Market Transformation Through the Introduction of Energy Efficiency Standards and the Labeling of Appliances in South Africa," United Nations Development Program South Africa PROJECT DOCUMENT

checks. In short, the program lacked measures to ensure its reliability. Generally, at an early stage of implementing a program, it is desirable to have incentives for companies to participate or conduct a publicity campaign to communicate the new program to the public. The country lacked policies supporting the program.

In South Africa, energy labeling is practiced mainly by overseas appliance manufacturers, while only a limited number of domestic manufacturers put labels on their products. The country's refrigerator market is dominated by local manufacturers. The energy efficiency of products of domestic manufacturers is relatively low. Domestic manufacturers claim that they may have to close their plants if the energy labeling program is made compulsory.

The figure below illustrates an energy label placed at the bottom right of a refrigerator displayed at an electronics retail store.

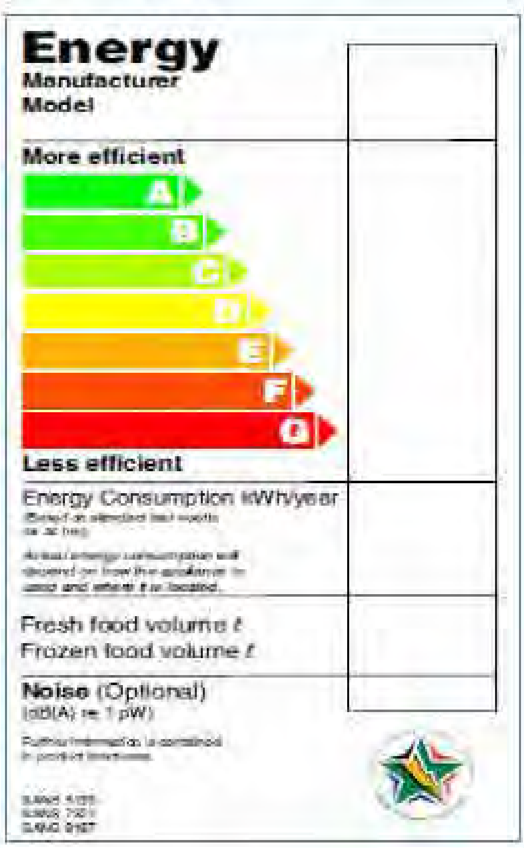
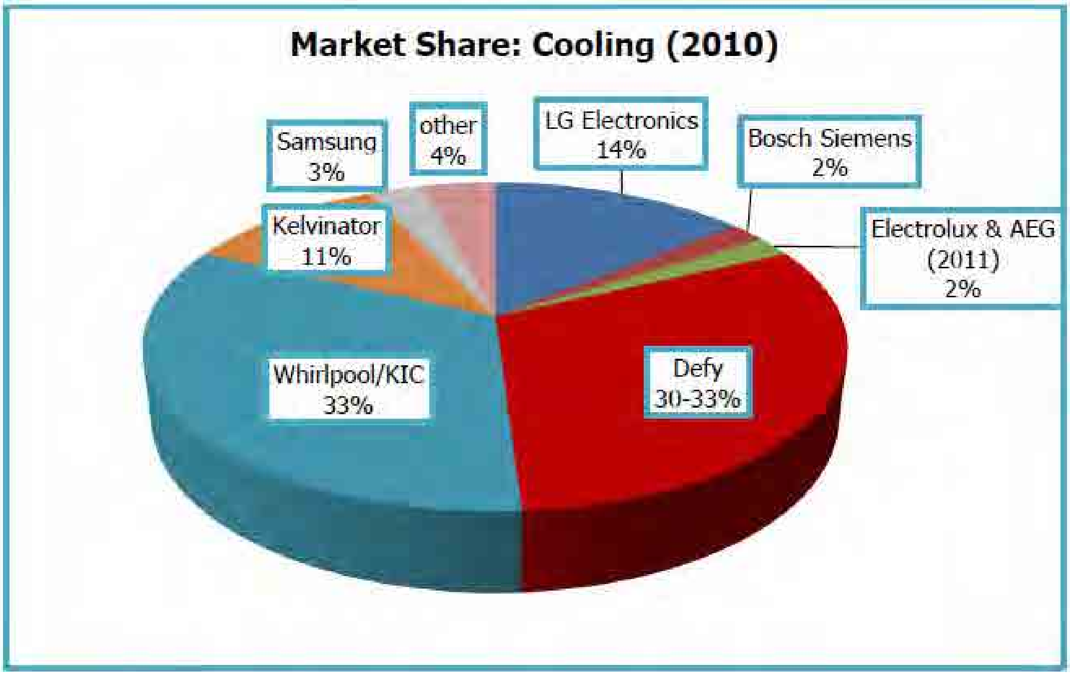
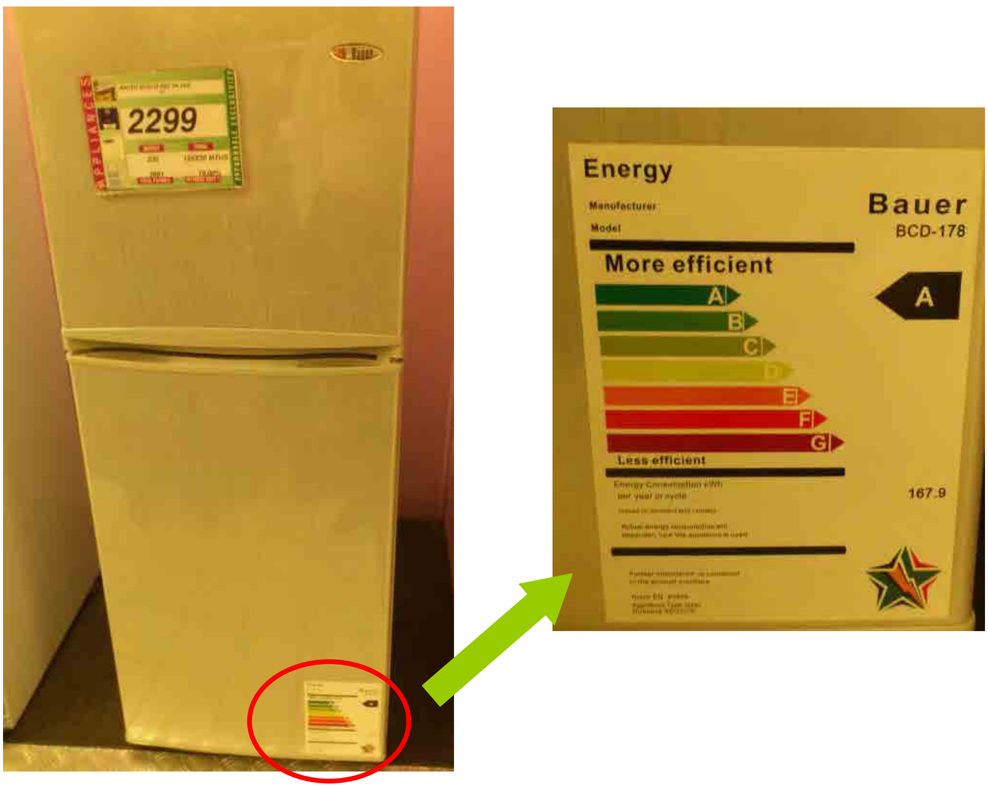


Figure 3.3-3 Energy Labeling in South Africa (refrigerator)



Source: Unlimited Energy Resources (Pty), Ltd

Figure 3.3-4 Shares of Refrigerator Market



Note: South Africa, Pretoria (May 2012)

Image 3.3-1 Voluntary Labeling of Refrigerators at an Electronics Retail Store

(4) Energy efficiency standard

South Africa has decided to introduce MEPS as an energy efficiency standard. SABS, an affiliate of DTI, is formulating an energy efficiency testing standard for each home appliance. In 2008, SABS set up the Working Group 941 (WG 941) under the Technical Committee (TC) to compile energy efficiency testing standards. WG941 is composed of members of SABS, DOE, DTI, NRCS, and a consumer group. The working group discussed the selection of equipment subject to regulation, the compilation of a testing standard for measuring selected equipment for energy performance, and a standby power standard. The contents of the agreement reached at WG941 were finally "recommended" to the Technical Committee SABS. South Africa's testing standard is based on the EU counterpart.

Starting in 2010, the energy efficiency testing standards (SANS941) were released sequentially. The standards were in place by February 2012 for the following product categories:

1) Air-conditioners (SANS 54511-3/EN 14511-3)
2) Audio, video, TV (SANS 62087/IEC 62087)
3) Dishwashers (SANS 50242/EN 50242)
4) Lighting (Electric ballast: SANS 60969/IEC 60969, electric lamps: SANS 50285/EN 50285, fluorescent lamps: SANS 60081/IEC 60081, SANS 60901/IEC 60901)
5) Electric ovens (SANS 50304/EN 50304)
6) Refrigerators (SANS 62552/IEC 62552)
7) Dryer (SANS 61121/IEC 61121)
8) Washing machines with dryers (SANS 50229/EN 50229)
9) Washing machines (SANS 60456/IEC 60456)

As of August 2012, MEPS energy efficiency thresholds are being reviewed by NRCS as part of its work on formulating "Technical compulsory." The thresholds are expected to be announced in 2013.

(5) Mandatory energy information labeling

The voluntary labeling program, currently in place, will be part of the mandatory labeling program. Under the mandatory labeling program, the labeling design mark under the voluntary labeling program may continue to be used. DOE is now reviewing energy information labeling, and it plans to modify the current labeling design. As with MEPS, energy grades of labeling are being discussed at the initiative of NRCS and will be published in 2013.

(6) Prospects for the future

According to the 2011 Action Plan, the mandatory labeling program and MEPS are to be introduced in 2013. However, they may be introduced in 2014 at the earliest, according to interviews with officials at DOE, DTI, NRCS, and other related organizations. An overall capacity shortage is causing a delay in program development. The roles in program development are divided among

DOE, DTI, NRCS, and other organizations, which require more time than expected for administrative procedures.

In 2012, the South African government and GEF will jointly start a five-year USD 13-million support project Market Transformation through Energy Efficiency Standards and Labeling of Appliances in South Africa with UNDP as the implementing organization. This is expected to help the country to accelerate development of an energy standard and a labeling program.

Under this project, many tasks will be carried out for introducing MEPS and a mandatory labeling program—formulating a policy and a regulatory framework; defining labeling specifications and MEPS thresholds for 12 products considered by the DOE & DTI; reinforcing the capacity of institutions and individuals; implementing an awareness-raising campaign for standards and labels, targeting manufacturers, distributors, retailers, and end-users; implementing S&L market surveillance and compliance regime; and developing a monitoring and evaluation (M&E) capacity.

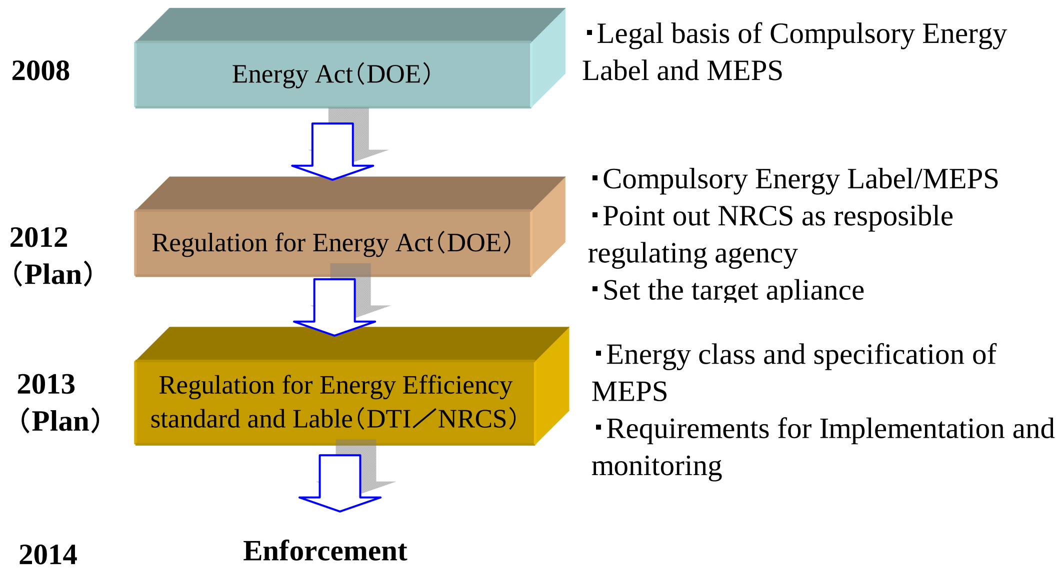


Figure 3.3-5 Policy Schedule

3.3.6. Support Programs for Energy Conservation

The Government of South Africa over the last decade has made large investments on upgrading its infrastructure under the Expanded Public Works Program (EPWP). The objectives of the program are: 1) to meet the demands of a growing economy and population; 2) prepare for the 2010 FIFA World Cup; and, 3) reduce unemployment by 1 million persons during the period 2004 to 2009. Several of the projects undertaken by the EPWP had as one of their objectives improving the use of energy or offering new services that would result in the more efficient use of energy.

The following is a list of some of the key initiatives undertaken by the South African Government, not all of which are part of the EPWP. It is not meant to be a comprehensive list, but aims to provide an overview.

(1) Industrial and Commercial

Eskom, through its Integrated Demand Program (IDM), has introduced several programs to incentivize the uptake of energy efficient technologies:

Performance Contracting: This is the bulk buying of energy conservation from project developers for a basket of projects. Performance contracting is best suited to large, capital intensive industrial projects and requires energy conservation that exceeds 30 GWh over a three-year period;

ESCO Model: This is best suited to individual projects (industrial) with unique requirements where project size exceeds 1 MW. Incentive payments are demand-based and paid for verified savings.

Standard Offer Program (SOP): This funding mechanism offers an incentive at a standard published rate (42 - 120 c/kWh) per technology type per unit of energy (kWh), which is saved during a specific period (16 hours) of a weekday. The project size has to be in the range of 50 kW-5 MW, and the savings are to be achieved Monday-Friday between 6:00 and 22:00 to qualify. The target market is the industrial and commercial sectors; and,

Standard Product: Pre-approved, published rebates are offered for deemed energy efficiency achieved as a result of replacing inefficient technologies with specific, pre-approved technologies. The incentive is aimed at medium-scale projects with a demand impact of less than 100 kW.

Industrial Energy Efficiency (IEE) Program: A joint program implemented by UNIDO and funded jointly by DTI, Department of Energy, UNIDO, Swiss Economic Cooperation and Development (SECO), and Department for International Development UK (DFID). NCPC promotes and implements energy efficiency initiatives by partnering with private sector companies who enroll in the program, which entitles them to a free energy assessment or audit.

Taxes and Tax Incentives:

Tax Incentives: Although not implemented yet, the Treasury has announced Section 12 L of the Income Act Tax. The incentives are for investments in energy efficient behavior and technology and allow an energy efficiency allowance/deduction from taxable income on the basis of energy efficiency savings (a similar incentive exists for Renewable Energy investment 12(I));

Green Energy Efficiency Fund (GEEF): A joint project between the Industrial Development Corporation (IDC) and German Development Bank (KfW) whereby soft loans (prime rate 2%) of up to R50 million are made available to companies making qualifying energy efficiency investments;

Manufacturing Enhancement Competitiveness Program (MCEP): The R5.8 billion incentive came into effect in June 2012 and aims to encourage local manufacturers to make capital investments to upgrade their manufacturing facilities, in order to improve their competitiveness. One of the five sub-components is the Green Technology and Resource Efficiency Improvement grant.

Carbon Tax: The Government pronounced its intention in the 2012 national budget to introduce a carbon emissions tax. It was announced during the budget to inform the private sector that the tax will be implemented and the form that it is likely to take. A vehicle emissions levy has already been introduced (refer to the Transport section for details).

(2) Residential

Although the residential sector is a high-priority area, the geographic spread and disparate nature of houses make it a difficult sector in which to introduce one-size-fits-all programs or initiatives. However, two programs stand out:

National Solar Water Heating (SWH) Program: Introduced in 2008 and administered by Eskom, qualifying SWH receive a rebate. The program is funded from the NERSA approved DSM budget. The Government's target is to install 1 million units by 2014/15 and 5 million by 2019. Low-pressure systems are targeted at low-income households and high-pressure systems at middle- to high-income households. As at 6 June, 2012, 147,906 low-pressure and 46,957 high-pressure system claims had been processed.

CFL Rollout: The program replaces inefficient, incandescent lamps with an equivalent, efficient compact fluorescent lamp. These are distributed at no cost in exchange for an incandescent lamp, which is then destroyed. The focus of the program has been primarily (if not exclusively) on the residential market. DSM funding and carbon revenues are being used to assist project financing. 43.5 million CFLs were fitted across SA (from 2004 – 2010) resulting in 2,006 MW demand savings

(3) Transport

Gautrain: A high-speed rail line linking Johannesburg, Pretoria, and the International Airport (O.R.Tambo);

Bus Rapid Transit (BRT): Guatrain is supported by the BRT, which uses dedicated lanes, in both cities. The Johannesburg system is operational, but has not been completed, while the Pretoria (Tshwane) system broke ground in July 2012 for 51 stations on a 80-kilometer route with a budget of R2.6 billion. Other cities are also implementing integrated public transport systems such as the City of Cape Town's Travel Smart' Program;

The Gauteng Freeway Improvement Project: This is an upgrade with new freeways built in the country's most populated province and economic heartland of the country. The South African National Roads Agency Limited (SANRAL) stated in July 2012 that the upgrades have reduced travel times by as much as 50%.

Fuel Emissions: The DOE recently promulgated regulations for fuel specifications that will, in broad terms, be the same as those introduced in Europe to enable Euro 5 vehicle emission standards. These are to be in place by July 2017. The country's refineries currently produce Euro 2.

Fuel Emissions Carbon Tax: The tax was introduced in 2011 and applies to all new passenger vehicles. In the case of passenger vehicles, the levy rate is R75 per g-CO_2/km on emissions exceeding the threshold of 120 g-CO_2/km. In the case of double-cab vehicles, the rate is R100 per g-CO_2/km on emissions over 175 g-CO_2/km.

3.3.7. Green Economy

Advocating the construction of a sustainable society, the South African government will take measures designed to shift to a green economy in the future. In November 2011, the DEA announced the National Strategy for Sustainable Development and Action Plan (NSSD1) in line with COP17 held in Durban, under which Phase 1 will start in 2011 and continue to 2014.

South Africa faces many environmental problems that could obstruct its future economic growth, including water pollution accompanying the extraction of natural resources, air pollution accompanying the wider use of coal and vehicles, and increasing waste. Moreover, the country is excessively dependent on coal in its energy mix, which is increasing greenhouse gas emissions. Since 1994, the impoverished population has been growing and includes immigrants flowing in from neighboring countries. The poverty issue in South Africa is worsening and poses a serious social challenge.

Under the slogan of sustainable development, the government is committed to shifting to a green economy to create jobs through public investment in infrastructure, respond to environmental problems, and avoid impacts of energy and environmental problems that are expected to arise in line with future economic growth.

Deliberations on specific policies were started at the initiative of the Department of Environment Affairs and Tourism (DEAT, currently DEA), following adoption of the "Johannesburg Plan of Implementation" (JPOI) at the World Summit on Sustainable Development (WSSD) held in Johannesburg, 2002. DEAT discussed strategies for sustainable development through roundtable talks with government agencies and stakeholders and in cooperation with development assistance agencies, such as UNDP and GTZ. As part of this process, investigations were carried out on the social and economic situation in the country, the status of energy resources, and the governance system of the country to clarify matters to be addressed to achieve the goals of the society.

Based on these specific deliberations, DEAT formulated "A National Framework for Sustainable Development in South Africa (NFSD)" in 2008, under which it presented a framework, a vision, and nine principles for the sustainable development of South Africa. Under the framework, DEAT designated five priority issues:

- Formulating a cross-agency integrated plan and reinforcing the policy implementation system to promote sustainable development;
- Protecting the ecosystem and using natural resources efficiently;
- Developing a sustainable economy by accelerating infrastructure investment and job training;
- Developing sustainable dwelling environments; and,
- Responding to cross-sectoral problems, such as climate change, surging energy prices, and HIV/AIDS.

NFSD is considering implementing these priority issues in three phases:

Phase 1: Formulating a common framework for sustainable development in South Africa (formulation of a NFSD).
Phase 2: Formulating a specific action plan for fulfilling targets and preparing for its implementation (formulation of the NSSD).
Phase 3: Implementing the action plan, and monitoring and reviewing the policies.

Under the NFSD, DEAT is to lead activities for sustainable development and work together with the National Planning Commission (NPC) under the presidential government to formulate a detailed action plan. It will integrate, into the NFSD objectives, strategies and plans formulated by government agencies that are in charge of each policy. To facilitate this process, personnel of government agencies other than DEAT will be assigned to formulate policies for sustainable development.

Following the announcement of NFSD, deliberations on sustainable development of South Africa were taken over in Phase 2, and NSSD1 was established in 2011. NSSD1 corresponds to Phase 2 of NFSD, and serves as a specific action plan to fulfill the objectives. Some changes were made to priority issues in NSSD1 as follows.

- Formulating a cross-agency integrated plan and reinforcing the policy implementation system to promote sustainable development;
- Protecting the ecosystem and using natural resources efficiently;
- Shifting to a green economy;
- Constructing sustainable communities; and,
- Responding to climate change effectively.

Specifically, the following initiatives are to be implemented to shift to a green economy:

- Promoting construction of green buildings (implementation of green building regulations);

- Accelerating implementation of sustainable transport (Modal shift, switch from gasoline-fueled vehicles to EV and PHV);
- Promoting clean energy and energy efficiency (rural electrification, introduction of renewable energy, and accelerated installation of solar water heaters);
- Reinforcing the saving and control of natural resources;
- Implementing a sustainable waste management system on a trial basis (e.g. waste segregation, weight reduction);
- Shifting to a sustainable agricultural and forestry system;
- Implementing water management (e.g. water demand management, reduction in water use in agriculture and industry); and,
- Promoting sustainable consumption and production (e.g. change of production methods, technology innovation).

These initiatives are expected to create jobs for young people in the green economy industry through skills development, accelerate technological development, and provide investment opportunities. Policies set up under NSSD1 will be implemented under the National Committee on Sustainable Development (NCSD) to be established in the near future. NCSD will be an independent organization responsible for sustainable development in South Africa. Involving a wide range of policies, NCSD will be tasked with coordinating NPC and other government agencies, and managing and monitoring the progress of policies.

As deliberations continue on sustainable development, the South African government includes the green economy among its important employment policies. The country attaches the same level of importance to both the green economy and economic development, considering the green economy to be a significant factor driving economic growth.

The New Growth Path (NGP), announced simultaneously with NFSD1, aims to create 300,000 jobs in 2020 and 400,000 in 2030 in the manufacturing, construction, and other industries through improved management of natural resources and manufacture of renewable energy equipment.

To fulfill these employment targets, government, industry, and labor unions signed the “Green Economy Accord.” This agreement is composed of 12 measures for shifting to a green economy.

- Accelerating the spread of solar water heaters (installation of one million units by 2014);
- Reinforcing investments in green economy;
- Accelerating the use of renewable energy (achievement of the IRP target of 3,725 MW by 2016);
- Improving energy efficiency (contribution to fulfillment of energy efficiency targets);
- Accelerating the recycling and reuse of waste (achieving a recycling ratio of 51% by 2014);
- Accelerating the use of biofuels;
- Developing clean coal technology (accelerated development of CCS technology);

- Renovating outdated coal-fired power plants;
- Reducing CO_2 emissions from the transport sector (development of public transport);
- Rural Electrification and reducing fossil fuel consumption;
- Creating jobs through a shift to a green economy; and,
- Making COP17 successful and following up COP commitments.

Pursuant to this Accord, measures are to be implemented to fulfill commitments through cooperation among participants. The progress of the project will be monitored.

4 Energy Supply and Demand Estimate

In this study, we seek to formulate a measurement model customized for South Africa as an analytical tool for estimating energy supply and demand in the country. Our tool is based on an energy supply and demand estimate model developed by the Institute of Energy Economics, Japan, and uses scenarios reflecting a variety of factors. Based on a multiple regression analysis, our measurement model estimates final energy consumption and primary energy supply until a target year. Scenarios are created in accordance with the purpose of the study and targets set up by the South African government.

Scenarios will be formulated through consultations with South African officials so that they are convincing and match the country's energy policy targets.

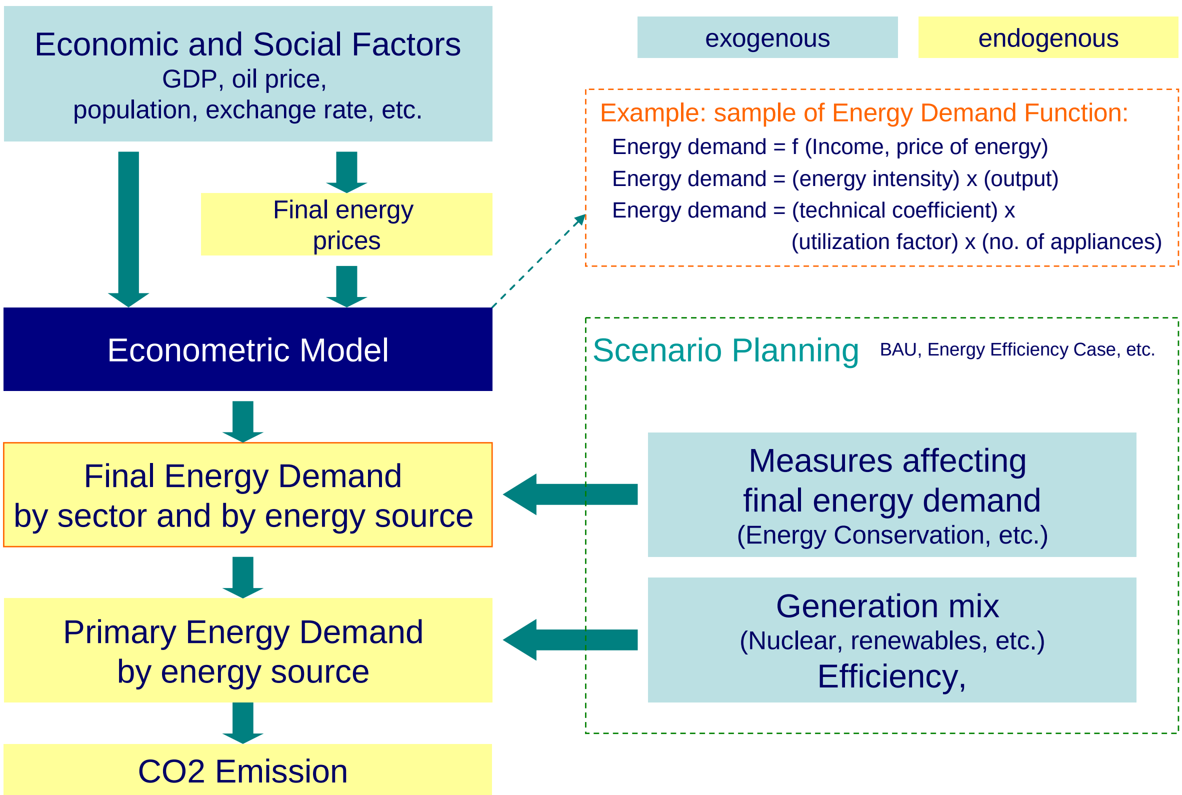


Figure 4.0-1 Flow of Energy Demand and Supply Forecast

Figure 4.0-1 shows the estimation process for energy supply and demand. To estimate future values of final energy consumption, primary energy supply, and CO_2 emissions, external variables are added to the energy supply and demand model, such as economic growth, population, and oil prices. Estimates are given in a Business As Usual (BAU) based on past trends and expected economic and population growth. At the same time, energy-conservation scenarios will be created to predict future energy-conservation cases for comparison with BAU cases.

4.1. Data Collection and Model Development

4.1.1. Data Collection

The following data are collected to develop a model and create scenarios:

(1) Energy balance data
For energy, data are taken from those on South Africa contained in "Energy Balances of non-OECD Countries," which is compiled by the International Energy Agency (IEA). These data provide energy consumption by energy source for the process from primary energy supply to final demand. The data show final demand after it is assigned to industry, transport, household, business, agriculture, other, and non-energy sectors. The industry sector is divided into steel, chemical, cement, non-ferrous metal, mining, paper and pulp, and other segments. The latest data year in the 2011 edition is 2010. Because abnormal values were observed in 2010 energy consumption data, the rate of increase and other indicators are based on 2009 as the starting point of the outlook.

(2) Energy prices
For energy prices, data from IEA's "Energy Prices and Taxes" are used. Electricity prices are shown for industry and household sectors.

(3) Economy and population
The BAU case is constructed based on the population projection in the "World Population Prospects: The 2010 Revision" of the United Nations and economic growth rate outlook in the "Integrated Resource Plan for Electricity 2010-2030, Revision 2."

(4) Power composition
The future power composition is estimated using "Integrated Resource Plan for Electricity 2010-2030, Revision 2" (March 2011) as reference.

4.1.2. Model Development

An energy supply-demand measurement model is formulated using Economate-macro software (Shonan Econometrics).

The energy supply and demand model is composed of energy price module, final energy demand module, power generation sector module, and primary energy supply module (Figure 4.2). The basic structure of the model is built in accordance with the energy consumption flow—the basis of an energy balance table—composed of final energy demand, energy conversion, and primary energy supply. Each simultaneous equation contained in the model consists of estimation and definition formulas based on the ordinary linear square method (OLS).

4.1.3. Creating Scenarios

Sensitivity analysis is conducted by setting high-growth and low-growth cases against the BAU case. A BAU-IRP case is also created by incorporating a power development plan into the BAU case. Energy-efficient cases are created on the basis of the BAU-IRP case, which is to be compared to the BAU case in terms of final energy consumption, primary energy supply, and CO_2 emissions expected when use of energy-efficient equipment spreads widely under an energy conservation policy.

Estimation is made for the 2010-2035 period. Table 4.1-1 shows the scenarios conceived.

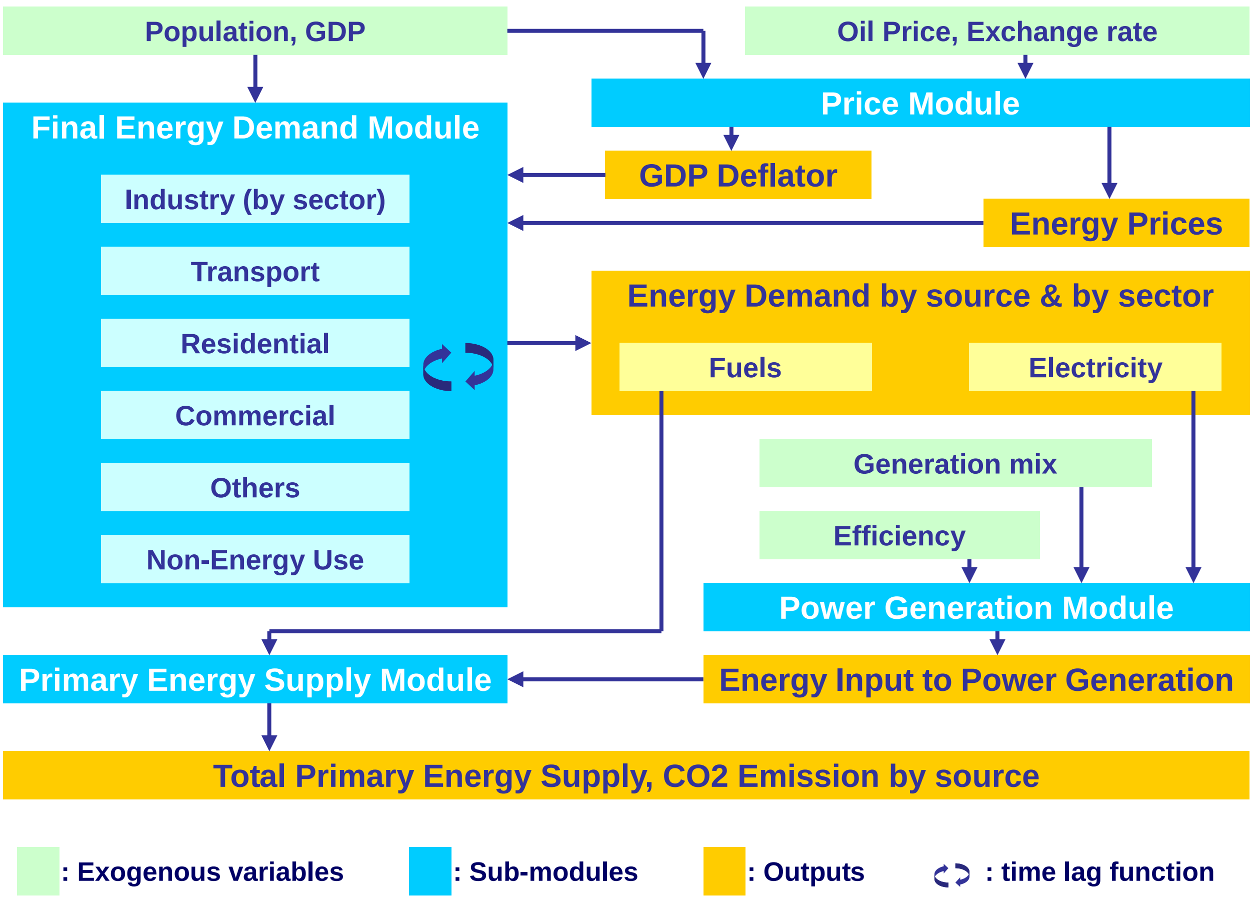


Figure 4.1-1 Structure of Energy Demand and Supply Model

Table 4.1-1 Scenario Setting

Case Name	Scenario	Objective
BAU case	Real GDP: 4.5%/year (2009~2035)	GDP-sensitivity analysis base on BAU case
High-growth case	Real GDP: 5.0%/year (2009~2035)	
Low-growth case	Real GDP: 2.2%/year (2009~2035)	
BAU-IRP case	Nuclear, renewables and natural gas power development plan from "Integrated Resource Plan for Electricity 2010-2030, Revision."	Analysis on energy efficiency scenario based on BAU-IRP case
Maximum Energy Efficiency case	Energy efficiency introduced at maximum speed (All equipment achieve highest efficiency technology level in 2011)	
Advanced Energy Efficiency Case	Energy efficiency introduced at the realistic speed (All equipment achieve highest efficiency technology level until 2035)	

4.2. Trends of Energy Supply and Demand for BAU Case

4.2.1. Assumptions

According to the United Nations' "World Population Prospects: The 2010 Revision," the country's population will grow from 49.3 million in 2009 to 54.2 million in 2030 and to 55.0 million in 2035 (Figure 4.2-1).

Real GDP is expected to grow from USD 187.0 billion in 2010 (2000 prices) to USD 464.0 billion (2000 prices) in 2030 and to USD 575.0 billion in 2035 (2000 prices) (Figure 4.2-2). The economy grew at an average annual rate of 2.6% during the period 1990-2009, and will grow at 4.5% during the period 2010-2035. National Planning Commission's "National Development Plan Vision for 2030" (November 2011) aims to reduce the country's unemployment rate to 6% (25% for 2010). To achieve the target, the government needs to double the 2011 real GDP by 2030. Therefore, our estimate of real GDP slightly increases the prediction of the "National Development Plan Vision for 2030."

Real GDP per capita will increase from USD 3,700 in 2009 to USD 8,500 in 2030 and to USD 10,400 in 2035 (Figure 4.2-3).

Crude oil prices per barrel (nominal) is estimated to increase from USD 79 in 2010 to USD 177 in 2030 and to USD 201 in 2035 (Figure 4.2-4).

The exchange rate is assumed to remain at 7.26 ZAR/USD into the future.

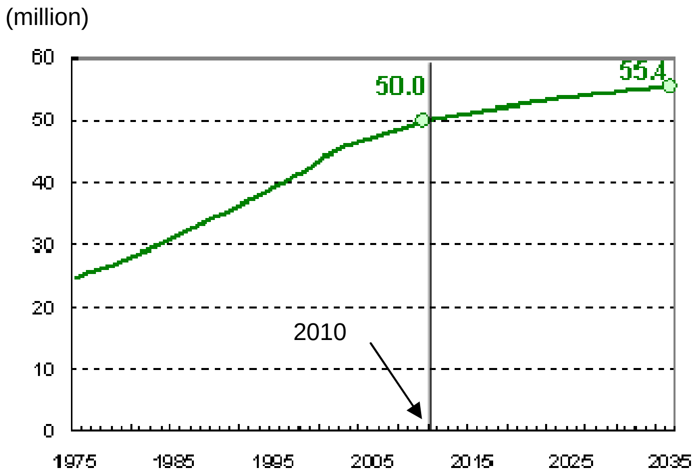


Figure 4.2-1 Population

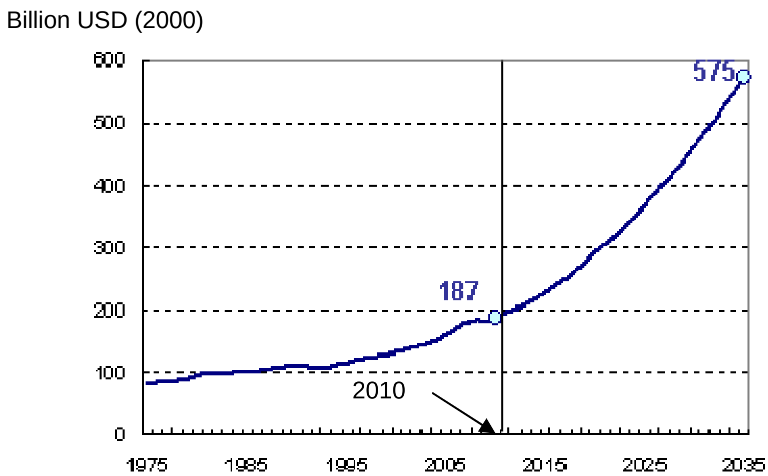


Figure 4.2-2 Real GDP

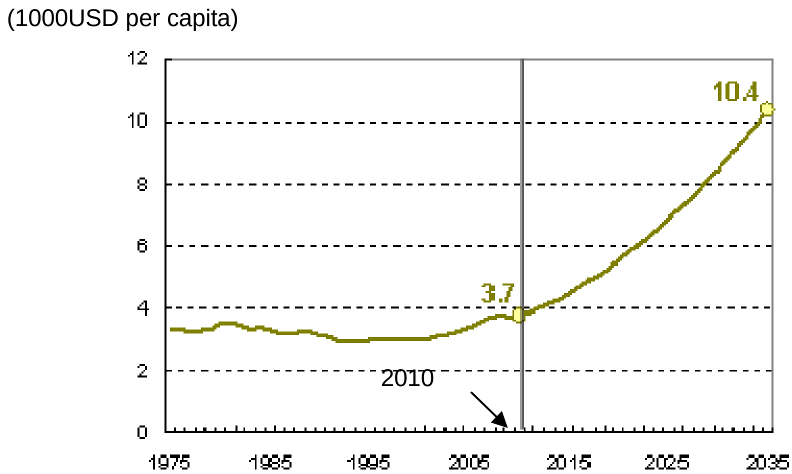


Figure 4.2-3 Real GDP Per Capita

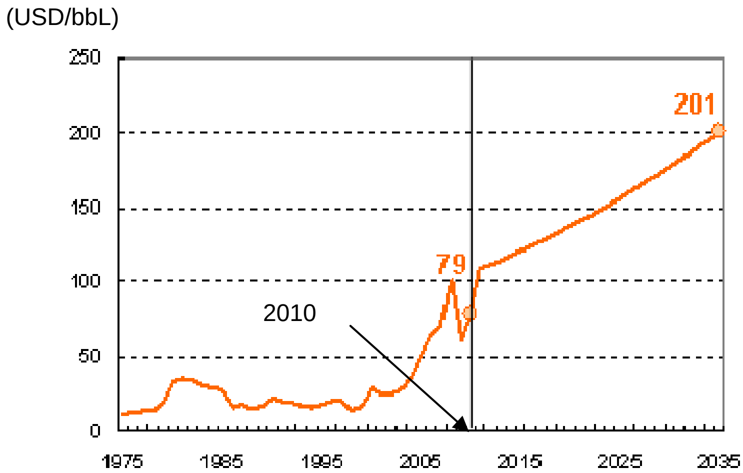
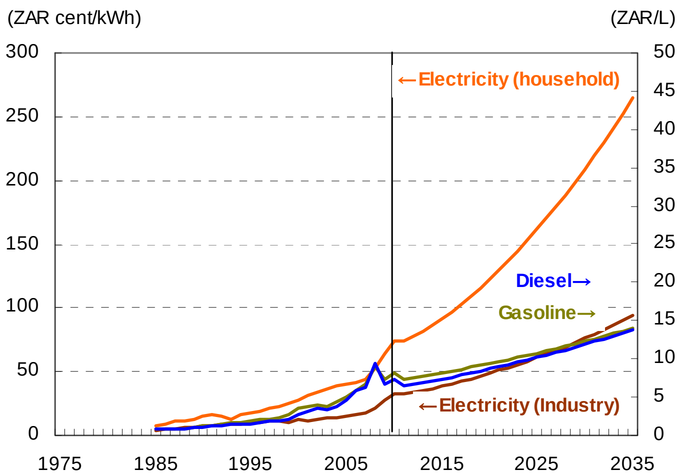


Figure 4.2-4 Oil Price

4.2.2. Estimation Results

(1) Energy prices

Electricity prices will grow by three times for industry and 3.5 times for households between 2010 and 2035. The prices of gasoline and diesel oil will double during the same period.

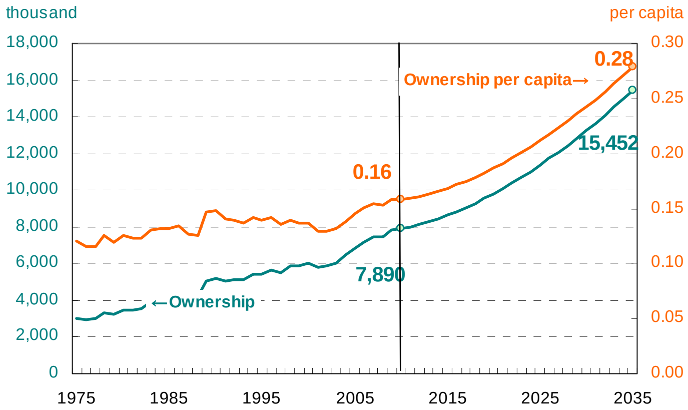


	Unit	1990	2009	2035
Industrial electricity	ZAR/kWh	0.07	0.32	0.94
Household electricity	ZAR/kWh	0.15	0.74	2.65
Gasoline	ZAR/L	1.20	8.14	14.02
Kerosene	ZAR/L	1.11	7.36	13.79

Figure 4.2-5 Energy Price

(2) Number of vehicles

The number of vehicles will increase from 7.9 million in 2010 to 15.5 million in 2035. The per-capita number of vehicles will increase from 0.16 to 0.28 during the same period.



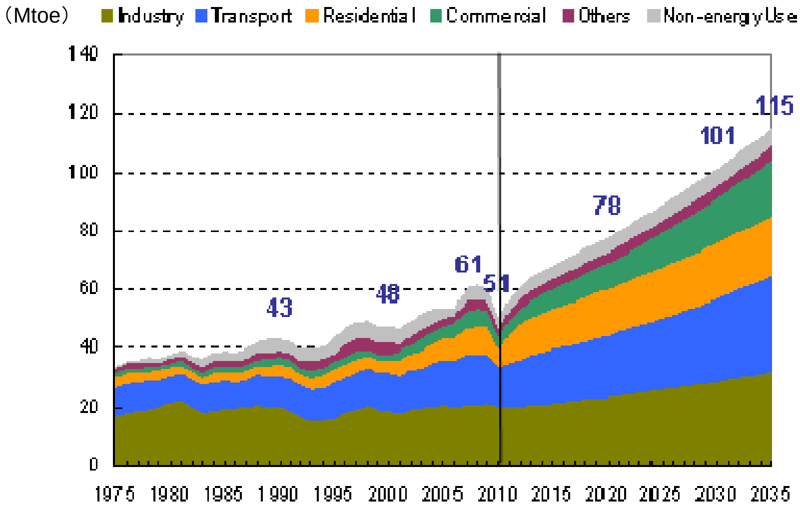
	1990	2010	2035
Number of Vehicles (million)	5.2	7.9	15.5
Number of Vehicles per capita	0.15	0.16	0.28

Figure 4.2-6 Vehicle Ownership Rate

(3) Final energy demand

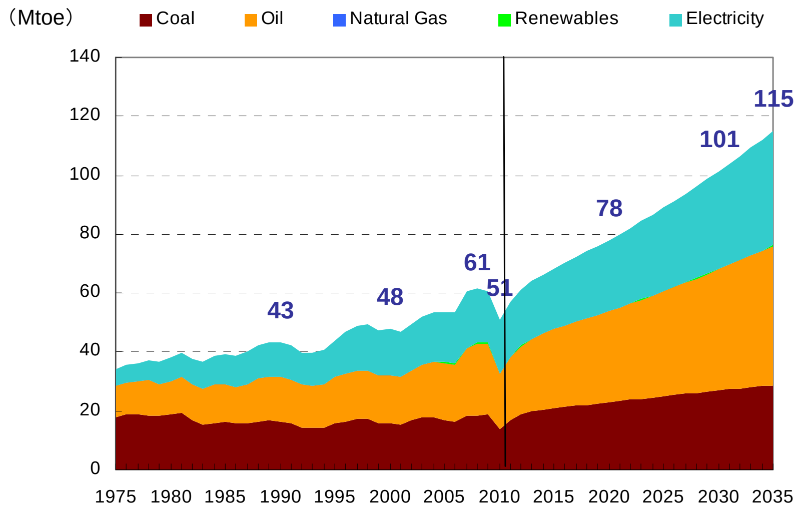
Figure 4.2-7 shows changes in final energy demand by sector. Total demand, at 61 Mtoe in 2009, will increase at an annual rate of 2.5% to 115 Mtoe in 2035. In 2009, the industry sector accounted for 35% of total demand, the transport sector for 28%, the household sector for 15%, and the commercial sector for 10%. In 2035, these sectors will represent 28%, 29%, 18%, and 17%, respectively. Energy consumption will increase in all sectors, especially in the household and business sectors.

By energy type, coal represented 31%, oil 39%, and electricity 29% of total final energy consumption in 2009, while in 2035 they will account for 25%, 41%, and 34%, respectively. Electricity will have a greater share in the future in line with electrification amid economic growth (Figure 4.2-8).



	Growth rate (%/year)		Share (%)	
	1990~2009	2009~2035	2009	2035
Total	1.8%	2.5%	100%	100%
Industry	0.2%	1.6%	35%	28%
Transport	2.7%	2.5%	28%	29%
Household	4.2%	3.2%	15%	18%
Commercial	4.9%	4.7%	10%	17%
Other	1.7%	1.8%	5%	4%
Non-Energy Use	0.7%	1.0%	8%	5%

Figure 4.2-7 Final Energy Demand by Sector



	Growth rate (%/year)		Share (%)	
	1990~2009	2009~2035	2009	2035
Total	1.8%	2.5%	100%	100%
Coal	0.8%	1.6%	31%	25%
Oil	2.5%	2.7%	39%	41%
Natural gas	-	-	0%	0%
Renewables	-	5.0%	0%	0%
Electricity	2.1%	3.1%	29%	34%

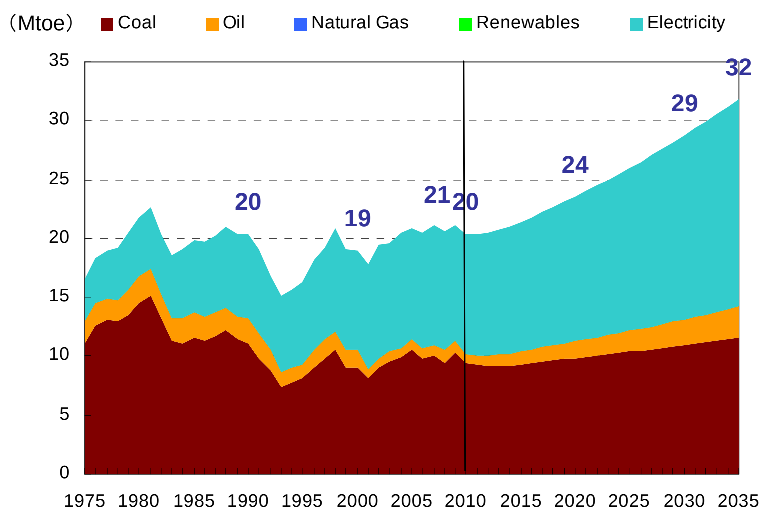
Figure 4.2-8 Final Energy Demand by Energy Source

By sector, final energy consumption will increase at an annual rate of 1.6% in the industry sector (Figure 4.2-9). Consumption will increase at an annual rate of 3.6% for oil and 2.3% for electricity, while consumption of coal will increase slightly.

Final energy consumption will increase at an annual rate of 2.5% in the transport sector (Figure 4.2-10). Automobiles will remain the main means of transport.

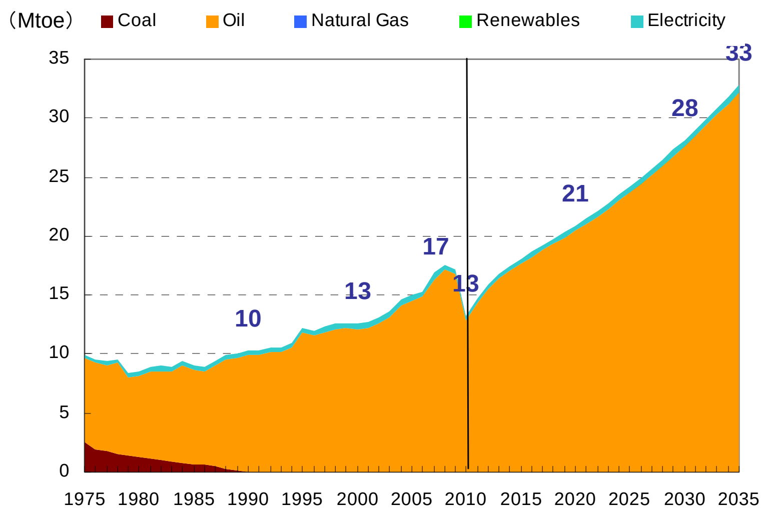
Final energy consumption will increase at an annual rate of 3.2% in the household sector (Figure 4.2-11). As electricity replaces coal, the share of electricity in final energy consumption will rise from 39% in 2009 to 45% in 2035.

Final energy consumption in the commercial sector will increase at an annual rate of 4.7% (Figure 4.2-12). As with the household sector, electricity will increase its share from 43% to 47%.



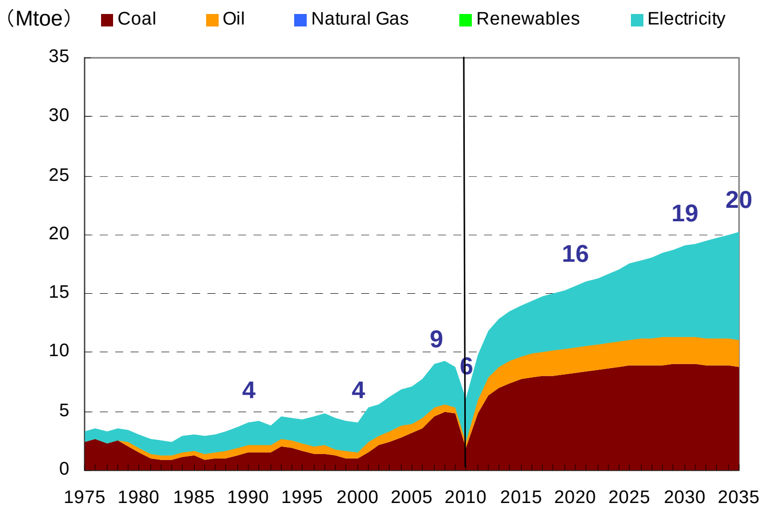
	Growth rate (%/year)		Share (%)	
	1990~2009	2009~2035	2009	2035
Total	0.2%	1.6%	100%	100%
Coal	-0.4%	0.5%	49%	36%
Oil	-3.8%	3.6%	5%	8%
Natural gas	-	-	0%	0%
Renewables	-	-	0%	0%
Electricity	1.7%	2.3%	46%	55%

Figure 4.2-9 Final Energy Demand by Energy Source in the Industrial Sector



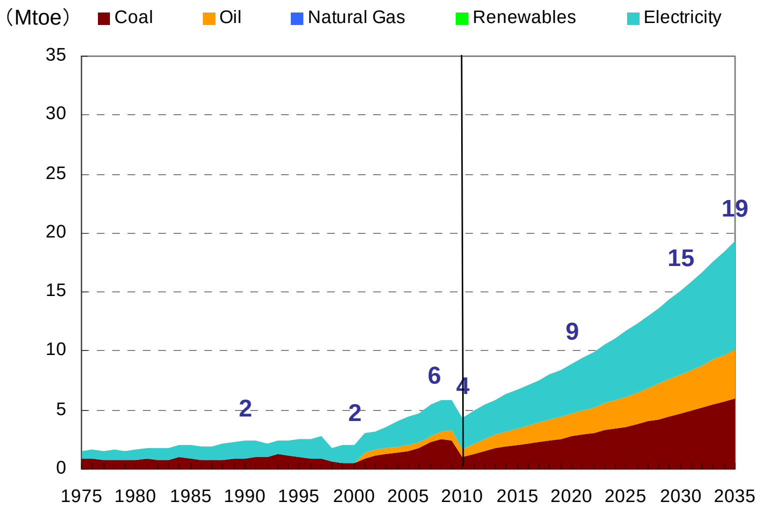
	Growth rate (%/year)		Share (%)	
	1990~2009	2009~2035	2009	2035
Total	2.7%	2.5%	100%	100%
Coal	-100%	-	0%	0%
Oil	2.8%	2.5%	98%	98%
Natural gas	-	-	0%	0%
Renewables	-	-	0%	0%
Electricity	-0.6%	2.8%	2%	2%

Figure 4.2-10 Final Energy Demand by Energy Source in the Transport Sector



	Growth rate (%/year)		Share (%)	
	1990~2009	2009~2035	2009	2035
Total	4.2%	3.2%	100%	100%
Coal	6.4%	2.3%	55%	44%
Oil	-0.1%	5.8%	6%	11%
Natural gas	-	-	0%	0%
Renewables	-	-	0%	0%
Electricity	3.1%	3.8%	39%	45%

Figure 4.2-11 Final Energy Demand by Energy Source in the Household Sector

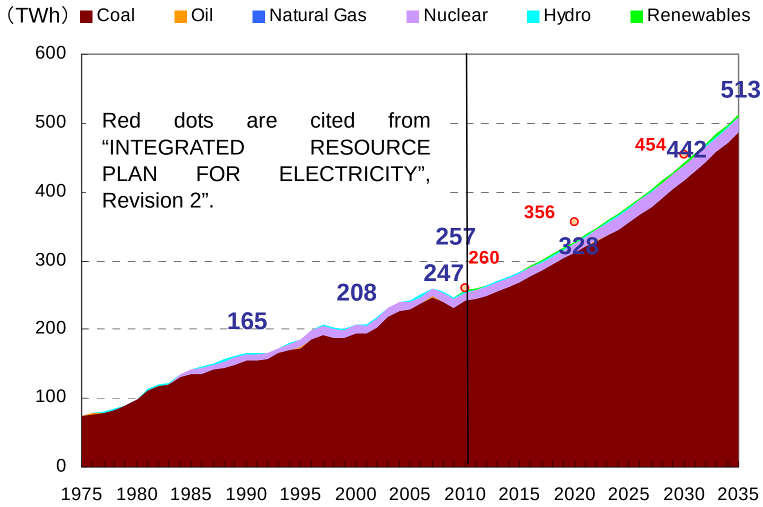


	Growth rate (%/year)		Share (%)	
	1990~2009	2009~2035	2009	2035
Total	4.9%	4.7%	100%	100%
Coal	5.3%	3.5%	42%	31%
Oil	-	6.1%	16%	22%
Natural gas	-	-	0%	0%
Renewables	-	-	0%	0%
Electricity	2.9%	5.1%	43%	47%

Figure 4.2-12 Final Energy Demand by Energy Source in the Commercial Sector

(3) Power generation

Power generation (Figure 4.2-13) will increase from 247.0 billion kWh in 2009 to 442.0 kWh in 2030 and to 513.0 billion kWh in 2035. Although generation of nuclear energy and renewable energy will increase, coal will still be the main source of electricity. These estimates are almost the same as the figures provided in “Integrated Resource Plan for Electricity 2010-2030, Revision 2” (March 2011).



	Growth rate (%/year)		Share (%)	
	1990~2009	2009~2035	2009	2035
Total	2.1%	2.9%	100%	100%
Coal	2.1%	2.9%	94%	95%
Oil	-	0.0%	0%	0%
Natural gas	-	-	0%	0%
Nuclear	2.2%	2.0%	5%	4%
Hydro	1.9%	0.0%	1%	0%
Renewables	-	9.9%	0%	1%

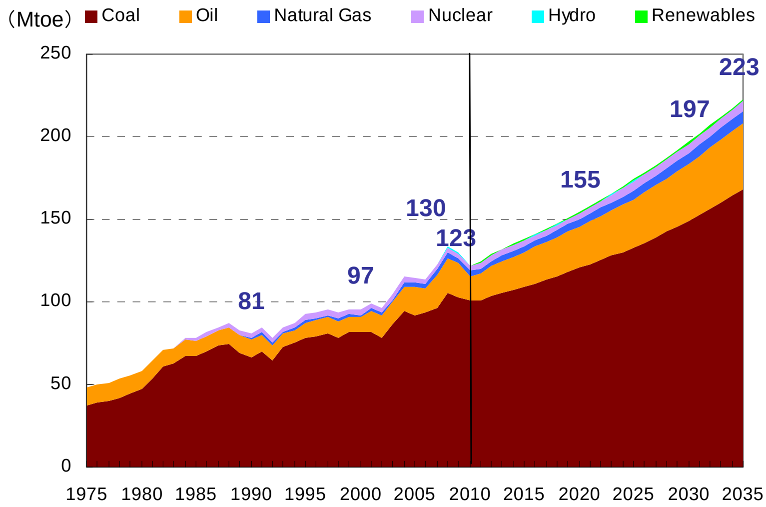
Figure 4.2-13 Power Generation

(4) Primary energy supply

Primary energy supply will increase from 130 M-toe in 2009 at an average annual rate of 2% (Figure 4.2-14) to reach 223 Mtoe in 2035. The share of coal will decrease from 79% to 75% in line with the increase of oil demand.

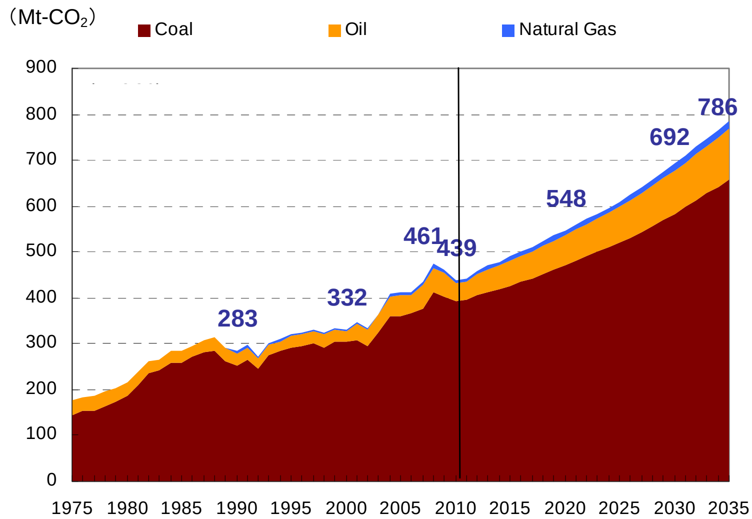
(5) CO_2 emissions

Because coal will remain the main energy source in the primary energy supply, CO_2 emissions will also increase at an average annual rate of 2% (Figure 4.2-15).



	Growth rate (%/year)		Share (%)	
	1990~2009	2009~2035	2009	2035
Total	2.6%	2.1%	100%	100%
Coal	2.3%	1.9%	79%	75%
Oil	3.7%	2.6%	16%	18%
Natural gas	2.9%	4.1%	2%	3%
Nuclear	2.2%	2.0%	3%	2%
Hydro	1.9%	0.0%	0%	0%
Renewables	-	8.6%	0%	1%

Figure 4.2-14 Primary Energy Supply by Energy Source



	Growth rate (%/year)		Share (%)	
	1990~2009	2009~2035	2009	2035
Total	2.6%	2.1%	100%	100%
Coal	2.5%	1.9%	87%	84%
Oil	3.5%	2.9%	11%	14%
Natural gas	2.9%	4.1%	1%	2%

Figure 4.2-15 CO_2 Emissions

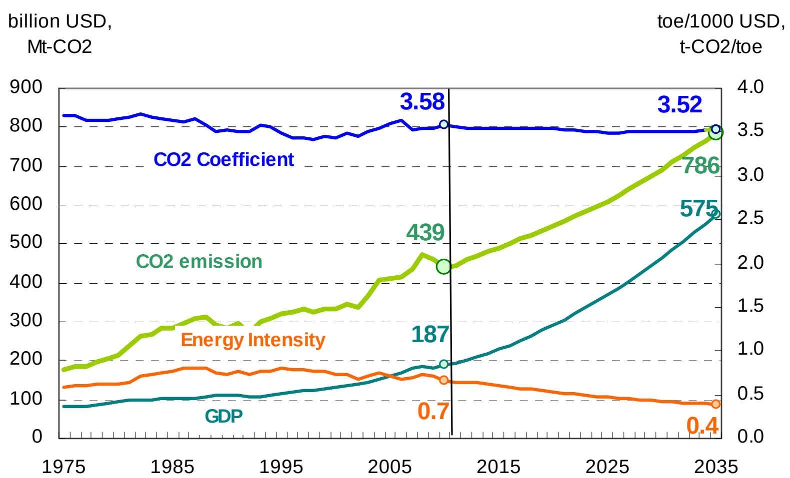
4.2.3. Analysis of Factors of CO_2 Emissions

The Kaya equation expresses CO_2 emissions by multiplying GDP by energy consumption rate and CO_2 emission factor, as follows.

$$CO2 = \frac{CO2}{E} \times \frac{E}{GDP} \times GDP$$

The rate of increase in CO_2 emissions is the sum of economic growth, rate of change of energy consumption rate, and rate of change of CO_2 emissions factor.

During the period 1990-2009, the economy grew at an average annual rate of 2.6%, unit energy consumption improved at an annual rate of 0.1%, and CO_2 emission factor remained unchanged, resulting in an annual increase of 2.6% in CO_2 emissions. Meanwhile, we assume that, in the BAU case, the economy will grow at an annual rate of 4.5% during the period 2009-2035, while unit energy consumption will improve 2.3% annually. Given that the share of coal in the primary energy supply will remain almost flat, the CO_2 emissions factor will also remain unchanged. As a result, CO_2 emissions will increase at an annual rate of 2.1%. Because the energy consumption rate will improve faster than the economic growth rate, increases in CO_2 emissions will slow.



(p.a.)	1990~2009	2009~2035
GDP	2.6%	4.5%
Energy Intensity	-0.1%	-2.3%
CO_2 coefficient	0.0%	0.0%
CO_2 emission	2.6%	2.1%

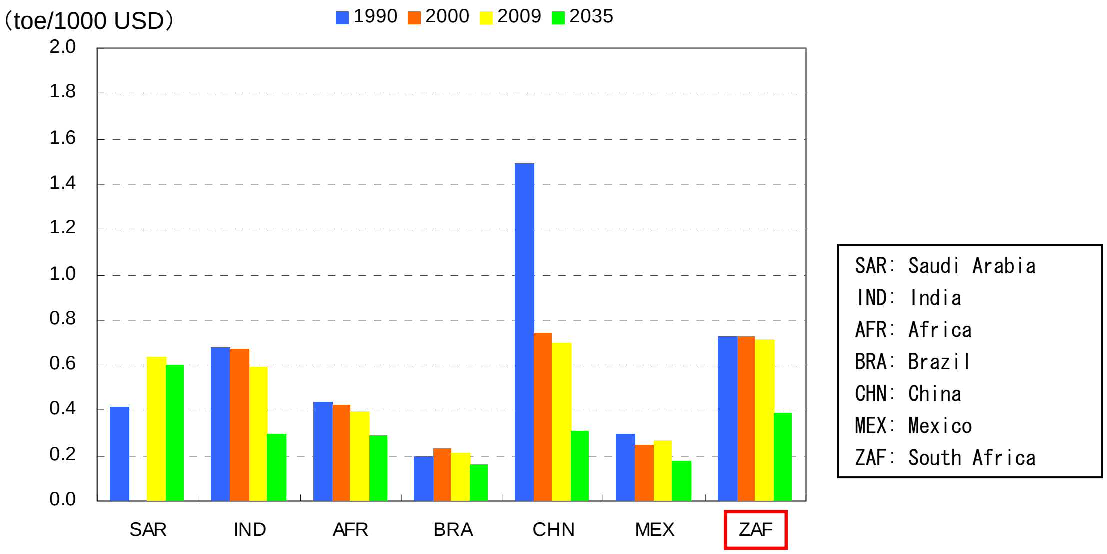
Figure 4.2-16 Factor Analysis of CO_2 Emissions

4.2.4. Energy Consumption Rate and Elasticity

Table 4.2-1 shows the GDP elasticity of primary energy supply and CO_2 emissions in South Africa. The GDP elasticity of primary energy supply was 0.97 during the period 1990-2009. The value will decrease to 0.46 during the period 2009-2035. The decreasing GDP elasticity of primary energy supply shows that the industrial structure of South Africa is shifting from secondary (industry sector) industrialization to tertiary (service sector) industrialization, and energy efficiency in South Africa is improving. For an international comparison, Figure 4.2-17 and Figure 4.2-18 shows the GDP elasticity of energy consumption rate and energy, respectively. The energy consumption rate is decreasing in South Africa, as with other emerging countries.

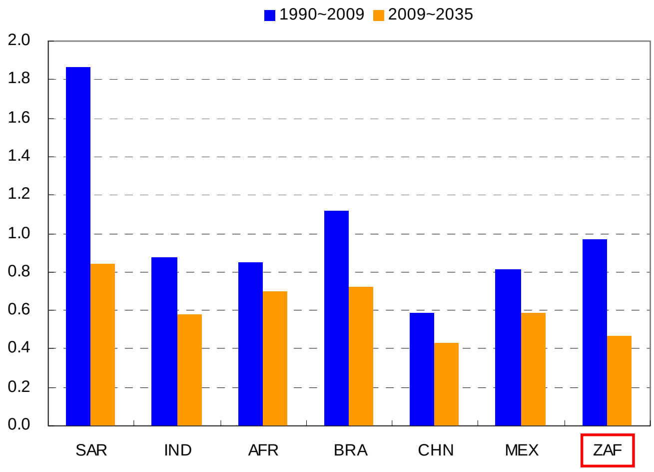
Table 4.2-1 Elasticity of South Africa

	GDP (p.a.)		TPES (p.a.)		CO_2 (p.a.)	
	1990~2009	2009~2035	1990~2009	2009~2035	1990~2009	2009~2035
BAU	2.6%	4.5%	2.6%	2.1%	2.6%	2.1%
			(TPES/GDP)		(CO_2/GDP)	
Elasticity			0.97	0.46	0.98	0.46



Source: Nations other than South Africa are cited from "Asia/World Energy Outlook 2011," IEEJ

Figure 4.2-17 Comparison of Energy Intensities

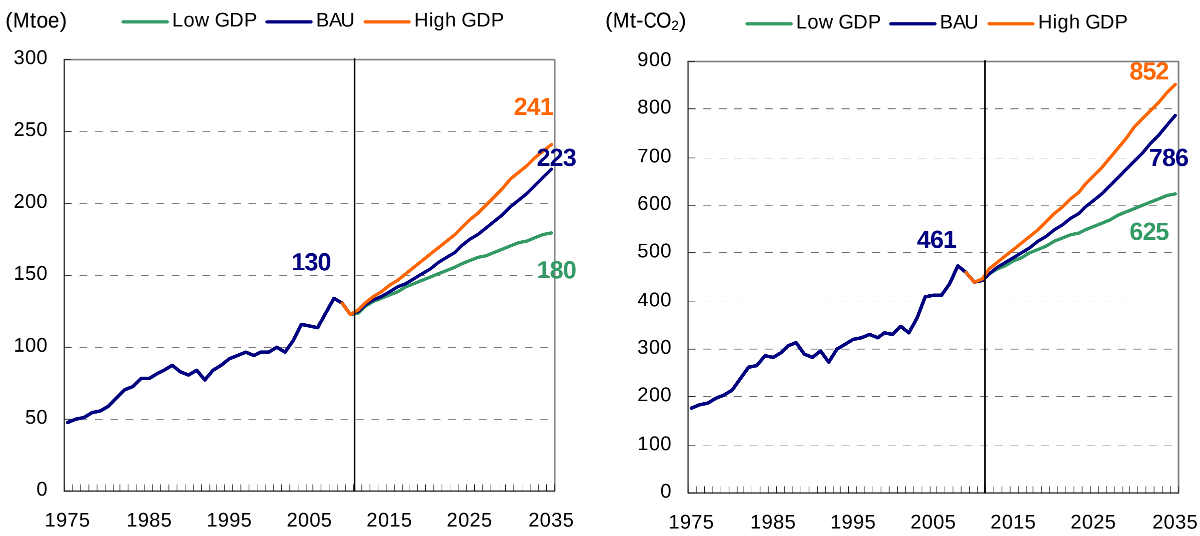


Source: Nations other than South Africa are cited from "Asia/World Energy Outlook 2011," IEEJ

Figure 4.2-18 Comparison of GDP Elasticity of Total Primary Energy Supply

4.2.5. Sensitivity Analysis

Figure 4.2-19 shows the sensitivity of primary energy supply and CO_2 emissions with respect to GDP. The GDP sensitivity is about 0.4% for both. The result of GDP sensitivity analysis shows that if GDP increases 1% compared to the BAU case, energy consumption will increase 0.4%.



(p.a.)		GDP	TPES	CO_2
GDPL		2.2%	1.2%	1.2%
BAU		4.5%	2.1%	2.1%
GDPH		5.0%	2.4%	2.4%
Sensitivity	BAU/GDPL	-	0.37	0.39
	GDPH/BAU	-	0.60	0.62
	GDPH/GDPL	-	0.41	0.43

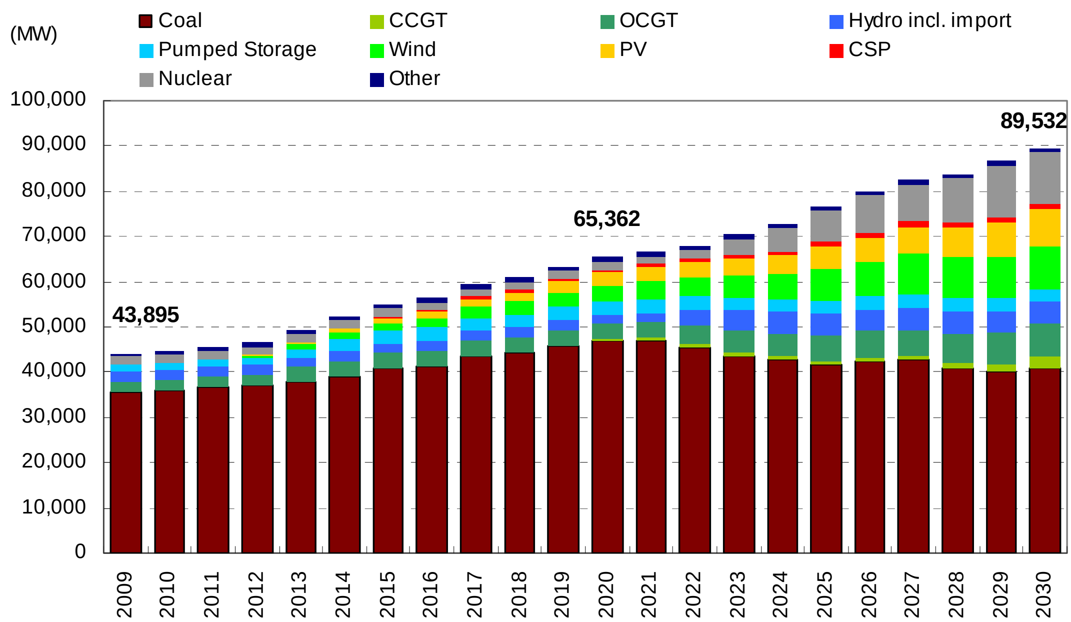
Figure 4.2-19 Sensitivity Analysis of Total Primary Energy Supply and CO_2 Emissions

4.3. BAU-IRP Case

The BAU case does not reflect the power development plan under the currently developed "Integrated Resource Plan for Electricity 2010-2030, Revision 2" (IRP). For this reason, in the BAU case, coal represents the major part of power generation, reflecting the trend. The BAU case is compared to the BAU-IRP case, which includes the power development plan.

4.3.1. Assumptions

Installed power generation capacity was 44.0 million kW in 2009. IRP plans to reinforce capacity to about 90.0 million kW by 2030 (Figure 4.3-1). Nuclear power generation will increase from the current 1.80 million kW to 11.4 million kW. In the plan, wind-power generation, photovoltaic generation, and solar thermal power generation (Concentrated Solar Power or CSP)—not yet introduced into the country—will be 9.2 million kW, 8,4 million kW, and 1.2 million kW, respectively. Natural gas combined cycle gas turbines are planned to generate 2.37 million kW. Regarding shares of power generation in 2030, nuclear energy will account for 20%, hydraulic energy for 5%, wind power for 5%, and photovoltaic generation for 3%. Meanwhile, the share of coal-fired thermal power will decrease to 65% (Figure 4.3-2).



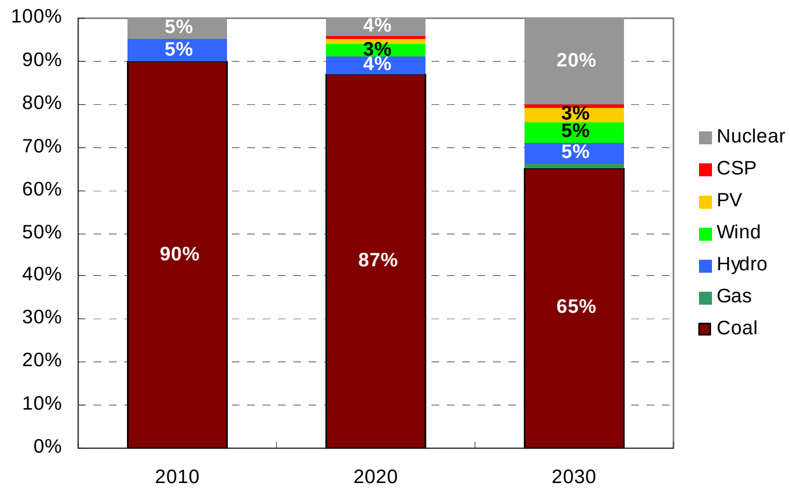
(MW)	Coal	Gas CC	Oil	Hydro	Pumped Hydro	Wind	PV	CSP	Nuclear	Other	Total
2009	35,590	0	2,400	2,150	1,580	0	0	0	1,800	375	43,895
2020	46,953	237	3,420	2,150	2,912	3,600	2,700	700	1,800	890	65,362
2030	41,071	2,370	7,330	4,759	2,912	9,200	8,400	1,200	11,400	890	89,532

Source: Estimate from "Integrated Resource Plan for Electricity 2010-2030, Revision 2"
Note: Gas CC means Gas-combined cycle

Figure 4.3-1 Power Development Plan of IRP

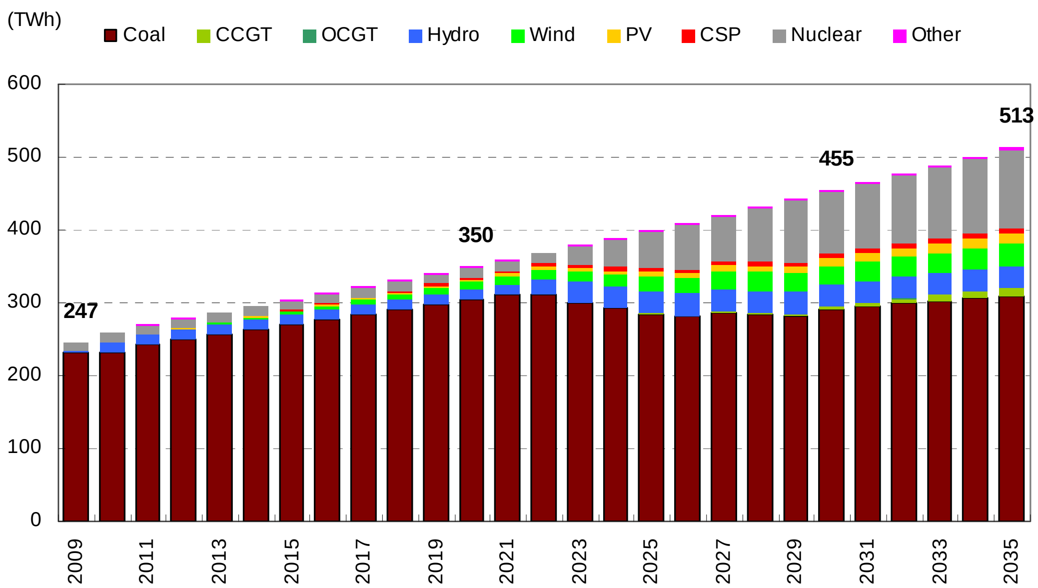
4.3.2. Assumptions of Power Generation by Energy Source

Based on the above discussion, this study estimates power generation by energy source, other than coal, as shown in Figure 4.3-2. In this study, coal power output is defined as the difference between total power generation and the above-mentioned value.



Source: Estimate from "Integrated Resource Plan for Electricity 2010-2030, Revision 2"

Figure 4.3-2 Power Generation Share of IRP



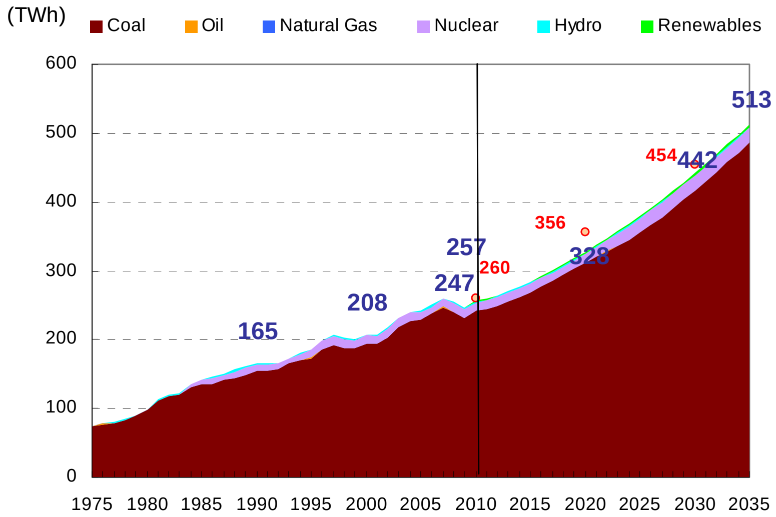
(TWh)	Coal	Gas CC	Oil	Hydro	Wind	PV	CSP	Nuclear	Other	TOTAL
2009	232	0	0	1	0	0	0	13	0	247
2020	304	0	0	13	10	3	3	13	2	350
2030	291	4	0	30	26	10	6	85	2	455
2035	310	11	0	30	30	15	6	109	3	513

Note: Total power generation is estimated in the BAU case. In the energy efficiency scenario, coal-fired power generation will decrease.

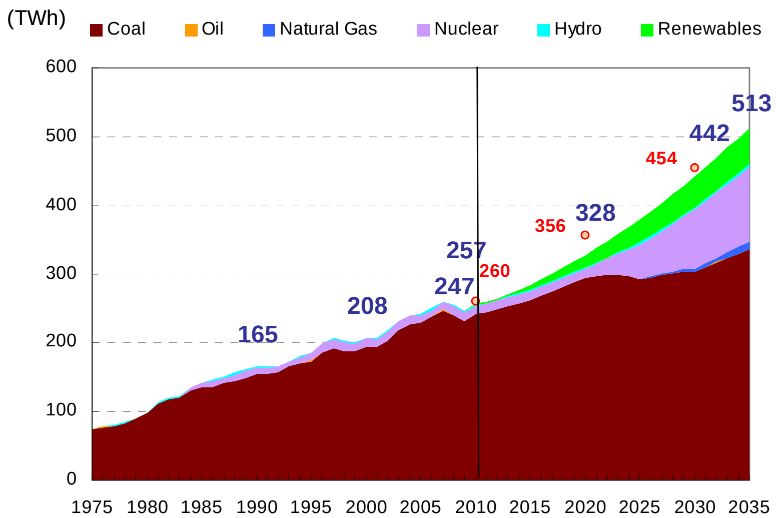
Figure 4.3-3 Power Generation Outlook (BAU-IRP Case)

4.3.3. Estimates

In the BAU case, coal accounts for 95% and nuclear energy for 4% in 2035 (Figure 4.3-4). In the BAU-IRP case, coal represents 66%, nuclear energy 21%, renewable energy 10%, and natural gas 2%. In the latter case, as the use of coal decreases, CO_2 emissions will decrease 19% from 786 Mtoe to 640 Mtoe in 2035.

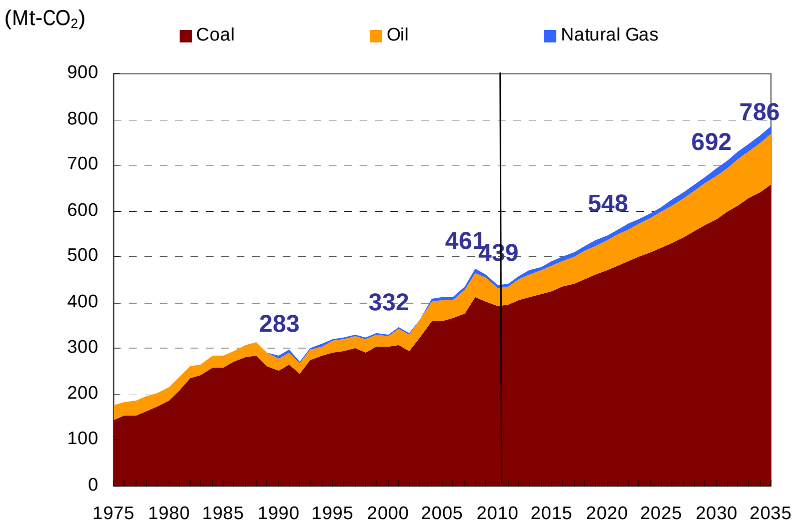


(BAU Case)

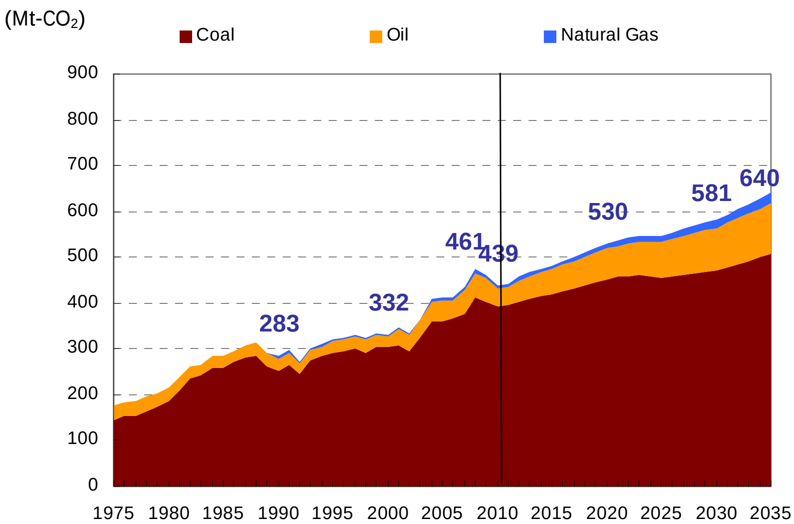


(BAU-IRP Case)

Figure 4.3-4 Comparison of Power Generation Mix (BAU and BAU-IRP)



（BAU Case）



（BAU-IRP Case）

Figure 4.3-5 Comparison of CO_2 Emissions Mix (BAU and BAU-IRP)

4.4. Supply and Demand Outlook in Energy Efficient Scenario

In the energy-efficient scenario, our analysis determines the effects on energy efficiency of the wider use of high-efficiency equipment.

4.4.1. Flow Stock Model

To quantify the effects of equipment updates on energy efficiency, we first need to calculate the number and energy consumption efficiency of existing equipment and new equipment introduced annually, and then estimate the annual average energy consumption efficiency (energy consumption) of the whole stock using a flow-stock model for equipment (Figure 4.4-1).

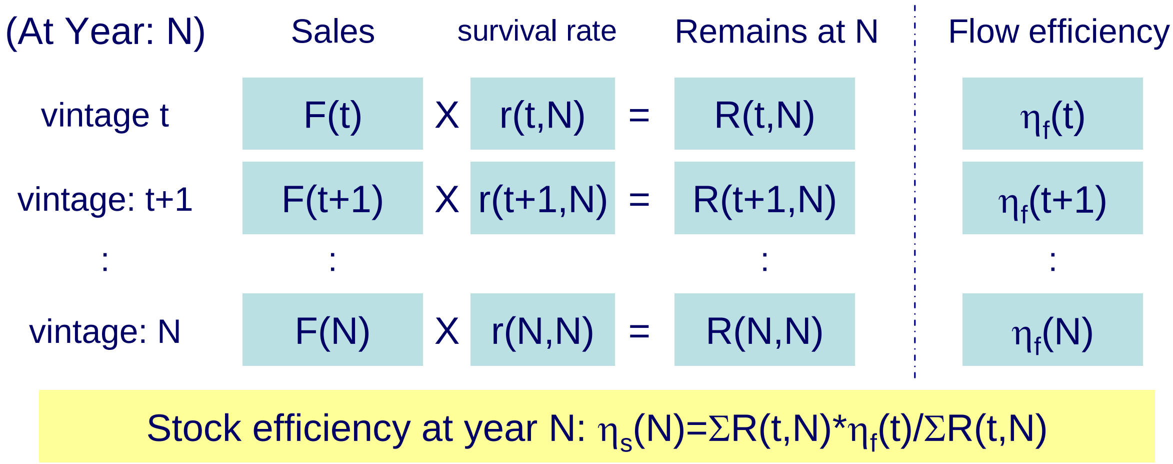


Figure 4.4-1 Bottom-up Model (Flow-Stock Model)

4.4.2. Equipment and Appliances Analyzed

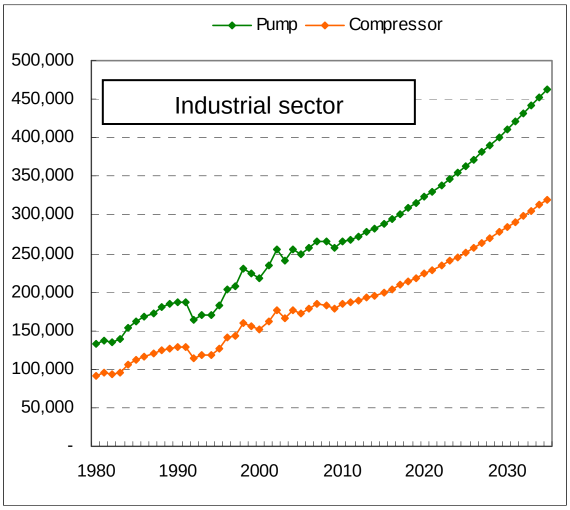
Table 4.4-1 shows equipment/appliances targeted in the analysis. These appliances were selected because data on energy performance and ownership rate exist. Others are estimated from existing statistics, existing studies, and a survey carried out by a local consultant for the study. The analysis of the industrial sector includes processes in the steel, cement, and paper and pulp industries, in addition to motors and pumps. Energy-saving effects are quantified based on improvements to energy consumption per unit production.

Table 4.4-1 Equipment/appliances Covered by Energy-saving Scenario Analysis

Sector	Equipment/Appliances
Household sector	Refrigerators, televisions, washing machines, air conditioners, water heaters (solar water heater), lighting, standby power
Commercial sector	Air conditioners, lighting, OA equipment (personal computer)
Transport sector	Passenger vehicles, freight vehicles
Industrial sector	Motors, pumps (Processes in steel, cement, and paper and pulp industries are analyzed)

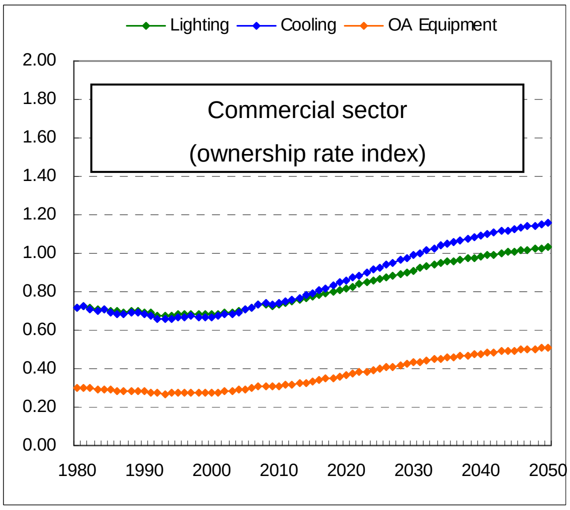
4.4.3. Estimates of Ownership Rate

The ownership rate in the future is estimated from GDP, population, electrification rate, urbanization rate, and other available data (see "Global Potential of Energy Efficiency Standards and Labeling Programs" (Lawrence Berkeley National Laboratory, 2008)). The ownership rate of home appliances and vehicles can be estimated directly. It is not preferred to express the ownership rate of equipment in the commercial sector because, for example, air conditioners in the commercial sector vary greatly in capacity and specifications. For this reason, the ownership rate in the commercial sector is expressed by an indicator that converts the actual ownership rate into the equivalent ownership rate for household air conditioners. Figure 4.4-2 to Figure 4.4-4 show forecasts of the ownership rate of major equipment/appliances.



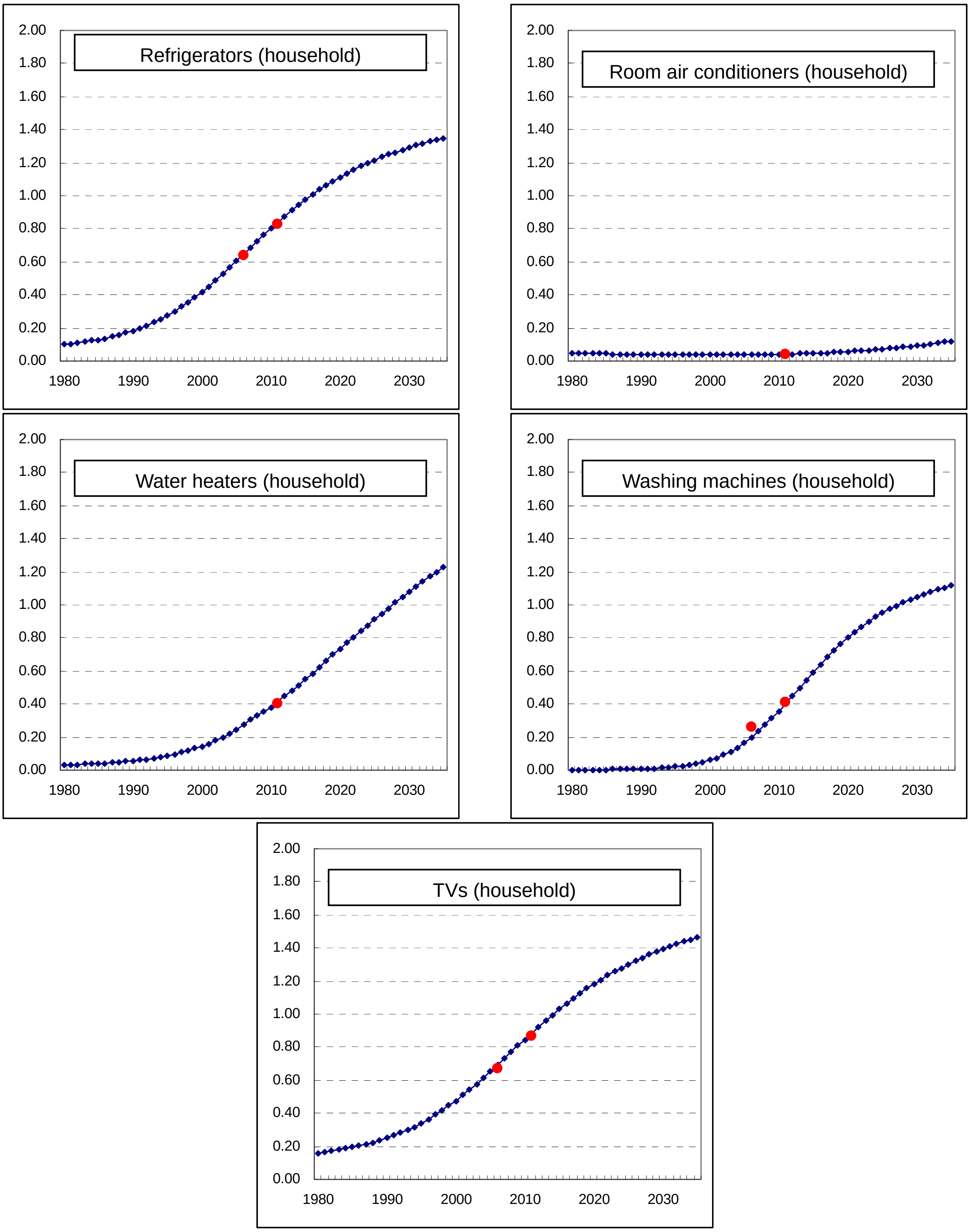
Note: Number of units owned with capacity equivalent to 10 kW for pump and compressor.

Figure 4.4-2 Forecast of Number of Units Owned in the Industrial Sector



Note: Ownership rate index per unit of commercial floor space area

Figure 4.4-3 Ownership Rate Forecast in the Commercial Sector



Note: Ownership rate per household

Note: Dots represent actual ownership rate based on existing statistics and survey by a local consultant.

Figure 4.4-4 Ownership Rate Forecast in Household Sector

4.4.4. Assumptions on the Efficiency of Sales Products

We assume two cases: the EE_max case, in which, starting from next year, all equipment introduced annually has the current highest efficiency, and the EE_adv case, in which average equipment will achieve the current highest efficiency in 2035 (Figure 4.4-5). The EE_max case represents the energy savings potential. Table 4.4-2 compares conventional and highest-efficiency equipment in terms of annual electricity consumption.

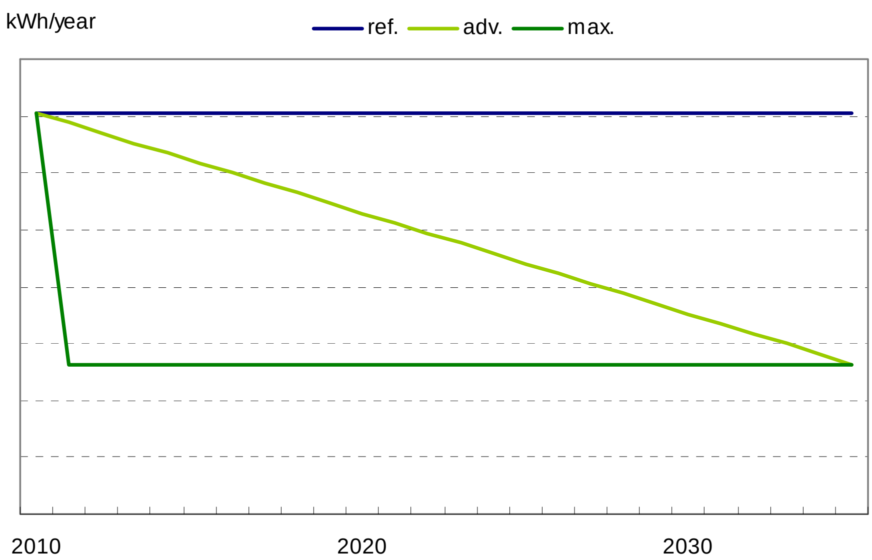


Figure 4.4-5 Thumbnail of Assumptions for Sales Product Efficiency

Table 4.4-2 Electricity Consumption by Conventional and Highest-efficiency Equipment

	Conventional ＝Current (2010) (kWh/year)	Maximum efficiency (kWh/year)
Refrigerators	353	132
TVs	187	112
Washing machines	181	132
Stand-by	44	26
Room air conditioners (cooling)	477	198
Room air conditioners (heating)	2,019	871
Lighting	48	27
Water heaters	1,111	0

Note: The highest efficiency of water heaters is zero because a solar water heater is assumed.

4.4.5. Estimation of Energy Savings

Figure 4.4-6 shows energy-savings for both cases. Energy saved in 2035 will be 12 Mtoe in the EE_adv case and 15.6 Mtoe in the EE_max case. Large potential energy savings are expected from air-conditioners in the commercial sector, from water heaters in the household sector, and from automobiles. In the household sector, electric water heaters are assumed to be commonly used. If they are replaced with solar water heaters, CO_2 emissions will be reduced, while energy consumption will stay flat.

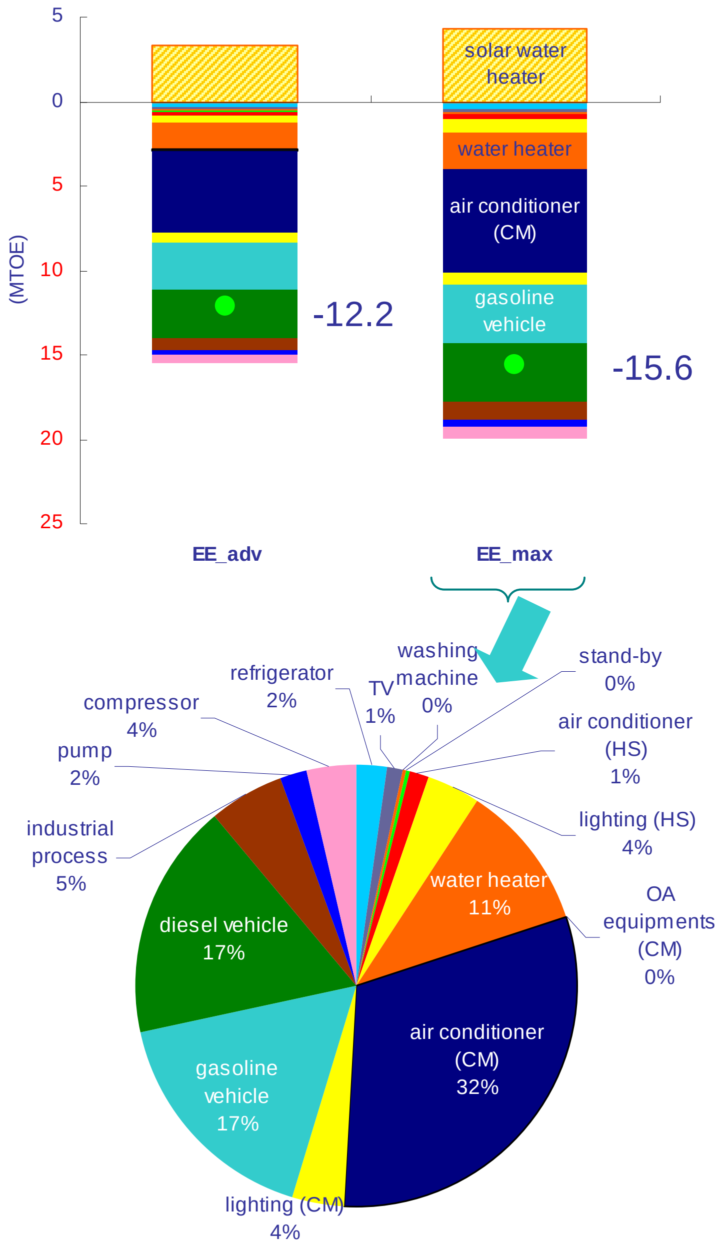


Figure 4.4-6 Energy-saving Effects and Potential

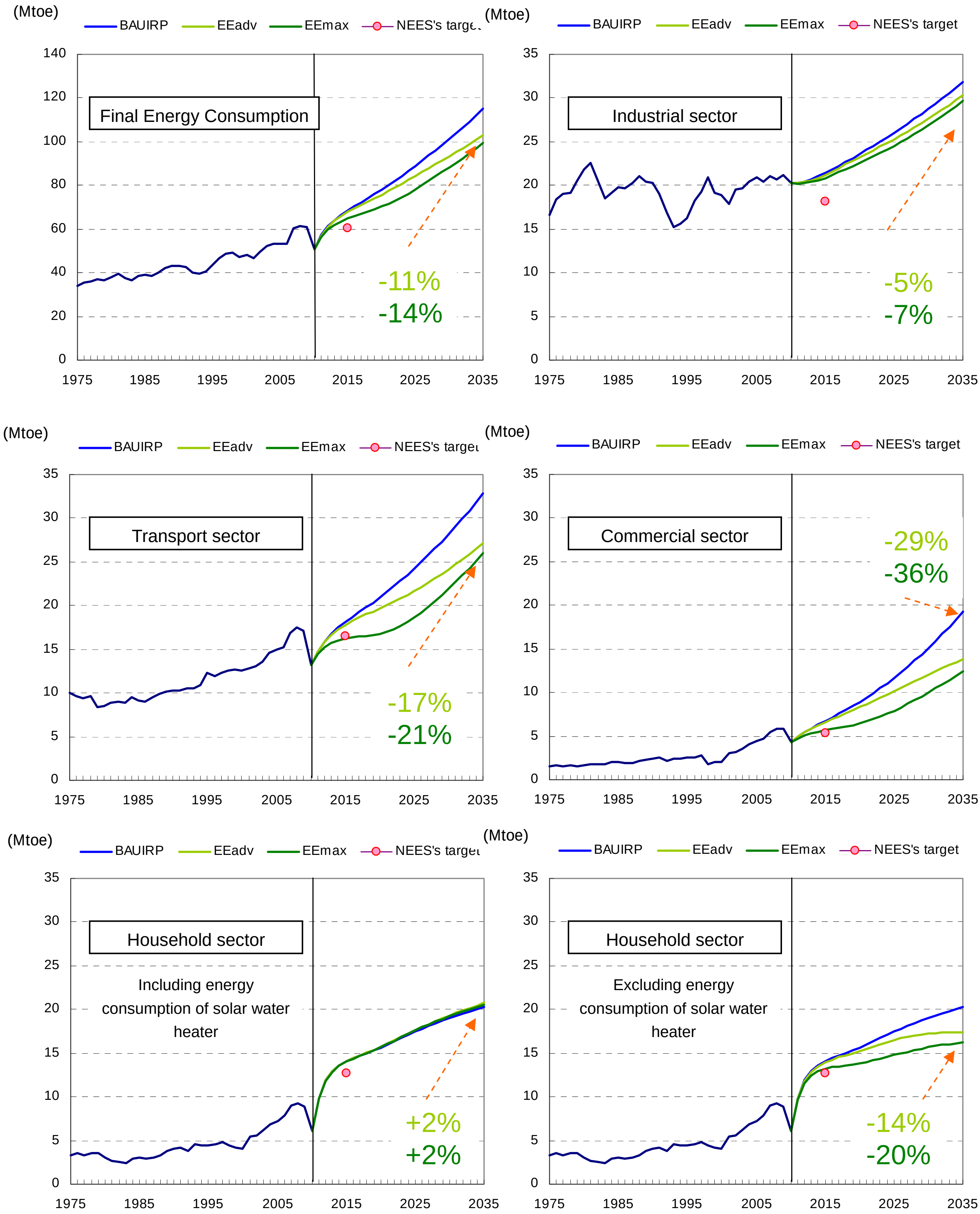
4.5. Implications of Supply-demand Analysis

Figure 4.5-1 shows final energy consumption in each sector by case, Figure 4.5-2 primary energy supply and Figure 4.5-3 CO_2 emissions.

In the industrial sector, it is difficult to achieve the 2015 energy consumption reduction target under the National Energy Efficiency Strategy (NEES), but in 2035, energy consumption is expected to be reduced by 5% in the EE_adv case and 7% in the EE_max case compared to the BAU case. In the transport sector, the 2015 target under NEES is estimated to be achieved in the EE_max case. In 2035, 17% of energy savings in the EE_adv case and 21% in the EE_max case will be achieved compared to the BAU case. In the commercial sector, the 2015 target under NEES is estimated to be achieved in the EE_max case. In 2035, 29% of energy savings in the EE_adv case and 36% in the EE_max case will be achieved compared to the BAU case. In the household sector, energy consumption will increase 2% in 2035 in both the EE_adv case and the EE_max case compared to the BAU case, because reduction in electricity consumption by electric water heaters is cancelled out by increased energy consumption by solar water heaters. When energy consumption by solar water heaters is excluded, energy efficiency improvements of 14% and 20% will be achieved in the EE_adv case and the EE_max case compared to the BAU case, respectively.

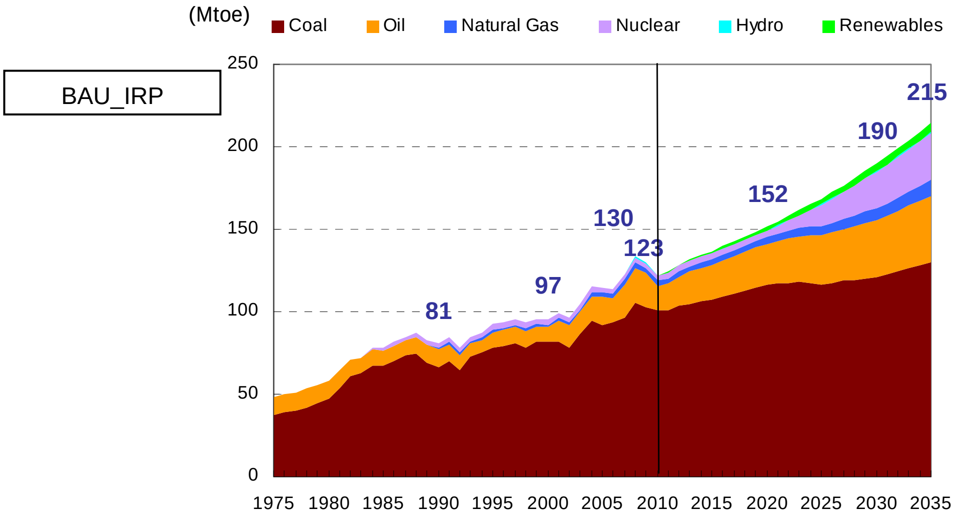
In 2035, primary energy supply is 215 Mtoe in BAU_IRP, while it will decrease 13% to 188 Mtoe in the EE_adv case and by 16% to 181 Mtoe in the EE_max case. In 2035, CO_2 emissions will be 640 Mt-CO_2 in BAU_IRP, while they will decrease 17% to 528 Mt-CO_2 in the EE_adv case and 23% to 495 Mt-CO_2 in the EE_max case.

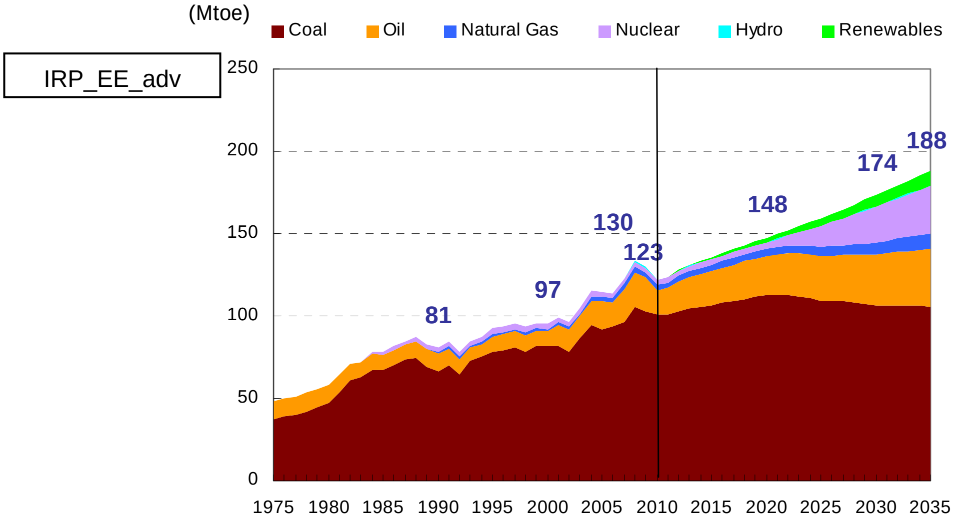
For the EE_max case, we assume that, starting from 2011, all new equipment introduced will have the highest efficiency. This represents the energy savings potential. For the EE_adv case, on the other hand, we assume that the average efficiency of equipment introduced will reach the current highest level in 2035. Thus, in practice, we should formulate energy efficiency policies to reflect the EE_adv case. Specifically, it is essential to reinforce energy-saving measures in the household and commercial sectors, where energy consumption is predicted to increase in the near future. In these sectors, increasing numbers of new equipment will be owned in line with high economic growth. It is, therefore, important to establish a system not only to replace existing equipment with new high-efficiency units, but also to encourage consumers who introduce equipment for the first time to select highest-efficiency equipment, in addition to a support policy.



Note: The dots represent the 2015 NEES target.

Figure 4.5-1 Final Energy Consumption in Each Sector by Case





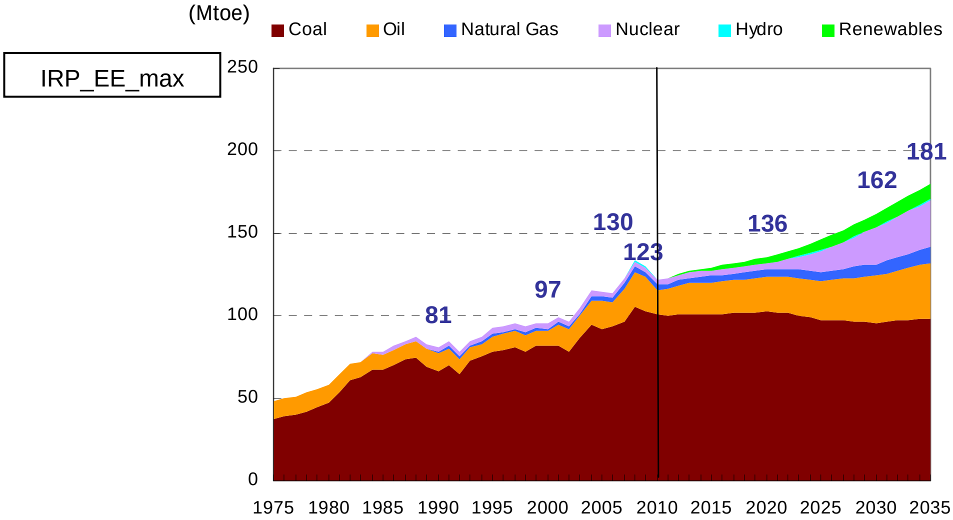


Figure 4.5-2 Primary Energy Supply by Case

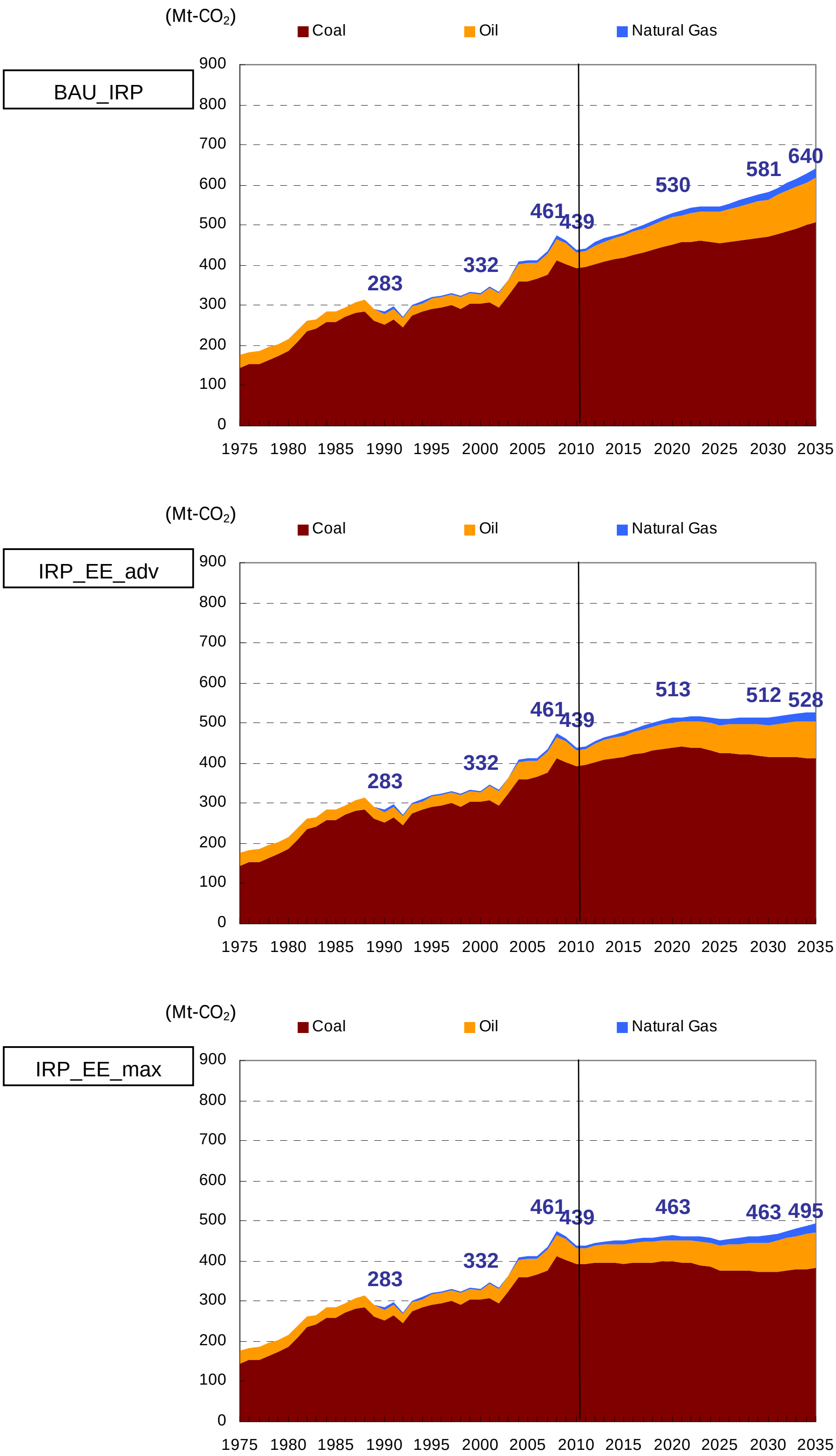


Figure 4.5-3 CO_2 Emissions by Case

4.6. Socioeconomic Impact Analysis

Analyses are made in this section with respect to reductions in energy cost, increases in coal exports, reductions in CO_2 costs, energy efficiency investments, and effects on job creation, on the basis of the results of analyses of the BAU case and energy-efficiency cases.

4.6.1. Reduction of Energy Costs and Energy Efficiency Investments

Energy savings enable consumers to cut energy costs. At the same time, investment costs are needed for energy efficiency. Reduction in energy cost is expressed by energy savings multiplied by unit price of energy. Energy efficiency investment is expressed by the cost of high-efficiency equipment less the cost of conventional equipment. Figure 46-1 shows estimated reduction in energy costs and energy efficiency investment (accumulated through 2035). In the EE_adv case, total energy efficiency investment will be 1,225 billion Rand, while energy cost will be reduced by 2,263 billion Rand. In the EE_max case, total energy efficiency investment will be 2,100 billion Rand while energy cost will be reduced by 4,230 billion Rand, far exceeding energy efficiency investment cost.

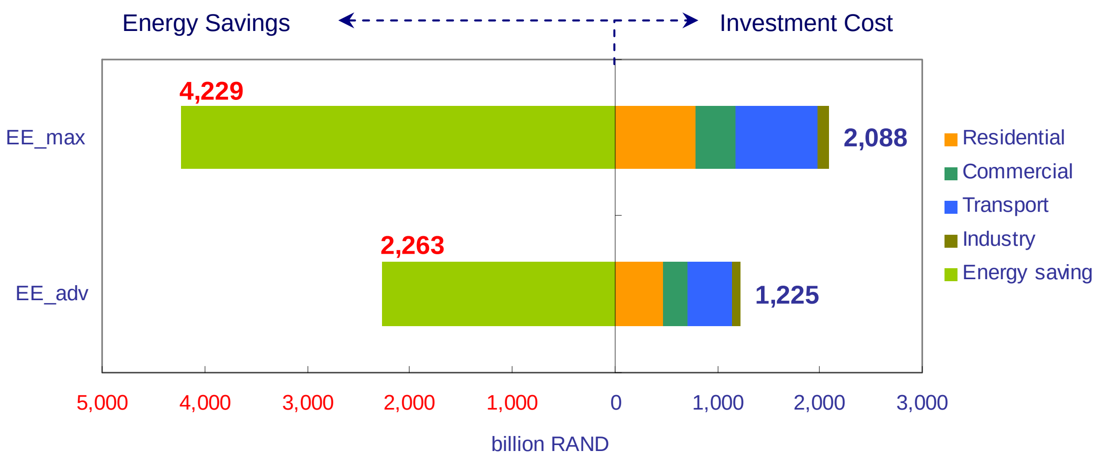


Figure 4.6-1 Reduction of Energy Costs and Amount of Energy Efficiency Investment (accumulated through 2035)

4.6.2. Reduction of CO_2 Costs

According to National Treasury's “Budget Review 2012, National Treasury Republic of South Africa, 22 February 2012,” carbon tax of R120/t-CO_2 will be introduced in 2013 and the amount of the tax will be raised by 10% annually. Figure 4.6-2 shows estimated reductions in CO_2 costs brought about by energy savings. In the EE_adv case and in the EE_max case, 222 billion Rand and 445 billion Rand will be saved, respectively, in CO_2 costs. This is due to a decrease in coal consumption for power generation and carbon tax of coal to reduce electricity demand from improved energy efficiency.

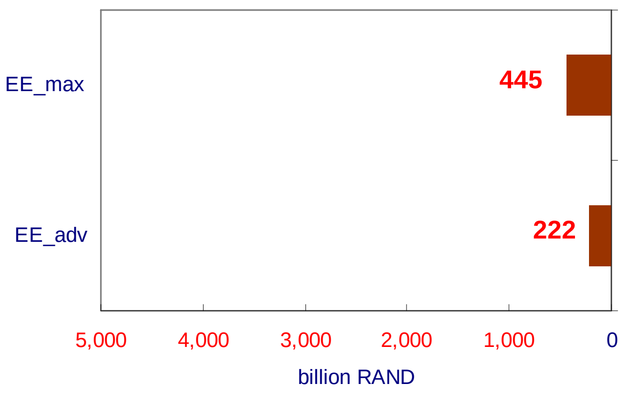
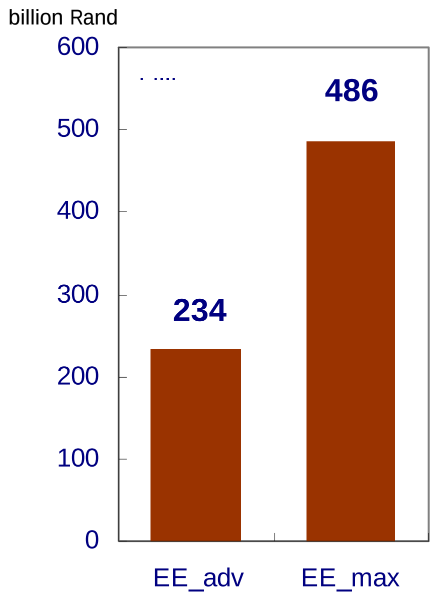


Figure 4.6-2 Reduction of CO_2 Costs (accumulated through 2035)

4.6.3. Trend of Coal Exports

By promoting energy efficiency improvements, it will be possible to increase coal exports corresponding to reduced domestic consumption. Figure 4.6-3 estimates the increase in coal exports achieved by energy efficiency improvements. Coal exports will increase 234 billion Rand and 486 billion Rand in the EE_adv case and the EE_max case, respectively.



Note: The coal price is assumed to be at 724 Rand /t, taken as a steam coal price from the South African Coal Report (coalportal.com).

Figure 4.6-3 Revenue from Increased Coal Exports (accumulated through 2035)

4.6.4. Impact of Energy Efficiency Investments on Job Creation

In general, investment acts to increase a country's gross domestic product and also creates jobs. Thus, energy efficiency investment is expected to create jobs. However, the impact on jobs varies depending on whether energy efficiency investment is yielded by domestic production or provided by imports. It is appropriate to analyze the impacts on job creation in both cases using a macro-economic model (Figure 4.6-4).

Figure 4.6-5 shows the results of the analysis. If all energy efficiency investment costs are yielded by domestic production, 50,000 (2020) to 160,000 (2035) jobs will be created in the EE_adv case, while 140,000 (2020) to 210,000 (2035) jobs will be created in the EE_max case. On the other hand, if all energy efficiency investment costs are provided by imports, 40,000 to 140,000 jobs and 140,000 to 150,000 jobs will be lost in the EE_adv case and the EE_max case, respectively.

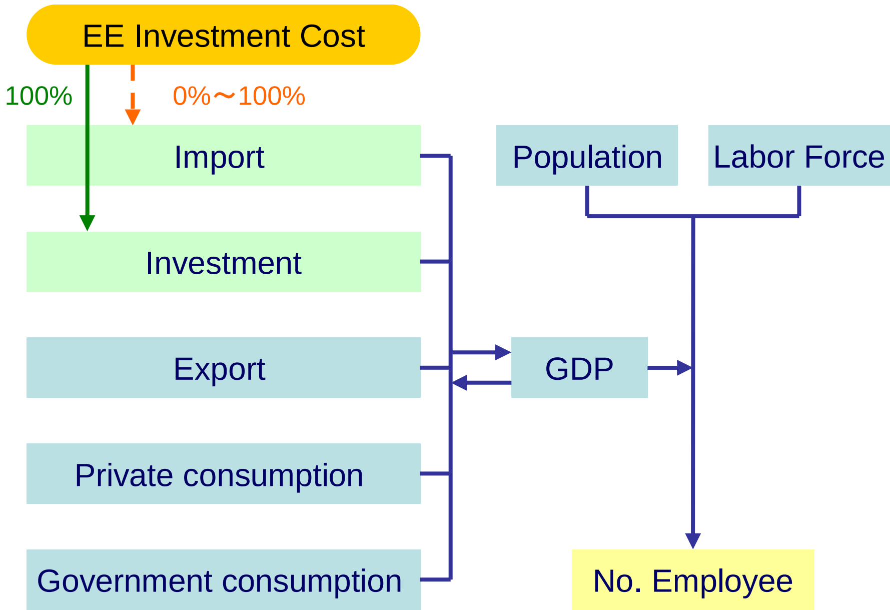


Figure 4.6-4 Flow of Analysis of Job Creation Using a Macro-economic Model

Because energy savings will bring about benefits such as reducing net energy cost and increasing income from increased coal exports, it is essential to promote energy-saving activities. It should, however, be noted that the additional benefits of job creation cannot be brought about until energy efficiency investments are provided from domestic production, instead of from imports.

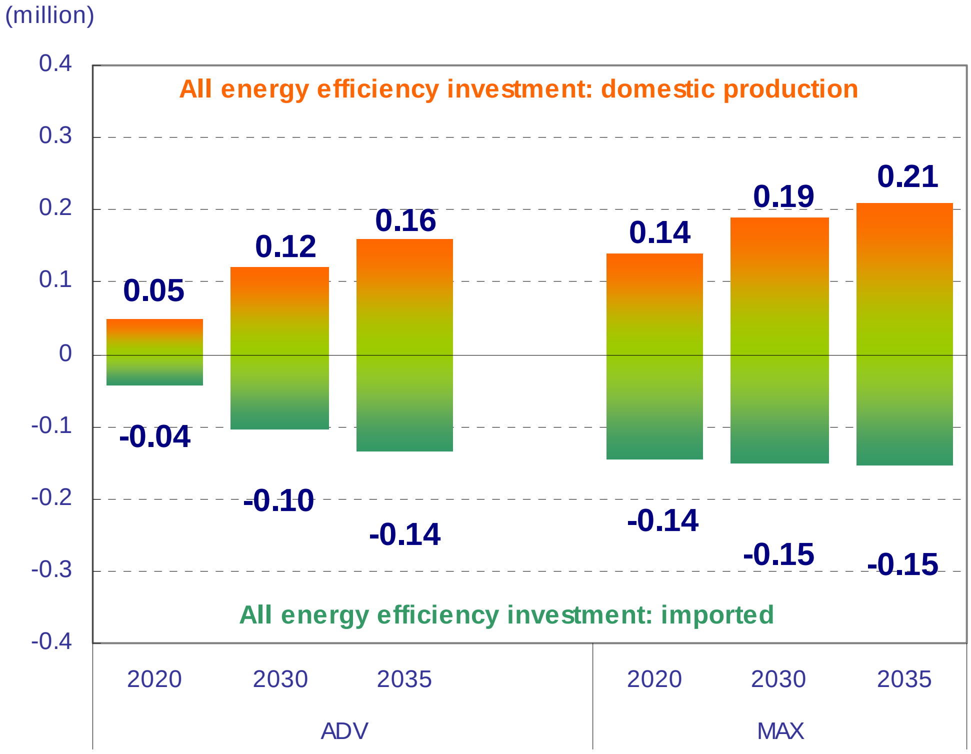


Figure 4.6-5 Job Creation through Energy Efficiency Investments

5 Applicable Energy Efficiency Technologies for South Africa

As described in previous chapters, energy-supply issues in South Africa are reducing energy consumption and decreasing the growth of peak power demand. For the former issue, not only energy saving on the demand side, but also energy efficiency improvement on the supply side and using renewable energy are needed. For the latter issue, in addition to energy-conservation measures, energy storage systems have to be installed widely to shift peak load. Japanese technologies, which are applicable to South Africa, are mainly shown in this chapter.

When considering application of these technologies to South Africa, we have to take into account the special features of the country, such as abundant coal supply, use of agricultural byproducts and solar heat/light and hot-water demand in homes. Furthermore, these elemental technologies can be integrated into one system, such as a Smart Grid, with information and communication technology (refer to Table 5.0-1). They are shown in detail below.

Table 5.0-1 Energy Technologies Applicable to South Africa

	Measures		Elemental Technology	System Technology
Supply Side	Renewable Energy			Smart Grid
		Solar Heat	CSS with Solar Tracking Controller	
		Solar Light	Bifacial PV Panel	
		Biomass	Generation fueled by Bagasse and Sawmill Waste	
		Waste	Alternative Fuel (Used tire, Household Garbage)	
	Energy Conservation			
		Supply Side	I GCC Cogeneration AMDT	
Demand Side		Demand Side	Heat Pump HVAC w/R32 Refrigerant	
	Peak Shift		Battery Energy Storage System Thermal Energy Storage System	

These technologies cannot fully achieve their aims simply by importing machinery. Some R&D and important parts need to be locally sourced in South Africa for efficient operation and maintenance. Because imported machinery is generally designed for environmental conditions in the country of origin, it is required to investigate this point and make the necessary modifications, especially in energy-saving applications. Furthermore, in the case of cogeneration and Smart Grids, energy-conscious operators and maintenance staff are essential. We think this requirement for R&D

and technical training can contribute a lot to developing technological capabilities in the long term and to improving the employment environment.

5.1. Renewable Energy

5.1.1. CSS with Solar Tracking Controller

Eskom produces good results in solar thermal applications by installing free solar water heaters for people with poor electricity supplies. To use this energy on a large scale, a Concentrated Solar System (CSS), which produces hot water or steam using mirrors and lenses, can be applied to hot water heaters, HVAC, desalination, and power generation. Solar thermal power generation (CSP) is configured with mirrors and lenses to produce steam for operating steam turbines and generators. In 2010, 1,095 MW CSP were in operation around the world. Dual fuel CSS has been developed already and in South Africa, coal and/or biomass can also be used with solar thermal energy.

Figure 5.1-1 shows a commercial CSS plant for HVAC installed at Newcastle, north of Sydney. A 345 m^2 solar collector is installed on the roof of a cinema complex and is used to operate 230 kW absorption chillers.

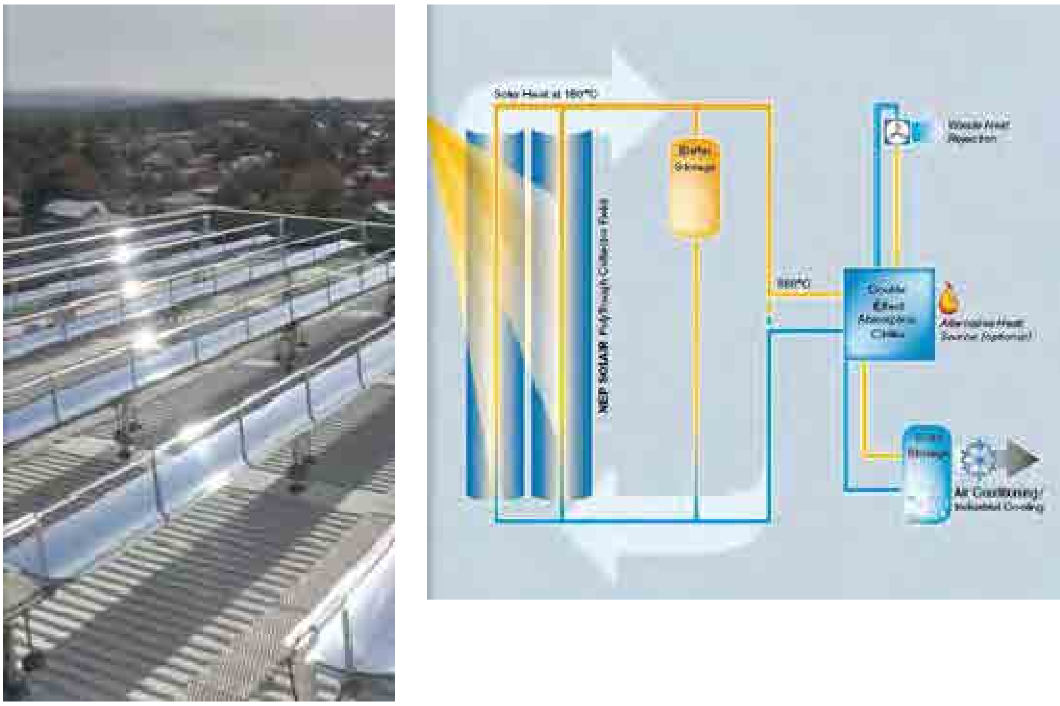


Figure 5.1-1 CSS at Newcastle, Australia

A critical aspect of the efficiency of a concentrated solar system is the ability to very accurately track the sun and adjust the angles of reflectors on two axes to capture the maximum incident solar rays. In the Newcastle project, Yokogawa's solar tracking controller HXS10 optimizes the angles of mirrors and lenses against solar altitude.

Image 5.1-1 Yokogawa’s Solar Tracking Controller HXS10

5.1.2. Bifacial PV Panel

Photovoltaic Panels (PV) are now widely used around the world. Prices have come down and they are assembled in South Africa by companies such as Tenesol. It is necessary to promote the use of PV systems; however, almost all available PV panels are of the single facial type. With this type of PV, installation is done at an angle of gradient to maximize power output. Now, we have bifacial PVs, which can generate power from both sides of the PV cell. This PV can provide space-savings, good maintenance performance, and reduce installation constraints because of its free orientation.

Image 5.1-2 Hitachi’s Bifacial R-Type PV Cell

As shown in Image 5.1-2, a bifacial PV can be used as a fence or a sound-insulating wall. Hitachi produces this bifacial PV, which has the four features below.

(1) Effective use of reflected beams

(2) Low solar altitude is suitable for vertical set

(3) Prevents snow piling up on the panel
(4) Higher efficiency at low temperatures

Based on simulations and installation experience, a single facial PV greatly reduces annual output with deviations from azimuth 0 degree, true south. However, with vertical installation of a bifacial PV, annual energy generated is independent of installation azimuth, and is almost constant. Therefore, effective PV generation can be achieved even when space is limited, and if combined wisely with a single facial PV, installation effects can be increased.

Johannesburg is now installing PV panels with batteries for traffic signals at road intersections to minimize traffic congestion in the event of a power outage. Bifacial PV can also contribute a lot for this application.

5.1.3. Generation Fueled by Bagasse and Sawmill Waste

University of Stellenbosch Business School (USB) reported the possibility of biomass power generation in KwaZulu-Natal (KZN). There are 12 sugar mills in KZN. Electricity has been produced from bagasse by some of these mills for many years, but almost exclusively for their own consumption. The low price offered for electricity sold to the national grid has discouraged the mills from expanding electricity generation to larger scale supply projects. In an interview with the JICA study team, an engineer at Tongaat Hulett said that there are no problems increasing generation output, but the biggest issue is negotiations with NERSA and/or the DOE.

There are 77 sawmills in KZN. Together, they supply about 18.5% of national sawn timber production. The waste generated by sawmills usually far exceeds waste supplied to pulp, paper, and board industries. The excess waste is costly to dispose of and some mills have invested in plants to convert waste into energy for in-house power. These have also not been expanded to larger scale supply systems. The average annual mass of sawmill waste is estimated to be 416 kilo tons.

It is necessary to use such energy sources more actively. Table 5.1-1 shows the biomass power generation potential in KZN. These analyses show that sugar bagasse has by far the highest electricity generation potential, namely 2,637 GWh per year versus the 300 GWh per year of sawmill waste[5]. A similar analysis on the forest waste component of the forestry industry reveals that the total capacity potential of biomass waste from this industry may be close to 1,000 GWh per year. The forest waste component was excluded from this financial viability analysis due to the costly transport factor.

5 Corn can be used as fuel too.

Table 5.1-1 Biomass Power Generation Potential in KZN

Biomass type	Annual tonnage Kilo tons	Average NCV MJ/ton	Potential energy 1,000 MJ	Conversion to power equivalent MWh	Power generation potential MWh
Sugar bagasse	5,411	7,017	37,969,039	10,546,955	2,636,739
Sawmill waste	416	10,368	4,313,088	1,198,080	299,520

Image 5.1-3 Takuma's Wood Waste-fired Boiler

Generally, biomass contains water and needs combustion technology for nonflammable fuel. Japanese manufacturers, such as Takuma, have had many successful results in the agriculture sector in tropical zones.

5.1.4. Alternative Fuels

The cement industry is one of the energy-hungry users. Many cement factories in South Africa depend on coal and power, but some (e.g. PC) use waste as fuel. Japanese cement companies such as Taiheiyo Cement have established energy conservation technologies in cement-manufacturing processes and use waste as fuel. These can also be applied in South Africa and details are shown below.

A rotary kiln in a cement factory has the following four unique characteristics:

(1) High temperatures in kiln can decompose almost all toxic organic substances.

(2) The primary raw material, limestone, is the most widely used neutralizing agent for hazardous materials.

(3) Ash components of waste are effectively used as a raw material, so no secondary waste is

generated from a cement plant.

(4) Trace elements such as heavy metals are safely captured in cement clinker.

(5) Production capacity of a kiln is very large compared to waste material usage.

With these characteristics, as shown in Figure 5.1-2, a rotary kiln can be fueled by waste oil, waste plastics, used tires, waste wood, sludge, coal ash, etc.

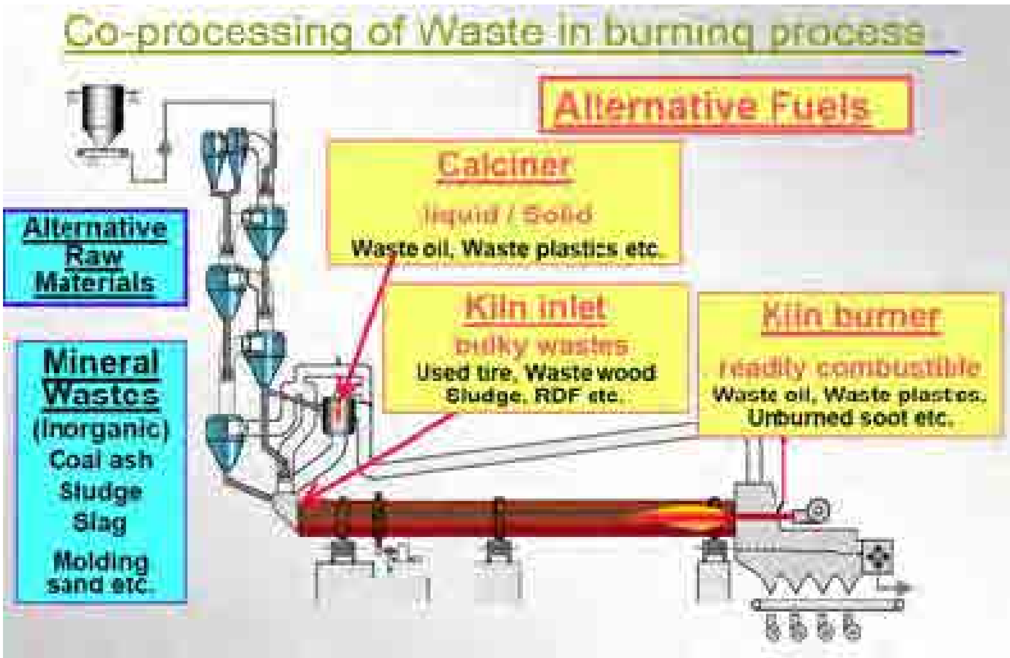


Figure 5.1-2 Alternative Fuel Use in a Rotary Kiln

However, to use these materials, we have to keep in mind some points. One is a sophisticated automatic control program to maintain stable operation; the second is mixing, feeding, and pre-processing to have uniform quality and quantity of fuel; and, the third is to prevent coating on process line and equipment to reduce hazardous elements (chlorine, sulfur …).

Image 5.1-4 Using Used Tires as Fuel

Image 5.1-4 shows an example of used tires as a fuel in a Japanese cement factory. Used tires and waste wood are input at the kiln inlet.

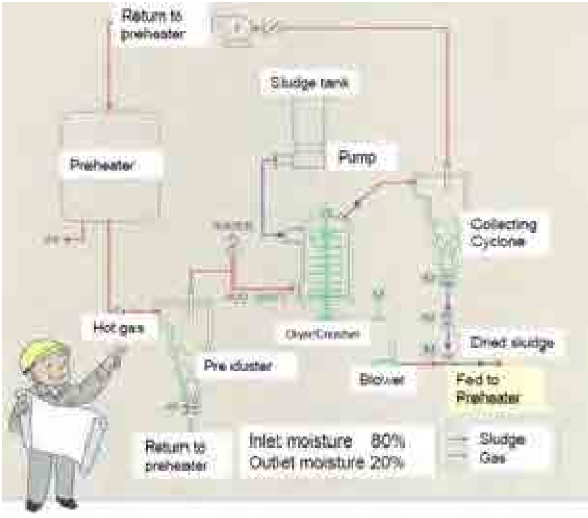


Figure 5.1-3 Process Flow of Sludge

Figure 5.1-3 is a process flow diagram of sewage sludge pre-processing, which contains dryer/crusher and collecting cyclone.

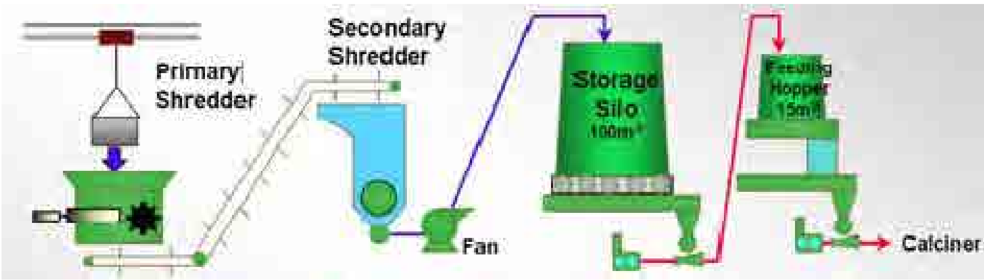


Figure 5.1-4 System Flow of Used Plastics

Image 5.1-5 Shredder for Used Plastics

Figure 5.1-4 is a process flow diagram of the pre-processing of used plastics, and Image 5.1-5 shows the shredder used in the process.

5.2. Energy Conservation

5.2.1. Supply Side

(1) Integrated coal Gasification Combined Cycle (IGCC)

The Integrated coal Gasification Combined Cycle (IGCC) is a power generation system using gasified coal (Figure 5.2-1). Using a combined cycle with gas and steam turbine in IGCC can provide higher generation efficiency (48 – 50% net output) than with a coal-fired (pulverized coal firing) thermal power plant. IGCC has almost the same carbon dioxide emissions as an oil fired thermal power plant.

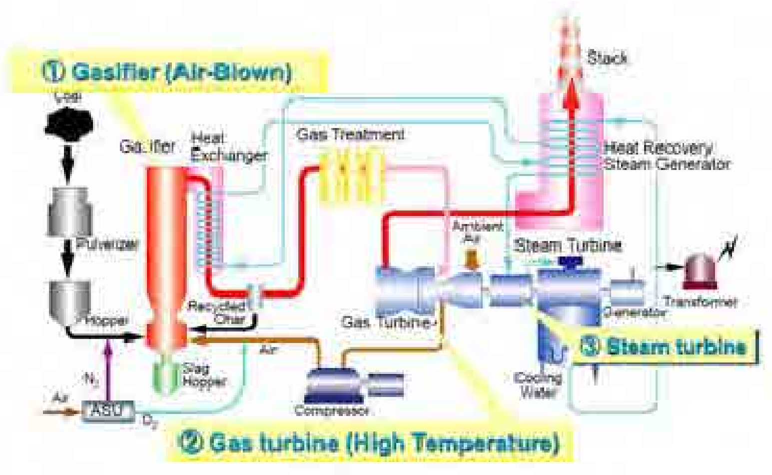


Figure 5.2-1 Integrated Coal Gasification Combined Cycle (IGCC)

In Japan, electric power companies, in conjunction with Mitsubishi Heavy Industries have been operating a 200 t/d IGCC pilot plant since the early 1990s. In September 2007, they started up a 250 MW demo plant at Nakoso, Japan. It runs on air-blown (not oxygen) dry feed coal alone, burning PRB coal with an unburned carbon content ratio of <0.1% and no detected leaching of trace elements.

Image 5.2-1 250-MW IGCC Demonstration Plant

(2) Cogeneration

In South Africa, most people think of electricity when they think of energy, and they use electricity for heating purposes in many cases. Such applications exist not only in the industrial sector, but also in the household sector, e.g., providing a hot water supply. If this heat demand can be satisfied without directly using electricity, energy consumption and peak power demand can be decreased. One effective technology for this issue is cogeneration (combined heat and power, CHP). It uses waste heat from turbines, engines, and boilers to generate power and produce motive energy, cold energy, and heat. Its overall energy efficiency is very high at 70 – 80%. Cogeneration uses a heat engine or a power station to simultaneously generate both electricity and useful heat. This technology is effective not only in a large-scale power station but also in distributed generation.

When applying cogeneration, we have to verify the thermoelectric ratio, which is obtained by dividing the quantity of heat needed by electric energy demand. The thermoelectric ratio of a building is greater in hotels and hospitals, but is smaller in office buildings and shopping malls. If the thermoelectric ratio of cogeneration and its demand differ, we cannot use energy effectively. Therefore, it is necessary to carry out a feasibility study on demand structure and machine selection.

Gas turbines are used in many cogeneration applications, but as South Africa has cheap domestic coal and demand for hot water, we consider cogeneration with coal to be effective. Coal may not be welcome because of recent concerns about smoke and soot, time-consuming handling, and carbon dioxide emissions. We think R&D to solve these issues when applying coal will be implemented by South Africa itself. In addition, some coal-fired boilers use biomass fuel. They can be effective in rural and farming areas of South Africa.

(3) Amorphous Metal Distribution Transformer (AMDT)

South Africa invested extensively in the energy sector in the 1980s and had a sluggish economy in the 1990s because of regime transformation. Up until the beginning of the 2000s power sources developed in 1980s were used, but the power supply capacity became insufficient with economic development. Therefore, since the 2000s investments in energy sector have been re-started with the main target being power generation. The power distribution system is still old and inefficient.

Municipalities distribute approximately 55% of power and Eskom distributes the remainder directly. Transmission losses are 3.08 - 3.27% and distribution losses are 5.46 - 5.87%, making a total loss of about 8%. The total loss is 1.6 times that in Japan, and distribution losses account for 70% of total losses. Therefore distribution losses need to be improved.

One measure for this issue is to use distribution transformers (DT). The South African standard for oil-filled DT is SANS 780:2009 Edition 441. Figure 5.2-2 shows the standards for oil-filled DT of some countries. In the comparison shown in Figure 5.2-2, India has the highest requirement, followed by China at D15 (AMDT), Australia at HEPS, Indonesia and Japan. South Africa is at a lower level. Distribution losses come from not only the low efficiency of old DT, but also from the low requirements in SANS standard 6.

In Japan Law Regarding the Rationalization of Energy Use (Energy Conservation Law) was revised in April 2003 and the Top Runner scheme has been applied to oil-filled DT for industrial use and mold DT. This means a DT manufacturer has to catch up with the required efficiency by the target year. The new requirement is a 38% reduction in losses compared to the traditional level (complying with JIS C4304:1994), and the target year was set at April 2006 for oil-filled DT and April 2007 for mold DT. The new JIS requirement has two specifications, which are energy efficiency of output on rated capacity and energy consumption efficiency. Energy consumption efficiency is defined as total losses (load loss plus no-load losses) at the standard load ratio (40% for less than 500 kVA and 50% for more than 500 kVA).

6 New Energy and Industrial Technology Development Organization (NEDO) “Study on reduction of greenhouse gas emissions by high efficiency distribution transformation pilot project in Vietnam, Indonesia and South Africa” (March 2012)

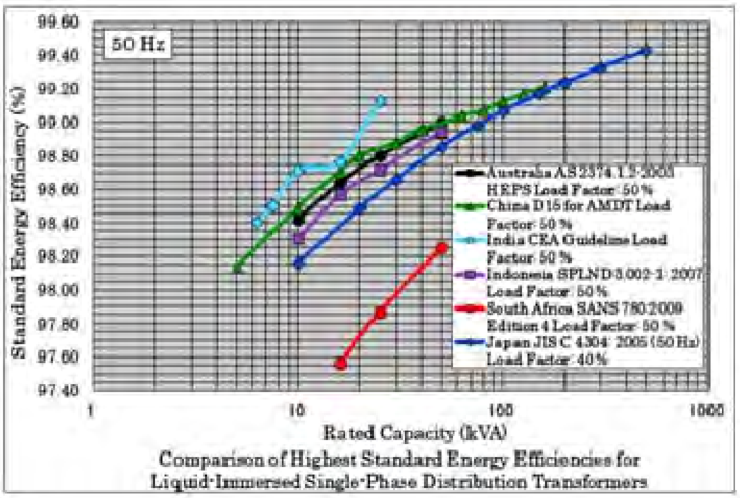


Figure 5.2-2 Comparison of Oil-filled DT (50 Hz) Efficiency Standard

With this standard, the Amorphous Metal Distribution Transformer (AMDT) became the mainstream from the 1990s. Iron losses of Amorphous Metal are about one fifth that of traditional Cold Rolled Grain Oriented Electrical Steel (CRGO) and about one third that of a high-performance CRGO. AMDT can also dramatically reduce losses at low loads.

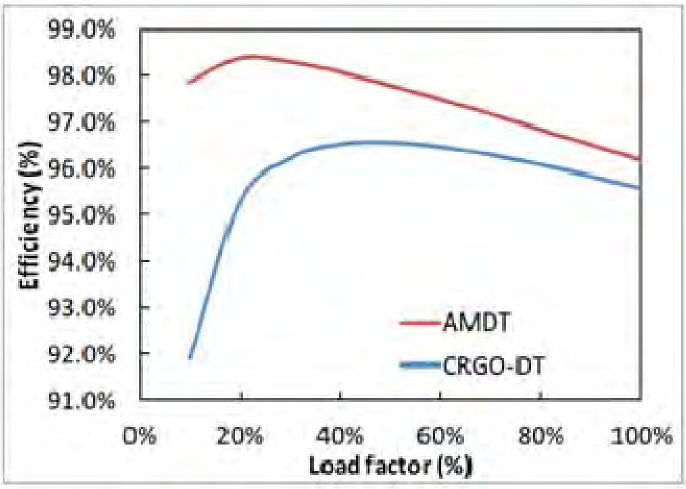


Figure 5.2-3 Comparison of Load Loss at Rated Capacity between 3-Phase Oil-filled DT Standard in SANS 780:2009 and AMDT Under the Same Conditions

Figure 5.2-3 shows a comparison of efficiency and load ratio between 315 kVA CRGO-DT of SANS 780:2009 and 315 kVA AMDT. Replacing one CRGO-DT with one AMDT reduces losses by 660 W and this gives 5,782 kWh of savings annually (this is equivalent to 5.72 tons of reductions of carbon dioxide emissions). Because it is estimated that approx. 20,000 DTs are replaced and/or newly installed, the annual energy savings with AMDT are about 116 GWh. Employing AMDT has great potential for the on-going rehabilitation of the distribution network in metropolitan and urban areas.

5.2.2. Demand Side

(1) Heat Pump

A heat pump transfers heat from a low-temperature side to a high-temperature side through a heat medium or semiconductor, and is used in refrigerators, air conditioners, and hot water supply equipment. It is more efficient than traditional technology, but costs are high. Therefore, to disseminate it, it is necessary to implement an awareness campaign, subsidy scheme, and incentives in the electricity tariff system. The configuration of a heat pump system is shown in Figure 5.2-4.

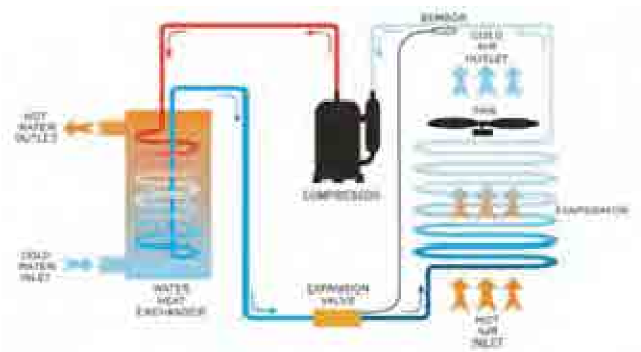


Figure 5.2-4 System Configuration of Heat Pump Water Heater

A South African company, One Energy, estimates that a typical family of four that uses water very conservatively uses about R500 of electricity per month to heat water7. Installing an ITS heat pump guarantees an instant saving of about R350 per month, which means the machine will pay for itself in less than three years. Hot water supply systems and HVAC with heat pumps are very popular in Japan and contribute a lot to saving energy. Image 5.2-2 shows a Japanese hot water supply system manufactured by Daikin.

Image 5.2-2 Heat Pump Water Heater (Daikin)

7 http://www.itsheatpumps.co.za/residential-domestic-heat-pumps-prices.asp

(2) HVAC w/R32 Refrigerant

The energy efficiency of HVAC has been improved by heat-pump and variable refrigerant flow (VRF) technologies. The next step is a new refrigerant R32 (HFC32), which has been employed in recent products. Table 5.2-1 shows the physical properties of some refrigerants and Figure 5.2-5 shows their energy efficiency.

Table 5.2-1 Comparison of Physical Properties of Refrigerants for HVAC

			Refrigerant physical properties					
			Cond.Press MPa	ODP	GWP (IPCC4)	Life time	Flammability	Toxicity
HFC	R410A	Azeotrope	2.73	0	2090	5.29	No	Low
HFC	R407C	Zeotrope	1.86	0	1800	5.29	No	Low
HFC	R32	Single	2.80	0	675	5	Low*1	Low
HFC	HFO1234ze	Single	0.88	0	6	11 days	Low*1	Low*3
HFC	HFO1234yf	Single	1.16	0	4	7 days	Low*1	Low*3
HFC	HFO mixture	Under investigation						Low
Non-HFC	Propane (R290)	Single	1.53	0	<3	Some days	High	Low
Non-HFC	CO2 (R744)	Single	10.0	0	1	120	No	Low*2
Non-HFC	Ammonia (R717)	Single	1.78	0	0	0	Low	High

*1 According to ISO817 draft

*2 Practical limit is 0.1 kg/m³ according to EN378

*3 Based on latest data proposed for ASHRAE34

R32, compared to the existing CFC substitute, R410A, has many merits as a refrigerant, such as 1.6 times higher refrigeration capacity, low pressure losses during pumping, one third of the global warming potential, and high energy efficiency in cooling/heating. In Figure 5.2-5, SEER is the Seasonal Energy Efficiency Ratio and is defined as the total cooling amount in Btu during normal annual use divided by input electricity energy (Wh), that is, annual averaged efficiency. SEER is an index used mainly for home-use air conditioners that have a capacity smaller than 65,000 Btu/h.

Daikin estimates that by replacing R410A with R32, its annual production gives a reduction of about 46 thousand tons of carbon dioxide emissions, and this almost equals the annual emissions from 10 thousand families.

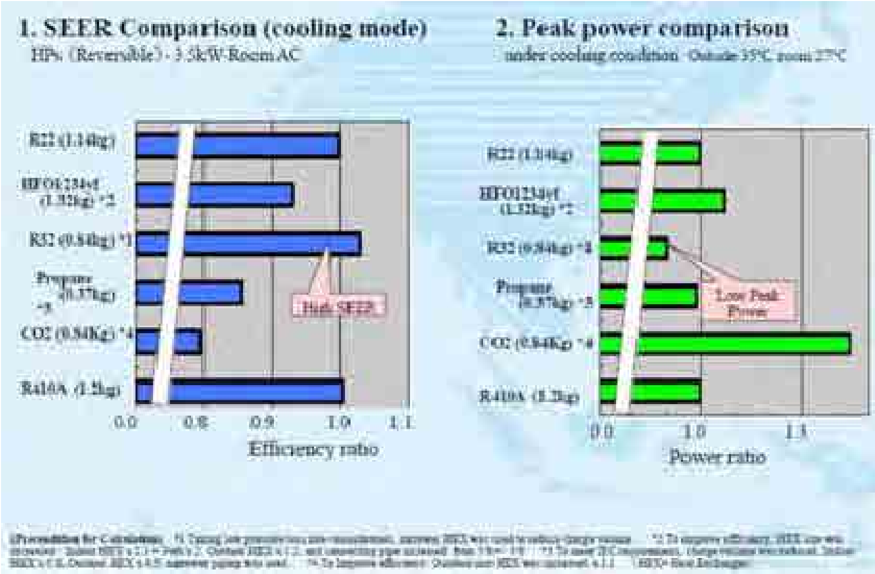


Figure 5.2-5 Comparison of Energy Efficiency of Refrigerants

5.3. Peak Shift

The daily load curve of South Africa is shown in Figure 5.3-1. Peak demand occurs at 18:00 – 20:00 at night with a smaller peak in the morning. Demand is low around midnight: 23:00 – 05:00. Energy conservation technology shifts this curve downward and contributes to reducing peak demand. However, measures to shift the peak are very important too.

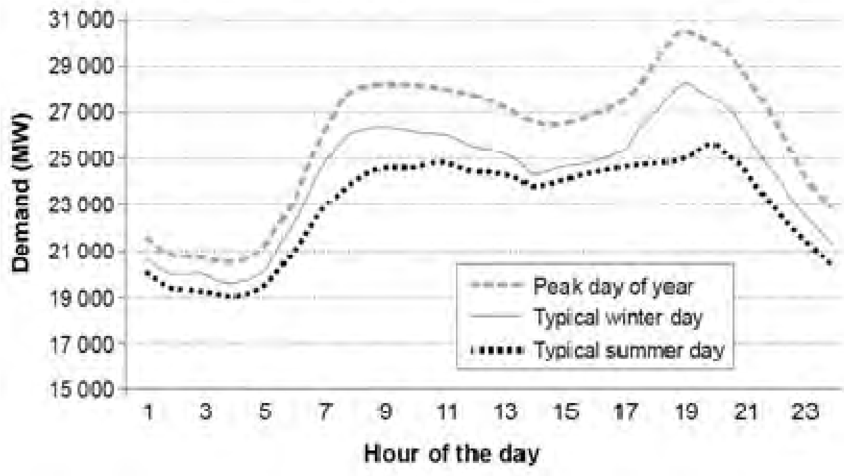


Figure 5.3-1 Daily Load Curve of South Africa (NER, 2001)

A thermal energy storage system (TES) is a technology that shifts the load from peak hours to off-peak hours. A battery energy storage system (BESS), which charges during off-peak hours and discharges at peak hours can also be used. To disseminate these technologies, it is necessary to provide incentives such as a Time Of Use tariff system (TOU), which has cheaper unit prices at off-peak hours and higher prices at peak hours. We have to recognize that energy storage for shifting the peak is essentially a loss. That is, BESS cannot discharge all of the charged energy, and TES and pumped storage need energy to operate their system equipment such as pumps.

(1) Battery Energy Storage System (BESS)

One large-scale energy storage system is pumped storage, and a secondary battery has been applied recently for energy storage to shift the peak. There are many kinds of battery, such as Deep Cycle Lead Acid Battery, NAS (Sodium Sulfur) Battery, Nickel Metal Hydride (Ni-MH) Battery, and Lithium-ion battery.

1) Deep Cycle Lead Acid Battery

Figure 5.3-2 shows Hitachi's Deep Cycle Lead Acid Battery. Its recycling rate is 90% and expected life is 17 years.

Specifications of Battery

Specifications		LL1500W-S
Voltage		6V
Battery Capacity (10hr)		1500Ah
Energy Capacity		12KW
Installation		Horizontal
Dimensions	Heights	473mm
	Widths	799mm
	Depths	500mm
Weights(4 cells)		485kg
Expected life time (under 25℃)		17 years
Recycling rate		90%
Storage Of Charge range		30-90%

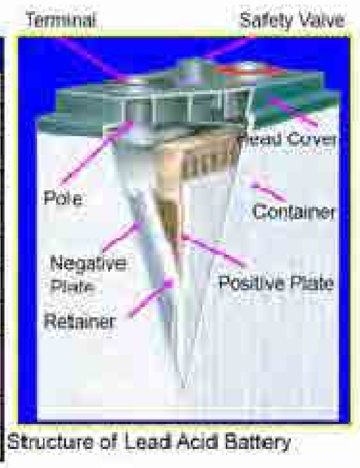


Figure 5.3-2 Deep Cycle Lead Acid Battery (Hitachi)

2) NAS Battery

The NAS Battery (Figure 5.3-3) was developed by Tokyo Electric Power Company (TEPCO) and NGK, and was the first MW scale BESS in the world. It has high capacity, high energy density, long life, and is space efficient (one third that of a lead acid battery), and can supply stable power for a long period. It is used for peak shift, emergency back up, stabilizing fluctuating renewable power, and reducing energy costs and environmental loads. Its negative electrode is sodium (Na), positive electrode is sulfur (S), and electrolyte between both electrodes is fine ceramics. The NAS battery repeats charging and discharging using a chemical reaction between Na and S.

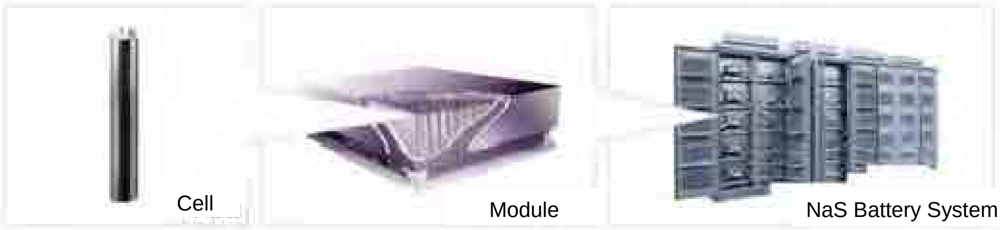


Figure 5.3-3 NAS Battery (NGK)

The energy density of a NAS battery is 100 kWh/t, charge/discharge efficiency is 75%, expected life is 15 years, and it is used for 2 – several 10 MW BESS.

3) Nickel Metal Hydride (Ni-MH) Battery

Kawasaki Heavy Industry has developed a Nickel Metal Hydride (Ni-MH) Battery called the GigaCell (Figure 5.3-4). It has a bipolar 3D structure, which suppresses energy losses inside the battery cell and among cells, to have fast charge/discharge characteristics and capability for large-scale BESS. Its negative electrode is a hydrogen adsorption alloy and its positive electrode is nickel hydroxide. The rated capacity is max 200 Ah and energy density is 17 – 31 Wh/kg. It is used not only for BESS, but also for trains and cranes.

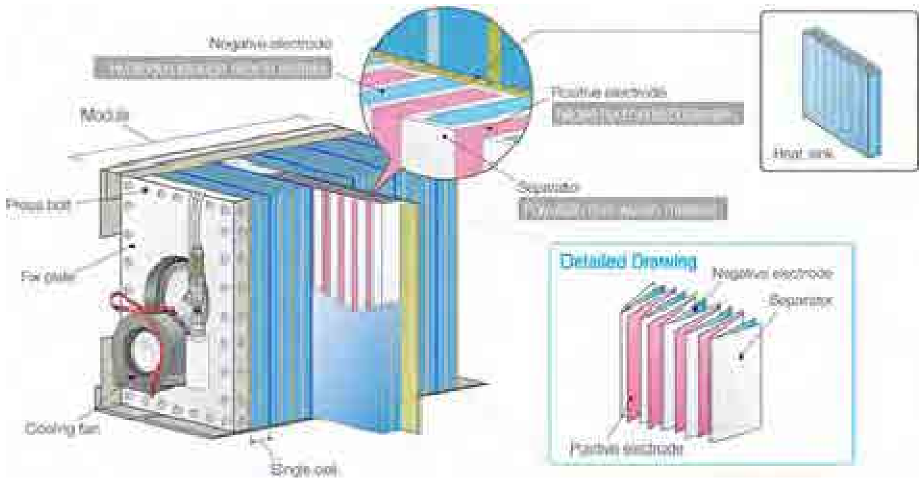


Figure 5.3-4 Nickel Metal Hydride (Ni-MH) Battery (Kawasaki Heavy Industry)

4) Lithium-ion Battery

The Lithium-ion Battery is very popular now for use in laptop PCs and mobile phones, as well as hybrid cars and electric vehicle (EV). It has very good characteristics in terms of energy density and charge/discharge speed, and is expected to have wider applications. The biggest issue is its cost. Because social infrastructure such as power facilities has large security implications for society, application to BESS is also expected.

Figure 5.3-5 Lithium-ion Battery (Mitsubishi Heavy Industry)

Figure 5.3-5 shows the specification of Mitsubishi Heavy Industry’s Lithium-ion Battery and Figure 5.3-6 shows a BESS with NEC’s Industry’s Lithium-ion Battery. NEC revealed a home-use BESS in July 2011 (Image 5.3-1), which has a 2 kW charge/discharge capability and a 6 kWh capacity.

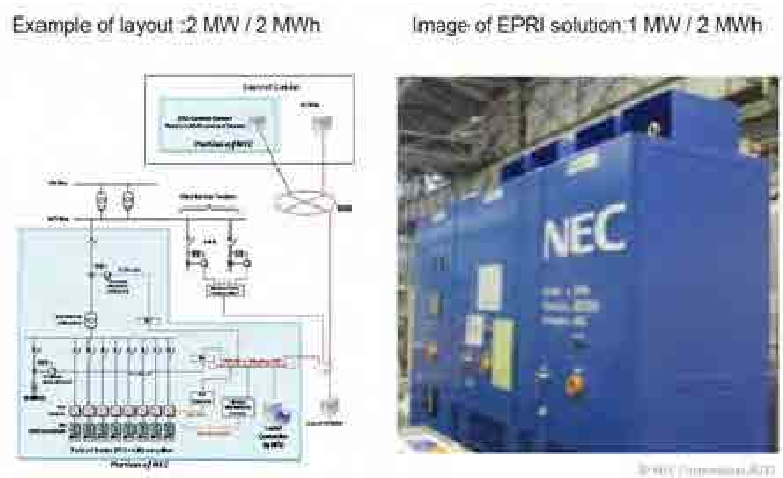


Figure 5.3-6 Battery Energy Storage System with Lithium-ion Battery (NEC)

Image 5.3-1 Home-use Lithium-ion Battery Energy Storage System (NEC)

A comparison of the four secondary batteries applicable for BESS—Deep Cycle Lead Acid, NAS, Ni-MH, and Lithium-ion Battery—described above are summarized in Table 5.3-1.

Table 5.3-1 Comparison of Secondary Batteries for BESS

	Strengths	Weaknesses
Deep Cycle Lead Acid Battery	• Proven technology • Lille regulation for installation	• Air conditioning needed for long life • Needs care for disposal (lead)
NAS Battery	• Large capacity • No air conditioning needed	• Fire protection law • Needs heater on standby mode
Ni-MH Battery	• Short charge/discharge time • Operation possible at room temperature	• Expected longer life • Memory effect[8]
Lithium-ion Battery	• Small memory effect • Good self-discharge[9] rate	• Expensive • Invites shorter life due to stand-by mode at full charge

(2) Thermal Energy Storage (TES)

Thermal Energy Storage (TES) is used to decrease peak time load by storing electric energy in thermal storage during off-peak hours and discharging during peak hours. This system averages the electrical power load over the day for HVAC operation. Figure 5.3-8 shows the concept of TES operation. This redistribution of power load reduces the burden on the environment by shifting electrical power consumption to nighttime hours when fossil fuel usage for power generation is lower, and contributes to reducing the load on a power generation plant. If TOU is applicable, the end user can also enjoy lower energy costs. Ice or cold water is used to store energy for cooling.

TES itself is a proven technology and is used widely in developed countries, but it is not popular in newly industrialized and developing countries. This is a very effective tool for achieve a peak shift.

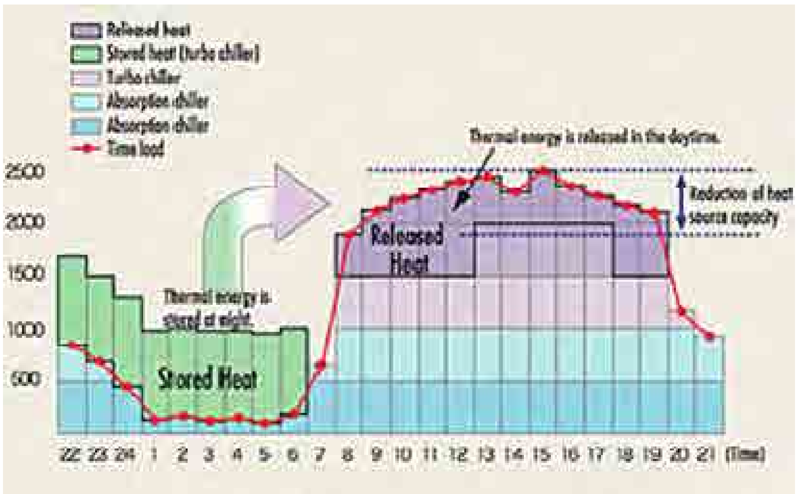


Figure 5.3-7 Concept of TES Operation (Mori Building)

8 An effect, by which batteries gradually lose their maximum energy capacity if they are repeatedly recharged after being only partially discharged.

9 A phenomenon in batteries, by which internal chemical reactions reduce the stored energy of the battery when there is no connection between electrodes.

5.4. Smart Grid

In Section 5.1 - 5.3, various technologies are described for renewable energy, energy conservation both at supply and demand sides, and peak shift. Each technology can be integrated into one system, named the Smart Grid using information and communication technology. The Smart Grid is capable of handling fluctuating renewable energy sources with BESS and base generation plant (normally thermal power) and minimizing operating costs under varying loads. It is an intelligent energy infrastructure for a specific district. Although generally connected to a utility's transmission and distribution (T&D) network at one point, the Smart Grid does not depend on the T&D network and manages its internal power sources (and sometimes loads too) to optimize operating performance (cost, stability, reliability, etc.). From the point of view of the utility owning the T&D network, a Smart Grid can be handled as a more stable load with small fluctuations, and higher peak demand may be restricted or penalized in supply contracts. It should be noted that the T&D network is the last resort for a Smart Grid.

Applicable targets may be industrial zones, shopping malls, gated communities, newly developed areas in metropolitan areas and provincial cities. It is one possible approach to building a new energy infrastructure in South Africa. In Japan, not only electric machinery manufacturers, such as Hitachi and Toshiba, but also heavy industries such as Mitsubishi Heavy Industry (MHI) have started marketing the Smart Grid. A conceptual diagram of MHI's Smart Grid is shown in Figure 5.4-1.

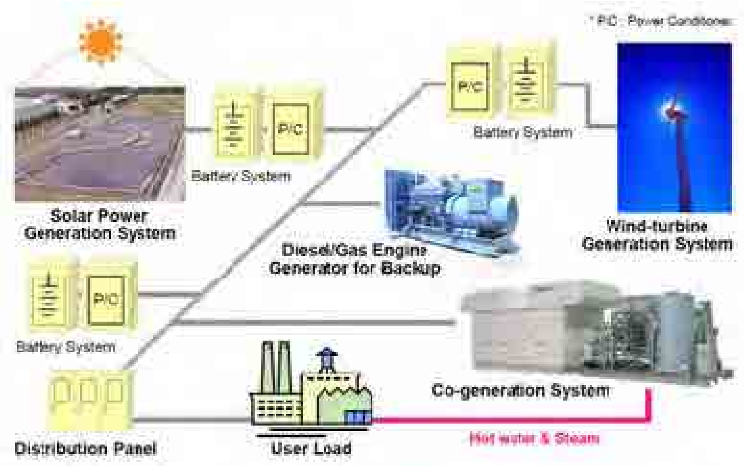


Figure 5.4-1 Conceptual Diagram of MHI's Smart Grid

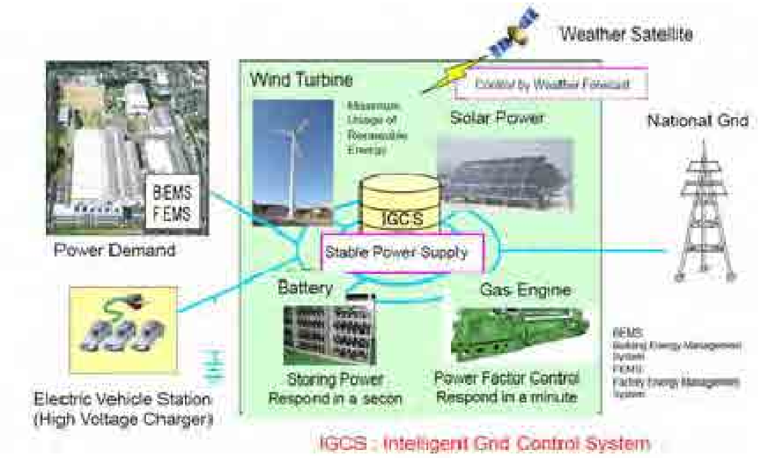


Figure 5.4-2 IGCS for a Factory Smart Grid (Hitachi)

Hitachi has developed a smart control system named Intelligent Grid Control System (IGCS), and has an experimental Smart Grid at its factory as shown in Figure 5.4-2. This system achieved 15% energy savings in the summer of 2011.

6 Recommendations

6.1. Energy Efficiency Policy

6.1.1. Organization

(1) Current situation and analysis

Regarding energy conservation in South Africa, the major governmental departments and other organizations are as follows (refer to Table 3.2-1 in Chapter 3).

DST, CSIR:	research and development of science and technology,
DTI, SABS, NRCS, NCPC:	industrial policy
DOE, SANEDI:	overall energy conservation policy
DBSA, IDC:	financial support

Although the roles of individual organizations are set forth, it is necessary to take interdepartmental and intersectoral approaches to proceed with energy conservation concretely. Accordingly, collaboration and cooperation among different organizations have also been undertaken in South Africa in line with the contents of tasks.

However, when the number of organizations involved increases, coordination among different organizations becomes necessary, and such coordination also causes delays.

A resource-rich country, South Africa has been meeting its domestic energy demand with abundant domestically available coal and Coal to Liquid (CTL). The government's energy efficiency initiative is still unsatisfactory, and its energy efficiency is low compared to other developing countries. Thus, it is essential to establish an energy efficiency policy to contain energy demand through improved energy efficiency.

Currently, the South African government is aiming to improve its energy efficiency by 12%, compared to BAU, by 2015. An energy efficiency policy has been planned and is now being implemented to achieve this target. Meanwhile, the government is yet to clearly define its medium and long-term goals. To improve energy efficiency, it is important to maintain consistent medium and long-term policies. For this reason, the country is urged to formulate medium and long-term plans and set numerical targets.

The South African government has been spending an enormous amount of time between establishment and implementation of a plan. In addition, the energy efficiency policy, which should be addressed at a cross-department level, does not clearly define the authority assigned to each department. During the course of compiling a plan by the government, too much time has been wasted on coordination among departments and stakeholders. Coordination and agreement among departments and among stakeholders is important; however, the government’s efforts in this respect would adversely affect the country's future economic growth if any delay in implementing policies leads to tight supplies of energy, especially electricity. To avoid this problem, the South African government should clarify and accelerate the decision-making procedure for its energy efficiency policy. For example, to make integrated and quick decisions, a high-level committee could be set up under the office of the President to coordinate departments on energy efficiency measures.

(2) Proposal

The government should improve the effectiveness of its energy efficiency policies. A number of energy efficiency policies are already in place, but many of them are not implemented or are insufficiently implemented. In this regard, we suggest establishing the Energy Efficiency Center. This Center should have the following functions:

- Collect data, methodologies, and experience inside and outside the country on energy efficiency;
- Publish collected information;
- Organize workshops and seminars on improving energy efficiency;
- Consult on improving energy efficiency;
- Build capacity for domestic activities; and,
- Support energy audits.

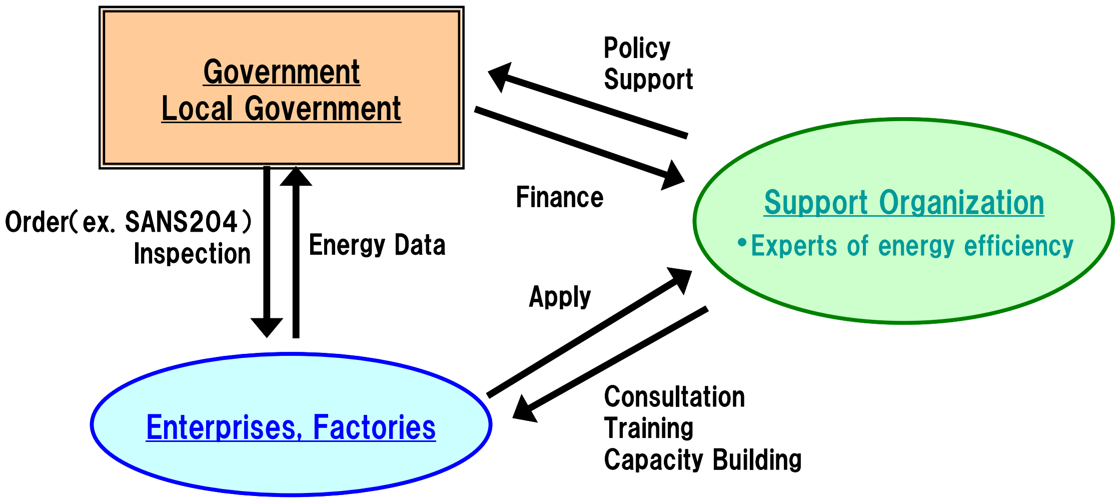


Figure 6.1-1 Outline of Energy Efficiency Center

Regarding energy efficiency policies already in place, it is advisable to have a third party verify their effects and effectiveness, in order to ensure the transparency and improvement of these policies. For instance, EEDSM conducted by Eskom has been contributing to reducing power demand in South Africa. At the same time, however, the effectiveness of EEDSM has yet to be verified. Subject to NERSA regulations, the transparency of policies needs to be ensured. One solution may be to have an organization such as SANEDI review and verify policies.

6.1.2. Information Sharing

(1) Current situation and analysis

The South African government is well aware of the benefits of improving energy efficiency. However, it lacks information on the policies to be adopted to improve energy efficiency. In addition, the people of South Africa know little about methods, measures, and technologies related to energy efficiency. This is the main obstacle to the country's efforts toward improving energy efficiency.

South Africa is still at the stage of developing an energy efficiency policy, while Japan and other advanced countries and developing countries, including India and China, have already introduced energy efficiency policies. Methodologies and experiences of these countries will provide an effective reference baseline for South Africa. Meanwhile, the IEA is discussing effective energy efficiency policies by sharing the best practices of individual countries. Through such international initiatives as Clean Energy Ministerial (CEM) and International Partnership of Energy Efficiency and Conservation (IPEEC), deliberations are underway on energy efficiency policies and related technical issues. By participating in these international opportunities, South Africa will be able to share information on energy efficiency policies with other countries and formulate its own policies on the basis of such information.

(2) Proposal

To deepen its understanding of energy-saving methodologies, measures, and technologies, it is essential to unify information on such issues. Energy-saving technologies have already been developed worldwide (see Section 5). However, people in South Africa know very little about these technologies. The government is urged to have more access to technical information. In addition, it is important for South Africa to share more information with other countries with respect to methods and measures for improving energy efficiency. The government will be able to reduce barriers caused by a lack of information by unifying available information on relevant technologies, methodologies, and measures, and distributing such information widely across the country. Besides, establishing energy efficiency benchmarks (e.g. energy intensity) would enable comparisons of domestic businesses in terms of energy efficiency, which would help them deepen their understanding of energy efficiency.

6.1.3. Energy Management System

(1) Current situation and analysis

South Africa is in the process of imposing energy management obligations by adopting the ISO50001 international standard as a South African National Standard (SANS). While this approach itself is appropriate for promoting corporate awareness about energy management, it is still necessary to adopt concrete energy efficiency guidelines to actually improve absolute values of energy efficiency. With respect of buildings, a binding standard was introduced in November 2011 as SANS204, which stipulates concrete numerical values for the sizes of windows, the efficiency of air-conditioners, etc. With respect of lighting, a compulsory standard called VC9091, which stipulates limits of illuminance and power consumption and other obligations, is already in place. However, because such a standard has not yet been introduced in industrial areas with high energy consumption, it is considered to be necessary for the country to establish enforceable standards in those areas in the future.

When establishing South African standards for industrial areas, technical standards adopted by the Japanese Energy Conservation Law can be referenced. However, because geological characteristics and the degree of industrial maturity differ between Japan and South Africa, it is necessary to adjust concrete numerical values to match actual conditions. When setting this type of standard, cooperation with countries having advanced energy conservation measures, such as Japan, is considered to be useful.

For example, reducing the air ratio and temperature of waste heat is required for managing the operation of a boiler. To secure stable combustion with an air ratio below a certain value, combustion monitoring and control systems are required. Moreover, to reduce the temperature of waste heat, waste heat recovery equipment is also required. To achieve energy conservation targets at an early stage, the target should be set at a low level because it is difficult to achieve high-level targets at the early stage (see Figure 6.1-2).

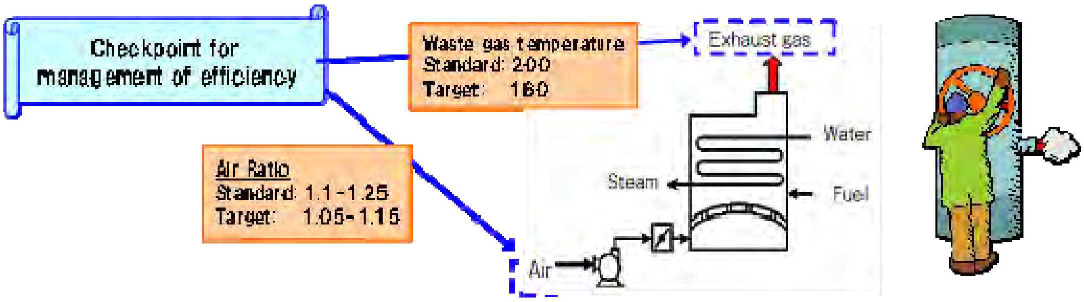


Figure 6.1-2 Example of Technical Standard for Energy Management

(2) Proposal

Two types of standard are established in the Energy Conservation Law of Japan,. One is a compulsory standard that can be achieved relatively easily, and the other is a targeted standard that indicates target values from the standpoint of energy management. When considering introduction of certain standards into South Africa where no relevant standards have been established, it is thought to be difficult in practice to compel companies to comply with standards by introducing strict binding ones from the outset. Therefore, it is recommended that the country establish compulsory standards with low thresholds, and also to set management targets separately, referring to examples of standards in Japan. In the case of Japan, the technical standards mentioned above have been established through a process of consensus building among stakeholders by holding meetings of committees involving industries.

Meanwhile, as South Africa has the problem of a high unemployment rate, it is necessary to consider ensuring employment as a priority issue for the policy on establishing technology standards. It is also necessary to consider such measures as giving a grace period to domestic manufacturers and providing subsidies for introducing high-efficiency equipment to manufacturing facilities, in order to avoid a situation where the ratio of imported goods increases sharply compared to domestic production, and the employment situation is adversely affected as the result of introducing absolute indices for energy conservation.

As stated above, such standards as SANS50001 for energy management, SANS204 for buildings, and VC9091 for lighting have already been established as enforceable standards in South Africa. Actual implementation of standards is thought to be relatively easy in the cases of lighting, which can be regulated at the stage of sales, and of buildings, for which it can be confirmed whether a relevant standard is satisfied or not when issuing construction permits. Conversely, to forcibly regulate daily energy management, structures of existing buildings, and equipment already in use in factories, it is necessary to establish criteria for performance evaluations and to decide upon administrative organizations, as well as to build an organizational structure for continuously implementing checks of documents and on-the-spot inspections, in addition to putting into effect laws and regulations that stipulate penalties. If administration is performed by governmental agencies or municipalities, it is necessary to arrange staff members of the administrative organizations and to provide them with an appropriate education. It will also be necessary to establish an official, third-party institution similar to the Energy Conservation Center, Japan, as a professional organization to support them.

As regards penalties, in Japan, the names of companies that fail to comply with compulsory standards are published and fines are imposed. It is noted here that publishing the names of failing companies is considered to be one of the strong incentives for companies to achieve energy conservation goals.

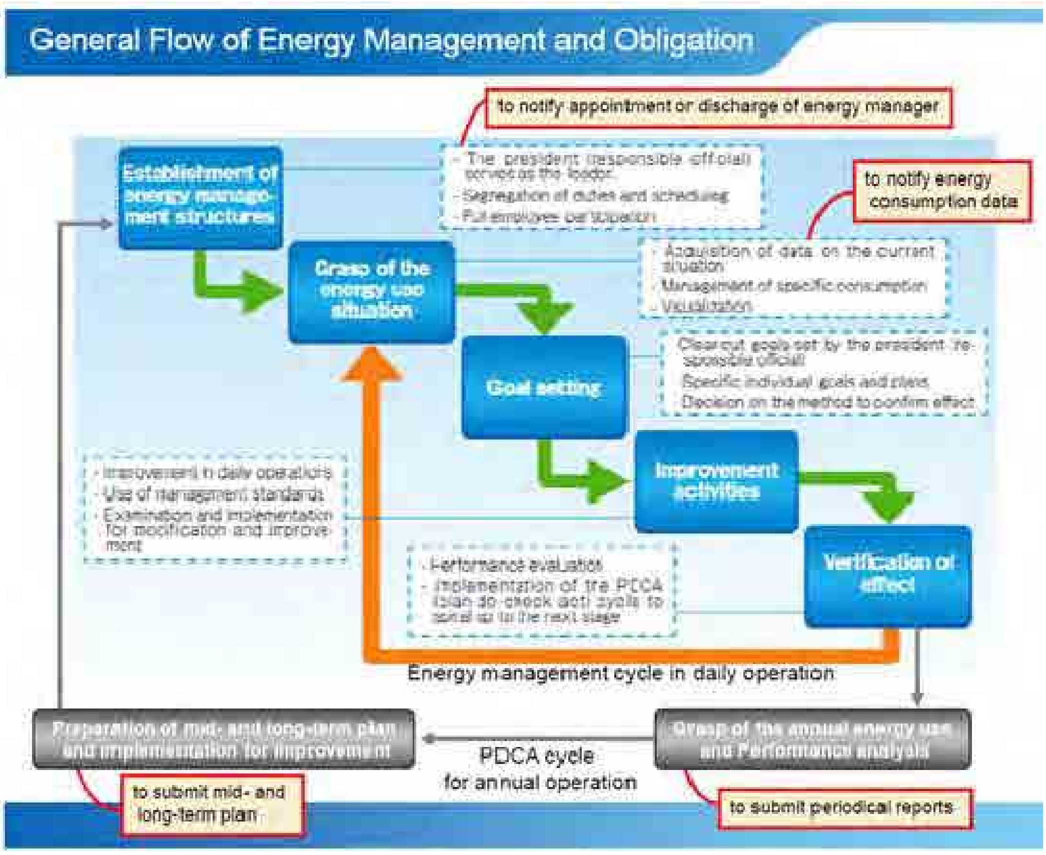


Figure 6.1-3 General Flow of Energy Management and Requirements

6.1.4. Energy Audit System

(1) Current situation and analysis

To promote energy conservation, it is necessary first to correctly evaluate the status quo of energy consumption, and then to grasp how much energy conservation potential exists and what options for energy conservation measures are available. Because electricity rates have been tending to increase in South Africa, there is a particularly strong desire among people and companies to reduce electricity consumption. While it is possible for large companies to have their own energy managers make appropriate evaluations of energy consumption, there seem to be many cases where small and medium-sized companies are unable to make energy diagnoses because of the high cost to commission the task to outside parties.

(2) Proposal

Although the National Cleaner Production Centre (NCPC) under the Department of Trade and Industry (DTI) offers energy audits free of charge, this system has not been well used because the degree of recognition of the system is low among small and medium-sized companies. Another problem is that the number of personnel at NCPC possessing technical knowledge about energy audits is not sufficient. Therefore, a useful support measure for small and medium-sized enterprises (SMEs) that find it difficult to have their own energy managers is to increase recognition about the free energy audit system and to enhance the potential of companies to conduct their own energy audits, as well as to enlarge the scope of free energy audits.

6.1.5. Energy Efficiency Standard and Labeling Program

(1) Current situation and analysis

Having paid special attention for a number of years to energy efficiency standards and labeling (EES&L) programs, the South African government has been working on establishing EES&L since 2008. A testing standard based on global standards is already in place. The government is now in the process of formulating a regulation for implementation. What it should do in the future is steadily implement specific measures. The following describes issues to be resolved to ensure the effectiveness of the program:

1) Building a testing laboratory for measuring the energy efficiency of refrigerators and air conditioners

Currently, South Africa has a testing laboratory for measuring safety of electric appliances, but there is no such laboratory for measuring energy efficiency. Energy efficiency measurements of air conditioners and refrigerators require special testing arrangements, complex testing procedures, and experienced testing staff. For air conditioners, construction of a testing laboratory generally takes two or three years. To achieve the standards and mandatory labeling program scheduled for 2015 by the Department of Energy (DOE), the government is urged to immediately start constructing a testing laboratory.

Prior to constructing a national testing laboratory, the government must determine the size of the laboratory on the basis of estimated annual demand for testing and testing equipment. It should be noted that testing demand varies with the energy efficiency standard applied and labeling program designed.

(a) Adoption of testing results produced by a company-owned testing laboratory

Some countries, including Japan and Malaysia, adopt testing results provided by company-owned testing laboratories. This type of system does not require the country to build a state-owned testing laboratory and thus reduces its financial burden. Instead, the government must establish measures to correct variations among testing laboratories and prevent falsification and other illegal acts in the reporting of testing results.

(b) Adoption only of testing results produced by a third-party testing laboratory, including a state-designated testing laboratory

Europe, the US, China, and many other countries mandate testing at third-party testing laboratories. This type of system ensures high reliability, but demands a financial burden on a country to build a testing laboratory that is appropriate for testing demand. Shorter development cycles and more models of appliances covered increase testing demand, requiring the establishment of multiple testing laboratories. Under budgetary pressure, it may be possible, for example, to approve testing by overseas third-party testing laboratories.

2) Development of testing standards appropriate to South Africa's climate

South Africa's energy efficiency testing standards are mainly based on European testing standards. Adopting testing standards from similar countries or regions would be an effective way to promptly introduce a system. However, South Africa is required to formulate testing standards that are appropriate to the climate and lifestyles of the people in the country, and reflect the pattern of use of products.

3) Construction of energy efficiency database by appliance

An energy efficiency database by appliance should be compiled from two perspectives: revising regulations and providing information to consumers. To ensure sustainable energy efficiency improvements to appliances, regulatory standards need to be revised periodically. It is also important to have energy efficiency data by appliance, in order to set appropriate criteria and label grades for each appliance.

(2) Proposal

One measure to collect relevant data is, for example, to mandate manufacturers to present energy efficiency data on appliances. These data should be made open to the public, consumers, and retailers, and access to energy efficiency data by appliance should be made available.

At the initial stage of implementing EES&L, it is necessary to conduct a variety of promotional and educational activities to raise awareness of the new system among consumers, including:

メーカーまたはブランド	製品愛称	機種名（室内）電源電圧100V	多段階評価	省エネラベリング制度（※1）省エネ性マーク	省エネ基準達成率（%）	APF（通年エネルギー消費効率）	年間の目安電気料金（円）	冷房 消費電力（W）	冷房 期間消費電力量（kWh）	冷房 能力（kW）	暖房 消費電力（W）	暖房 期間消費電力量（kWh）	暖房 能力（kW）	期間消費電力量（kWh）
★★★★★（多段階評価）														
パナソニック	エコナビ搭載エアコン	CS-222CXR	★★★★★		124	7.2	13,500	395	155	2.5	420	457	4.5	612
パナソニック	エコナビ搭載エアコン	CS-X222C	★★★★★		124	7.2	13,500	395	155	2.5	420	457	4.5	612
★★★★（多段階評価）														
シャープ	プラズマクラスターエアコン	AY-B22SX	★★★★		115	6.7	14,500	420	149	2.5	465	509	4.2	658
ダイキン工業	うるるとさらら	AN22NRS	★★★★		115	6.7	14,500	425	162	2.5	460	496	4.4	658
東芝	大清快 VOiCE	RAS-221NDR1	★★★★		115	6.7	14,500	450	164	2.5	450	494	4.4	658
日立	ステンレス・クリーン 白くまくん	RAS-S22B	★★★★		117	6.8	14,300	385	158	2.5	420	490	4.5	648
富士通ゼネラル	W シリーズ	AS-W22B-W	★★★★		117	6.8	14,300	425	162	2.5	460	486	3.9	648
富士通ゼネラル	ノクリア Z	AS-Z22A-W	★★★★		117	6.8	14,300	390	158	2.5	415	490	4.6	648
富士通ゼネラル	ノクリア Z	AS-Z22B-W	★★★★		117	6.8	14,300	395	158	2.5	430	490	4.6	648
富士通ゼネラル	V シリーズ	AS-V22A-W	★★★★		115	6.7	14,500	445	169	2.2	375	489	3.6	658
富士通ゼネラル	V シリーズ	AS-V22B-W	★★★★		115	6.7	14,500	450	169	2.2	375	489	3.6	658
三菱電機	霧ヶ峰ムーブアイ	MSZ-ZW222	★★★★		118	6.9	14,100	440	160	2.5	465	479	4.1	639
★★★（多段階評価）														
シャープ	プラズマクラスターエアコン	AY-B22VX	★★★		108	6.3	15,400	540	163	2.2	415	537	3.7	700
ダイキン工業	S シリーズ	AN22NSS	★★★		108	6.3	15,400	470	189	2.5	460	511	3.3	700
パナソニック	エコナビ搭載エアコン	CS-EX222C	★★★		108	6.3	15,400	520	164	2.2	450	536	3.5	700
パナソニック	エコナビ搭載エアコン	CS-SX222C	★★★		108	6.3	15,400	480	164	2.2	450	536	3.8	700
富士通ゼネラル	ノクリア S	AS-S22A-W	★★★		112	6.5	14,900	430	169	2.5	440	509	4.3	678
富士通ゼネラル	ノクリア S	AS-S22B-W	★★★		112	6.5	14,900	440	169	2.5	455	509	4.3	678
三菱重工	ビーバーエアコン	SRK22RSM-W	★★★		112	6.5	14,900	425	169	2.5	460	509	3.9	678
三菱重工	ビーバーエアコン	SRK22RSN-W	★★★		112	6.5	14,900	435	169	2.5	465	509	3.8	678
三菱電機	霧ヶ峰ムーブアイ	MSZ-HM222	★★★		108	6.3	15,400	500	176	2.5	510	524	3.4	700
★★（多段階評価）														
コロナ	B シリーズ	CSH-B2212	★★		100	5.8	16,700	530	210	2.5	520	550	2.8	760
コロナ	N シリーズ	CSH-N2212	★★		100	5.8	16,700	530	210	2.5	520	550	2.8	760
コロナ	W シリーズ	CSH-W2212	★★		100	5.8	16,700	510	210	2.5	520	550	3.6	760
シャープ	プラズマクラスターエアコン	AY-B22DX	★★		100	5.8	16,700	580	182	2.2	440	578	2.8	760
シャープ	プラズマクラスターエアコン	AY-B22EX	★★		100	5.8	16,700	555	180	2.2	435	580	2.9	760
シャープ	プラズマクラスターエアコン	AY-B22EXF	★★		100	5.8	16,700	555	180	2.2	435	580	2.9	760
シャープ	プラズマクラスターエアコン	AY-B22SD	★★		100	5.8	16,700	580	187	2.2	440	573	2.6	760
ダイキン工業	E シリーズ	AN22NES	★★		100	5.8	16,700	580	200	2.2	450	560	2.8	760
ダイキン工業	F シリーズ	AN22NFS	★★		100	5.8	16,700	530	204	2.2	430	556	3.0	760
ダイキン工業	ラクエア	AN22NWS	★★		100	5.8	16,700	530	204	2.2	430	556	3.0	760

Annual Electricity fee

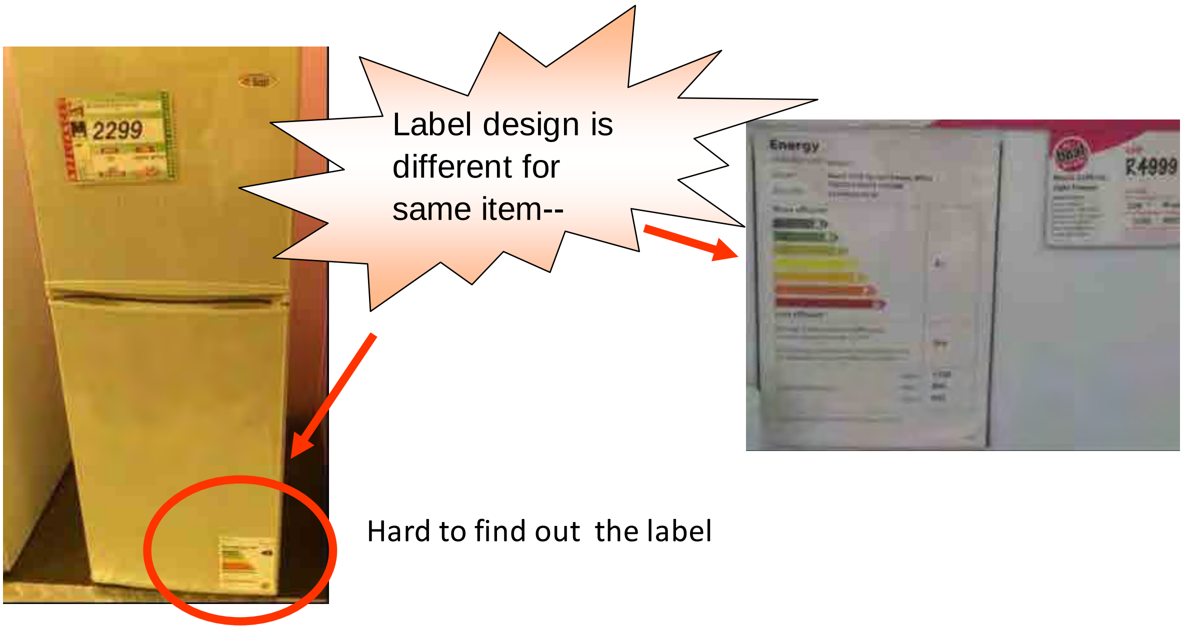
Source: Ministry of Economy, Trade and Industry, Japan

Figure 6.1-4 Japanese Catalog of Energy Efficiency Performance (2012)

1) Energy savings retail shop award
   - Target: Small, medium-size and large home appliance retailers
2) Energy savings award (Award for manufacturers)
   - Target: Manufacturers, products, business models covering the industry, commercial, transport sectors, schools, and public sector
3) Incentives for consumers such as a rebate program
4) Public information campaign using media and school programs to promote consumer recognition.

Currently, South Africa has in place a voluntary labeling program for refrigerators and some other appliances under an agreement between the government and manufacturers. Prior to shifting to a mandatory system in the future, the government should establish a detailed labeling procedure.

Image 6.1-1 shows labels attached to refrigerators sold at a shop in South Africa. There is no rule specifying whether to attach a label directly to the product or where on the product to attach it and, depending on the product, labels are attached at different sites, which prevents consumers from recognizing a label. In addition, the same products may have different labeling designs, causing confusion among consumers. It is recommended that these specifications be unified under a mandatory program.



Source：Retail shop in Pretoria, July 2012

Image 6.1-1 Examples of Labels on Refrigerators

Some products carry labels from other countries. These labels should also be unified.

Source: Retail shop in Pretoria, July 2012

Image 6.1-2 Examples of Labels on Lighting Appliances

6.1.6. Monitoring System

(1) Current situation and analysis

South Africa's current energy monitoring system is designed basically to promote energy savings. The country's energy efficiency strategy was established in 2005 and revised in 2008. Taking this opportunity, the Energy Efficiency Monitoring and Implementation Project was initiated with financial support from the Swiss Agency for Development and Co-operation (SDC) by the South

African Local Government Association (SALGA) and the DOE, in order to provide support for developing and introducing an energy efficiency monitoring system for the construction sector. A basic survey was conducted in 2005, and an agreement was concluded between SDC and South Africa (SALGA and DOE) in 2010. SALGA and DOE are planning to monitor implementation, support, and achievement of the energy efficiency strategy for the construction sector in five local districts during the period from April 2010 to December 2013, using a 28.5 million rand SDC fund. Under this project, a monitoring method will be formulated during the period 2011-2013. The project is to be continued until 2015 to ensure implementation of the energy efficiency policy in 2014 and thereafter.

In addition to implementing the above project, the DOE was authorized effective March 1, 2012 to mandate companies to submit data on energy production and consumption and other matters for the purpose of achieving the 2008 target under the National Energy Efficiency Strategy. Such data are collected by SANEDI through an online system and stored in the energy management system at the DOE.

The obligation to submit data under the current monitoring system applies to five sectors: mining, industrial, transport, business, and public. In practice, however, this submission requirement is applied only to some companies in energy-consuming industries, so it is currently impossible to cover all energy savings in the country.

At present, two energy audit systems are offered. One is conducted by Eskom as part of the EEDSM Program, and the other is a free energy audit conducted by National Cleaner Production Centre (NCPC), which is an organization under the DTI. In addition to these two energy audit systems, ESCO companies also conduct energy audits. Companies lack a system to handle all of requirements under the national monitoring system. Therefore, the government is considering establishing a qualified energy manager. However, a qualified energy manager system requires expertise, so it is still a serious challenge for the government. The issues to be examined in the future are to select an appropriate organization and to increase the number of energy managers. Therefore, the DOE is expected to have a role.

(2) Proposal

To monitor energy savings in South Africa as a whole, companies in all sectors consuming a certain amount of energy should be legally mandated to collect relevant data.

A qualified energy manager training system should be introduced to enable companies to employ a qualified energy manager. To implement this, training and examination for energy managers, and training for instructors of energy managers are required. Besides, the required number of energy managers in the future and well-planned educational measures are needed.

6.1.7. Data Collection Mechanism

(1) Current situation and analysis

Statistics South Africa manages a database containing basic economic data for the last 20 to 30 years and releases them to the public through publications and a website, but it does not collect some data needed to estimate energy demand. On the other hand, there is no database available to provide energy data covering all energy sources. Instead, DOE, SANEDI, university-affiliated research organizations, and private enterprises, such as Eskom, collect data independently and organize them in their own databases. Relevant data are collected by the DOE and DTI for the industrial, commercial, and public sectors, and by the DOE and DOT for the transport sector.

To achieve targets under the National Energy Efficiency Strategy 2008, the DOE was authorized, from March 1, 2012, to require companies to submit data on energy production and consumption, as well as other figures. In practice, however, this obligation is currently being imposed on some companies in energy-consuming industries. Such data are collected by SANEDI through an online system, and are stored in the DOE's energy management system.

To plan and establish energy policies in South Africa, the government needs to prepare medium- and long-term energy supply and demand outlooks for the coming 20 to 30 years. Based on these outlooks, policies and measures should be built for the whole country and by energy source. To compile more reliable energy supply and demand outlooks, the government needs to obtain past economic data and actual energy supply and demand data. Thus, it is necessary to collect past data in a database.

Currently, energy data are held separately by the DOE, university-affiliated research organizations, and power companies and other private enterprises. These data must be unified in a single energy database.

The Minister of Energy released a statement dated March 23, 2012, concerning New Regulations on the Mandatory Provision of Energy Data, which is yet to be enforced.

(2) Proposal

Past energy data currently held by the DOE, university-affiliated research organizations, and power companies and other private enterprises should be unified to improve the energy database.

Data collected should cover more items that are important for estimating energy consumption. For example, data should include the number of households, floor area, and quantity of energy-consuming equipment, for the civilian and business sectors, and the number of automobiles owned, sales of transport fuels, and distances traveled, for the transport sector. In some cases, sampling surveys may be carried out to obtain specific data. To promote cogeneration, it is important to collect heat supply and demand data.

The DOE or its contractors should collect energy data needed to prepare energy supply and demand forecasts, build a database, and manage data together with relevant economic data in the database. In general, consolidated energy data should be made available to the public. An energy statistics section should be added to the DOE website to post an energy supply and demand summary by final demand sector and by energy source, in order to disseminate information on energy supply and demand inside and outside the country.

The New Regulations on the Mandatory Provision of Energy Data should be put into effect as soon as possible and fully communicated nationwide. The collection system should be used more systematically and, at the same time, the mandatory data collection requirements should be applied to more fields and segments.

The government should consider introducing an energy audit system and a scheme to collect energy data from reports submitted by companies in exchange for government subsidies to cover audit expenses.

6.1.8. Public Awareness

(1) Current situation and analysis

Awareness of energy conservation in South Africa was low because the electricity tariff in residential sector was low. However, Eskom is planning to increase the electricity tariff each year. This plan will promote energy conservation.

(2) Proposal

To make energy efficiency policies more effective, it is essential to raise public awareness of energy efficiency. For this purpose, initiatives may include an Energy-saving Week, an energy-saving award program, and events by educational institutions.

Energy-saving Week is aimed to raise public awareness of energy efficiency by organizing symposiums, international workshops, and other seminars intensively during a specific week. These initiatives are carried out in many countries because they are effective for conveying information on energy efficiency.

In addition to these intensive campaigns, daily activities are important to educate people on energy efficiency at workplaces and schools. For instance, public awareness of energy efficiency can be developed by distributing teaching materials, setting up energy efficiency classes, and conducting seminars at workplaces.

Teaching materials may include energy-saving guidelines. To enhance public awareness of energy efficiency in daily life, such guidelines should contain descriptions of, for example, how much energy could be saved by turning off unnecessary lighting and how to use televisions, refrigerators, and other appliances to save energy.

An energy efficiency award program would offer equipment manufacturers and consumers an incentive to improve energy efficiency by applying the most energy-efficient methods and measures. For example, in Japan's energy efficiency award program (Energy Conservation Grand Prize), award winners are selected from among various high-efficiency appliances and energy-efficient methods after being evaluated for their innovativeness, originality, energy efficiency, marketability, economic potential, and other features. Winning companies are given awards by the minister and are entitled to highlight the energy efficiency of their products in advertisements and newsletters.

6.1.9. Financial Incentive

(1) Current situation and analysis

The government of South Africa has implemented several programs to promote energy efficiency as follows.

1) Section i tax incentives for manufacturing-related projects
2) Section l tax incentives for all energy efficiency projects (underway)
3) Green energy efficiency fund (soft loan, less 2%)
4) Bulk buying of energy savings from project developers
5) Free energy assessment or audit by UNDP
6) Approved price from cogeneration
7) Vehicle emissions levy
8) National solar water heating program
9) Free high efficient fluorescent lamp
10) Electricity tax from non-renewables
11) Incandescent bulb tax of R3 per globe
12) Accelerated depreciation allowance for renewables plants such as biofuel, wind, solar, etc.

Table 6.1-1 shows the contents of each program.

Table 6.1-1 Programs for Energy Efficiency Promotion

Program	Description
1) Section i tax incentives for manufacturing-related projects	The incentive is for investments in renewable energy by allowing for an energy efficiency allowance/deduction from taxable income on the basis of energy efficiency savings
2) Section l tax incentives for all energy efficiency projects (not implemented yet)	The incentive is for investments in energy efficient behavior and technology by allowing for an energy efficiency allowance/deduction from taxable income on the basis of energy efficiency savings
3) Green energy efficiency fund (soft loan, less 2%)	A joint project between the Industrial Development Corporation (IDC) and German Development Bank (KfW) whereby soft loans (prime less 2%) up to R50 million for one company are made available to companies making qualifying energy efficiency investments
4) Bulk buying of energy savings from project developers	This is the bulk buying of energy savings from project developers for a basket of projects. Performance contracting is best suited to large, capital intensive industrial projects and requires energy savings that exceed 30 GWh over a 3-year period
5) Free energy assessment or audit by UNDP	A joint program implemented by UNIDO and funded jointly by DTI, Department of Energy, UNIDO, Swiss Economic Cooperation and Development (SECO) and Department for International Development UK (DFID). The National Cleaner Production Centre (NCPC) promotes and implements energy efficiency initiatives by partnering with private sector companies who enroll in the program, which entitles them to a free energy assessment or audit.
6) Feed in Tariff (FIT) of electricity from cogeneration	In 2006 Eskom pricing approved 45 c/kWh for cogeneration projects, based on cost avoidance benefits. Tenders were then invited for new cogeneration projects, but none came in under the approved price and the pilot project was halted. During 2007 the approved price was increased to 65 c/kWh and new tenders were invited for cogeneration projects.
7) CO_2 tax for high-emissions vehicles	The tax was introduced in 2011 and applies to all new passenger vehicles. In the case of passenger vehicles, the levy rate is R75 per g-CO_2/km on emissions exceeding the threshold of 120g-CO_2/km. In the case of double-cab vehicles, the rate is R100 per g-CO_2/km on emissions over 175 g-CO_2/km
8) National solar water heating program	The program is funded from the NERSA approved DSM budget. The Government's target is to install 1 million units by 2014/15 and 5 million by 2019. Low-pressure systems are targeted at low income households and high-pressure systems at middle to high income households. As of 6 June 2012, 147,906 low-pressure and 46,957 high-pressure system claims had been processed.
9) Rolling out of compact fluorescent lamp (CFL)	The program replaces inefficient, incandescent lamps with an equivalent, efficient compact fluorescent lamp. These are distributed at no cost in exchange for an incandescent lamp which is then destroyed. The focus of the program has been primarily on the residential market. DSM funding as well as carbon revenue is being used to assist with project financing. 43.5 million CFLs fitted across SA (from 2004 – 2010) resulting in 2,006 MW demand savings
10) Electricity tax from non-renewables	Implementation of electricity generation tax (1 July 2009), which serves as a proxy for a carbon tax. The electricity tax of 3.5 c/kWh applies to electricity generated from non-renewables.

11) Incandescent bulb tax at 3 rand per globe	Incandescent bulb tax at 3 rand per globe implemented from 1 November 2009.
12) Accelerated depreciation allowance for renewables plants such as biofuel, wind, solar, etc.	The programs are three-year accelerated depreciation allowance for plant, equipment, and machinery used in the production of biofuel plants and renewable generation plants such as wind, solar, small-scale hydro, and biomass, at the rate of 50:30:20 %.

So far, the major policy measures promoting energy efficiency in South Africa are taxes imposed on low energy efficient equipment and tax reductions on high energy efficient equipment. The Japanese government is also introducing many policy measures for promoting improved energy efficiency such as energy audits, subsidies, low interest loans, and tax incentives. Regarding policy measures, it is thought that subsidies and low interest loans in South Africa are less than those in Japan. Regarding SMEs, it is necessary to support their financing.

Sources of finance for SMEs in South Africa are limited, especially more risk-taking financial instruments. About two thirds of SMEs in the country do not receive debt financing from the formal financial sector. SMEs have been suffering from a lack of long-term finances for investments. At present, although IDC provides soft loans for energy efficiency, the budget is not enough for SMEs.

There are levy systems such as carbon tax and incandescent bulb tax in South Africa. A subsidy system for capital investments to improve energy efficiency is also necessary using taxation revenues. In the industry sector, energy efficiency can be improved by regulation. But, it is difficult to control energy saving in the residential and transport sectors because of a lack of awareness and understanding of energy efficiency. The subsidy system will be accelerated for purchasing high-efficiency equipment such as electric appliances and passenger vehicles.

(2) Proposal
To promote energy efficiency and conservation, the following systems are effective.

1) Accelerate low-interest loans with long repayment periods to SMEs
2) Use two-step loan from international organizations
3) Provide subsidies for high-efficiency equipment

Generally, SMEs do not have the funding ability of large enterprises. Therefore, even if they recognize that high-efficiency equipment is useful for energy saving, they cannot introduce them because of a lack of funds. Low-interest loans with a long repayment period will accelerate investment on high-efficiency equipment for SMEs. Developing the supporting SMEs and job creation are important policy tasks for the country.

Financial intermediary loans are implemented through the financial institutions of the recipient country based on the policy-oriented financial system of the partner country. These loans provide funds needed for implementing designated policies, such as the promotion of SMEs, agriculture, and other specified industries. These loans are known as two-step loans (TSL), because under the process funds pass through two or more financial institutions before being received by the end-beneficiaries. Under this type of loan, funds can be provided to a large number of end-beneficiaries in the private sector.

Japan has experience of two-step untied loan agreements totaling $100 million, yen equivalent, having signed an agreement with the Industrial Development Corporation of South Africa (IDC) to bolster SMEs in 2000.

Figure 6.1-5 shows the structure of a two-step loan. A foreign bank provides a loan to a financial institution in receiving country. In this case, the government of the receiving country guarantees an obligation if the primary obligor defaults. Then, the financial institution in the receiving country provides loans to end users. Depending on the term of the agreement between the foreign bank and the financial institution, generally, loan conditions such as repayment period, interest rate, and grace period, are better than those of a commercial bank.

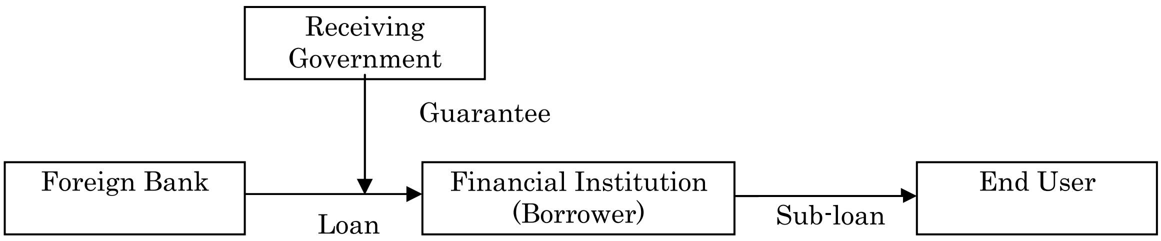


Figure 6.1-5 Structure of Two-step Loan

To promote high-efficiency equipment, there are many subsidy systems in Japan. In particular, the sales volumes of passenger vehicle and electric appliances were rapidly increased by the subsidy system.

6.2. Priority Areas for Energy Efficiency and Japanese Countermeasures

6.2.1. Energy Conservation Potential and Target

According to the results described in Chapter 4, the energy conservation potential of South Africa is 15.6 MTOE in the EE_max case and 12.2 MTOE in the EE_adv case. Air conditioners in the commercial sector account for 32% of total energy conservation potential, followed by gasoline vehicles (17%), diesel vehicles (17%), water heaters (11%), industrial processes (5%), and household and commercial lighting (4%) (Refer to Figure 6.2-1). 90% of the energy conservation potential (15.6 MTOE in the EE_max case and 12.2 MTOE) will be achieved effectively by improving energy efficiency in the above fields.

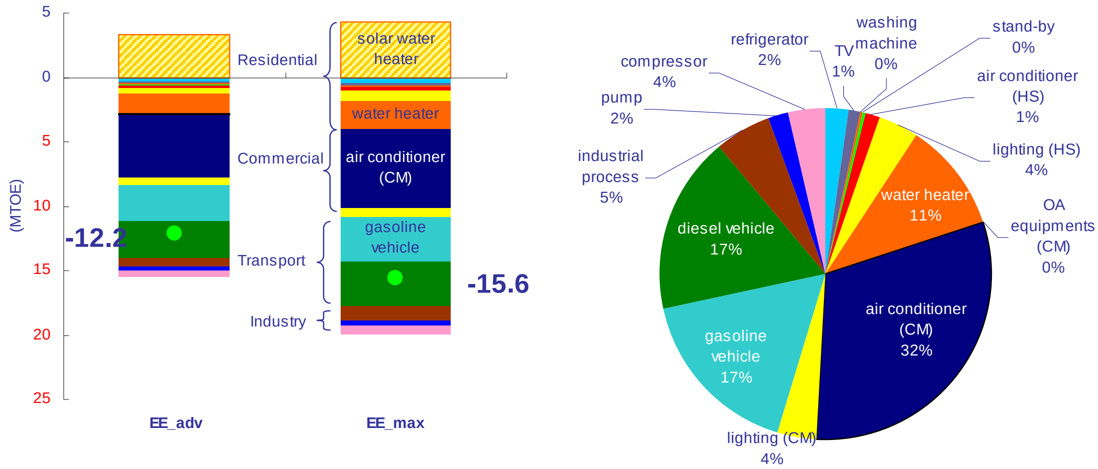


Figure 6.2-1 Energy Conservation Potential of South Africa

South Africa's National Energy Efficiency Strategy 2005 (NEES) aims to improve energy efficiency by 12% by 2015, compared to the baseline scenario for final energy consumption set forth in its National Integrated Energy Plan 2003. Figure 6.2-2 shows estimated final energy consumption until 2035 in the BAU_IRP case, EE_max case, and EE_adv case, and the 2015 12% reduction target by sector. This figure indicates that it is almost impossible to achieve the 12% target for the country as a whole even in the EE_max case, specifically, in the industry sector.

In the light of these circumstances, South Africa should focus in the medium to long term on such priority fields as air conditioners in the commercial sector and automobiles, which have high energy conservation potential, and other industrial processes, which would be the key to achieving energy efficiency targets. Section 6.2.2 introduces Japanese countermeasures for priority fields of energy efficiency in South Africa.

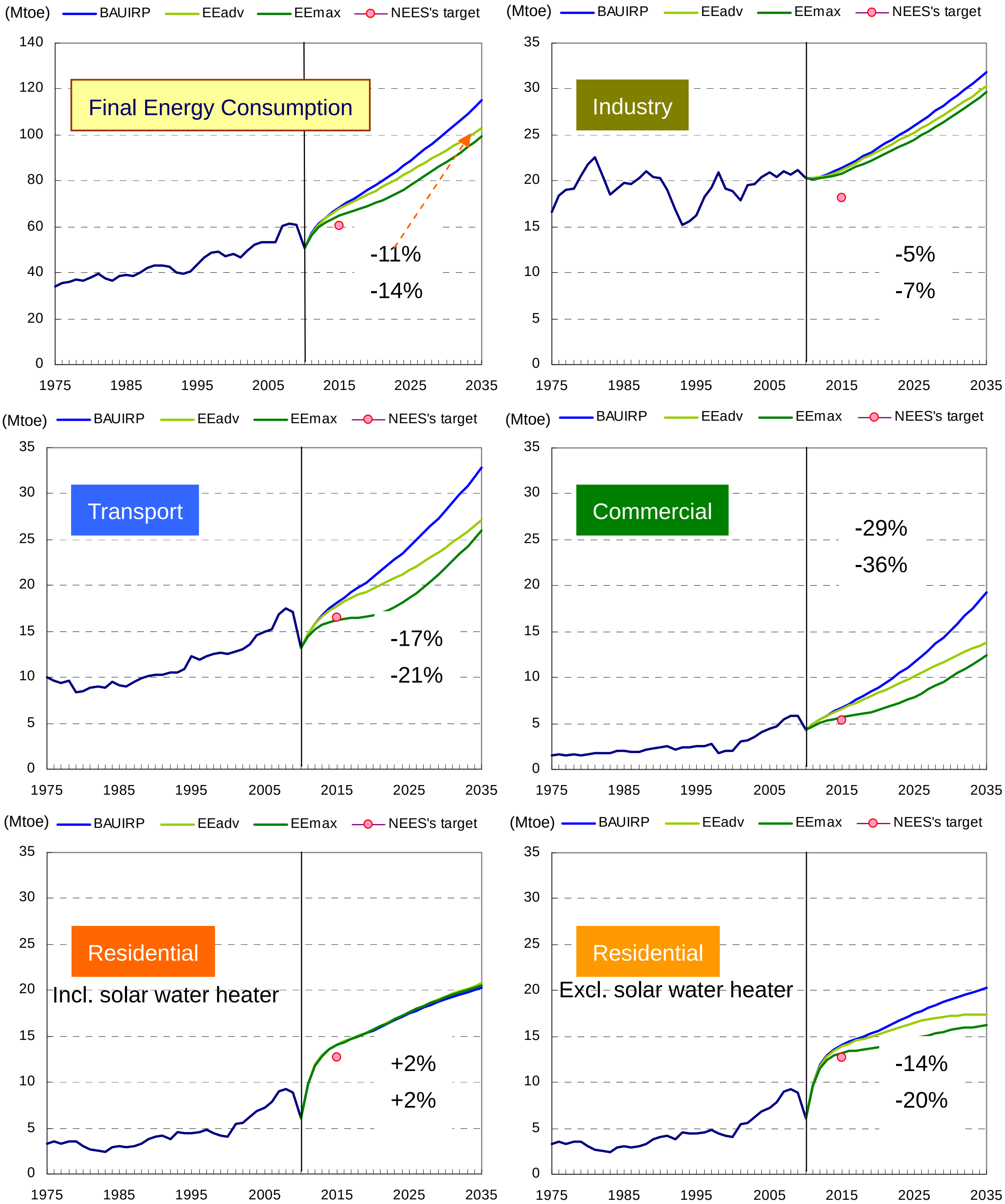
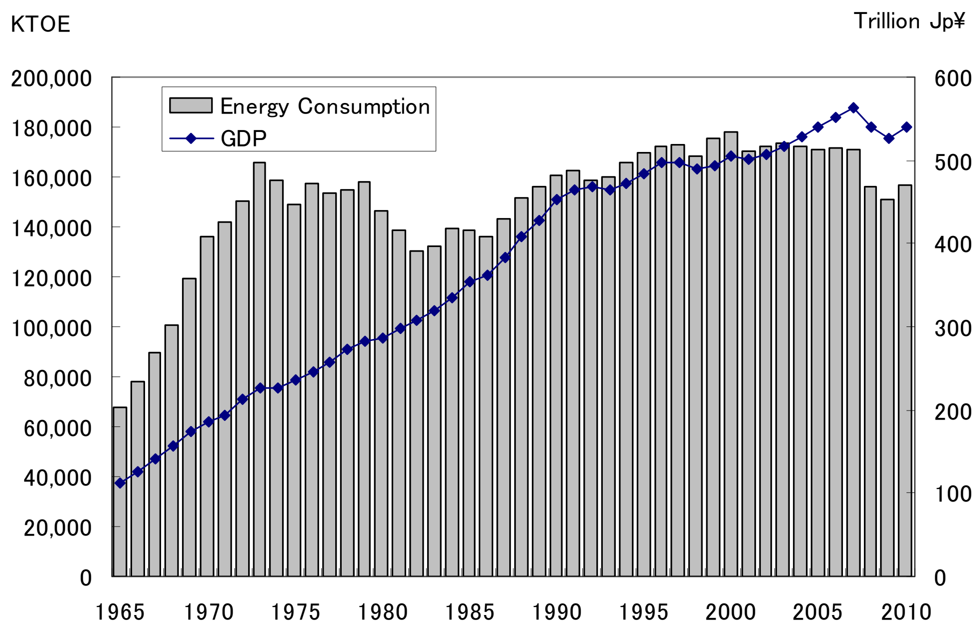


Figure 6.2-2 Estimated Final Energy Consumption and Energy Conservation Targets in 2015

6.2.2. Japanese Countermeasures for Priority Fields of Energy Efficiency in South Africa

(1) Industry

Japan has experienced two oil crises. In the 1960s, an era of high growth, industrial energy demand increased sharply in line with economic growth. Despite surging energy prices following the first oil crisis of 1973, the industrial sector successfully managed to reduce energy consumption without slowing economic growth by cutting energy costs through energy conservation. While the industry sector took the initiative in saving energy, the government actively promoted energy efficiency improvements. In the 1990s, reducing CO_2 emissions became a priority issue as a global environmental problem. The Japanese government decided to set up a reduction target for the industry sector and impose penalties or disclose the names of companies who failed to achieve the target. Although the penalties are smaller than energy efficiency investments, Japanese companies have achieved their reduction targets through efforts to cut energy consumption. Japanese companies do not like to having their names disclosed for failing to achieve their targets. Under these circumstances, energy consumption in the industry sector has remained flat since the oil crisis, also partly because the Japanese economy shifted attention from heavy energy-consuming industries to a light industries. Figure 6.2-3 shows changes in Japan's industrial energy demand and GDP.



Source: Handbook of Energy & Economic Statistics in Japan, IEEJ

Figure 6.2-3 Japan’s Industrial Energy Demand and GDP

Japan’s success in reducing industrial energy consumption was brought about mainly by the following factors:

1) Energy efficiency investments by companies to cut energy costs amid sharp energy price increases;

2) The government’s support for energy conservation with subsidies, tax reduction, and awareness

campaigns;

3) Industry’s voluntary action plans (formulation of voluntary action plan by industry and publication of the results of periodic reviews of progress); and,

4) Targets set by regulations.

The past oil crises led to a global diversification of energy sources, thus reducing oil dependency and weakening the impacts of sharp oil price increases. IEA member countries are obligated to maintain certain oil stockpile levels, and they flexibly respond to supply shortages by releasing stored oil. These factors have helped avoid the sharp oil price rises seen in the 1970s, but oil prices have still remained high. In the manufacturing industry, energy cost cuts play an important role in strengthening competitiveness compared to imports, so improving energy efficiency is necessary in this respect. Energy efficiency projects in other countries implemented by Japan indicate that the manufacturing industry has high energy conservation potential. It is also important for South Africa to evaluate its energy conservation potential, specifically in accordance with the following procedure:

1) Estimating energy conservation potential and costs and benefits using ESCO or energy managers;
2) Establishing a voluntary action plan by industry sector, similar to one implemented by Japanese industrial association; and,
3) Establishing a low interest rate financing system to facilitate initial investment.

(2) Air conditioners in commercial sector

Air conditioners in the commercial sector include air conditioning systems used in office buildings, financial institutions, hotel, schools, hospitals, shopping centers, and entertainment facilities. Using a macro-analysis model, future energy demand from air conditioners in the commercial sector is estimated based on expected increase of floor area, and energy conservation potential is estimated under the assumption that the coefficient of performance (COP) of air conditioners has reached the latest technical level. For this reason, we have not surveyed or estimated air conditioners currently in common use in South Africa. In the long run, in addition to improving COP, the country should consider introducing electric chillers and gas-cogeneration systems if gas becomes available in the future.

An Indonesian energy efficiency project carried out in the past by JICA indicates that investment in air conditioners in the commercial sector can be paid back within three years, which is short compared to the industry’s average energy efficiency investment. This Indonesian project was implemented in 2010. The electricity tariff in the commercial sector at that time was about US10 ¢ /kWh in Indonesia, which is nearly the same that in South Africa. Based on this, the payback period of energy efficiency investments in air conditioners would be almost the same in both countries. However, because less energy can be saved in buildings with a smaller floor area, energy efficiency audits covered buildings having a floor area of 30,000 m2 or more, considering energy audit fees paid to ESCO by the commercial sector in the Indonesian project. In South Africa, the following procedure will be taken to save energy in buildings:

1) Setting target floor area of buildings considering costs and benefits;
2) Implementing energy audit for target buildings; and,
3) Designating energy-management buildings and mandating energy consumption reports if necessary.

(3) Automobile sector

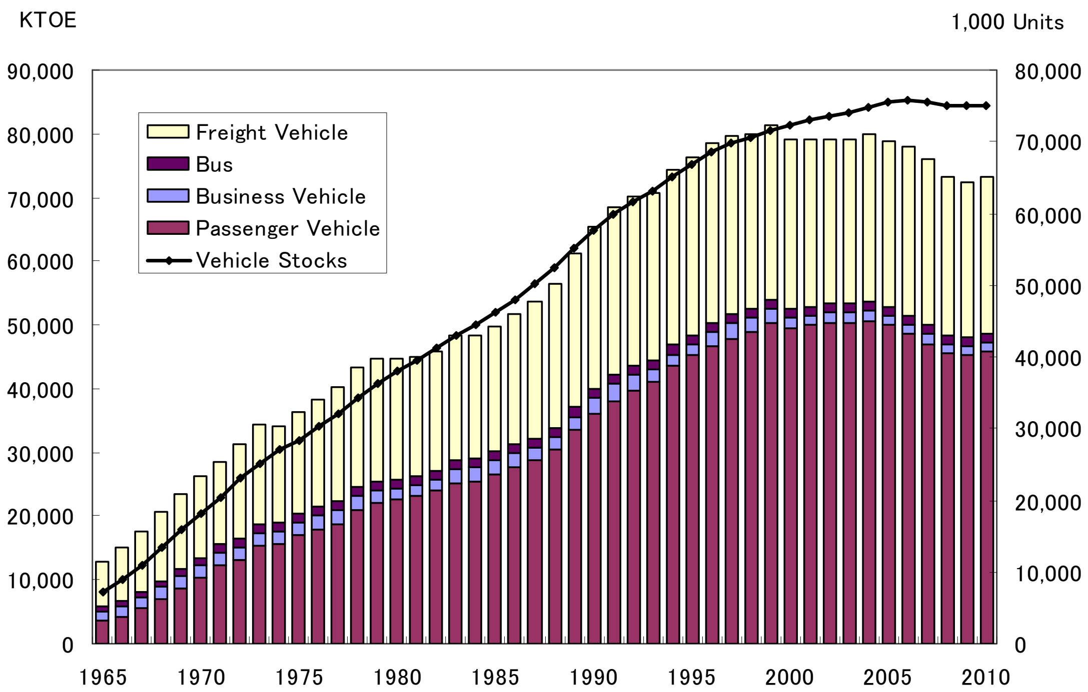
South Africa introduced a gas emissions tax for all new vehicles. Passenger cars exhausting 120 g or more of CO_2 per km are subject to a tax of 75 rand per gram/km, and double cabs exhausting more than 175 g/km are subject to a tax of 100 rand per gram/km. Based on CO_2 emission factors (2,320 g-CO_2/ℓ for gasoline and 2,620 g-CO_2/ℓ for diesel oil), fuel efficiency must be 19.3 km/ℓ or more for gasoline passenger cars, 13.3 km/ℓ or more for gasoline double cabs, 21.8 km/ℓ or more for diesel passenger cars, and 15.0 km/ℓ or more for diesel double cabs. That is, the majority of vehicles are subject to taxation.

In Japan, two main measures were implemented to reduce energy consumption in the automobile sector. One measure is a specific goal imposed on automobile manufacturers. Under this goal, a manufacturer is required to achieve the maximum fuel efficiency of other manufacturers within a few years by developing energy efficiency technologies. Called the top-runner standard, this policy was adopted in 1998 in line with an amendment to the Energy Conservation Act. Failure to achieve this goal is not subject to a penalty, but fuel efficiency has been significantly improved through efforts to develop energy efficiency technologies.

The other measures implemented in Japan are eco-car subsidies and eco-car tax reductions. An eco-car subsidy was started in April 2009 for eco-friendly cars for a limited time. The subsidy amounted to a total of about 580 billion yen to the end of September 2009. The eco-car subsidy program was resumed in December 2011 and continued until September 2012, when the budget was used up. Under this program, buyers of high fuel efficiency automobiles are granted 100,000 yen (70,000 yen for minimum-vehicles).

The eco-car tax reduction has been in place since June 2009. This program, which is scheduled to continue until April 2015, is intended to reduce car weight tax and automobiles acquisition tax upon registration by 50% to 100%, depending on vehicle type. Larger cuts are given to vehicles with higher fuel efficiency. The total amount of the tax reductions reached about 200 billion yen in 2009.

Further, a disused-car subsidy was put in place between April and September 2009. Under this program, buyers were granted 250,000 yen (125,000 yen for minimum-vehicles) in an eco-car subsidy and disused-car subsidy combined if they purchased an eco-friendly car in exchange for a car that was 13 years old or more.



Source: Handbook of Energy & Economic Statistics in Japan, IEEJ

Figure 6.2-4 Energy Demand of Automobiles and Number of Cars Owned in Japan

As for the effects of eco-car subsidies and eco-car tax reduction, 2.59 million units of new cars were sold during the April-September period of fiscal 2012, up 33.5% from a year earlier, accelerating sales of fuel-efficient vehicles. Figure 6.2-4 shows the trend of Japan's energy demand by automobiles and number of cars owned. This figure indicates that energy demand by automobiles has been declining since the introduction of the top-runner standard. The eco-car subsidy and the eco-car tax reduction were introduced relatively recently. It will take time for Japan's current stock of 75 million units to be totally replaced by new cars. Currently, automobiles are used for about 12 years on average. The quantified effect of the two programs is not clear yet.

China introduced a similar eco-car subsidy at about the same time as Japan, to accelerate sales of eco-cars. For this study, we estimate that the number of automobiles owned in South Africa will increase from 7.9 million in 2010 to 15.5 million in 2035. Vehicle ownership per person will increase from 0.16 to 0.28. While the number of vehicles in Japan is expected to remain flat in the years to come, the figure for South African will grow at an annual average rate of 2.7%. Based on the estimate, an increase in the number of eco-friendly cars will promote energy savings. South Africa has already introduced a gas emission tax on automobiles. Tax revenues should be used to finance eco-car subsidies and eco-car tax reduction in accordance with the following procedure:

1) Calculating a budget for eco-car subsidies and eco-car tax reduction;
2) Establishing fuel efficiency criteria for imported cars; and,
3) Establishing rates of eco-car subsidies and eco-car tax reduction.

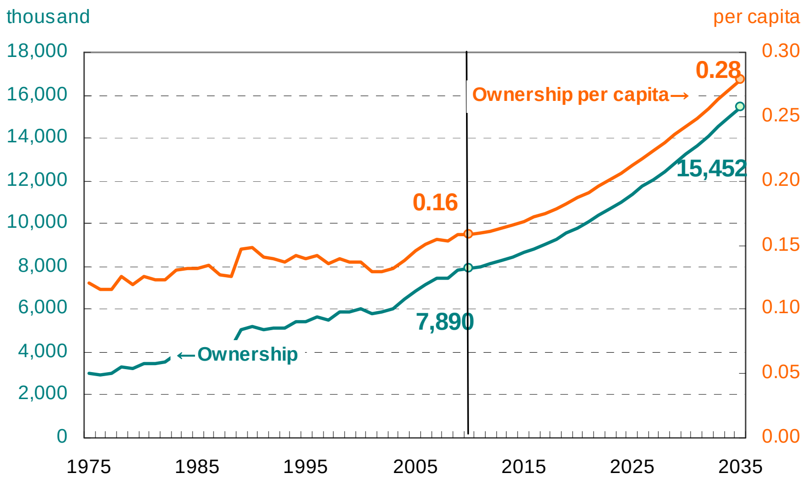


Figure 6.2-5 Forecast of Number of Vehicles in South Africa

6.2.3. Other Initiatives for Priority Fields

In Section 6.2.2, initiatives targeted at priority fields having high energy conservation potential are discussed based on model results. This section focuses on South African initiatives for priority fields on the basis of information obtained by our local surveys.

(1) Energy and economic statistics

Energy and economic statistics provide an indispensable tool to estimate future energy demand and monitor energy efficiency policies for their effectiveness. In Japan, various energy statistics are collected from energy suppliers and consumers in accordance with the Statistics Law and the Energy Conservation Law. In addition, industry associations such as those of the cement and steel industries compile statistics and publish them independently. The Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry compiles Comprehensive Energy Statistics based on these statistics and releases them on its portal site. The Institute of Energy Economic, Japan, a private think tank, independently compiles and publishes the Handbook of Energy and Economic Statistics in Japan. The two statistical publications contain data on energy output, converted energy amount, energy consumption, and other energy-related activities collected from the Resources and Energy Statistics, the Current Survey of Energy Consumption, the Survey of Electric Power Statistics, the Gas Business Statistics, and other statistical data. Household energy consumption is estimated using sampling surveys. Figure 6.2-6 shows the flow of the energy statistics compilation process in Japan.

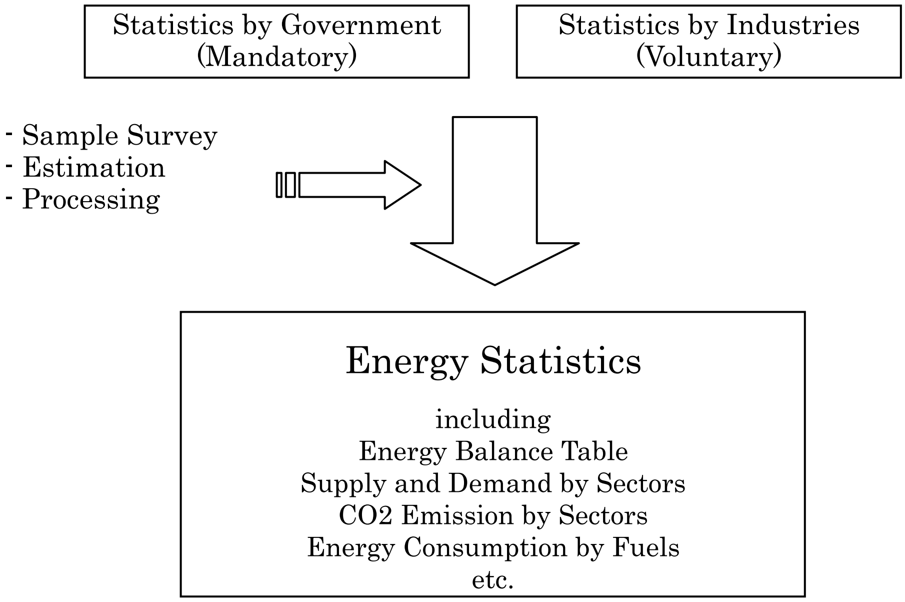


Figure 6.2-6 Flow of Energy Statistics Compilation in Japan

In South Africa, SANEDI under the DOE manages energy consumption data for energy efficiency projects. The DOE's portal site carries energy data by field, but energy statistics are not edited in a comprehensive manner. Compiling energy data is indispensable to analyze the energy situation of South Africa and plan a future energy policy. The government is urged to establish a statistics section under the DOE.

(2) Energy management system

In Japan, factories annually consuming 1,500 kl of oil equivalent or more are designated as Designated Energy Management Factories. If such factories are in the manufacturing, mining, electricity supply, gas supply, or heat supply business, they are obligated to appoint one to four Energy Managers from among those qualified as such, depending on the energy consumption level. Factories in other businesses and factories consuming less than 3,000 kl are required to appoint an Energy Management Officer.

Energy managers' responsibilities include maintaining energy-consuming equipment, improving energy-use methodology, monitoring energy consumption, and other activities set forth by relevant laws and regulations.

In Japan, two methods are available for designating an energy manager. One is a national exam given every August by a testing organization (Energy Conservation Center in Japan) designated by the Minister of Economy, Trade and Industry. Applicants are required to have had on-the-job training for one year.

Another is a certified training session. Applicants are required to have had on-the-job training for three years. The energy management training session is organized every December by the Energy Conservation Center in Japan registered by the Minister of Economy, Trade and Industry. Applicants are qualified when they pass the final examination after the session. To be selected as an energy manager for a company, a candidate must be an energy management officer or have completed an energy manager training session. Figure 6.2-7 shows the required number of energy managers and energy management officers for different levels of energy consumption.

Examinations are given on the following:
Heat management officer: Outline of heat management and relevant laws and regulations, basics of flows of hot fluids, and fuels and combustion.
Electricity management officer: Outline of electricity management and relevant laws and regulations, basics of electricity, and electrical equipment and devices.

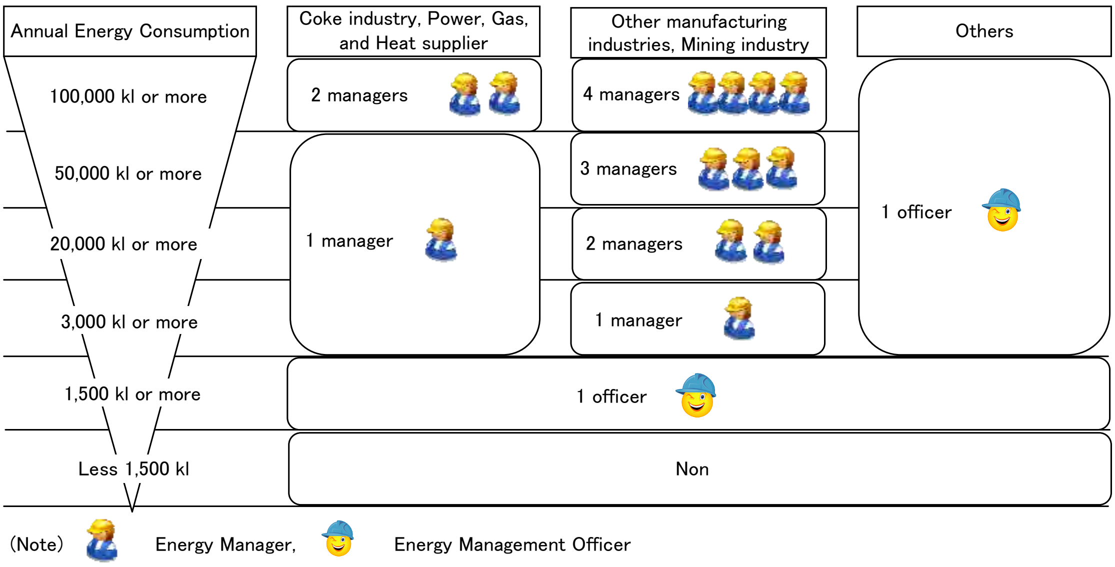


Figure 6.2-7 Number of Energy Managers and Energy Management Officers

The South African government is considering an energy manager system. Other countries are also planning to introduce an energy manager system. They must consider such matters as required number of energy managers, methodology for training energy manager trainers, certifying organizations, and training centers. South Africa also needs to formulate a framework for the energy manager system, estimate the number of energy managers needed, and establish a systematic program for developing energy managers.

As of March 31, 2009, Japan had 14,703 designated energy management factories. In 2009, 3,719 persons passed the energy manager examinations. About 3,000 energy managers have been produced annually.

(3) Labeling system

Table 6.2-1 compares power consumption by electric appliances in South Africa and maximum power consumption in Japan as discussed in Chapter 4. The current power consumption in South Africa was estimated based on surveys carried out by local consultants. These figures indicate that, in South Africa, power consumption is about twice the maximum level of Japan. A labeling system is already in place in South Africa, but its effectiveness is yet to be confirmed. In Japan, electric appliances carry a label stating their benefits to the effect, for example, that the product reduces annual electricity costs by 5,000 yen. Similarly, South Africa needs to design labels for products in a way that attracts consumers.

Table 6.2-1 Comparison of Power Consumption of Conventional and High-efficiency Appliances

	Current (2010) (kWh/year)	Max. in Japan (kWh/year)
Refrigerators	353	132
TVs	187	112
Washing machines	181	132
Stand-by	44	26
Room air conditioners (cooling)	477	198
Room air conditioners (heating)	2,019	871
Lighting	48	27

6.3. Action Plan

The following action plans based on the review in Section 6.2 are recommended.

<table>
<tr><td>1. Program name</td><td>Reducing energy consumption for industry and buildings</td></tr>
<tr><td>2. Implementing organization</td><td>DTI, DOE</td></tr>
<tr><td>3. Relevant players</td><td>Private and state-owned companies</td></tr>
<tr><td>4. Target</td><td>Reducing energy consumption in industry and buildings by 12% compared to BAU by 2020</td></tr>
<tr><td>5. Expected effect</td><td>Reinforcing energy management activities</td></tr>
<tr><td colspan="2">6. Description of program
- Prepare technical standard on energy management for industry and buildings
- Prepare laws and regulations including penalties
- Establish framework for document and on-site inspection for continuing implementation
- Inform free energy audit system for SMEs
- Expand free energy audit system

[For large enterprises]
Factories and buildings of a predetermined size designated for energy management should be obligated to undergo an energy audit by ESCO or energy managers. DTI should encourage industrial associations to take the initiative to set voluntary action targets for their respective sectors.

[For SMEs]
A low-interest-rate financing scheme should be set up to extend the two-step loan and other credit facilities to SMEs.</td></tr>
<tr><td colspan="2">7. Issues concerning implementation
The energy audit should require regulation by law. There will be some time before the scheme is enforced. In addition, it is required to determine whether to finance low-interest loans with the national budget or foreign aid.
Although the National Cleaner Production Centre (NCPC) offers free energy audits, this system has not been well used as the degree of recognition of the system is low among SMEs. There is another problem in that the number of personnel at NCPC possessing technical knowledge about energy audits is not sufficient. It is necessary to train energy managers.</td></tr>
<tr><td colspan="2">8. Assistance required
South Africa wishes to learn from Japan's experience and apply it to its policies. It is recommended to transfer Japan’s technical expertise to the country, including detailed information on Japan’s energy management system and formulation of voluntary action targets for industrial sectors.</td></tr>
</table>

1. Program name	Reducing consumption of automobile fuels
2. Implementing organization	DOT
3. Relevant players	DOT, the automobile industry, automobile importers
4. Target	Improving fuel efficiency by 1.5% for gasoline vehicles and 1.2% for diesel vehicles annually.
5. Expected effect	Reducing energy consumption in the transport sector

6. Description of program

A top-runner standard should be set up for auto manufacturers to encourage them to improve fuel efficiency. Imports of low fuel efficient vehicles should be banned.

Incentives, such as tax reductions and subsidies, should be given to buyers of high fuel efficient vehicles.

In addition to the above, the government should examine the following items.

- Fuel efficiency standards for imported vehicles
- Financial source of subsidy for high-efficiency vehicles
- Appropriate tax reduction rate and amount of subsidy for high-efficiency vehicles
- Subsidy of disused automobile for old cars
- Mandatory reporting of fuel consumption to large transportation business owners
- Promotion of public transportation such as buses and railways to reduce fuel consumption by passenger cars
- Introduction of electric vehicles and natural gas vehicles for public transportation and official vehicles in the future

7. Issues concerning implementation

Cost efficiency analysis is needed for tax reductions, subsidies, and other incentives because they will put pressure on the government's budget. In Japan, the effects of tax reductions and subsidies for eco-friendly vehicles are not yet known.

In 2010, the number of automobiles in South Africa was 7.9 million. But, the number of automobiles will increase by 300,000 every year. To control fuel consumption in the transport sector, a modal shift is effective. Complaints have been made about public transport. Other issues are huge investment costs and long construction terms for a modal shift.

8. Assistance required

Japan provides data and information on eco-car subsidies and eco-car tax reductions.

1. Program name	Establishment of energy statistics system
2. Implementing organization	DOE
3. Relevant players	DOE, DTI, DOT, energy suppliers, industrial sector
4. Target	Publication of energy statistics by 2015 on the portal site of each industrial associations and DOE
5. Expected effect	Each industrial sector's understanding of its average unit energy consumption and setting an energy efficiency target.

6. Description of program

The obligation to submit energy data using a statistical law should be established. Industrial associations should take the initiative to compile energy consumption statistics and publish a statistical report on a voluntary basis. The DOE should consolidate energy data needed for South Africa to create an energy balance table and establish an energy policy.

The government should put New Regulations on the Mandatory Provision of Energy Data into effect as soon as possible.

The DOE prepares data collection mechanism, questionnaire sheet, and example of description.

At the early stage, the contents of questionnaire sheet will be simple and necessary information will be increased as the knowledge of energy users improves.

Format of energy statistics should be in accordance with IEA's format for international comparison.

7. Issues concerning implementation

Data collection requires a lot of time and a large workforce. It is necessary to build an online data collection system. In addition, it should be noted that data providers may lack knowledge of energy. For this reason it is required to set up a system to verify data collected.

Data inspection needs a lot of staff and statistical knowledge on energy. Regarding the estimation of energy consumption in the residential sector, a common estimation method needs to be prepared.

Regarding other sectors such as industry, commercial, and transport sectors, it is possible to collect a certain level of energy data. Eventually, energy consumption will meet energy supply.

Energy statistics will be updated every month. Therefore, it is necessary to establish an organization for data maintenance.

8. Assistance required

Advice should be given concerning the estimation of energy consumption. Japan's technical experience, especially in the commercial, residential, and transport sectors should be transferred to the government.

1. Program name	Establishment of Energy Conservation Center
2. Implementing organization	DOE, SANEDI
3. Relevant players	DOE, DTI, energy suppliers, energy users, industrial sector
4. Target	Energy Conservation Center that has the function to promote energy conservation similar to Japanese Energy Conservation Center is to be established in SENADI by 2015.
5. Expected effect	Activities of Energy Conservation Center promote awareness of energy conservation and increase number of energy managers.

6. Description of program

The center promotes energy auditors by training energy managers and through energy manager examinations. Energy conservation activities for companies will be promoted by sharing information on energy efficiency technology and awareness campaign for energy conservation using the portal site of the center.

The following are the activities of the center.

- Collecting data, methodology, and experience inside and outside the country on energy efficiency;
- Publishing collected information;
- Organizing workshops and seminars on improving energy efficiency;
- Consulting on improving energy efficiency;
- Capacity building for domestic activities; and,
- Supporting energy audits.

7. Issues concerning implementation

Activities of Energy Efficiency Policy and Planning Section in SANEDI are limited. If a comprehensive energy conservation function is required in SANEDI, expertise on operation, required manpower, and role-sharing arrangements are needed.

To operate the center, financial support from the government is necessary and the government should examine financial sources. By promoting improved energy efficiency, it will be possible to reduce foreign currency for imported energy and to increase coal exports corresponding to the reduction of domestic consumption. Moreover, it will be possible to have job creation.

8. Assistance required

To understand activities, required manpower and budget, training in Energy Conservation Center, Japan (ECCJ) is necessary.

Attachment-1

The Institute of Energy Economics, Japan

South Africa Market Survey - Energy Efficiency

Final Report

September 2012

UNLIMITED ENERGY

Contents

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Table of Figures

Introduction

The Government of South Africa requested the Government of Japan to cooperate and provide input into its Energy Efficiency Project. The Project's objective is to monitor and forecast domestic energy demand and supply. It will also support the development of energy efficiency programmes. The Japanese International Cooperation Agency (JICA) is the overall custodian of the programme and has appointed the Institute of Energy Economics, Japan (IEEJ) to undertake the first initiative - 'The study of Energy Efficiency in the Republic of South Africa'. This will be done in conjunction with the Department of Science and Technology (DST) and the DTI. By working with their South African counterparts, the objective of the study is capacity enhancement by providing input and insight:

- Analysis of energy efficiency policy;
- Data collection and monitoring capabilities; and
- To provide data, analyse results and review reports to assist/support the South Africa's Energy Efficiency Policy institutions.

A key requirement of the study is the availability of data which is challenging for the IEEJ on three fronts, 1) they are not based or familiar with South Africa; 2) there is limited data available. This has been recognised by the Department of Energy where in the foreword of the 'Digest of Energy Statistics' (2009) it stated: '*One of the key challenges that the Department faces is the lack of accurate, timely and reliable provision of data from our various sources. As a result this Digest only includes statistics for the years up to and including 2006 while we are in the process of collecting and verifying 2007 and 2008 data. In addition to hampering the timely production of our annual publications, the lack of data also creates a challenge to policy formulation as there are limited measurable input and output indicators.*'; and 3) energy efficiency research has not been a priority to date. What has been done is often not publicly available and / or difficult to source.

Unlimited Energy (UE) was asked by the Institute of Energy Economics, Japan (IEEJ) to assist in overcoming these challenges by conducting an energy efficiency market survey for the residential, commercial and transport sectors. The study had two objectives:

- To conduct new research in the middle income residential sector to determine their views towards energy usage and energy efficiency. This was seen as important and necessary given the events which have taken place in the last 5 years – high tariff increases and blackouts. This was done by interviewing 419 households in Johannesburg and Durban
- To collect and consolidate all relevant reports and publicly available data for the residential, commercial and transport sectors.

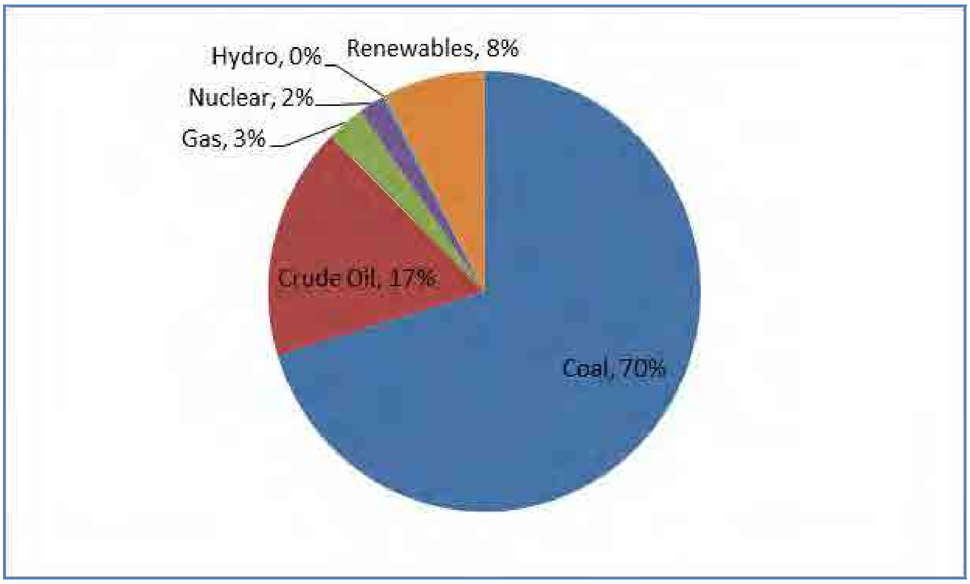
1 Overview of SA Energy Sector

1.1 Contextual Background

By mid-2011 the South African population was estimated to be 50.54[1] million with more than 70% living in formal houses. The World Bank[2] has stated the nominal GDP for 2011 as USD408.2 billion with the GDP per capita being estimated at USD11,000. The unemployment rate was at 25.5%.

With small deposits of natural gas and oil but very large coal deposits the country relies heavily on coal for most of its energy needs. The world coal institute reported in 2005[3] that SA has the sixth largest coal reserves (50 billion tons) and is the world's 5th largest producer. It is therefore unsurprising that South Africa's energy profile is dominated by coal for electricity and of course oil for transport, as illustrated in Figure 1, 2 and 3.

Figure 1: Total primary energy sources (2007)



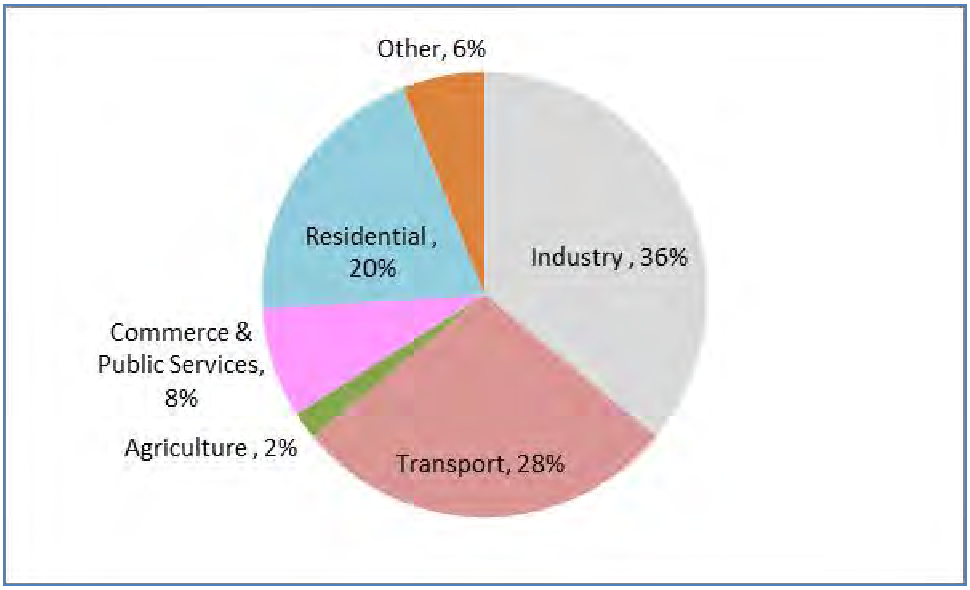
Source: Department of Energy

[1] Stats SA http://www.statssa.gov.za/keyindicators/keyindicators.asp

[2] http://data.worldbank.org/country/south-africa

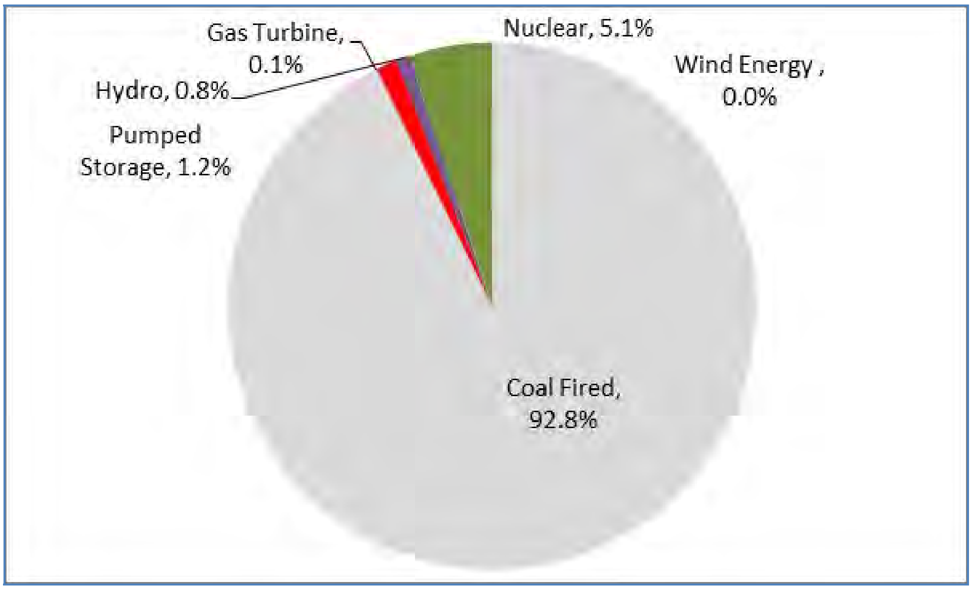
[3] The coal resource: a comprehensive overview of coal, London 2005

Figure 2: Energy use by Sector (2007)



Source: Department of Energy

Figure 3: Electricity by energy source (2011). Total Eskom Output 237,430GWh



Source: Eskom Annual Report 2011

This status quo is expected to change as:

- In recent years there has been much debate about the accuracy of the historic coal deposit estimates with the Minerals Bureau suggesting in 2005 that the figure may be closer to 33 billion tons[4]. A more recent publication in the South African Journal of Science says it may even be as low as 15 billion tons[5]. Regardless of which is the more accurate estimate it is increasingly becoming accepted by many that the country's coal reserves are lower than what was first thought.;

[4] Characterization of Coal Resources of South Africa, Jeffrey, 2005

[5] South Africa's Diminishing Coal Reserves, Hartnady, 2010, Article #360 SA Journal of Science

- A related issue, supported by the above reports, as well as the Fossil Fuel Foundation[6] is that the large, accessible and high quality coal fields, within the central coal basin (Witbank, Highveld Ermelo and South Rand Coalfields) are almost exhausted, with some estimates that 'peak coal' took place in 2007, while others say it will take place by 2020[7]. Of further concern is that the remaining areas in South Africa which do have large reserves face significant challenges such as location (ecologically sensitive areas), quality or mining conditions;
- The almost exclusive use of coal for electricity generation has resulted in South Africa being major emitter of Greenhouse Gas (GHG) emissions, ranked 13th in the world by total emissions[8]. South Africa has accepted its obligation to take steps to reduce its GHG emissions having ratified both the UNFCCC (in 1997) as well as the Kyoto Protocol. Under the terms of the Copenhagen Accord (UNFCCC Copenhagen Accord, 2009), South Africa committed itself to reduce its GHG emissions to 34% below its "business-as-usual" growth trajectory by 2020, and by 42% by 2025, subject to specified conditions; and 3) the high capital costs of building new generation plants, regardless of the fuel source.

These key, but by no means only, drivers are behind the need for South Africa to implement an effective energy efficiency programme which is able to deliver meaningful savings. This is reflected in the Integrated Resources Plan (IRP), which provides the planning framework for the management of electricity demand in South Africa for the period 2010 – 2030, where an assumption is made that the total 'avoided' power capacity from 2017 onwards will be 3 420MW.

The SA economy compromises of a significant amount of heavy industry, such as mining with its associated industries like smelters, which by their nature are very energy intensive. The National Energy Efficiency Strategy (NEES) of 2008 reported that the '*SA economy uses a lot of energy for every Rand of value added. In 2006, the country had the 42nd biggest GDP in the world but was the world's 21st largest consumer'*. Two reasons were given, the first being the energy intensive nature of the economic activity highlighted above and the second reason is the often wasteful use of electricity by all users (industry, commercial and residential). The country's abundant coal reserves have largely contributed to a situation where South Africa's unit cost of electricity has been and continues to be amongst the cheapest in the world.

With regards the first issue identified in the NEES, both the South African Government and industry have taken steps to reduce the energy used per unit of economic activity and the country's energy intensity has declined by a material 33% between 1990 and 2008. A report released in 2011 by the United Nations Industrial Development Organization (UNIDO)[9] found that the country's industrial energy intensity fell from 1.2 toe for every unit of manufacturing value add (MVA) to 0.8 toe. At the same time the global average has dropped to 0.35 toe for a unit of MVA. This highlights how much further the country still needs to improve to raise its competitiveness and confirms that there are opportunities for further improvements.

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6 SA Coal Reserves: After the Act, Prevost, 2004

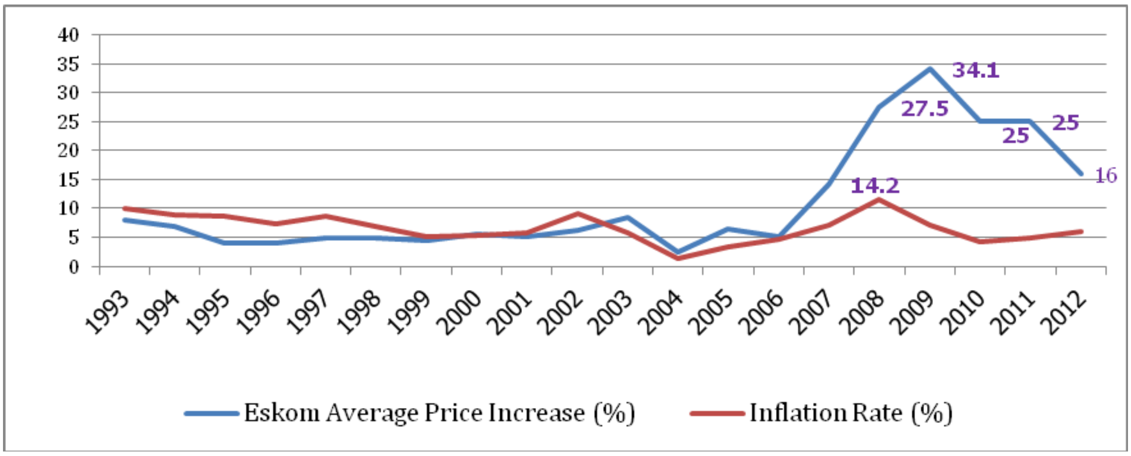
7 SA is nearing peak coal, Mail and Guardian, 25 September, 2010

8 US Energy Information Authority, 2010

9 http://www.engineeringnews.co.za/article/sas-industrial-energy-intensity-falls-but-still-lags-world-average-2012-03-23

South Africa's electricity tariffs are no longer as cheap as they used to be. Starting in 2007 the tariffs have been increasing by double digit percentages – the actual percentage increases are shown in figure 4. These increases are against a backdrop where the tariffs actually decreased in real terms from 1987 until 2003, also shown in Figure 4, due to the surplus supply available and a government requirement to keep the tariffs low for social reasons.

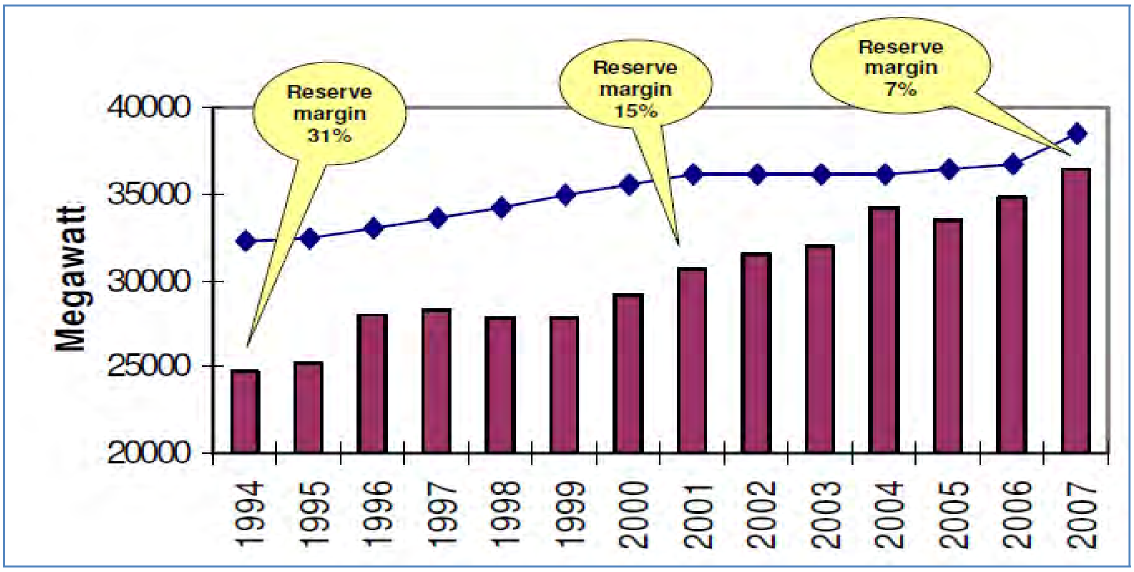
Figure 4: Electricity tariff increases and Consumer Price Inflation



Source: StatsSA and NERSA

The combination of artificially low, in effect subsidised, tariffs and a long period of oversupply resulted in an underinvestment in new supply and maintenance. This, as well as logistical shortfalls, was why the reserve margin fell to below 7% in 2007 when the rolling blackouts occurred (2008) – illustrated in Figure 5.

Figure 5: SA Electricity Reserve Margins



Source: www.gsb.uct.ac.za/mir

With demand exceeding supply it was no longer possible to further delay the building of new generation plants. The high tariff increases were deemed necessary to 1) fund the new build programme; and 2) to fund essential maintenance work. In its 2009 annual report Eskom[10] estimated that SA needed to build 40,000MW of new generation capacity by 2025, of which over 13,1000 MW was already under construction (mainly Medupi and Kusile power stations, return to service stations and Ingula power station) and shown in Table 1 below.

Table 1: New generation capacity

Project	Generation Capacity
Two new coal power stations are being built (Medupi and Kusile)	9,564 MW
Three 'retired' power stations are being brought back into service	3,645 MW
Four 'peaking' plants have been installed (diesel and gas)	5,032 MW

Source: Eskom

Notwithstanding the tariff increases a 16 country study[11] undertaken in 2011 by NUS Consulting Group which found that Canada replaced South Africa as the cheapest provider of electricity in 2011 (Table 2) shows the low base of the South African electricity tariffs. In effect it took five consecutive double digit tariff increases, four of which were greater than 25% and it still remains amongst the lowest in the world.

Table 2: Electricity Tariff Comparison for 16 Countries (2011)

2011 Rank	2010 Rank	Country	Cost in US¢/kWh	1 Year change (%)
1	1	Italy	19.7	9.4%
2	2	Germany	18.56	24.8%
3	5	Spain	15.37	16.4%
4	4	Belgium	15.23	14.9%
5	7	UK	15.1	24.5%
6	3	Austria	14.58	7.5%
7	6	Netherlands	14.37	13.2%
8	8	Portugal	13.51	14.5%
9	11	Finland	12.11	24.8%
10	9	Sweden	11.94	17.1%
11	10	Poland	11.87	21.0%
12	14	Australia	10.02	15.7%
13	13	France	9.61	10.0%
14	12	USA	9.48	2.2%
15	16	South Africa	8.55	27.8%
16	15	Canada	7.98	3.1%

Source: NUS Consulting

Institutional Context

Approximately 60% of the country's electricity is distributed by local municipalities, of which there are 284. Eskom supplies the remaining 40% of 'municipal' consumers but this is predominantly in smaller municipalities, rural areas and 'townships' in larger cities which have relatively low household income levels. Eskom also supplies the large industrial customers, such as mines.

[10] Eskom Annual report 2009, pXi

[11] http://eepublishers.co.za/images/upload/Energize_2011_/05_vco_sa-electricity.pdf

This arrangement is different to the international norm where consumers are supplied directly by the utilities, private or public sector of which there are a few. The consequence of this is that the electricity tariff, fee structure and bill layout is different in each municipality. This does tend to cause confusion and makes it difficult and complicated to compare tariffs.

Households can opt for a residential account (which is charged in arrears and included in their monthly rates and taxes bill), or pay upfront via a prepaid service. And while prepaid users pay an 'all in fee', account users pay a rate per kWh, as well as a service charge, network charge, DSM levy and Value Added Tax (VAT). Table 3 gives a comparison of the electricity tariffs for selected metros in South Africa.

Table 3: Selected Electricity Tariffs[12] (2012)

Area	ZAR / kWh Tariff
Prepaid – City of Johannesburg*	1.09
Prepaid – Tshwane* <100kWh 101-400kWh 401-650kWh >650kWh	 1.07 1.20 1.25 1.32
Prepaid – eThekwini*	1.03
Prepaid – Ekurhuleni*	0.97
Residential Account – City of Cape Town* <=600kWh >600kWh	 1.07 1.18
Residential Account – eThekwini*	1.03
Residential Account – City of Johannesburg**	0.81
Residential Account – Ekurhuleni**	0.97
Residential Account – Tshwane* <100kWh 101-400kWh 401-650kWh >650kWh	 1.03 1.16 1.22 1.29

*includes service charges

**excludes service charges

1.2 Sectoral Energy Consumption

The NEES of South Africa was first published by the Department of Minerals and Energy (now known as the Department of Energy) in 2005. The strategy was published with the proviso that it would be reviewed every three years. The first review was completed in 2008 and the 2nd review is currently being finalised.

The NEES recognises the need for sustainable energy – whereby energy is used more efficiently to achieve social, environmental and economic objectives. These have been defined broadly and include: alleviation of fuel poverty, improvements to human health, supporting job creation, reducing environmental pollution, reducing carbon dioxide emissions, improving industrial competitiveness, enhancing energy security and reducing the need for additional generation capacity.

The NEES outlines Government's intention to implement a variety of regulatory measures, demonstration and awareness raising programmes, as well as voluntary agreements. The Strategy identifies an overall **voluntary** target of a 12% reduction in

[12] Sourced from official tariff schedule issued by each authority and included as an annex to the report

final demand by 2015. This is broken down across five sectors with each one having a voluntary demand reduction target, namely:

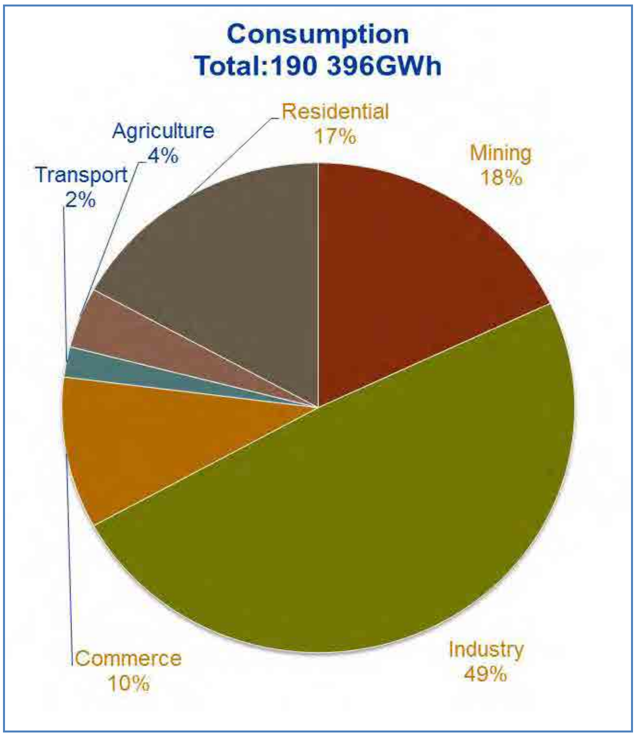
- Industry and Mining: Final demand reduction of 15%;
- Commercial and Public Buildings: Final demand reduction of 15%;
- Residential: Final demand reduction of 10%;
- Transport: Final demand reduction of 9%; and
- Power Generation: Interim target of 15% of 'non-essential' consumption.

Even though energy efficiency has been a cornerstone of South Africa's energy policy since the adoption of the Department of Energy's Energy Efficiency Strategy of 2005, the implementation and take-up of energy efficient technologies, measures and behaviour remains muted. The following overview of the electricity and transport sectors provides some insight into the current status and challenges faced.

1.2.1 Electricity

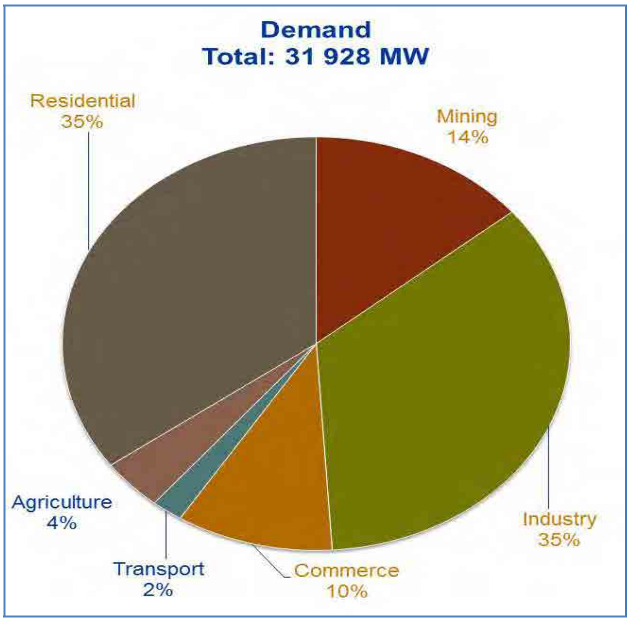
Excluding transport, electricity is the primary energy source for the sectors identified in the NEES. Figure 6 provides electricity consumption per sector and Figure 7 the demand for 2011.

Figure 6: Electricity Consumption per Sector for 2011



Source: Eskom

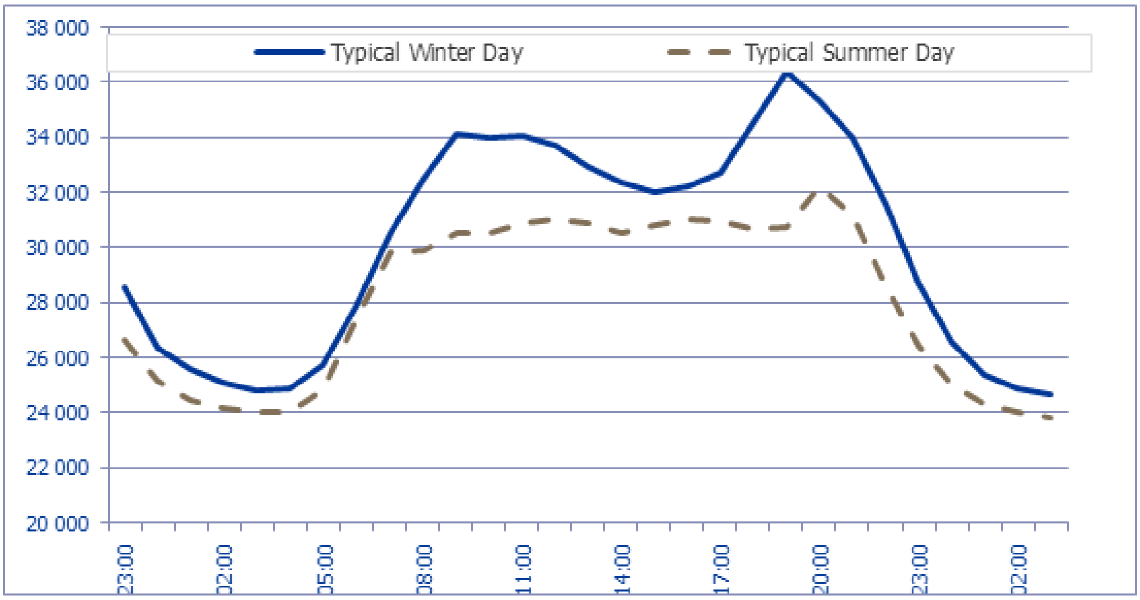
Figure 7: Electricity Demand per Sector for 2011



Source: Eskom

With 17% consumption but 35% demand the residential sector has a big 'swing' factor on the stability of supply. The winter and summer demand profiles, shown in Figure 8, further demonstrates the impact that residential customers have on the grid during the morning (06h00 to 08h00) and evening (17h00 to 20h00) peaks. A colder than expected winter increases pressure on the system and for every 1°Centigrade drop in temperature electricity increases by 600-700MW. Conversely in a warmer than expected summer, air conditioners increase demand by up to 400MW [13]. This phenomenon largely explains why Eskom's activities in the past have largely focused on load shifting rather than outright load reductions.

Figure 8: Winter and Summer Electricity Demand Profiles

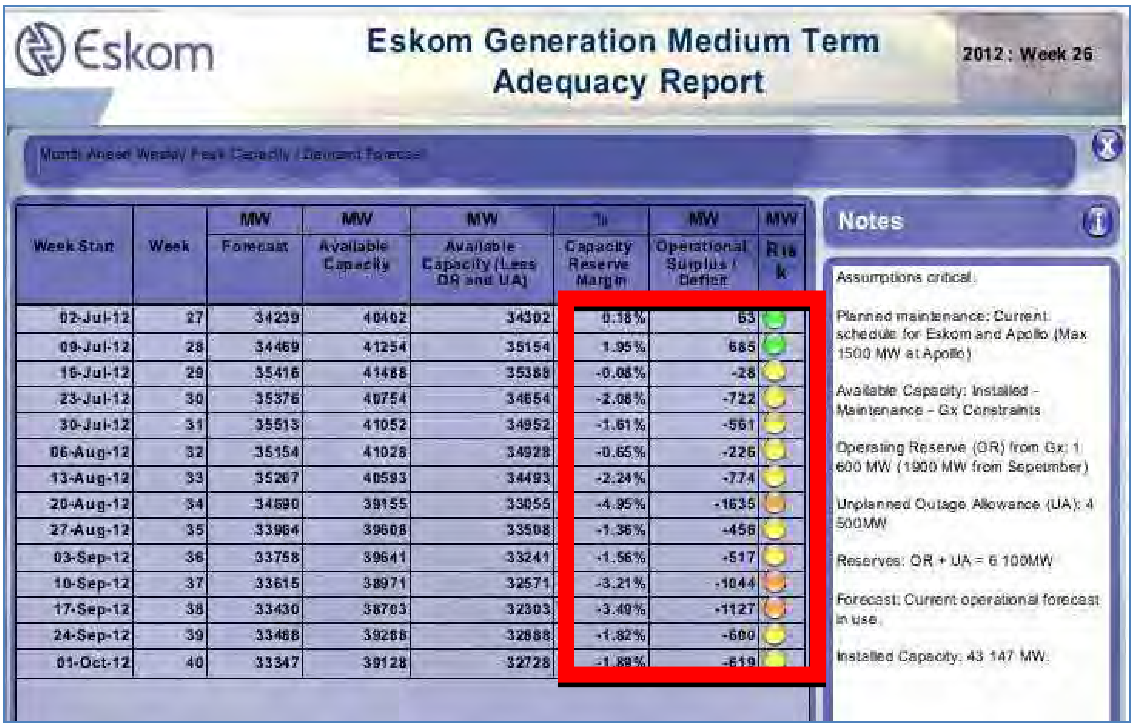


Source: Eskom

[13] Overview of Eskom's view of energy efficiency and programmes available, April 2012, Eskom. Presentation by Andrew Etzinger

The precarious situation of demand exceeding supply which first started in 2007 continues to persist and is illustrated by the red block in Figure 9 below. The supply status report[14] which is published by Eskom and provides a forecast of expected generation adequacy, shows that the utility expects to operate for most of the 2012 winter with an operational deficit. This deficit or shortfall is managed through the use of Open Cycle Gas Turbines (OCGT) which provide additional capacity during peak periods. These turbines are an expensive but necessary short term solution to avoid blackouts and power outages. The situation is expected to improve when the new coal fired power station (Kusile) becomes operational in 2014/15 and will add an additional 4,800MW to the supply system.

Figure 9: Eskom Electricity Supply Status



Eskom Generation Medium Term Adequacy Report

2012 : Week 26

Week Start	Week	MW Forecast	MW Available Capacity	MW Available Capacity (Less OR and UA)	% Capacity Reserve Margin	MW Operational Surplus / Deficit	MW Risk
02-Jul-12	27	34239	40402	34302	0.18%	63	
09-Jul-12	28	34469	41254	35154	1.95%	685	
16-Jul-12	29	35416	41488	35388	-0.08%	-28	
23-Jul-12	30	35376	40754	34654	-2.08%	-722	
30-Jul-12	31	35513	41052	34952	-1.61%	-561	
06-Aug-12	32	35154	41028	34928	-0.65%	-226	
13-Aug-12	33	35267	40593	34493	-2.24%	-774	
20-Aug-12	34	34690	39155	33055	-4.95%	-1635	
27-Aug-12	35	33964	39608	33508	-1.36%	-456	
03-Sep-12	36	33758	39641	33241	-1.56%	-517	
10-Sep-12	37	33615	38971	32571	-3.21%	-1044	
17-Sep-12	38	33430	38703	32303	-3.40%	-1127	
24-Sep-12	39	33488	39288	32888	-1.82%	-600	
01-Oct-12	40	33347	39128	32728	-1.89%	-619	

Notes

Assumptions critical.

Planned maintenance: Current schedule for Eskom and Apollo (Max 1500 MW at Apollo)

Available Capacity: Installed - Maintenance - Gx Constraints

Operating Reserve (OR) from Gx: 1 600 MW (1900 MW from Sepember)

Unplanned Outage Allowance (UA): 4 500MW

Reserves: OR + UA = 6 100MW

Forecast: Current operational forecast in use.

Installed Capacity: 43 147 MW.

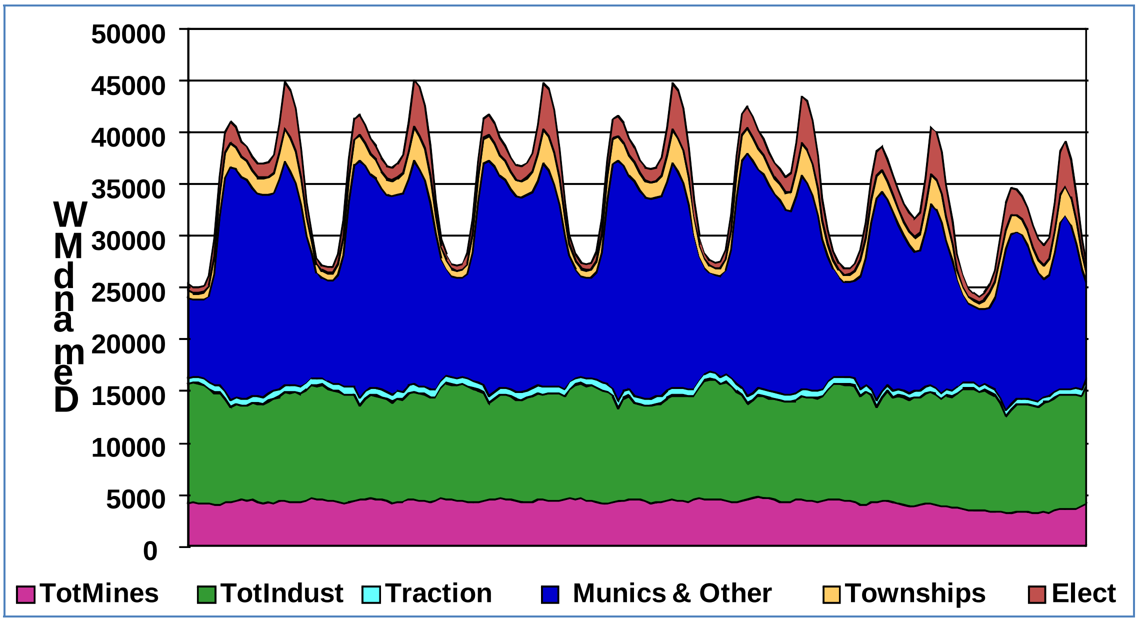
Source: Eskom

Future Demand (2016)

The graph (Figure 10) below illustrates the expected consumption pattern during a winter week in 2016. The graph clearly demonstrates how predictable industrial (including mining) electricity demand is and the impact that peak demand has on the grid. Elect = the expected increased demand due to new connections.

[14] http://www.eskom.co.za/c/59/supply-status/

Figure 10: Expected Demand – Winter Week 2016



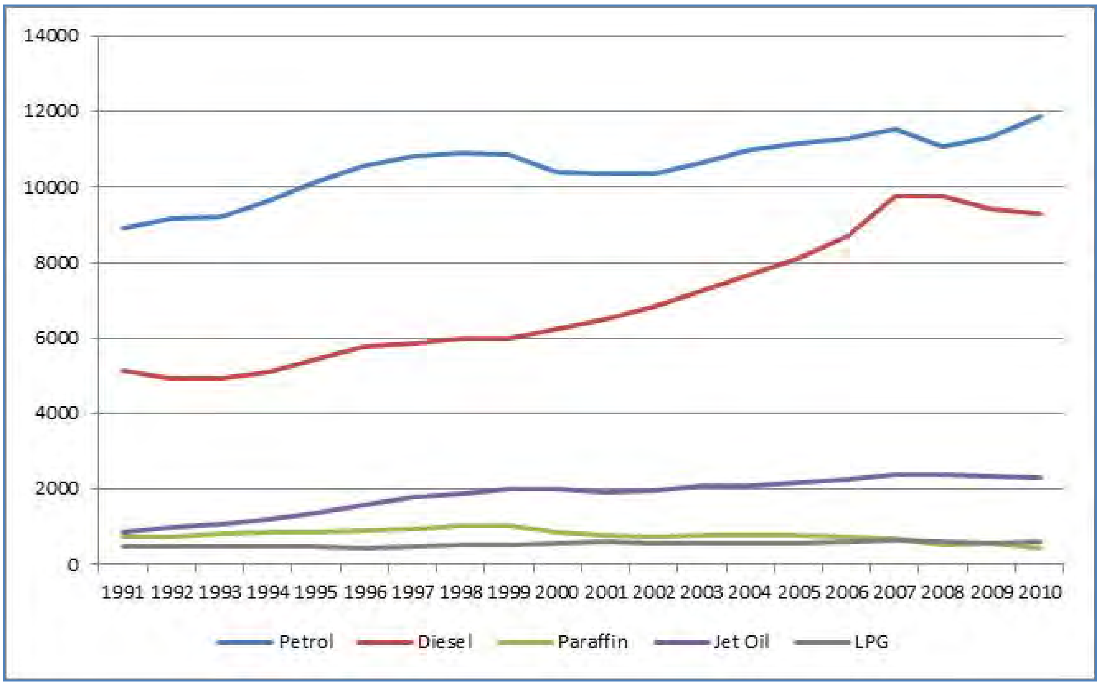
Source: Eskom

1.2.2 Crude Oil

The NEES 1st review (2008) reported that Transport accounted for 25.7% (2004) of the country's total energy consumption. It also stated that this figure was forecast to '*grow considerably in the medium term'.* This was indeed the case with the figure increasing to 28% in 2007 – refer to Figure 2. The NEES accepts that light motor vehicles have become the primary means of transport in South Africa and notes (and accepts) that energy efficiency measures '*will not be easy to implement'* citing international experience. The National Association of Automobile Manufacturers of South Africa (NAAMSA)[15] stated that the Department of Transport's (DoT) primary objective and message to the industry during the late 1990s and early 2000's was 'affordable' transport. The industry responded by shifting their production to lighter and smaller vehicles resulting in higher accessibility and increased volumes. This approach, over the long term, is unsustainable and having achieved its objectives the DoT in recent years has shifted its focus to 'safe and public' transport. Figure 10 illustrates the upward trajectory of oil consumption in South Africa and any decline in consumption on the whole can be attributed to the global economic downturn of 2008. Any uptake in economic activity results in an immediate increase in demand of both petroleum and vehicles. The only noticeable decline has been in the use of paraffin, which peaked in 1999 at 1,054 million litres, down to a historical low of 456 million litres in 2011. This is for two reasons 1) the progress made in electrifying large parts of the country; and 2) concerted effort to encourage a fuel switch due to the risks associated with paraffin use in rural homes.

[15] Discussions held with NAAMSA representative July, 2012

Figure 11: Consumption of Petroleum Products (millions of litres)



Source: SA Petroleum Industry Association

1.3 Policy and Legislative Landscape

There is little doubt that the South African Government does recognise the potential benefits and the role which Energy Efficiency should play to ensure the country has a more sustainable energy supply. The Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) undertook an energy efficiency policy mapping study (2012 unpublished) which provides an overview of existing and planned policies. The following extracts from the report covers the most relevant policies and regulations:

- **Energy Efficiency Strategy of the Republic of South Africa, DME 2005 (Revised in 2008):** Please refer to Section 1.2 for detail.
- **Electricity Regulation Act: DME 2005 (as amended):** Published in terms of section 35 of the Electricity Regulation Act, the Regulations establish norms and standards for reticulation services and in this regard include a number of specific measures to support both energy efficiency (EE) and Demand Side Management (DSM).
- **National Energy Act, DME 2008:** The National Energy Act is a broad document which covers many arrears. It does, however provide the legislative basis for a number of potentially important energy efficiency related matters:
    - **mandate and implementing agency –** SANEDI is required to, inter alia, undertake energy efficiency measures (as directed by the Minister of Energy), increase energy efficiency throughout the economy and the gross domestic product per unit of energy consumed, and optimize the utilization of finite energy resources16;
    - **basis for a regulatory framework –** the Minister of Energy is empowered (following consultation with Cabinet Ministers whose areas of

[16] Section 7 of the National Energy Act

responsibility will be impacted upon by the regulations) to make regulations regarding:

- o **minimum levels** of energy efficiency in each sector of the economy;

- **Multi-Year Price Determination Policy (MYPD) Process:** The MYPD process requires Eskom to submit an application for annual tariff increases which must be supported by an EE DSM implementation plan, which is subject to review and approval. The MYPD process also allows for the inclusion of other energy efficient technologies and alternate funding mechanisms – please refer to Section 1.5 Industrial and Commercial for the full list. The MYPD cycle is a three year cycle and the process for MYPD 3 was initiated by Eskom in June 2012. The targets for MYPD 2 are given in the table 4 below. Table 5 provides an update of the progress made as at April 2012

Table 4: MYPD 2 (2010 – 2013) Allocation for EE DSM Programmes

Description	Metric
Amount	5.4 Billion ZAR
Period	3 Years
Demand Savings	1,037 MW
Energy Savings	4,055 GWh

Table 5: MYPD 2 Results 2010 up to April 2012 (unless indicated otherwise)

Classification	Projects	Demand Savings (MW)	Energy Savings (GWh)
ESCo	406	793	2,347
Standard Offer	61	31	148
Performance Contracting	16	131	2,076
Standard Product	572	19	87
Residential Mass Rollout	14	66	N/A
National SWH Rollout (2008 start)	38,371 High Pressure 84,677 Low Pressure	30	60
CFL Mass Rollout (2004-2010)	43,5 million	2,006	6,667
Industrial and Mining (pre 2010)	164	527	1,440

Source: Eskom

- **Industrial Policy Action Plan 2, DTI 2010: IPAP2 aims to address what is considered to be South Africa's unsustainable** consumption driven growth path. The document is intended to provide a comprehensive response to scale-up industrial policy and ensure stronger coherence between macro and micro economic policies. A key focus of the document is on strengthening the productive / manufacturing side of the economy. A specific sector cluster of IPAP2 is concerned with 'Green and energy-saving industries'. This sector cluster is categorised under 'qualitatively new areas of focus'. The document notes that there are 'significant opportunities to develop new green and energy efficient industries and related services' in South Africa, and further highlights that the country's manufacturing sector will need to improve its energy efficiency. Within this sector cluster, specific focus is placed on solar water heaters (SWHs), industrial EE and energy efficient vehicles (specifically the commercialisation of electric vehicles).

- **National Land Transport Act, DoT, 2009:** The objective is to promote socio-economic development through an efficient and cost-effective land transport system and to promote safety and security in public transport (as per NAAMSA comments – Section 1.2.2). The Act provides for the following:

- o Encouraging and promoting the optimal use of available travel modes so as to enhance the effectiveness of the transport system and to reduce travel time and costs;
- o Greater promotion and prioritization of public transport, managing energy demand and improving the efficient utilization of energy resources

1.4 National Barriers

The Energy Efficiency Strategy of South Africa which was first introduced in 2005 to achieve the above objectives noted in its third review (2011) that the global phenomenon of rising incomes and population growth places increasing pressure on supply and consequently the price of energy. It went on to say that although awareness and understanding of the importance of energy efficiency in South Africa has improved, more still needs to be done. However the strategy states that the biggest barrier is '*Resistance to change, attitudes to the value of improved energy efficiency and the cost associated with the disruption of energy projects'.* Conflict of interest, such as the building owner and tenant scenario, was also identified as a key barrier.

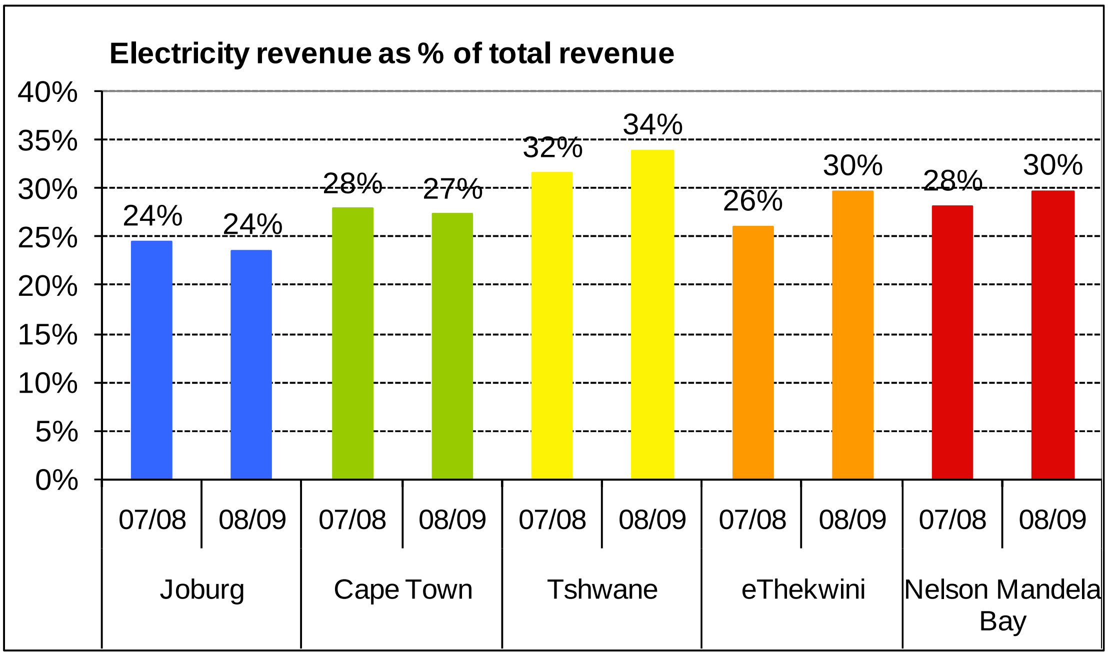
A combination of desktop research and semi-structured interviews undertaken (GIZ Policy Mapping Study 2012 – unpublished) with industry and government participants has been used to investigate why the uptake of energy efficiency initiatives to address national emission reduction targets remains low. The following issues have been identified:

- **General lack of awareness and understanding of energy efficiency:** Many companies do not have a portfolio or department with a mandate to analyse energy consumption, rather than just scrutinise their energy costs. Within companies which do invest in energy conservation and energy efficiency, there is often a lack of awareness of the policy and regulatory landscape regarding the potential for energy efficiency savings and incentives, and as a consequence energy efficient technology is often regarded as high risk.
- **Lack of appropriate and effective financial incentives:** Coupled with deep-rooted mind-sets, 'business as usual' practises persist where energy efficiency has a low priority. Some of the common reasons include a lack of understanding of the new technology, scepticism with regard to performance and / or energy savings, adopting conservative financial evaluation methods such as straight payback with very short time periods (typically less than two years) rather than life cycle costing, unwillingness to incur capital expenditure and a general aversion to change behaviour.
- **Lack of consumer awareness and understanding:** A general complaint is that most consumers are not aware that incentives are available and if they have heard about them they do not know where or how to access them. If they are accessed, further issues raised are:
    - o The application process is unclear or complex, therefore the effort is not warranted; and
    - o Different incentives for the same initiative creating overlaps or no incentives for other initiatives creating gaps.
- **Electricity Sales as a Revenue Source:** Landlords of large developments, such as office blocks, shopping centres, remain responsible for the payment of the total electricity consumed by the building and then recover from their tenants. They are

therefore able to negotiate bulk tariffs, which are lower, from Eskom or the municipality. In many instances they do not disclose the tariff they are paying and charge their tenants a higher tariff thus making a profit. This is in addition to the well-known owner-tenant barrier whereby the landlords tend not to invest in energy efficient technologies as they are more expensive and the benefit will be derived by the tenant.

- **Clear disincentive for municipalities to participate in energy efficiency initiatives**: A further concern to business is the clear disincentive for municipalities, who distribute the bulk of the country's electricity, to encourage and promote energy efficient practises – especially amongst large users. Arguably, they do have an incentive to promote energy efficiency amongst smaller users who they subsidise or who have high percentage of bad debt. A recent study conducted found that between 24-34% of the metros' revenue is derived from the electricity sales as shown in Figure 11.

Figure 12*:* Municipal electricity revenue as a percentage of total revenue (financial years 07/08 and 08/09)



Source: Palmer Development Group, 2012[17]

- **Inadequate co-ordination mechanisms:** While Government policies and strategies remain voluntary, many private and public sector operations take little notice of them. There is also a lack of alignment of national economic, industrial, energy and climate objectives. Energy efficiency targets at a local level currently do not exist and will take time to develop.

- **Non-optimal enabling framework**: Lack of effective mandate for government departments/branches or uncertainty as to mandate. For example, the energy efficiency strategy calls for a 15% reduction in energy usage per capita in the residential sector. For this to be effective it should be executed by provincial and local government departments, which has not been the case to date.

[17] Demand Side Management for Electricity and Water and Financial Implications for Local Authorities, Palmer Development Group / Employment Promotion Group, 2012

- **Need for capacity building:** As with the introduction of any new technology or policy the up-skilling of existing capacity and the recruitment of new resources in the public sector is vital if the Government is to achieve its objectives. Based on the discussions and feedback from the various stakeholders, the skills shortage appears to be particularly acute at the Department of Energy (DoE).
- **Single Occupancy Vehicles:** A long-standing inefficient and ineffective public transport system has resulted in most commuters using privately owned vehicles. Government is investing in the upgrade of existing and building of new public transport infrastructure, (Refer to Section 4) but commuters resist giving up the convenience of their motor vehicles with South Africa having the lowest average occupancy per vehicle in Africa as shown in Table 6.

Table 6: Average Occupancy per vehicle for passenger modes in African cities

City	Passenger Car (pass/veh)	Diesel Bus (pass/veh)	Minibus-Taxi (pass/veh)
Abidjan	2.0	60	18
Accra	2.0	68	18
Dar Es Salam	1.9	45	29
Douala	2.3	45	17
Johannesburg	***1.4***	***37.1***	***8.5***
Lagos	1.8	43	18
Nairobi	1.7	70	18

Source: Energy Research Centre, UCT

1.5 Key Government Programmes and Initiatives

The Government of South Africa over the last decade has made large investments in upgrading its infrastructure under the Expanded Public Works Programme (EPWP). The objectives of the programme are to 1) to meet the demands of a growing economy and population; 2) prepare for the 2010 FIFA World Cup; and 3) alleviate unemployment for 1 million people for the period 2004 to 2009. Several of the projects undertaken by the EPWP had as one of their objectives to improve the use of energy or offer new services which would result in a more efficient use of energy.

The following is a list of some of the key initiatives undertaken by the South African Government, not all of which are part of the EPWP. It is not meant to be a comprehensive list but aims to provide an overview.

Industrial and Commercial:

- Eskom, through its Integrated Demand Programme (IDM), has introduced several programmes to incentivise the uptake of energy efficient technologies:
    - **Performance Contracting**: This is the bulk buying of energy savings from project developers for a basket of projects. Performance contracting is best suited to large, capital intensive industrial projects and requires energy savings that exceed 30GWh over a 3-year period;
    - **ESCO Model**: This is best suited to individual projects (industrial) with unique requirements where the project size exceeds 1 MW. Incentive payments are demand-based and paid for verified savings (refer to Section 3.2 for an analysis of ESCos);
    - **Standard Offer Programme (SOP)**: This funding mechanism offers an incentive at a standard published rate (42 – 120 c/kWh) per technology type per unit of energy (kWh) that is saved during a specific period (16

hours) of a weekday. The project size has to be in the range of 50kW-5MW, and the savings achieved Monday-Friday between 6:00 and 22:00 to qualify. The target market is the industrial and commercial sectors; and
  - **Standard Product**: Pre-approved, published rebates are offered for 'deemed energy savings' (24/7) achieved as a result of replacing inefficient technologies with specific, pre-approved technologies. The incentive is aimed at medium projects with a demand impact of less than 100kW.

- **Industrial Energy Efficiency (IEE) Programme**: A joint programme which is implemented by UNIDO and funded jointly by DTI, Department of Energy, UNIDO, Swiss Economic Cooperation and Development) SECO and DFID (Department for International Development UK). The NCPC promotes and implements energy efficiency initiatives by partnering with private sector companies who enrol in the programme, which entitles them to a free energy assessment or audit.
- **Waste Heat Recovery and Cogeneration**: Waste heat recovery in its various forms and applications (recycling of energy or to produce electricity) has been recognised by the energy industry as an important component of the comprehensive electricity system and as a potentially, inexpensive energy source.

  Prior to 2008, 'cogeneration' (with the term cogeneration loosely applied to various forms of distributed generation) was being investigated as a pilot programme spearheaded by Eskom. In 2006 Eskom pricing approved 45c/kWh for cogeneration projects, based on cost avoidance benefits. Tenders were then invited for new cogeneration projects, but none came in under the approved price and the pilot project was therefore halted. During 2007 the approved price was increased to 65c/kWh and new tenders were invited for cogeneration projects. This time 6 projects qualified and were approved. But all further activity stopped pending a policy decision by DoE and NERSA.

  NERSA did publish a draft policy at the time ("NERSA Consultation Paper Cogeneration Regulatory Rules and Feed-In Tariffs"), but it provided no clarity to qualifying criteria for co-generation other than the maximum installation size of 500 MW. The draft policy also only covered cogeneration systems that would be trading power on the grid, and not systems that are installed for own consumption.

  Following the severe 2008 electricity supply crises up to 2009 a significant amount of effort (feasibility studies, tariff design, incentive mechanisms, pilots, etc.) again went into creating an environment conducive to the development of cogeneration capacity.

  Unfortunately, the IRP 2010 does not specify cogeneration capacity targets which has completely diverted the focus of investors and developers away from waste heat recovery, combined heat and power and cogeneration initiatives and towards renewable energy (primarily wind and solar). And again all relevant activity appears to have been discontinued.

  Discontinued incentives, tariffs and programmes that were in the pipeline were focused on electricity production with the purpose to sell and hence significant effort went into the development of a COFIT (Cogeneration Feed In Tariff) and Power Purchase Agreements (PPAs). Given the recent change in policy direction from a REFIT (Renewable Energy Feed In Tariff) to a tender process, it is uncertain whether any of the prior co-generation work would still be relevant.

The focused development of Cogeneration and Waste Heat Recovery capacity does not appear to be the domain of any specific entity in the country at present. All current evidence of activity relating to waste heat recovery and cogeneration seem to be ad hoc and lead by industry. Numerous case studies have been published in mainstream media recently showing innovative solutions at various industrial sites, but theses have primarily been to supplement or displace own electricity consumption.

There are therefore no known institutional and structural facilities such as special electricity tariffs, pricing or incentives specifically to promote waste heat recovery and cogeneration. There was also no mention of a national promotion programme or funding support or incentive mechanism in any of the recent case studies.

The planned Carbon Tax, when implemented, may indirectly provide an incentive where cogeneration can off-set own consumption and hence carbon emissions. Currently the potential for cogeneration in the country is largely unexplored.

- **Taxes and Tax Incentives**:
  - **Tax Incentive:** Although not implemented yet the Treasury has announced Section 12 L of the Income Act Tax. The incentive is for investments in energy efficient behaviour and technology by allowing for an energy efficiency allowance/deduction from taxable income on the basis of energy efficiency savings (A similar incentive exists for Renewable Energy investment 12(I));
  - **Green Energy Efficiency Fund (GEEF):** A joint project between the Industrial Development Corporation (IDC) and KfW (German Development Bank) whereby soft loans (prime -2%) up to R50 million are made available to companies making qualifying energy efficiency investments;
  - **Manufacturing Enhancement Competitiveness Programme (MCEP):** The R5.8 billion incentive came into effect in June 2012 and aims to encourage local manufacturers to make capital investments to upgrade their manufacturing facilities in order to improve their competitiveness. One of the five sub-components is the 'Green Technology and Resource Efficiency Improvement grant'.
  - **Carbon Tax:** The Government pronounced its intention in the 2012 national budget to introduce a carbon emissions tax. It was announced during the budget to inform the private sector that the tax will be implemented and the form that it is likely to take. A vehicle emissions levy has already been introduced (refer to the Transport section for details).

Residential

Although the residential sector is a high priority area for the reasons given in Section 1.2.1 the geographic spread and disparate nature of houses make it a difficult sector to introduce 'one size fits all' programmes or initiatives. However, two programmes do stick out:

- **National Solar Water Heating (SWH) Programme**: Introduced in 2008 and administered by Eskom, qualifying SWH receive a rebate. The programme is funded from the NERSA approved DSM budget. The Government's target is to install 1 million units by 2014/15 and 5 million by 2019. Low pressure systems are targeted at low income households and high pressure systems at middle to high income households. As at 6 June, 2012[18] 147,906 low pressure and 46,957 high pressure system claims have been processed.

- **CFL Rollout**: The programme replaces inefficient, incandescent lamps with an equivalent, efficient compact fluorescent lamp. These are distributed at no cost in exchange for an incandescent lamp which is then destroyed. The focus of the programme has been primarily (if not exclusively) on the residential market. DSM funding as well as carbon revenue is being utilised to assist with project financing. 43.5 million CFLs fitted across SA (from 2004 – 2010) resulting in 2,006MW demand savings

Transport

- **Gautrain**: A high speed rail link between Johannesburg, Pretoria and the International Airport (O.R.Tambo);
- **Bus Rapid Transit (BRT)**: The Guatrain is supported by the BRT, which uses dedicated lanes, in both cities. The Johannesburg system is operational but has not been completed while the Pretoria (Tshwane) system broke ground in July 2012 for a 51 station on a 80 kilometre route with a budget of R2.6 billion[19]. Other cities are also implementing integrated public transport systems such as the City of Cape Town's 'Travel Smart' Programme[20];
- **The Gauteng Freeway Improvement Project**: This is the upgrade and building of new freeways in the country's most populated province and economic heartland of the country. The South African National Roads Agency Limited (SANRAL) stated in July 2012 that the upgrades have resulted in reducing travel times by as much as 50%[21]. ***Note:*** All major cities have had their road networks improved and upgraded but the details are not included in this report;
- **Fuel Emissions**: The DoE recently promulgated regulations for fuel specs that will, in broad terms, be the same as those introduced in Europe to enable Euro 5 vehicle emission standards. These are to be in place by July 2017. The country's refineries currently produce Euro 2.
- **Fuel Emissions Carbon Tax**: The tax was introduced in 2011 and applies to all new passenger vehicles. In the case of passenger vehicles, the levy rate is R75 per g/km on emissions exceeding the threshold of 120g/km. In the case of double-cab vehicles, the rate is R100 per g/km on emissions over 175g/km

[18] Eskom SWH Programme, Weekly Administrative Dashboard, 6th July 2012. Available on request

[19] newsletters.creamermedia.co.za/servlet/link/14/48626/241501/1103112

[20] http://www.capetown.gov.za/en/TravelSMART/Pages/default.aspx

[21] http://www.twa.co.za/2012/07/05/roads-better-after-gfip-benefits-all-sanral/

2 Residential Sector (Living Standards Measure (LSM) 5-8)

2.1 Quantitative Analysis

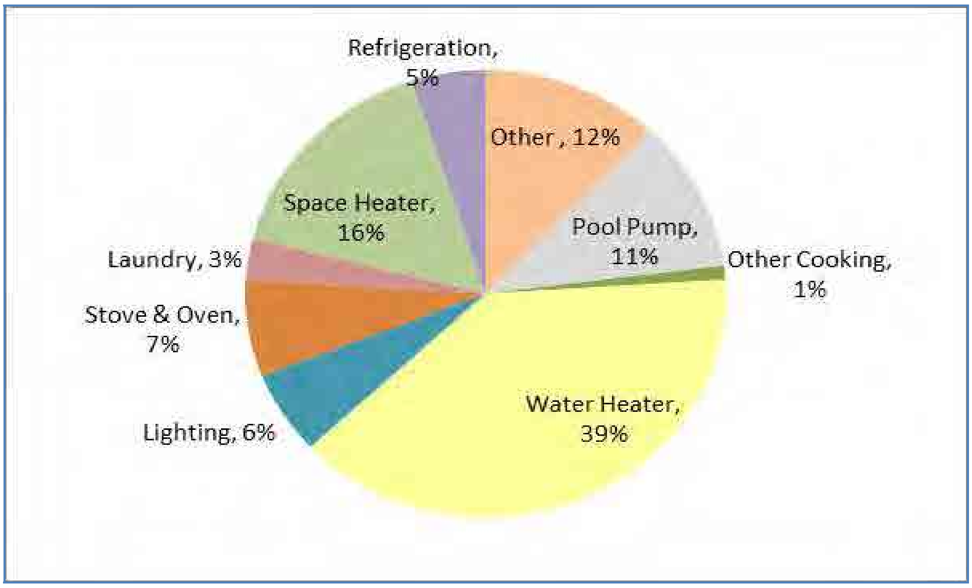
Introduction

As detailed in Section 1 of this report, the South African landscape has changed significantly over the last decade. High tariff increases, blackouts and a supply which is constantly under threat results in different consequences for each sector. Historically limited research has been undertaken in the residential sector and much of what has been made publicly available was conducted prior to the 2008 blackouts. It was therefore decided to supplement the limited publicly available research in the residential sector with a quantitative analysis. The key objective was to investigate how households interact with energy and their understanding of energy efficiency, particularly home appliances, in middle income homes LSM 5 to 8 – refer to Section 2.2.2 for details. Kaufman, Levine and Associates (KLA) were appointed to develop the questionnaire, conduct the interviews and report back on the findings. Annex 1 of this report provides a summary of the KLA findings. The questionnaire and full report are available as supporting Documentation.

2.2 Data Collection: Desktop Research

In 2009 over 90% of all households in SA had access to electricity, with 2012 marked as the government's target for universal access while the Community Survey undertaken by Statistics SA in 2007[22] reported that electricity is the primary energy source in households for lighting (80%), cooking (67%) and heating (59%). A publication issued by Eskom in 2010 estimated that the average household consumes 1,100kWh per month. Water heaters, domestic refrigeration, lighting and cooking appliances were the largest household electricity consumers. The full breakdown is given in Figure 13 and Table 7 gives the breakdown of end use of all fuels.

Figure 13: Average Household Electricity Usage Across the most common Appliances



[22] Community Survey 2007, Statistics South Africa, http://www.statssa.gov.za/community_new/content.asp

Table 7: End-Use Shares by Fuel for Middle Income Electrified and Non-Electrified Households

End-Use	Electricity	Oil Paraffin	Coal	Biomass Wood	Oil LPG
Middle Income Electrified					
Lighting	9%	-	-	-	-
Cooking	12%	67%	-	86%	28%
Space Heating	10%	18%	100%	10%	72%
Water Heating	35%	15%	-	4%	-
Refrigeration	9%	-	-	-	-
Other	25%	-	-	-	-
Middle Income Non-Electrified					
Lighting	-	1%	-	-	-
Cooking	-	21%	49%	68%	28%
Space Heating	-	25%	51%	13%	72%
Water Heating	-	53%	-	19%	-
Refrigeration	-	-	-	-	-
Other	-	-	-	-	-

Source: Energy Research Centre, UCT

Market Penetration, Sales and Performance of Selected Appliances

The All Media and Products Survey (AMPS) is administered by the South African Advertising Research Foundation (SAARF)[23] and its objective is to publish product and brand research. The SAARF AMPS survey covers the total adult population of South Africa (15 years and older). The survey uses personal in-home interviews with thousands of people representative of the total South African population. The data is categorised using the LSM index. Table 8 uses AMPS data to provide penetration rates, annual sales, average cost, Unit energy Consumption (UEC) and replacement cycle for selected appliances. Annual AMPS data going back to 2000 has been provided – see supporting documentation below. ***Note:*** AMPS data only represents household data and therefore does not represent total sales. For example, refrigerators may be sold to houses, hotels, offices, hospitals etc.

[23] More details about SAARF and AMPS can be found at http://saarf.co.za/saarf/allabout.asp

Table 8: Key Statistics for Selected Appliances. AMPS and Manufacturer data 2011, Euromonitor 2008

Total Number of HH - All LSMs	14,074,000
Number of HH - LSM 5-8	8,136,000

Category	Appliance Type	Number of HH All LSM (000)	Number of HH LSM 5-8 (000)	Penetration Rate All LSM (%)	Penetration Rate LSM 5-8 (%)	Purrchases Past 12M in (000) to all HH	Average Price (Rand) Entry Level	UEC	Energy Rating (Market Average)	Replacement Cycle (years)
Source		*AMPS*	*AMPS*	*AMPS*	*AMPS*	*Market Sources & Euromonitor**	*Market Sources*	*Manufacturer Data*	*Manufacturer Data*	*Euromonitor*
Cooking	Microwave	8 646	6 295	61.4	77.4	642	R 600.00			9.5
	Electric Stove	9 209	6 685	65.4	82.2	670	R 2 500.00		Imported = A Local = B	
	Other Stove (Gas or coal)	1 406	620	10	7.6					
	Electric Hotplate	4 189	1 975	29.8	24.3		R 200.00			
Refrigerators	Combination Fridge/Freezer	11 642	7 845	82.7	96.4	800	R 2 500.00	Imported=275kWh/year Local = >450kWh/year	Imported = A Local = C and D	10.2
	Freezer	3 111	1 576	22.1	19.4	350	R 2 000.00	300kWh/year	F	8.5
	Refrigerator	N/A	N/A	N/A	N/A	70	R 4 000.00	240kWh/year	Imported = A Local = C and D	10.8
Cleaners & Washers	Vacuum Cleaner & Floor Polishers	2 681	1 016	19	12.5	220	R 800.00			6
	Dishwashers	503	63	3.6	0.8		R 2 500.00			9.5
	Top Load Washing Machine	3 040	1 792	21.6	22	260	R 2 200.00	N/A	N/A	7
	Front Load Washing Machine	1 047	507	7.4	6.2	150	R 3 000.00	1.1kWh/cycle	A	7
	Semi Automatic Washing Machine (twin Tub)	1 714	1 439	12.2	17.7	135	R 5 500.00	0.96kWh/cycle	N/A	7
	Tumble dryer	1 277	386	9.1	4.7	135	R 2 200.00	3.8kWhh/cycle	Imported = C Local = D	6.9
Electronics	TV*	12 251	7 942	87	97.6	1,100 (eWaste) 1,600 (retailer)	R1,200 CRT R2,000 LCD / LED	Electronics in SA are imported and therefore international norms can be applied, such as Dell, HP and Acer for laptops or PCs and Sony, LG, Samsung etc for televisions		
	DVD Players	7 050	4 671	50.1	57.4		R 750.00			
	Hi Fi Music System	7 398	4 666	52.6	57.4					
	Home Theatre System	3 857	2 399	27.4	29.5					
	Desktop Computer	2 031	753	14.4	9.3		R 4 500.00			
	Laptop Computer	1 353	449	9.6	5.5		R 5 000.00			
Cooling & Heating	Air Conditioners (excl fans)	605	85	4.3	1	211	R 5 500.00			10
	Electric Water Heaters	7 369	3 337	40.1	45.2	400	R 6 500.00	2.5kWh/ day (standing losses)	E	7

Notes

Grey data fields source may be unreliable and has been provided as a guideline

* Survey does not distinguish between CRT, LCD and Plasma but the bulk (especially LSM 5-8) can be assumed to be CRT

2.3 Supporting Documentation

The following reports and supporting documentation have been provided to support and add to this section of the report:

Quantitative Study

- The questionnaire developed for the quantitative study;
- The answers received from the participants;
- The final report prepared by KLA; and
- Report explaining the criteria used to categorise LSMs.

Data

- Annual AMPS Data for LSMs 5-8 for the period 2000 – 2011 on type of housing, appliance penetration, number of vehicles and distances travelled;
- End use fuel types for electrified and non-electrified houses;
- Database of performance of selected household appliances; and
- Electricity tariff schedules of major cities in South Africa for 2011-2012.

Relevant and Useful Reports

- Community Survey (2007);
- Energy Performance and Labelling Requirements for Specific Electrical Appliances and Equipment (2012) and Final Report (Project Amber) on outcomes of Focus Groups conducted on consumer response to the proposed S&L programme and Label Design (2012);
- South African National Appliances Energy Efficiency Action Plan (2010);
- Global Environment Facility Market Transformation through Energy Efficiency Standards & Labelling of Appliances in South Africa (2011); and
- Results of the National Consumer Surveys Relevant to the Labelling Communications Campaigns (2004).

3 Commercial Sector

3.1 Introduction

The commercial sector includes office buildings, financial institutions, hotels, schools and universities, hospitals, shopping centres, retailers and places of entertainment. This sector’s energy use was 8% in 2007 (Figure 2) and grew to 10% by 2011 (Figure 5). This predominant energy source for this sector is electricity but there is some use of other fuels such LPG, coal and fuel, which are predominantly used for cooking and heating. Given the diverse business types included in this sector it is clear that the energy use characteristics do not only vary between but also within each facility. For example, retail ranges from large department stores to small specialised boutiques, both of which may be found in a shopping centre which has a controlled environment or street access.

3.2 Energy Service Companies (ESCos)

ESCo's can, and should, play a large role towards the country meeting its EE targets and objectives. A study undertaken for the implementation of the clean technology investment fund (CTF) for South Africa[24] noted that in its ideal form an ESCo identifies opportunities to maximise energy consumption of large users. ESCo's can offer significant benefits due to their energy management expertise, experience, capital investment and guarantees. Typically the full service offering is:

- Perform an energy analysis and audit;
- Energy management services;
- Project design and implementation;
- Project maintenance and operation;
- Monitoring and evaluation of savings;

The operational features of the ESCo, which distinguishes them from consulting or energy firms, are:

- ESCo's guarantee the energy savings and / or the supply of the equal supply of energy service at a reduced cost through the implementation of the service and the technology. This is done through a energy performance contract (EPC) which is entered into with the company, the most popular forms are, (but not limited to):
    - The actual energy savings from the project;
    - The energy savings are sufficient to service the monthly debt repayments incurred for the project and once the debt has been repaid the financial benefit accrues to the company;
    - The same level of energy service is supplied at a lower cost.

  Under an EPC agreement, ESCo remuneration is based on demonstrated performance – which is based on one of the above forms.

- The ESCo's remuneration is directly linked to the actual savings achieved by the project, making it a performance based contract in its purest sense;

- ESCo's are able to finance, or assist in securing the finance required for a project by providing and quantifying the guaranteed energy savings;

- To achieve the above the ESCo forms an ongoing and long term relationship with the company for the duration of the contract in order to maintain, measure and verify the savings.

To achieve and maximise the expected energy savings ESCO projects need to be comprehensive, this is done by employing a wide range of cost effective measures or interventions. These normally include the following: high efficiency lighting, high efficiency heating and air conditioning, efficient motors and variable speed drives, centralized energy management systems, process heating, steam and compressed air.

However, ESCo's as described above do not exist in SA. It is understood that in 2010 there were only seven fully fledged ESCo's in the USA. In SA the number is closer to

[24] A Business Plan for the Implementation of the Clean Technology Investment Fund in the Private Sector – Industrial Energy Efficiency, UE and PDG, June 2010

200 “ESCo’s” registered on the Eskom website[25]. In truth these companies are preferred Eskom suppliers. This is not an indictment of their services, skills or product offering. However, almost all of these firms are small with only a handful of resources and lack the engineering capacity and skills to take on major projects[26]. Very few, if any, are in a position to finance the equipment and then share in savings based on the EPC model.

The 2010 CTF study interviewed four of the most successful ESCos in South Africa, based on the number of Eskom approved submissions. To determine how, if at all, the ESCo landscape has changed over the last two years they have been contacted again to provide input and views. Table 9 summarises the results.

[25] http://eskomidm.co.za/esco/form/find/

[26] Confirmed with C Openshaw, Eskom IDM, Senior Consultant, Technology Consulting

Table 9: Selected Interviews with Leading ESCo's (2010 and 2012)

	2010	2012
HVAC International www.hvacinternational.com	**Profile:** The director has been involved in this sector for just under 30 years. The company is one of the bigger energy services companies in SA and employs a highly skilled workforce. HVACI focuses on large industrial projects where the intervention will yield a minimum of >1MW, with the average project being 2 – 3MW. The project costs range from a minimum of R10 million and go up to R60 million. The company focuses on the mining sector. **Electricity profile:** SA's electricity profile is different to the international norm. Globally, approximately 50% of electricity is consumed by the built environment (offices and businesses) but in SA this figure is around 30%. This is due to about half of SA's electricity being consumed by the mines (15%) and industry (35%). Therefore the opportunities are different and cognisance of this must be taken. **ESCO's**: The consultant's assessment of the ESCo's industry in SA was confirmed. In HVACI's view the local ESCo's are not and will not be able to enter into EPC's with the industrial sector for a long time. This is due to the mismatch between the size of the ESCo and their clients. In this context it is very unlikely that an ESCo is able to enforce any breach of contract terms by its client – the result is that all the risk resides with the ESCo. Under the Eskom DSM programme companies enter into a contract with Eskom, through the ESCo, which requires them to maintain the savings for 5 years in return for the incentive paid. The ESCo therefore has this security under the current model and is therefore not required to take on any risk. **Awareness:** HVACI believes that there is a willingness and a commitment from company CEO's and boards to conserve energy. However, HVACI's experience is that there is a disconnect between the top level of management and the operational management who are in control of the plant. Their objective is to maximise output at the lowest possible cost. **Project investment criteria:** Companies tend to invest only projects that offer the greatest returns. EE project must therefore compete with projects such as new business units etc. Other barriers which further disadvantage energy efficiency projects are: • Payback period requirements which are as low as 12 – 18 months;	Since 2010 the company has expanded its service offering to include other large industrial customers and not just mines, but these remain limited to the industrial sector. The tariff increases since 2010 have resulted in many EE projects being implemented. However, most of the 'quick win' projects have been implemented meaning that the next level of viable projects are more expensive and therefore often on hold until further tariff increases come into effect. The types of projects undertaken by HVACI require capital investments, as they are classified as CAPEX and not OPEX, so the biggest barrier faced is access to capital. Because of this classification the EE projects proposed compete with other capital expenditure projects and in most instances do not yield the returns required. A secondary issue is that although awareness has increased and there is a greater willingness to implement EE projects the mindset remains deeply entrenched in the old paradigm of generating returns from new business activity rather than EE. This is especially prevalent in medium size companies, who have fewer financial and technical resources. HVACI clients are large industrial clients who can access funding at a lower rate than any concessionary funding available; furthermore these companies tend not to be willing to pay interest on a loan to implement an EE project. Therefore all projects undertaken by HVACI are almost 100% reliant on Eskom incentives and financing. A further advantage of an Eskom agreement is that a contract must be entered into to maintain the savings for a period of 5 years which assists in ensuring that awareness is further increased as the returns are achieved. However, long lead times for approval at Eskom continue to hamper and reduce the number of projects undertaken. The company believes that the only lever for further investments into EE is increasing tariffs. It is unlikely that mandatory requirements will be successful as it is will be difficult to monitor and evaluate. Their view is that once the industrial tariff goes above 80c/kWh most EE projects will become viable – until then EE projects will be done on an ad-hoc basis. It is estimated that the industrial tariffs are currently around 50c/kWh but this is

	• Little or no internal policy requirement which obligates a reduction in energy consumption; • The still low electricity rate. The company relies heavily on the Eskom rebate (50%) to make projects attractive to customers. Without this incentive few projects would be undertaken. **Comments:** HVACI believes that meaningful EE projects will not occur for another two years, when electricity tariff reflects the true cost of energy. The only other alternative to kick start the industry is to introduce legislation obligating companies to reduce energy through punitive penalties. Any ESCo model that is developed, outside of the Eskom DSM programme, needs to find a mechanism to eliminate the risk to the ESCo due to the very high capital costs of the equipment being installed.	an estimate.
Energy Resource Optimizers (ERO) www.energyoptimizers.co.za	**Profile:** ERO is an Eskom registered vendor which specialises in commercial and industrial energy efficiency projects. ERO has been operating for over 5 years. Typical project sizes range from 200 kW and go up to 2 MW – this is through multiple independent projects within an organization. For example the company has done several lighting retrofits for a hotel group, each hotel averages 100 – 300 kW per hotel and up to 7 hotels in total. ERO shares HVACI view of the ESCo industry and as such are not repeated. The following is a summary of their further experiences and views: **Awareness:** This remains a key obstacle and in most cases new clients are responding to the need for energy efficiency, i.e: it is reactive. As a result most companies have not budgeted for it and then include it in the following years planning. This results in a minimum delay of 6 – 12 months. Companies try and introduce energy efficiency measures internally often resulting in poor or inefficient choices, but more importantly their interventions are insignificant. The most common example is companies upgrading to energy efficient lights only, but as a proportion of their total electricity consumption profile this is small or negligible and much bigger savings can be made in other areas such as HVAC or water heating. A further barrier is an influx of inferior products entering into the country. ERO is often shown quotes from new market entrants who are marketing	There has been minimal change in the company's profile and business activities. The only notable changes are 1) the minimum project size has dropped down to 10 - 15kW due to the introduction of the Standard Offer and Standard Product offerings from Eskom; and 2) ERO have become significantly less reliant on the Eskom programmes and have gone from an 80/20 split to 40/60. Although the increase in tariffs has assisted, ERO have not experienced a noticeable increase in new projects or interest. Their experience is that companies which are actively seeking to become more EE are implementing EE projects more readily and expanding them to other areas. The companies who were not interested have remained so. This is probably due to these businesses having become accustomed to the high annual increases and as a result management accepting them as a 'fact of life'. ERO also strongly concur that if the building owner does not occupy the building there is no interest in implementing EE programmes as this cost is passed on to the tenants at a profit. This explains why the Leisure (hotels and resorts) are so active in EE. A further problem being faced by the market is that the market is flooded with inferior and low quality technology (motors, lighting etc). This results in 1) customer becoming confused; and 2) if they buy low quality equipment and it fails or there are minimal energy savings then they do not undertake

	their services aggressively. These products do not perform to expectations as they either fail early or do not deliver the expected energy savings. The impact it is having is that companies either have a bad experience and refrain from further energy efficiency interventions or they become confused with the number of options and wide pricing so they do nothing. **Project investment criteria:** ERO's experience is that companies tend to use economic models which will broadly deliver their desired outcome. This view supports HVACI's assertion of a 'numbers' game where all projects regardless of their nature are grouped together. ERO's experience is that companies tend to undertake EE projects only if the internal budget is available and will not take on debt to fund a project. They would rather delay the project for a year until the internal funding is made available. ERO has in all instances advised their clients that the funding costs are lower than the savings and as a result it is a self-funding project but this makes little or no difference. **Comments:** Further education or awareness is required to encourage companies to take on debt to fund EE projects. This could be done through demonstration projects. 80% of their projects are through the Eskom DSM programme and only 20% are customer funded. Few projects would be undertaken without the DSM incentives	any further projects – or a combination of the two. As a result even if companies do have allocated budget to undertake EE projects they tend not to as they do not know how to spend it. EROs experience is that local engineers are generally unwilling to be influenced by international examples of EE installations or technologies. They want this to be proven under local conditions. It is therefore believed that what is required are high profile demonstration projects (case studies) which have been undertaken by independent and credible entities – such as Government, Universities etc but not by product suppliers as this raises issues of conflict. ERO has experienced the first signs of commercial clients starting to consider financing projects through debt but the vast majority continues to be funded from available capital. Companies are also willing to consider EPC contracts whereas in the past they would not. Eskom process time and other administrative issues remains a key barrier. For example, the rules are applied inconsistently across the 'regions' which becomes problematic for businesses which have a national footprint. The sustainability of ESCos lies with Eskom which is not a natural home; the DSM programme should be managed by another Government agency which will not have the conflict faced by Eskom and will be able to create an environment for business development, which at the moment is not the case with Eskom.
Honeywell www.honeywell.co.za	Honeywell is a diversified multinational company and a world leading ESCo. Although it has been operating in SA for many years it is only now (2010) in the process of setting up an ESCo offering. Honeywell's size means that it does not face the financial challenges that the local ESCo's do, which are almost exclusively SMEs. In most instances its market capitalization is bigger than that of its clients. The company aims to offer full ESCo services as described in the role of ESCo's section above, which is to offer a self-financing (no CAPEX and no OPEX) offering with guaranteed energy savings. If required finance will also be provided. Honeywell's value proposition to its clients is to target all EE opportunities identified and bundle them into one offering. The advantage of this is that	Honeywell was contacted and responded by saying that little has changed since 2010.

	there is no need to use multiple firms for different interventions i.e: different vendors for lighting, HVAC, water heating etc. This approach allows them to identify energy savings in excess of 15 - 20% of total consumption, which in their experience is the benchmark for a viable project. The average financing period is between 7 – 10 years. Honeywell also able to maintain the systems which reduces the chance of energy savings not meeting the EPC targets and also ensures that savings are maximised to the benefit of both parties. Issues around maintenance are staff turnover, lack of motivation and commitment in maintaining a third parties equipment and costs of training. Honeywell intends to enter the industrial sector in the future. One of the concerns raised about the industrial sector is that the opportunities lie in their internal processes and companies are often reluctant to reveal these for competitive reasons or accept advice from external parties on what they consider to be their core business. **Comment:** Honeywell believes that concessionary funding could help unlock the market as it will enhance the Return on Investment.	
Iskhus Power (www.iskhus.co.za)	**Profile:** The company was founded in 1998 and employs 60 people. Iskhus serves the commercial and industrial sector, but does not do mining projects. To date the company has undertaken over 200 projects which have yielded over 24MW of savings. Less than 20% of the company's projects rely on DSM funding. **Awareness:** The COO believes that the need for energy efficiency in the private sector is finally on the agenda of companies. Unfortunately this has not been transformed into an action item yet. They have also identified two types of companies, which they have titled internally as 'leading' or 'the rest'. A leading company exhibits the following characteristics: • Energy efficiency and sustainability, excluding social initiatives, is firmly entrenched in the company's values; • Almost all these companies operate internationally (SAB) or their customer base is international (Peermont hotels and Distell); and • The company strategy incorporates energy and climate change issues (Woolworths) Unfortunately their view of 'the rest' is that they pay lip service to energy efficiency and have not fully understood or are not willing to understand the	The company now has 35 employees but has expanded its product offering which now includes the residential, agriculture and manufacturing sectors. It estimates that the company's projects have now yielded close to 50MW of savings. Iskhus management believes that the ESCo industry is too reliant on subsidies and the Eskom IDM programme, which will result in a collapse when the subsidies are reduced or terminated. Only 30% of the company's projects are linked to rebates. Iskhus does believe that the Eskom processes have improved and the new product offerings are easier to understand and access. However long turnaround times are still common – they may often take in excess of 12 months which creates problems from a company perspective with regards to budgets and how they are spent. The increase in electricity tariffs and a better understanding of EE [since the previous meeting in 2010] has increased interest but there is still some way to go before the 'tipping point' is reached. Most of Iskhus new business is from existing clients who are either doing additional work or upgrading existing projects. Banks are now willing to discuss projects whereas in the past they would not. For its commercial projects the company's biggest

importance or the need to conserve energy.

Project investment criteria: The company is prepared to guarantee energy savings but will only do so if a comprehensive baseline is developed. However, the client is required to pay for the services provided on completion of the installation. Their experience is that this model works as they are able to build a strong working relationship with the client as both parties have the same objectives.

Iskhus has recently introduced an in house finance offering, which companies can use to pay for the upfront capital costs of the project. Iskhus was unable to structure this through a bank and the directors had to use their personal assets to fund this initiative. They now have several demonstration projects and are finally able to source limited funding from banks - the banks are now prepared to take on the client risk but not the performance risk.

Comments: Iskhus management believes that the availability of concessionary funding would greatly assist the company in undertaking a greater number of projects. As at 2010 banks remained unwilling to provide finance for projects using new technology due to the perceived risks. The funding available from Iskhus is expensive (prime +1) making EE project less attractive.

challenge remains the building owner / tenant scenario (listed under Section 1.4 barriers and Section 3.9.1 Operational Norms). Unless the owner of the building occupies a large majority (>40%) their experience is that there is **no** interest in EE.

The table below gives a high level overview of the Iskhus service offering:

Service	**Explanation**	**Revenue Type**
Audit	Determine baseline	Consulting
Power Fix	Power Factor correction	Consulting & EPC
Metering	Assist with on-going performance	Consulting
Alternatives • PV • Biogas	 Design & Installation Design & Installation	 Consulting & EPC Consulting & EPC
Project Management • Heat Pumps • SWH • Energy partnerships • Other	 Design & Installation Design & Installation Design & Installation	 Consulting Consulting Consulting

Iskhus believes that the following should be considered for the country to meet its EE targets and objectives:

- Specific elements of EE should be legislated (made mandatory)
- There is a poor understanding of EE and ESCos land up performing this function during the sales cycle. This is at great cost and risk (as the client is inclined to try and implement internally – which generally results in a poor installation, no energy savings and increased reluctance to undertake further EE initiatives). The Government should devise a way to ensure ESCos cover specific topics during their sales pitch for which they are remunerated
- EE (and ESCos) is perceived as an electrical engineering service resulting in the wrong people getting involved, such as electrical engineers. It is a business offering which uses proven technology to increase productivity and or cut costs.

3.3 Data Collection: Energy Audits

Due to a lack of readily available public data, the approach taken for this report was to consolidate actual data gathered from energy audits undertaken by a registered and credible Energy Services Company. Energy Resource Optimizers (ERO) have been in operation since 2002 and are consistently one of the top 5 ESCos, by number of registered projects, on the Eskom EEDSM programme. The data provided by ERO, Section 3.4 to 3.8 covers hotels, resorts, shopping centres, hospitals and schools. Energy audits undertaken on a commercial building, industrial building, prison and a process plant are included in the Annex Section of the Report.

Section 3.9 then provides energy data sourced from desktop research and other credible sources.

Energy Audits Activities

ERO's business model is to undertake a full energy audit for which it charges a fee. A report is then prepared and presented to the client where recommendations are made based on the findings. The client then has the following options: 1) do nothing or implement some or all of the recommendations in-house; 2) use another company or supplier to implement some or all of the recommendations and apply for any DSM incentives; or 3) appoint ERO to submit the applications for DSM incentives and implement.

The following is a breakdown of EROs standard energy audit activities:

- Site visit and walk through audit
  - Site orientation
  - Understand production process and drivers
  - Understand energy sources used as well as energy flow through process
  - High level identification of energy conservation measures
  - Identify major energy consuming equipment
  - Identify equipment operating times
  - Identify equipment consumption levels
  - Determine factors that influence energy consumption

  e.g. Energy(total) = αE(production) + βE(admin) +δE(auxiliaries) + εE(losses)
- Load profile measurements: Identify areas for possible load profile measurements and install data loggers
- Analysis of historical energy accounts – minimum of one year to identify patterns, rates etc
- Review of operation and maintenance procedures
- Power quality audit on main incoming supply
- Define energy conservation measures, such as
  - Technology
  - Bill of materials
  - Prices
  - Energy savings
  - Financial analysis (NPV, IRR, payback)
- Compile energy conservation measure report and present

The following explanation has been provided to explain how the data was sourced for this section and to confirm that it is objective and reliable.

3.4 Hotels

3.4.1 Introduction

South Africa has a mature hospitality industry. This sector provided accommodation to business and leisure travellers. The properties are graded according to the international star grading system. A five star property is the most luxurious whereas a one star is the least. Guest houses and lodges form a large part of this sector.

Operational Norms

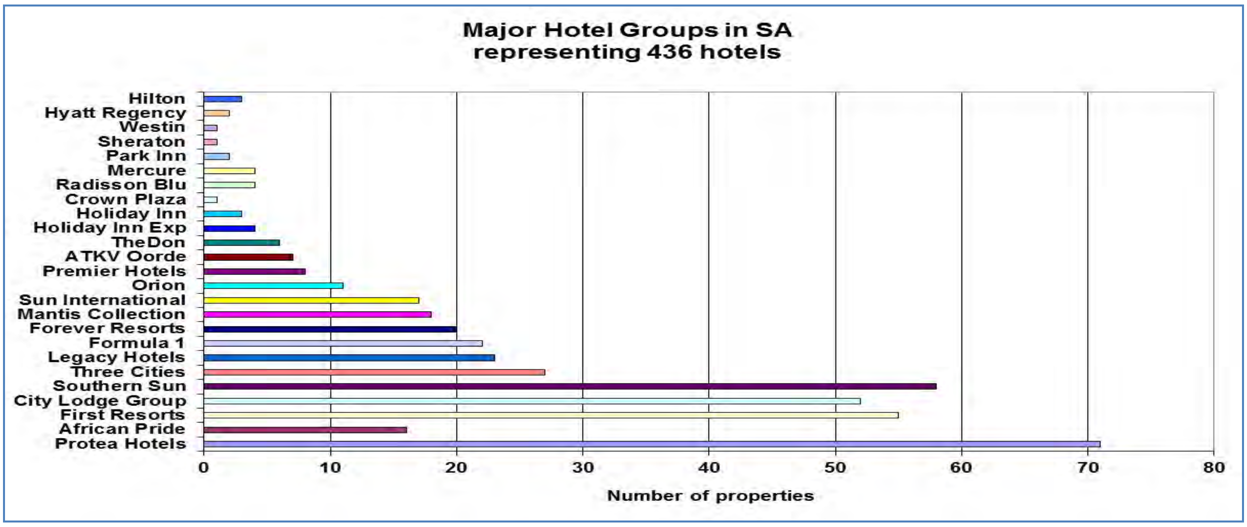
The hospitality industry is going through a tough period in South Africa. In the run up to the 2010 Soccer World Cup many new hotels were built. The economic crisis of 2008 however resulted in occupancy levels dropping from 71.8% in 2007 down to 53% in 2011 but is expected to increase by 9.1% to 62.1% by 2016.[27] The decreased occupancy levels, coupled with high electricity tariff increases, has proved challenging for many operators and this is indeed one sector which is focussing on identifying and implementing energy efficiency programmes.

Historically, hotels in South Africa were large and inefficient users of electricity and therefore opportunities which yield large returns are readily available. The newer hotels being built tend to be more energy efficient with LED lighting, heat pumps and key card systems being the norm.

3.4.2 Data Collection

The information provided in this section is derived from energy audits conducted at 116 hotels of two of the largest hotel groups in the country. These properties range from 5 star to 1 star. The ESCo is appointed as a full time energy consultant. It is believed that these properties represent approximately 26% of the hotels in South Africa. Figure 14 below shows the number of hotels by major group.

Figure 14: Breakdown of Hotels in South Africa



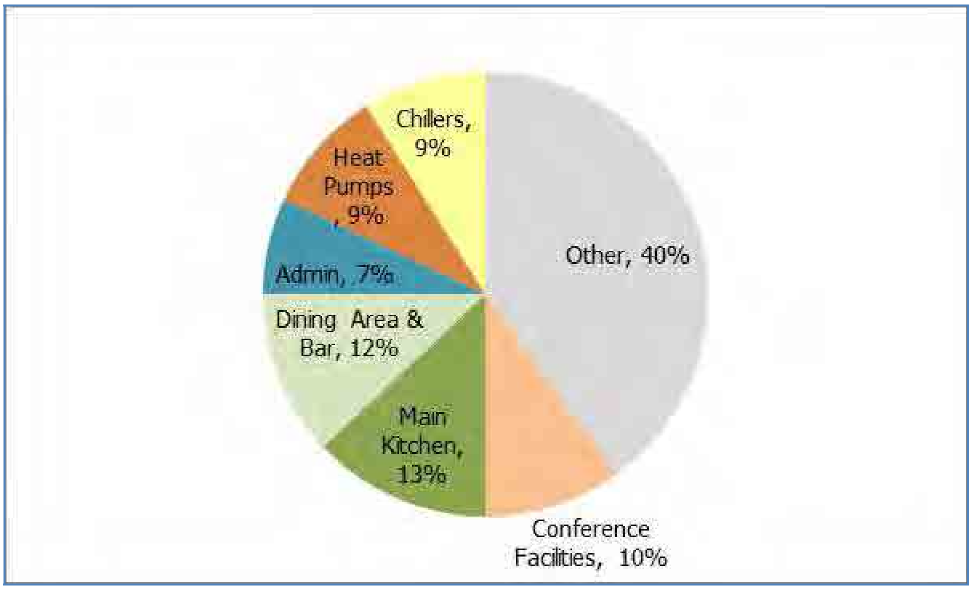
27 South African Hospitality Outlook 2012 – 2016, PriceWaterhouseCoopers, July 2012.

3.4.3 Results

Analysis of Electricity Load Profiles

Some of the properties have sub metering installed on various areas. Figure 15 shows an example of such a breakdown. This is representative of a typical four star property. Note that this property serves breakfast, lunch and dinner. ***Notes*:** 1)'Other' is made up primarily of rooms and corridors; and 2) In this example the hotel has installed heat pumps, if this was not the case the water heating would increase by a factor of three.

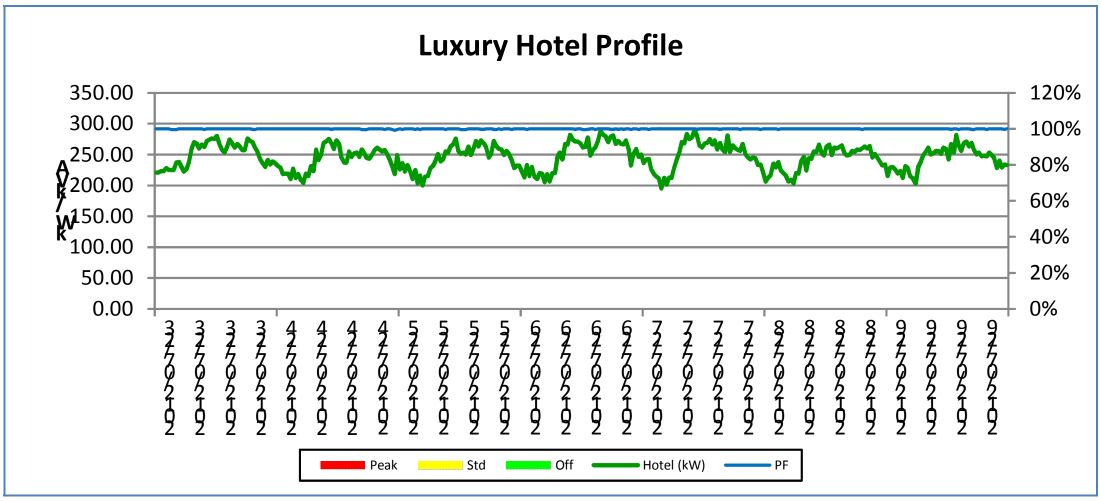
Figure 15: Energy Consumption per process Energy Usage (kWh)

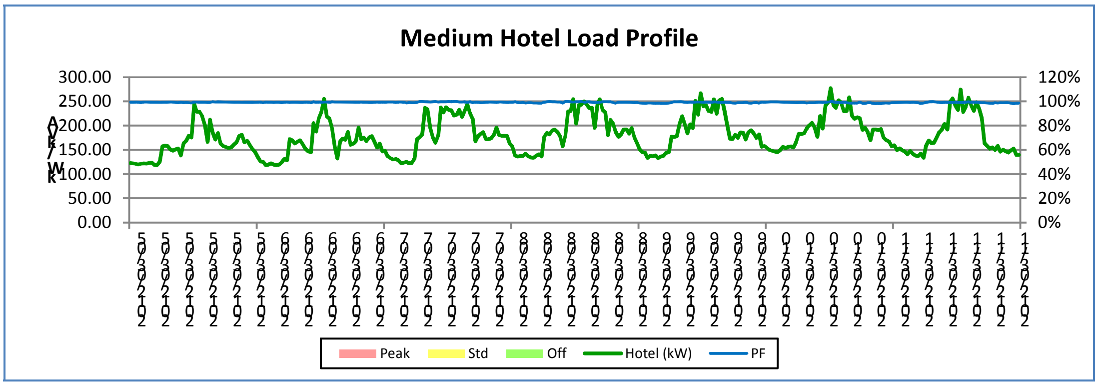


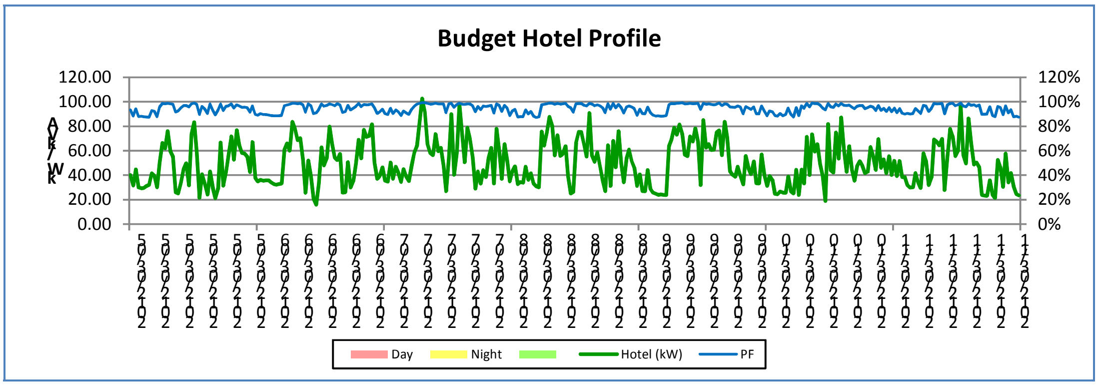
Main Electricity Supply Load Profile

Figure 16 below shows the week load profiles for a luxury, medium and budget hotel. The luxury and medium hotel are on a Time of Use tariff while the budget hotel is billed using a two part tariff.

Figure 16: Average Daily Consumption







In Figure 16 it is evident that the daily electricity use profile remains fairly similar for each day of the week. Depending on the services the peak is either in the morning, midday or evening. The properties are managing their loads according to the relevant electricity tariff signals. A property on a demand tariff would do load shifting of the water heating system whereas those on time of use will try to avoid laundering and water heating during the peak times.

Seasonal Consumption

The location of the hotel has a big influence on the seasonality of the electricity consumption. The location determines the prevailing climatic conditions as well as the occupancy patterns. A hotel located at the Kwazula Natal beach would be busy during the summer holidays whereas the Gauteng hotels are very quite during the same time. From a climatic perspective the KZN hotels tends to draw more power during the summer months due to the high demand for air-conditioning. In contrast the hotels situated in Gauteng draw more power during winter due to the increased need for space heating. Figure 17 shows the consumption history of a KZN hotel and Figure 18 for a Gauteng Hotel.

Figure 17: Monthly Consumption KZN Hotel (kWh)

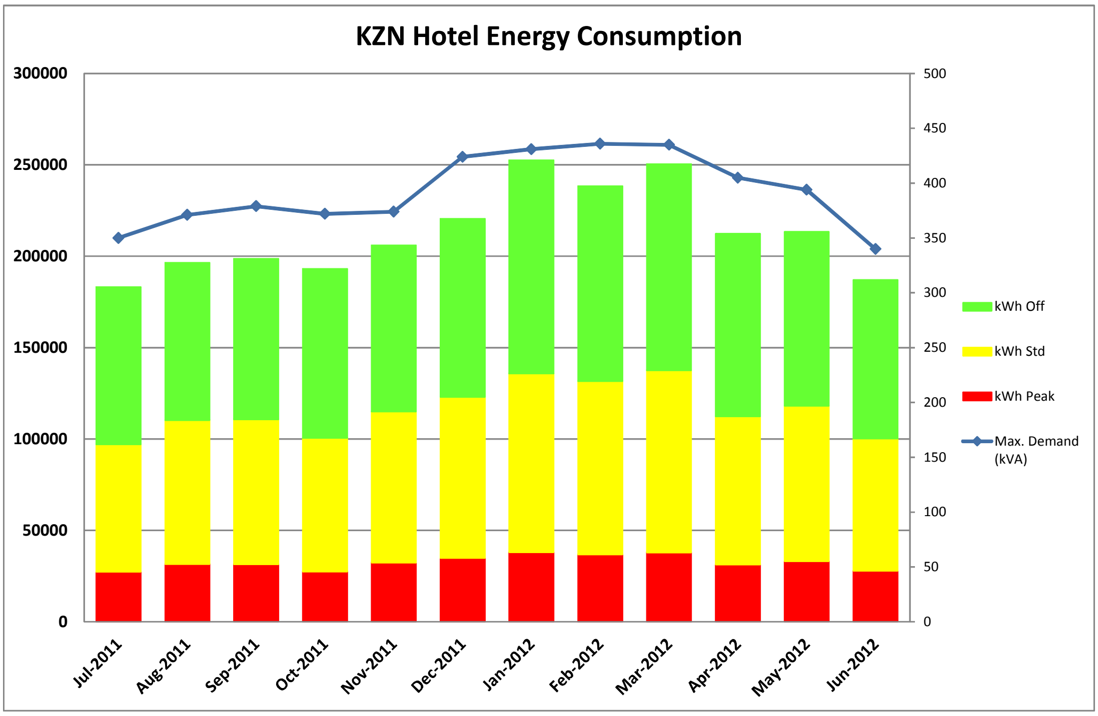
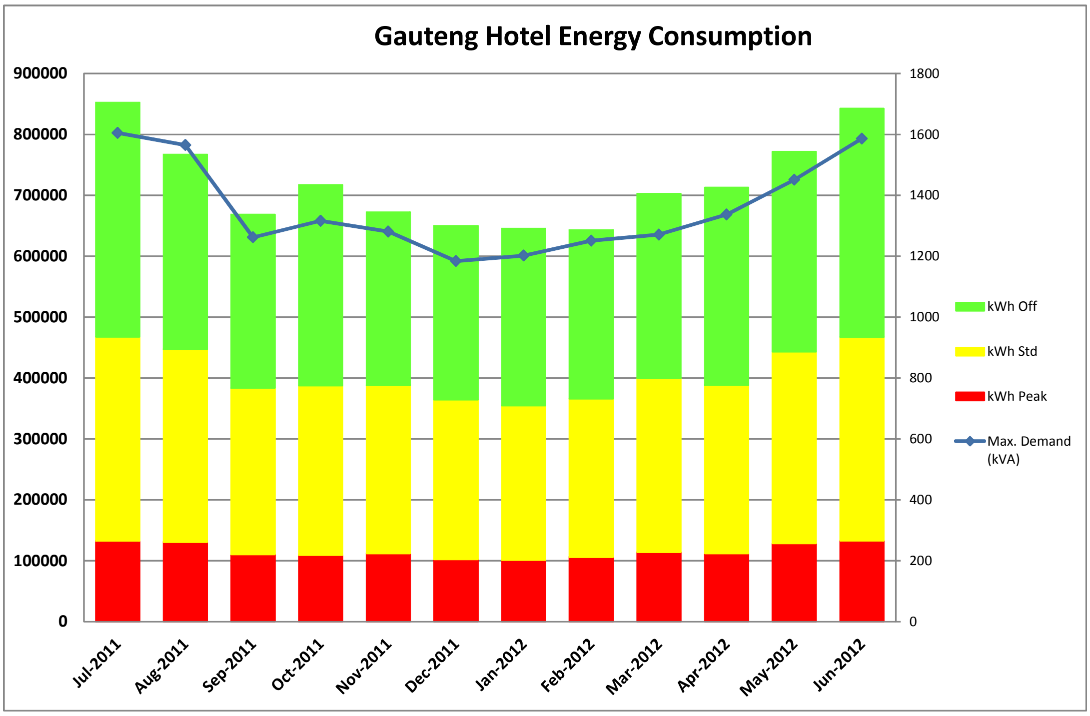


Figure 18: Monthly Consumption Gauteng Hotel (kWh)



Findings and Opportunities

Based on experience and the actual measurements taken, luxury hotels have a higher load factor compared to mid-class and budget hotels. This is due to the extended service periods and increased features offered; such as 24 hour room service, valet services, health spas etc. The consumption in the budget hotels reduces considerably during daytime once the guests have checked out. Most of the budget hotels offer a limited breakfast which does not require a lot of energy to prepare.

HVAC: Only the large hotels have central air-conditioning with chillers, cooling towers and air handling units. The HVAC system contributes on average 12% to the monthly consumption. (summer 20%, winter 2%). Heating in winter is distributed via the AHU and not the HVAC and therefore their electricity consumption falls under 'other'.

Lifts and Escalators: The energy consumption associated with lifts is minimal. Very few medium and budget hotels have lifts.

Lights: The majority of the light fittings in the hotels are 50W low voltage down lights. In the rooms there are bed lamps and floor lamps fitted with compact fluorescent lamps. In the 'back of house' or administration areas (storage, canteen, office areas, workshops) there are fluorescent fittings with T8 lamps and magnetic control gear. Since most of these lights are on 24 hours per day it is cost effective to change all the magnetic ballasts to electronic control gears (ECG) and all down lights to LED.

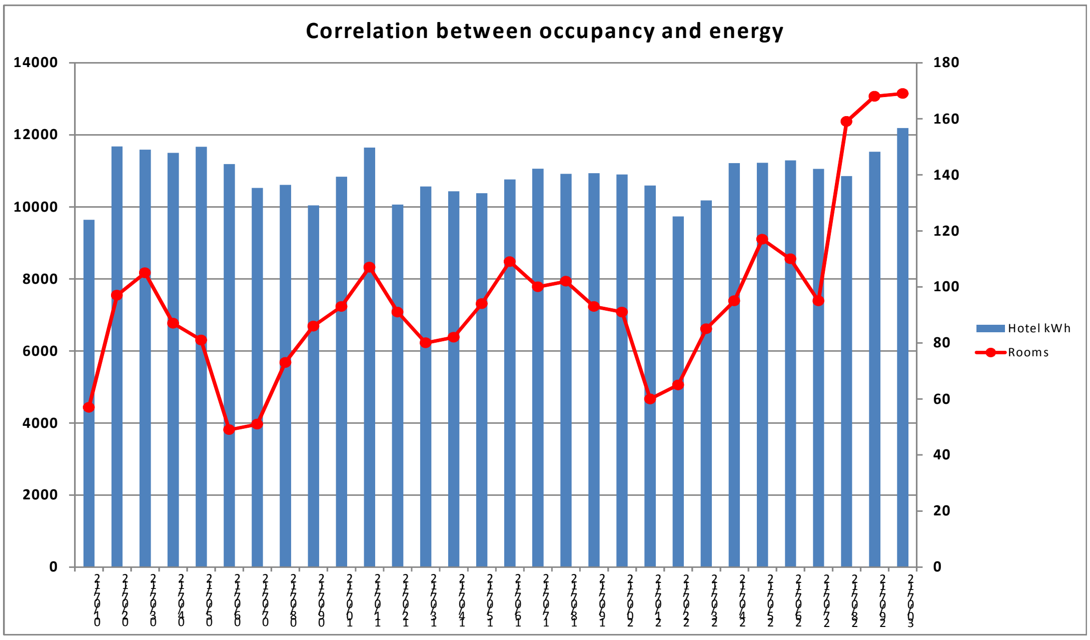
Water heating: The majority of hotels use electric boilers to heat the water for the guest rooms. The hotels have large storage vessels that are heated by means of electric elements. The vessels are sized in such a way that it would provide all the hot water for one peak period. i.e. morning or evening. This means that these vesels are reheated twice in a 24 hour cycle. The electrical input is sized in to provide a reheating time of less than 6 hours. Water is stored at between 55 and 60° C. In recent years there has been a trend to convert to heat pumps.

Laundry: This can account for as much as 10% of the electricity consumption of the hotel. Key opportunities is shifting these activities to out of peak demand periods and upgrading equipment.

General Comments

Contrary to the common belief the main driver for the hotels energy consumption is not occupancy. Figure 19 shows the daily electricity consumption and daily occupancy.

Figure 19: Daily energyconsumption (kWh) and occupancy (rooms sold)



From the figure above it is clear that there is not a high correlation between occupancy and consumption. This correlation is better with the budget hotels where there is less common and 'back of house' energy consumption compared to the guest related energy consumption.

Opportunities for large scel energy savings do exist in the hospitality sector. The experience of the ESCo is that these are to be found in both facility energy conservation measures as well as operational measures. The technical expertise of this sector is low and they tend to look for free advice from suppliers and the utility companies, as opposed to contracting a qualified ESCo where they will be required to pay for the service.

Although they have strict financial criteria for investments in energy efficiency, with the norm being a three year pay back, it is the opinion of the ERO that the hotel groups have their own capital for energy efficiency projects. The reason why it is not happening faster is their lack of knowledge of the opportunities as well as their distrust of the large number of new suppliers offering sub-standard products.

The following opportunities have been identified:

- HVAC upgrades: Most hotels use console type air conditioners. These units use electric elements for heating. There is an opportunity to replace these with inverter type heat pump air conditioners. Very few hotels with central air conditioning systems have building management systems (BMS) installed. The controls often contradict each other. (simultaneous heating and cooling) An upgrade of the HVAC controls is a good opportunity;
- Heat pumps for water heating: Heat pumps generate hot water using on average one third of the energy of electric elements;
- Lighting: As appropriate depending on the application as well as daylight and motion sensors as many lights are on 24/7;
- Training and operational procedures: Training staff members to be more alert and vigilant with electrical appliances will lead to material reductions. For example; not leaving HVAC systems on unnecessarily or not setting them to cold or too hot;
- Laundry: These stations often have inefficient and old equipment which use large amounts of water and energy.

Final Comment

For the reasons provided in the introductory paragraph hotel groups are increasingly contracting ESCo's or using their internal skills to reduce their energy consumption. Due to the very public nature of hotels, where they receive different guests on a daily basis and a high staff complement with a high turnover rate which is not highly skilled, to achieve meaningful and sustainable energy savings technology improvements must be coupled with organisational measures. This includes energy management training and awareness of all levels of staff, remote metering system to identify new opportunities and track the success of the implemented measures.

3.5 Holiday Resorts

3.5.1 Introduction

Resorts typically refer to a number of freestanding accommodation units with a central building for administration and other guest services. Some resorts include camping facilities. The accommodation units are normally self-catering and are privately rented or belong to a time share pool. These resorts cater to the local tourist market.

Operational Norms

Resort occupancy is driven by weekends and school holidays. It is normal to have 100% occupancy during these times. During the week, especially in winter months, the occupancy is very low. A second factor is that the resorts are generally used during off-peak periods. This profile makes it very difficult to secure an acceptable payback period when implementing energy conservation measures.

3.5.2 Data Collection

Energy audit data from seven different resorts has been used in this report.

3.5.3 Results

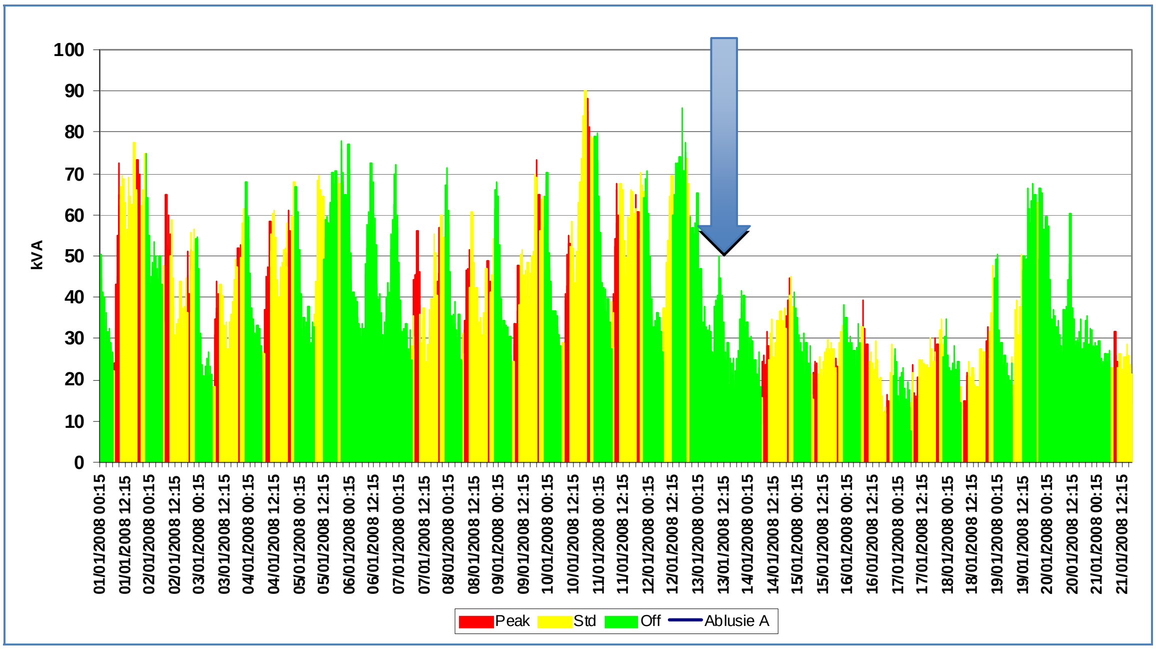
Analysis of Electricity Load Profiles

All resorts audited did not have sub metering installed; only the main supply to a section of the resort was measured.

Main Electricity Supply Load Profile

Figure 20 below shows the load profile for a resort over a one month period. The impact of the school holiday is clearly visible. The school holiday ended 13/01/2008 and is marked with a blue arrow. It is also evident that the daily electricity use profile is different each day of the week. Depending on the services the peak is either in the morning, midday or evening. The properties are managing their loads according to the relevant electricity tariff signals. A property on a demand tariff would do load shifting of the water heating system whereas those on time of use will try to avoid laundering and water heating during the peak times.

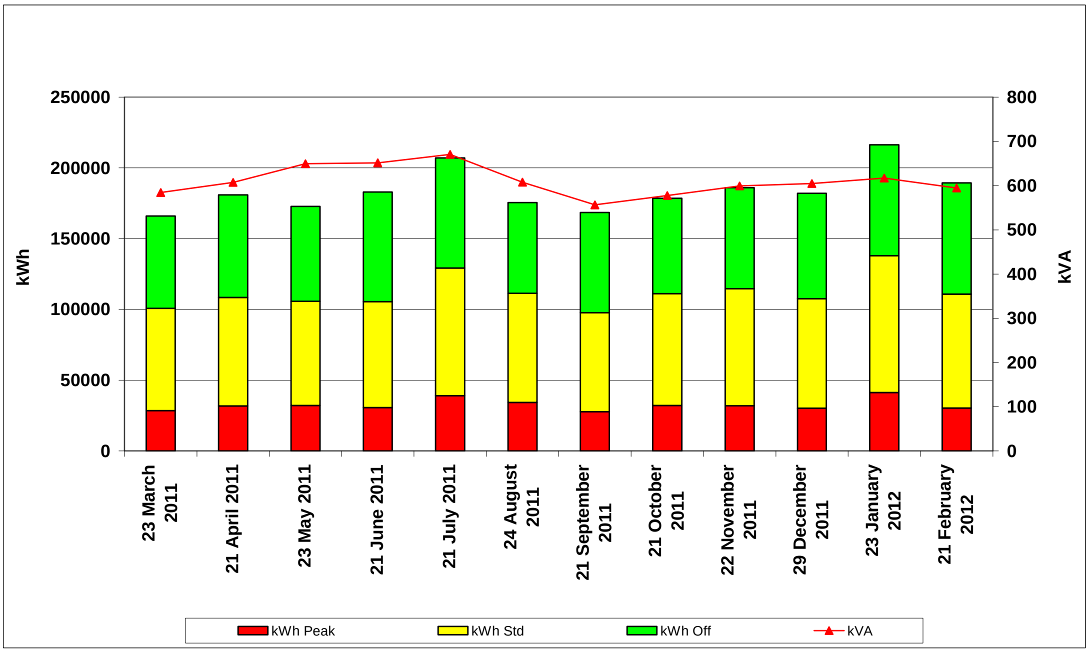
Figure 20: Daily Energy Consumption (kVA)



Seasonal Consumption

Electricity consumption is seasonal and is influenced by school holidays, weekends and public holidays.

Figure 21: Monthly Consumption of a resort (kWh)



Findings and Opportunities

Based on experience and the actual measurements taken, resorts have low load factors. This is because occupancy increases dramatically over weekends and during holidays.

HVAC: The accommodation units would have fans or split type air-conditioners.

Lights: The majority of the light fittings at the resorts are 50W low voltage down lights. The rooms there are fitted with bed lamps which use compact fluorescent lamps. In the service areas there are fluorescent fittings with T8 lamps and magnetic control gear.

Water heating: Water heating is predominantly done with electric boilers. The resorts have large storage vessels that are heated by means of electric elements in the communal ablution facilities. The freestanding accommodation units have domestic geysers.

General Comments

Opportunities do exist in this sector but are harder to justify on financial grounds due to the occupancy profile. These are in line with the ones identified in the hotel sector and are therefore not repeated.

3.6 Shopping Centres and Complexes

3.6.1 Introduction

The typical mall layout in South Africa is an enclosed area with shops lining both sides of a broad pedestrian thoroughfare. The entire complex is usually air-conditioned and artificially lit. In recent years ‘strip’ or open area shopping malls, which are smaller in size have grown in popularity.

Operational Norms

The prevailing practise in South Africa is for property owners or ‘landlords’ to charge their tenants a rental on a per square meter rate. This rate does not include electricity and water usage which is measured with Actual Meter Reading (AMR) meters connected to the particular shop’s supply and then added on to the rental as spate line items. In addition, the tenants are liable for additional services such as cleaning, maintenance, security and a proportional contribution towards the public area’s electricity and water usage. These additional services are also added to the monthly rental.

Understanding the business model of shopping centre owners provides the key reason as to why they are reluctant to get involved in energy efficiency programmes. The landlord typically buys the electricity at bulk, high voltage connection rates and then ‘redistributes’ to all the tenants. In effect, the landlord re-sells the electricity purchased from the bulk supplier to the tenants. Under this arrangement the tenant, or end-user’ has no relationship with the utility (Eskom) or distributor (municipality) and only deals with the landlord as they are responsible for the centre’s electricity distribution, maintenance and administration. Under South African law it is illegal to re-sell or on-sell electricity at a profit but it is allowed to pass electricity costs through to tenants at any applicable published rates for the area / municipality. This is exploited by the landlords who charge their tenants a higher end consumer published rate while they purchase the electricity at lower bulk rates. Typically the landlord is able to over-recover by as much as 30%. This is an additional and lucrative revenue stream which to date they are unwilling to sacrifice or reduce. A secondary issue with the current status-quo is that because the utility has no relationship with the tenant they are not able to introduce DSM interventions to reduce their electricity consumption.

The large and regular electricity tariff increases since 2007 (refer to Section 1) combined with a slowdown in the economy which started in 2008 is resulting in tough operating conditions which many are not able to absorb. Shopping centres are increasingly losing tenants due to high service charges and rentals. For this reason, some centres are reluctantly starting to review the public area electricity consumption.

On the higher end of the LSM scale South Africa is seeing newer, more efficient malls being built. Existing centres which are being refurbished are also incorporating newer and more efficient technology as part of the upgrade. Based on its experiences it is the view of the ESCo (ERO) that this has little to do with curbing expenses, but focuses on delivering a more pleasant shopping experience to customers which research has shown generally results in higher traffic volumes and in turn high sales.

The tariffs differ vastly from municipality to municipality. However the tendency is to force the commercial customer towards Time of Use (ToU) tariffs by keeping this type of tariff's increase below the Two-part (energy and Demand) tariff increase. There are essentially four types of tariff structures used in South Africa:

1. **Flat rate**: This is very uncommon and mostly used in residential tariffs. You pay a flat rate for the kWh consumed.
2. **Inclined block rate:** This is used only in the residential area. The more you use the more you pay.
    a. 0 – 100kWh charged at 35c / kWh
    b. 101 – 200 kWh charged at 60c / kWh
    c. Everything over 200 kWh charged at 100c / kWh.

    Note: The above rates are examples only. The rates differ from municipality to municipality.
3. **Time of Use rate (ToU)**. This is the most widely used rate in the commercial and industrial sectors and it is understood that it is NERSA's intention to migrate all consumers to this type of rate. However, commercial customers cannot be forced to change and therefore price signals are used whereby the other types are slightly more expensive. It is therefore recommended for consumers to conduct tariff studies regularly to ensure they are still on the most beneficial rate. Time of use, has two major tariffs.
    a. The typical one that works in Peak, Standard and Off Peak.
    b. The second TOU tariff only has Peak and Off Peak. The demand charge is only measured in peak periods. Descriptions of these tariffs are provided in the Eskom tariff sheet included in the supporting documentation
4. **Two part tariff**. This is based on energy (kWh) and Demand (kVA) measured over 24 hours a day.

Therefore to minimise energy costs by migrating from the Demand tariff to the ToU tariffs there is a requirement to change the way in which the tariffs are managed by the consumer as well as applicable technologies. This means that demand controls are no longer as vital and that the focus should now move towards load shifting out of peak periods.

3.6.2 Data Collection

The information provided in this section is derived from an energy audit conducted in an urban shopping mall which caters for the mid to low LSM groups. The ESCo was appointed by the Centre's Management team to review the energy bills due to a sudden and sustained increase in energy costs which had a material impact on their operational costs. It is believed that this mall is a fair representation of the average shopping mall found across South Africa. Table 10 provides a profile:

Table 10: Profile of Shopping Centre

Description	Number
Visitors (per month)	960,000
Number of Floors (Levels)	2
Number of Stores	94
Parking Open Underground	 415 1,395
Large Retailers Supermarkets Clothing Gym	 2 9 1
Banks	5

3.6.3 Results

Analysis of Electricity Load Profiles

Figure 22 shows the difference between billable tenant power and communally used power such as the mall corridors, parking, ablutions and other. Approximately 30% of the shopping centre's maximum demand can be contributed towards public area power. Figures 23 and 24 show the public area's contribution to maximum demand and energy usage.

Figure 22: Maximum Demand Split – Midday (12h00)

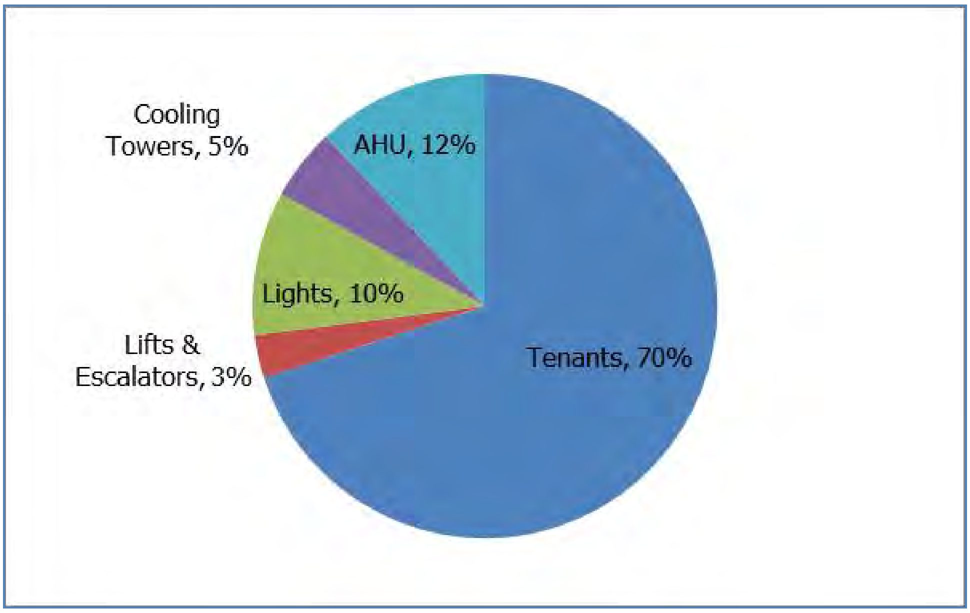


Figure 23: Public Area Contribution to Maximum Demand

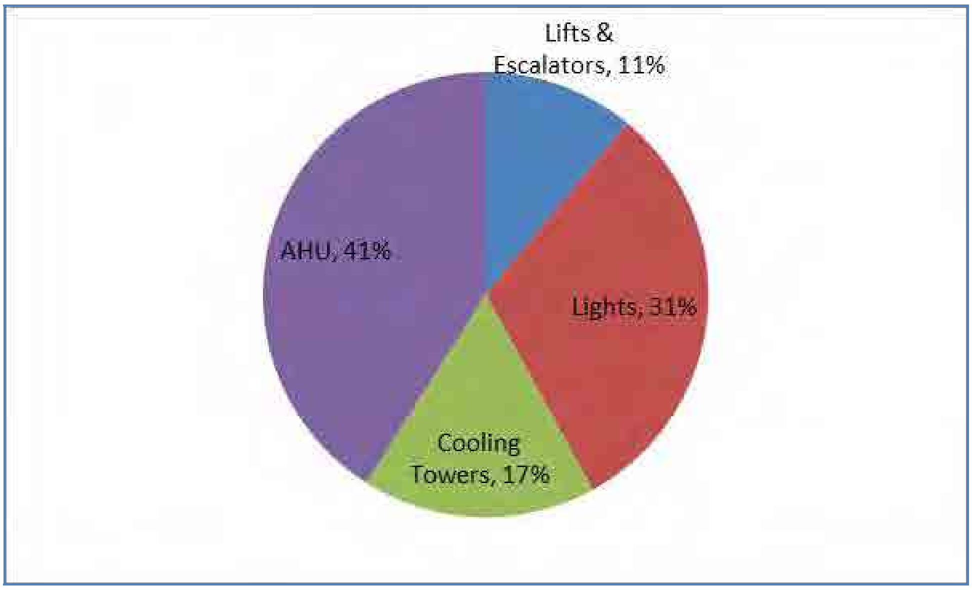
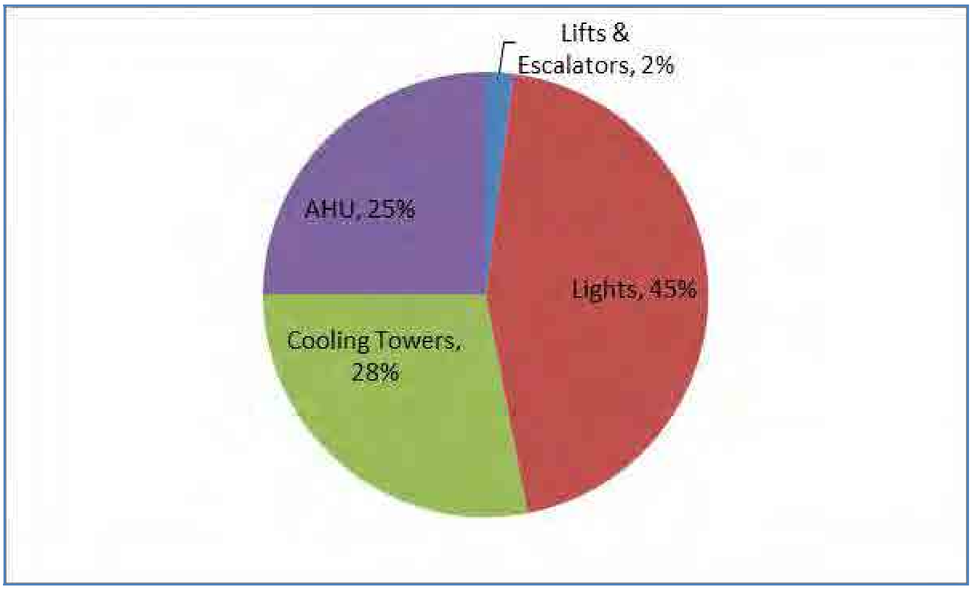


Figure 24: Public Area Contribution to Energy Usage (kWh)



Main Electricity Supply Load Profile

Figure 25 below shows an average day load profile for the entire shopping centre. The centre operates 7 days a week with the exception of Sunday, which is a half day.

Figure 25: Main Supply Profile for Shopping Centre

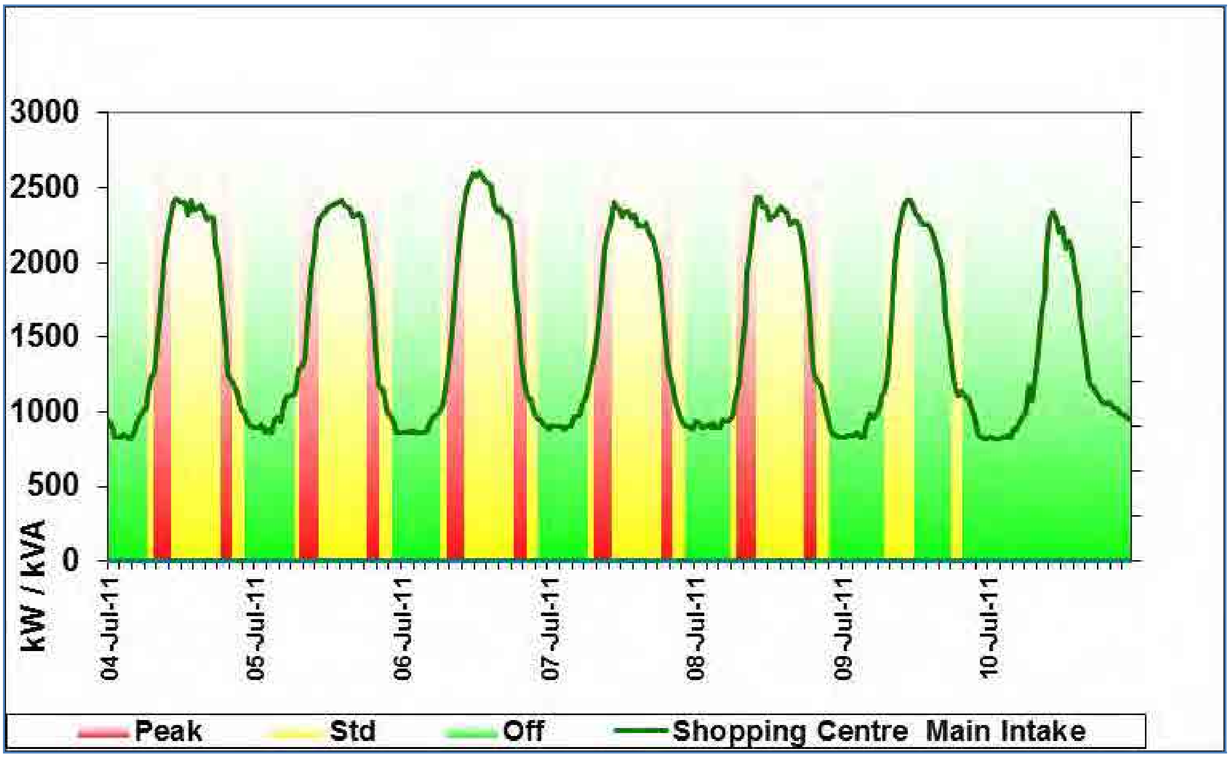


Figure 26: Average Daily Consumption – Shopping Centrre

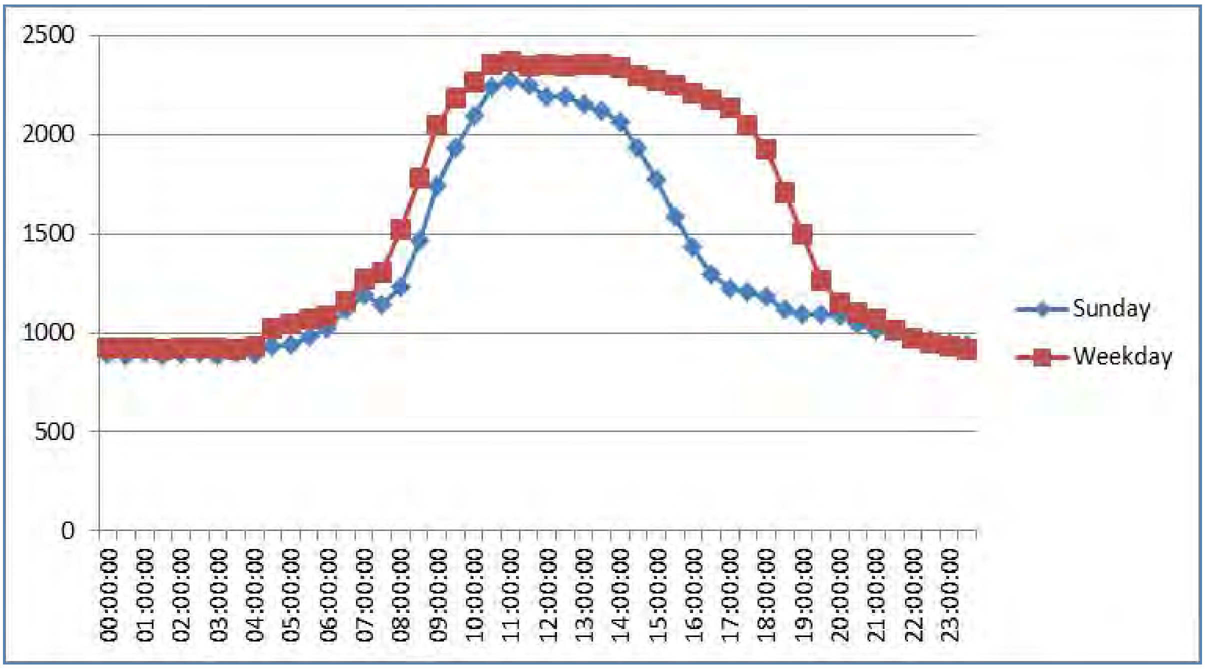
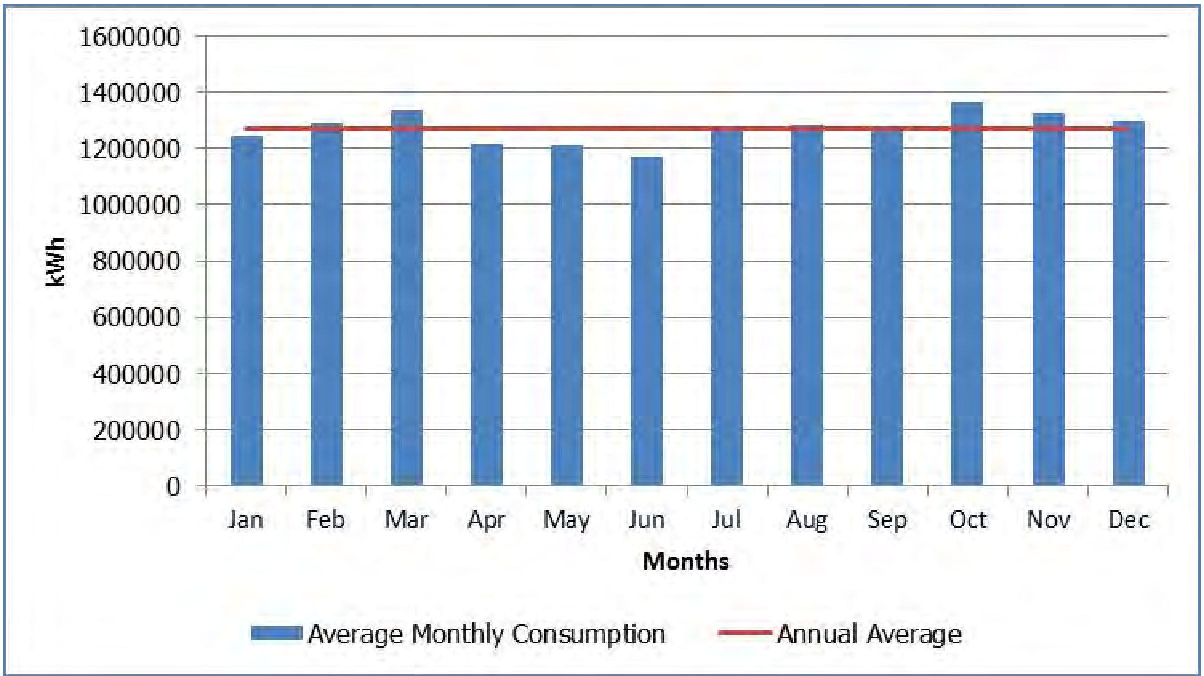


Figure 25 and 26 above show that the daily electricity use profile remains fairly similar for each day of the week. The maximum demand occurs around midday when all HVAC systems are running at full capacity.

Seasonal Consumption

This specific shopping centre has little seasonal variation as shown in Figure 27. This may be due to it being an artificial environment, with very limited exposure to the outside environment, meaning that the HVAC and lighting is always required, regardless of the season, when the centre is open for business. However this may be specific to this centre.

Figure 27: Monthly Consumption – Shopping Centre (kWh)



Findings and Opportunities

Based on experience and the actual measurements taken, shopping centres tend to have an electricity load which does not dip below 30% of average maximum demand. This is due to continuous operation of HVAC as well as lights that are on 24 hours a day, for security and cleaning.

HVAC - Cooling Towers: The metering done at the centre shows that even though the Cooling Towers make up only 17% (Figure 35) of the load during maximum demand they contribute 28% (Figure 36) to the monthly consumption. This is attributed to the fact that many of the cooling towers rarely, if ever, shut down completely. This is due to inefficient control systems.

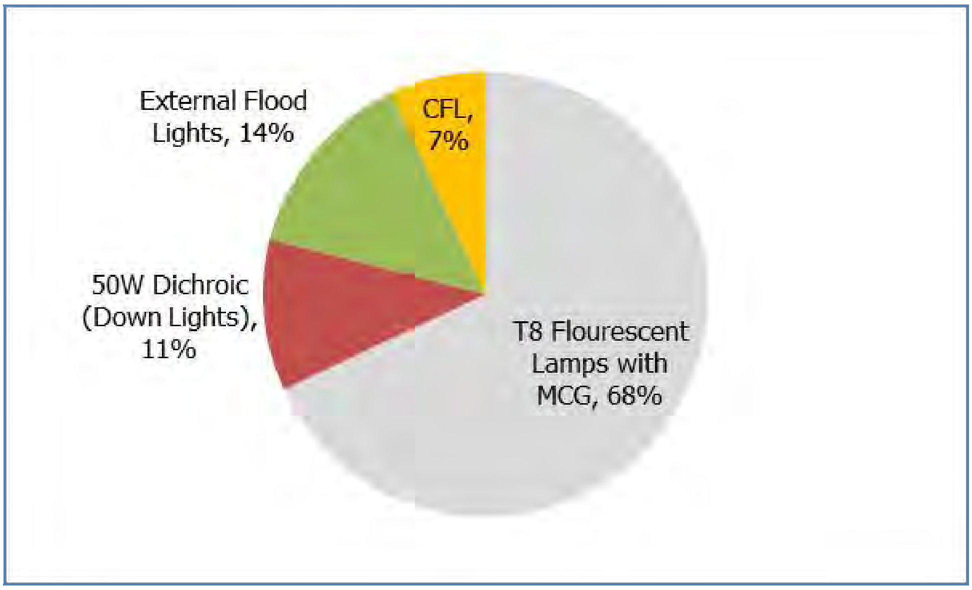
HVAC - Air Handling Units (AHU): The AHUs shows the complete opposite of the cooling towers in that it makes up 41% (Figure 35) of maximum demand, but contributes only 25% (Figure 36) towards the monthly consumption. These units are mostly on timers and only operate during business hours (between 8am and 6pm).

Lifts and Escalators: The operation of the lifts and escalators are minimal. Although the installed capacity is in the region of 80 kW, the lifts do not operate continually and the escalators are generally switched off at night.

Lights: The majority of the fluorescent fittings in the shopping centre use old magnetic ballast technology – the breakdown is shown in Figure 28. Since most of these lights are on 24 hours per day it is cost effective to change all the magnetic ballasts to electronic control gears (ECG). Currently the norm is that the maintenance teams are changing MCGs to ECG as and when they fail, however this process is painstakingly slow.

The overwhelming majority of lights used in shopping centres are fluorescent tubes. These are used extensively in under cover parking areas, 'back of house' as well as providing ambiance lighting in ceiling alcoves.

Figure 28: Installed Lighting – Shopping Centre (kW)



General Comments

It is not possible to install meters at every point where electricity is consumed. However, a physical audit of the shopping centres shows that at least 70% of the nocturnal electricity consumed is unaccounted for. A strong possibility exists that the majority of this electricity is consumed by the individual stores as very few shops switch off their lights and other systems for security reasons and to promote 'window shopping'. Another contributing factor is cleaning, maintenance and security staff that operates at night.

The following opportunities have been identified:

- Although there is significant resistance and indifference towards energy efficiency, opportunities do exist in this sector of the market. The experience of the ESCo is that these are to be found in the higher LSM oriented shopping malls, where larger budgets are available and the design requirement is to incorporate passive measures, such as natural light and ventilation. This allows the architects and engineers the opportunity to install higher quality and energy efficient equipment and not build on a 'lowest cost per square metre' basis;
- For ESCo's and the utility to bypass the landlord altogether and engage with the tenants directly, however this is generally limited to the large department stores and supermarkets. Although these companies have already started to consider and invest in energy efficient technologies, this market remains largely untapped. This is because EE is not their core business and they are not aware of incentive

opportunities being offered under the DSM programme as they have no interaction with the utility (as explained above);

- The majority of shopping malls in SA have large undercover parking areas with fluorescent tubes which are on 24/7. Currently the trend is to remove one tube from the fitting or to disconnect every second light. This reduces the light level significantly and results in security concerns. A better solution is the installation of Passive Infrared Sensors (PIR) sensors. However, many landlords have the misperception that this will create a security risk even though case studies have shown the opposite; whereby security guards are alerted to criminal activity when lights switch on in areas where no normal activities are taking place;
- HVAC upgrades: Because of the enclosed nature of malls, all malls have conditioned air. These systems are typically archaic, overused and under-maintained. HVAC systems typical makes up over 60% of all the energy consumed in the common areas.

Final Comment

Centre management contracted the ESCo to conduct an energy audit, which would:

- Confirm whether the centre was being billed correctly by its supplier (municipality);
- Assist to better understand where and how electricity is being used in the centre; and
- Identify opportunities for energy savings. The ESCo was asked to analyse the results and make recommendations.

Although multiple opportunities were identified which were both financially attractive and easy to implement no action was taken. The decision not to, was because a reduction in total electricity consumption would reduce the revenue being made by on-selling electricity to their tenants which in turn would reduce their profits.

The South African Council of Shopping Centres (www.sacsc.co.za) was contacted on several occasions for comment but failed to respond. This further underlines the low regard in which EE is held in this sector. It is recognised that this is not an extensive study and it is not to say that upgrades and new shopping centres being built are not installing new and more efficient technology. Indeed there are a few examples where EE is a cornerstone of the development but these are few and far between. These findings are supported further through research – Refer to Section 3.7 Hospitals

3.7 Hospitals

3.7.1 Introduction

As with most countries, South Africa's health care system is split between the public and the private sector. The public health system is at least twice as large as the private sector and the number of private hospital beds is controlled by Government. Three groups dominate the private health care sector locally and the information in this report relates is limited to the private sector.

Operational Norms

Hospitals offer 24 hour services. The hospitals included in this report have operating theatres, intensive care units, casualty sections as well as other various wards. The support services include a kitchen, laundry and centralised sterilisation department.

In recent years few new hospitals have been built, there are many contributing reasons for this but they fall outside the scope of this report. At the same time very little has been done to improve the energy efficiency of existing hospitals. These two factors mean that the hospital sector in South Africa is very inefficient from an energy efficiency perspective and large opportunities exist.

3.7.2 Data Collection

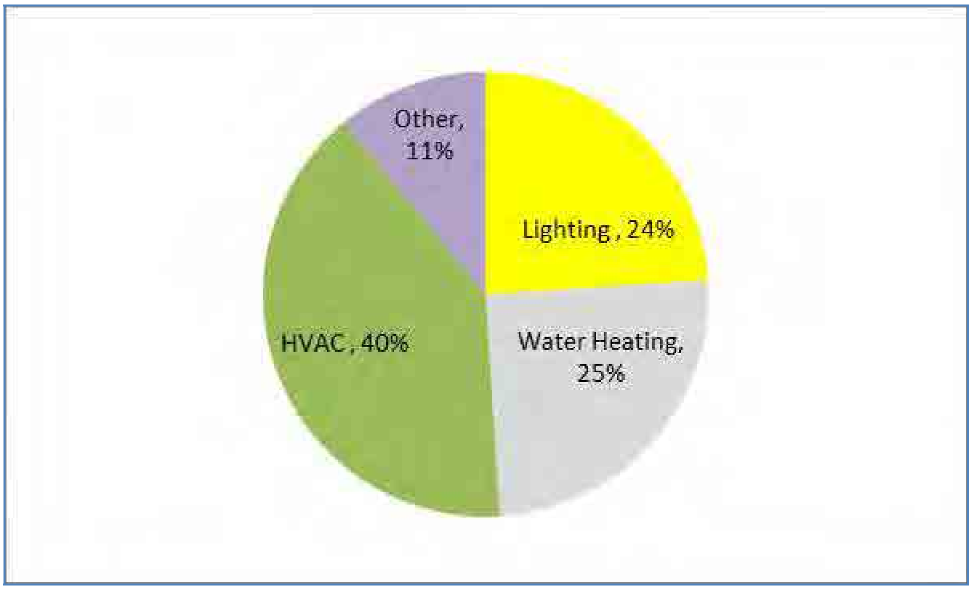
The information provided in this section is derived from energy audits conducted at 27 hospitals operated by one of the three largest private hospital groups in the country. These hospitals range from 21 to 214 beds.

3.7.3 Results

Analysis of Electricity Load Profiles

The typical breakdown of energy consumption in private hospitals is shown in Figure 29

Figure 29: Energy Consumption by Application - Hopsital



Main Electricity Supply Load Profile

Figure 30 below shows the typical week load profiles for a large hospital.

Figure 30: Typical Weekly Load Profile - Hospital

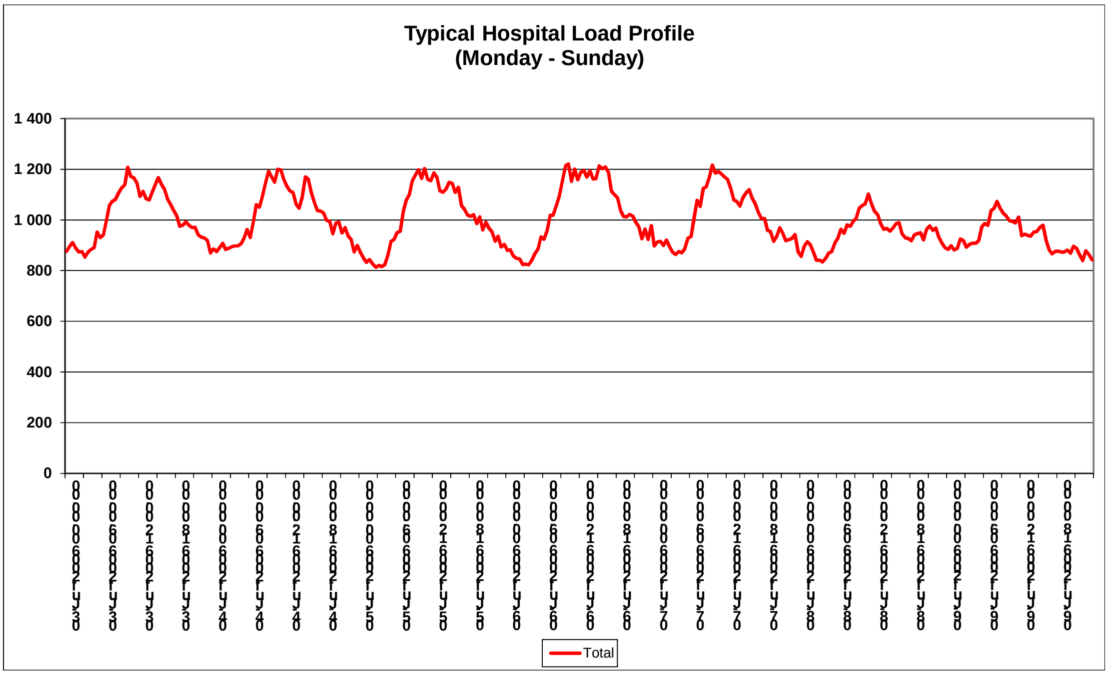
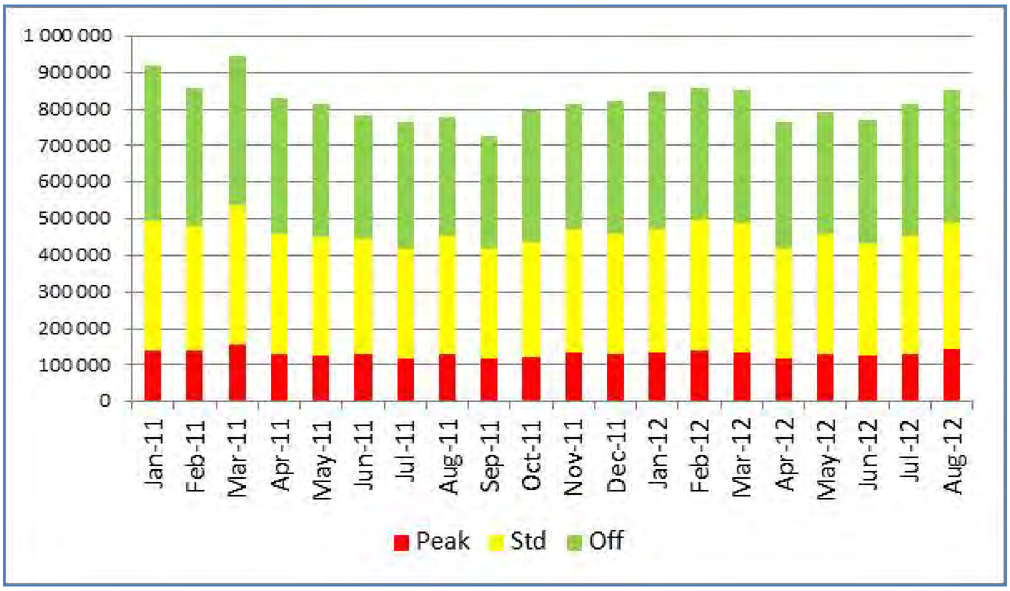


Figure 30 above shows that the daily electricity use profile remains fairly similar for each day of the week and tends to reduce over weekends. The hospitals have a significant base load due to the lighting and other support services which remain operational 24 hours per day.

Seasonal Consumption

Figure 31 shows the consumption history of a hospital. Seasons do not have any significant impact on the energy consumption.

Figure 31: Monthly Electriciy Consumption (kWh)



Findings and Opportunities

HVAC: Hospitals have large air conditioning systems. These systems are regulated and require that some areas, like ICU, only use fresh air. Each theatre would have its own system with filters. The type of system will depend on the classification of the theatre. A central chiller with chilled water coils in the individual air handling units is most common. Heating is done by means of electric elements inside the air handling units and ducts.

Lifts and Escalators: The energy consumption associated with these are minimal. All the multi storey hospitals would have lifts to transport patients between the various departments.

Lights: The majority of the light fittings in the hospitals are linear fluorescent fittings. In the rooms there are bed head units with one or two fluorescent tubes. The nurses stations as well as consulting rooms have 50W LV down lights. The theatres have linear fluorescent lights for background lighting and specialised lights for operations.

Water heating: Water heating is predominantly done with electric boilers. The hospitals have large storage vessels that are heated by means of electric elements. The vessels are sized in such a way that it would provide all the hot water for one peak period. i.e. morning or evening. This means that these vesels are reheated twice in a 24 hour cycle. The electrical input is sized in to provide a reheating time of less than 6 hours. Water is stored at between 55 and 60 degC. Very few hotels have converted to heat pumps.

Medical equipment: Most of the medical equipment is powered by electricity. X-ray machines, scanners etc. require clean power. All the hospitals would have UPS systems installed with diesel generators as back up.

Compressed air and vacuum: Compresses air and vacuum is supplied to each bed. The vacuum pumps and compressors are normally located in a plant room in the service area. Very little attention has been given to the optimisation of these systems.

General Comments

Most of the electrical systems in hospitals are controlled by the staff. This is different from hotels where the guests have control over a large portion of thee energy consumption.

The following opportunities have been identified:

- Opportunities do exist in the healthcare sector. The experience of the ESCo is that these are to be found in both facility energy conservation measures as well as operational measures;
- The technical expertise of this sector is low and they tend to look for advice from suppliers and the utility companies. They have strict financial criteria for investments in energy efficiency. The norm is a three year pay back;
- It is the opinion of the ESCo that the hospital groups have limited own capital for energy efficiency projects.

- HVAC upgrades: Most hospitals have central air conditioning systems but very few have building management systems (BMS) installed. The controls often contradict each other. (simultaneous heating and cooling) An upgrade of the HVAC controls is a good opportunity. In addition to this efficient motors and variable speed drives are opportunities.
- Heat pumps for water heating: Heat pumps generate hot water using on average one third of the energy of electric elements.

Final Comment

The ESCo has implemented an efficient lighting retrofit and heat pump project at 14 hospitals. This has resulted in 11% energy savings.

3.8 Schools

3.8.1 Introduction

In broad terms there are three operational models for South African schools, namely:

- State funded where 100% of funds are received from the Government. The majority of schools in the country fall under this category;
- Co-funded. These schools are administered and must still comply with all Government policies and directives. However they do not rely solely on the Government for funding and raise private funds to increase their operational budget. Sources include levies charged, private sector and other fund raising; and
- Private schools: These schools are independent and do not receive any funding from the Government.

Co-funded and private schools may also offer boarding facilities to scholars. The data in this report only considers co-funded and private schools, with and without accommodation.

Operational Norms

The school day starts at 07h30 and typically ends at 14h00, after which sporting activities take place. The sporting activities last well into the evening at which time significant lighting is used to light up the sporting fields. Many schools have a wide variety of educational subjects, some of which includes cooking and machinery usage.

Energy usage in schools is typically wasteful for a variety of reasons, the key ones being:

- Multiple users and common areas. This makes it very difficult to allocate ownership and accountability or to implement a long term programme as scholars change annually etc;
- The age group of users (children and teenagers) and school teachers;
- The school management team is made up of teachers who tend not to concern themselves with operational and life cycle costing. They are also not aware of new technologies and the potential for energy savings; and

- The historical low costs of energy meant that it was not a key expense.

The recent electricity and petrol increases is having a material impact on school's which operate on tight budgets and many are realising that action needs to be taken to reduce energy costs associated with fulfilling their educational needs as the energy costs are placing a burden on the schools cash flow and hence capital expenditure in other areas is being curbed. ERO was appointed by several schools to conduct an energy audit.

3.8.2 Data Collection

ERO has conducted energy audits on eight schools in total. Although the tariffs differ vastly from municipality to municipality, the schools consumption pattern is governed by the educational requirements and very little can be done to change this profile. For this reason the data presented in this report represents the findings from two types of schools:

Type 1: School with no accommodation

Type 2: School with boarding house

3.8.3 Results

The annual energy consumption profile varies significantly between the two schools as shown in Figures 32 and 33.

Figure 32: Annual Energy Consumption (kWh) – Type 1: No Accommodation

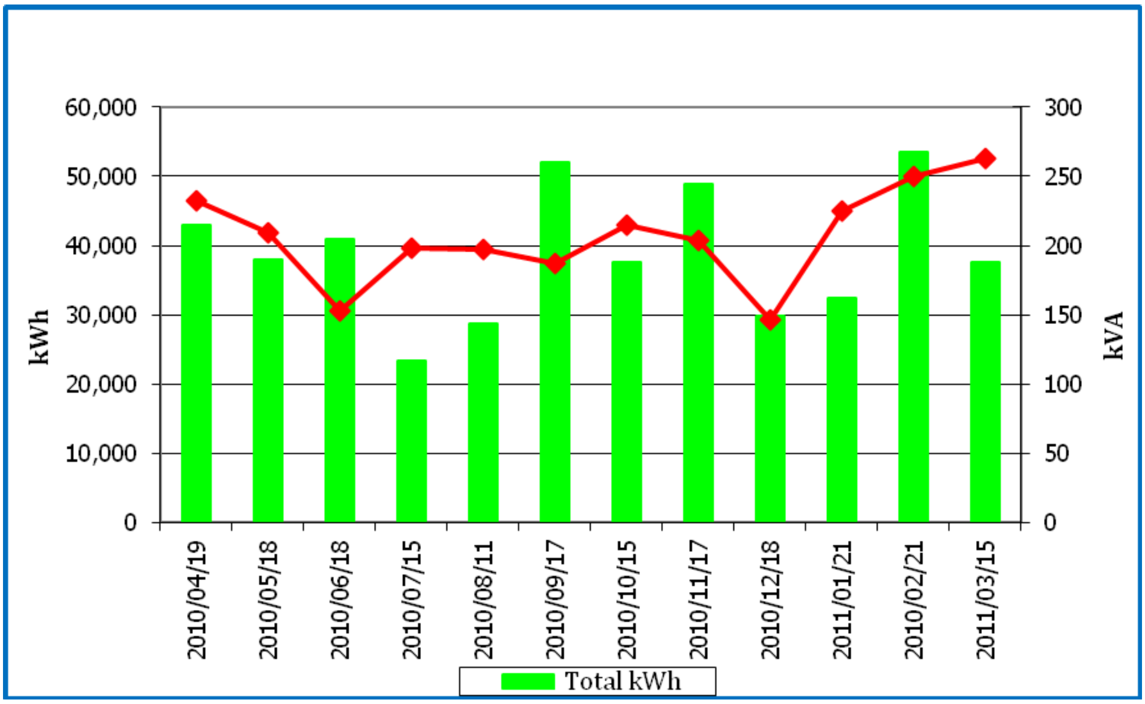
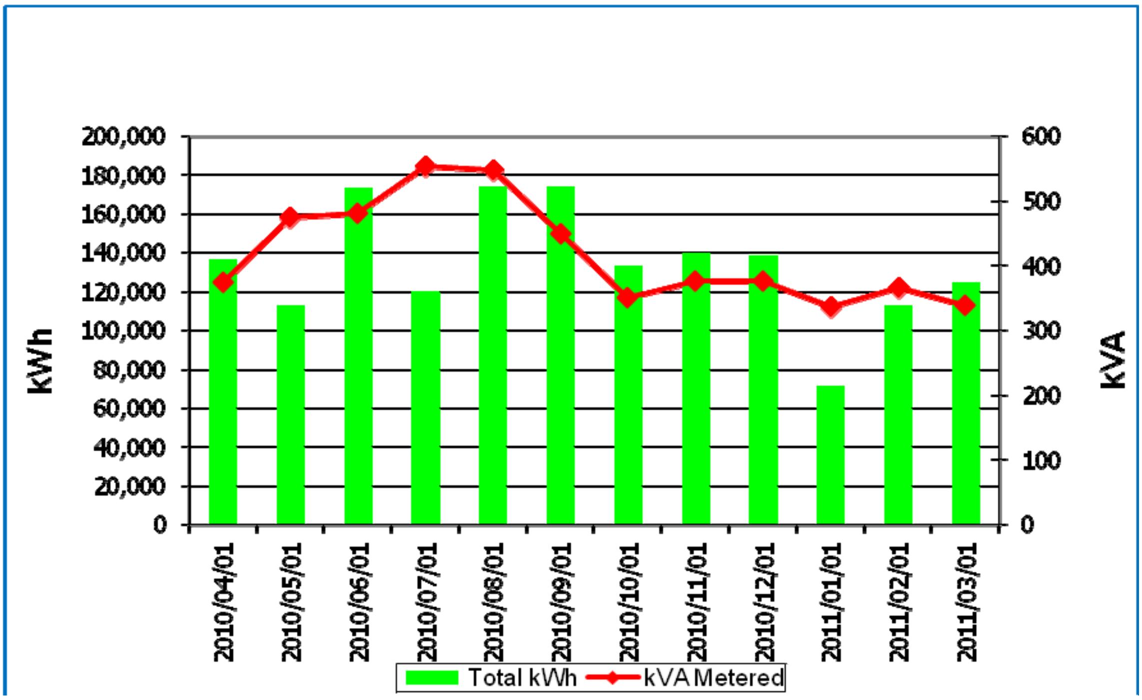


Figure 33: Annual Energy Consumption (kWh) – Type 1: With Accommodation



The two types of schools show a completely different profile, although both schools are situated in the same climate. When comparing the two profiles the following is observed:

Similarities:

- July shows a decrease in consumption.
- December / January show a decrease in consumption.
    - These are the main holiday periods, with very little activity at the schools.

Differences:

- Type 2 School uses much more energy during the year, due to the additional housing.
- Type 2 School has a greater demand in February and March due to a large lighting load used for sporting activities.

Opportunities do exist in this sector of the market, but they are limited as activities determine the consumption patterns. Most opportunities are with classroom lighting and outdoor lighting. Where boarding houses are present there are greater opportunities available.

Analysis of Electricity Load Profiles

The electricity load profile between the types of schools is again different as the impact of the boarding houses is clearly evident in the afternoon and evenings – Figure 34 and 35. Over weekends the energy consumption drops significantly as it is common practise for most pupils to go home and return on Sunday afternoon or Monday morning. The impact of the external lights for sporting activities is clearly evident in Figure 34.

Figure 34: Main Electricity Supply Load Profile – Type 1 No Accommodation

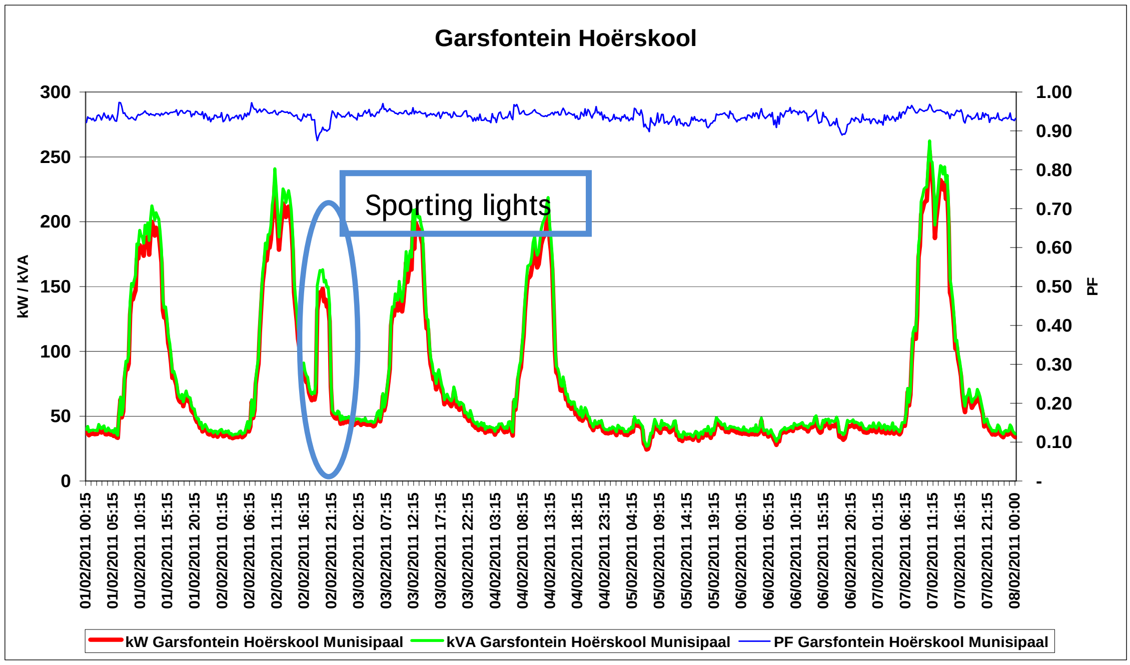
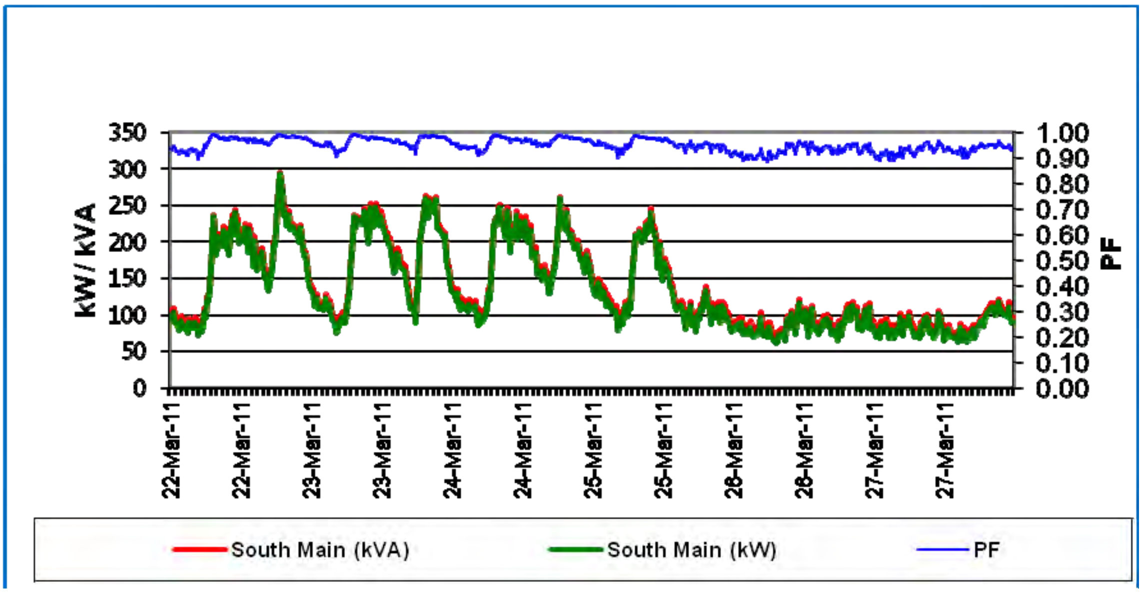


Figure 35: Main Electricity Supply Load Profile – Type 2 With Accommodation



From the graphs above it is seen that the daily electricity use profile remains fairly similar for each weekday, the exception being when sporting activities require evening lighting. The maximum demand occurs during the morning tuition time and again in the evening at the boarding houses.

It is difficult to say for certain what contributes to the maximum demand as rosters and practical studies change according to the day of week and curriculum. However it can be concluded that the classroom lighting and equipment is responsible for the majority of this demand.

Installed Capacity

For the purpose of this report the boarding house component has been removed as it has a layout and consumption pattern similar to a hotel with laundry, restaurant, kitchen, public areas and bedrooms. Please refer to the hotel section for detail.

The installed capacity therefore for a typical school, excluding the accommodation, is shown in Figure 36 and the total consumption is shown in Figure 37. From the graphs it is evident that the bulk of the energy (62%) is consumed in the classroom if the educational (training) kitchen is included. Lighting is the second biggest consumer with general and sports lights accounting for 27% of demand.

Figure 36: Total Installed Electrical Capacity (kW) – Type 1 Scool No Accommodation

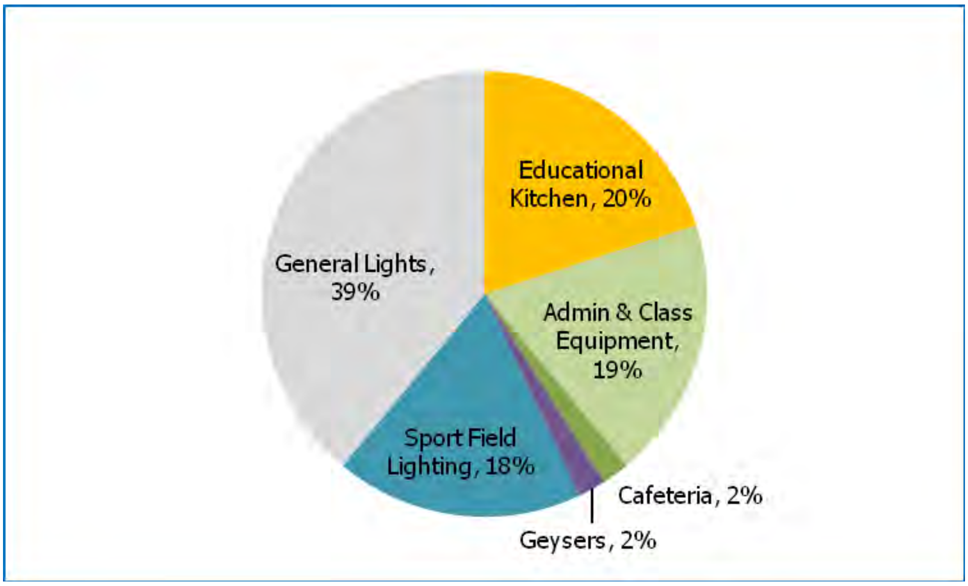
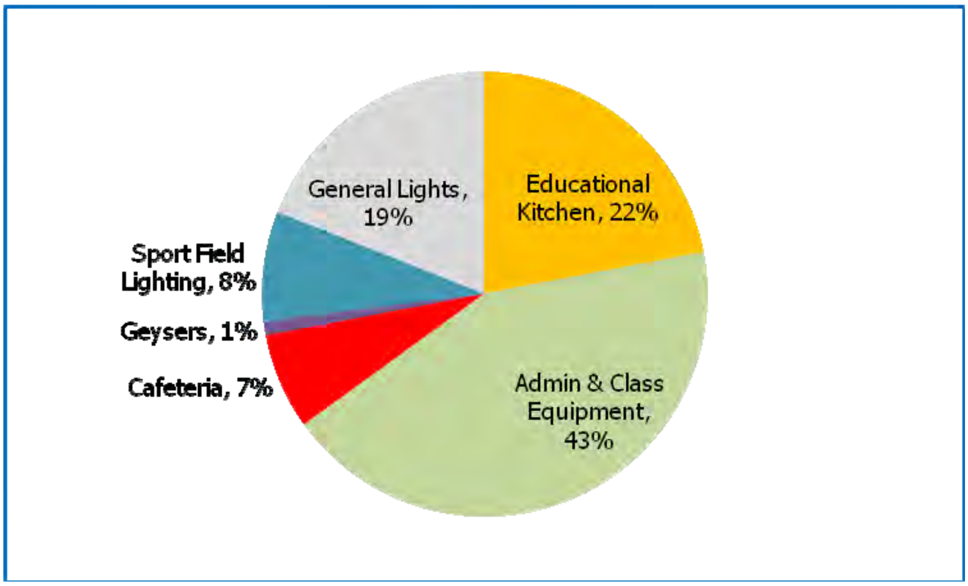


Figure 37: Total Consumption (kWh) – Type 1 Scool No Accommodation



The 'Admin and Class Equipment' in Figure 49 comprises of the following:

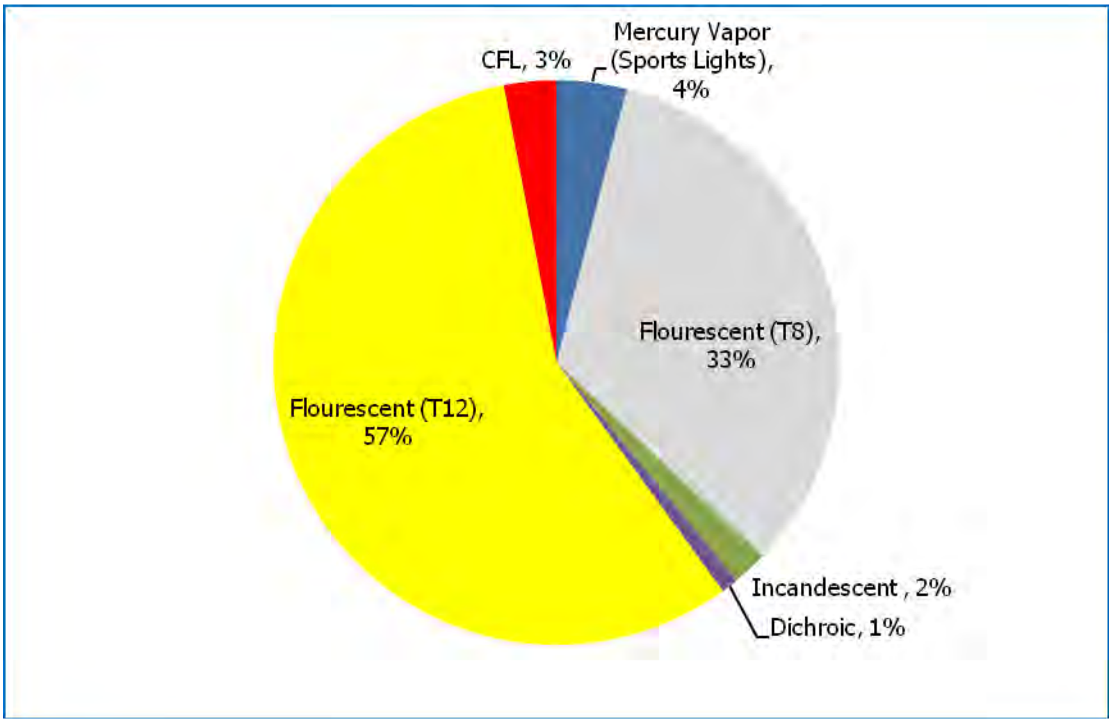
• Woodwork Equipment	1.2%
• Staff Kitchen (kettles, toasters etc)	15.2%
• Heating and Ventilation	1.2%
• Computer Room and other IT equipment	82.2%

The computer room and other IT equipment is made up of two computer rooms which operate virtually throughout the day. Combined the school has a total of 135 (450W) PCs. Although it is not the case for this particular school many of the other schools which were audited had a much higher heating and ventilation consumption.

Finding and Opportunities

The installed lighting, shown in Figure 38, shows that there are opportunities to improve electrical consumption by switching to more efficient alternatives as the majority of the fluorescent fittings in the schools use old magnetic ballast technology. Since these lights form the bulk of energy consumption it is cost effective to change all the magnetic ballasts to electronic control gears (ECG).

Figure 38: Installed Lighting Capacity (kW)



Other opportunities identified:

- **Other equipment:** Various pieces of equipment are used in the classrooms from projectors and computers to scientific equipment. All of these can be replaced with energy efficient counterparts at the end of their lifespan. The use of electrical equipment, such as computers, is increasingly being incorporated into the curriculum and electricity consumption will continue to increase.

- **Kitchen equipment (Educational and Canteen):** The focus here should be on induction type stove tops. The stove tops are by far the biggest contributors towards high energy costs as very few schools utilise gas in the kitchens. The equipment used in the schools is of dated technology.
- **Education:** By far the biggest intervention and opportunity is to institute an energy management programme and awareness programme. The administrators of the schools are not familiar with new technology, very risk averse and use a short term pricing model. They are therefore not willing to spend extra capital on new equipment which they are not familiar with and therefore tend to replace 'like with like' which traps them into a circular cycle of ever-increasing energy bills.

3.9 ESCo Insights and Findings: Concluding Comment

In all instances two components need to be considered when applying energy conservation measures, as these two components form the basis of all considerations.

- Operational requirements
- Technology improvements

3.9.1 Operational Requirements

In almost all energy audits undertaken it was found that the proprietor has very limited or no knowledge of the tariff signals. The users are ignorant of the benefits that they can derive by applying different techniques towards limiting the energy costs.

Certainly by reducing energy usage as a whole it will have a positive influence on the energy consumption and therefore the costs as well, over and above the many other opportunities that can be explored.

The energy users are left in the hands of salesman of technology to inform them about savings opportunities. In many instances capital is spent on equipment that does not achieve the desired results because of misinterpretation of the energy bills and signals.

The first point of achieving the desired result is to conduct in-depth tariff analysis and thereby ensuring that the user is on the best applicable tariff for the property. Secondly one should consider what the impact of operational and behavioural changes will have on the existing or new tariff. Only thereafter should one consider the impact of technological changes to the operation. These simple steps applied in the wrong order can lead to the user being exploited and not achieving the desired results.

3.9.2 Technology Improvements

The market in South Africa is generally unaware or has failed to take up on opportunities make technology changes which will reduce energy consumption.

HVAC: South Africa has an extremely varied climate with exceptionally hot and humid summers and short, but blistery cold winters. Conditioned air is therefore not a luxury, but a requirement in most commercial installations. Bigger properties make use of centralised air conditioning systems and smaller and older properties have individual units installed.

Centralised units consist of four major components:

- **Cooling Towers:** This equipment is generally left to run 24 hours a day as they are usually located on rooftops or other inaccessible areas. With very little intervention, such as timers or proper BMS inputs large savings are possible.
- **Air Handling Units:** Once again the systems are hidden in enclosed ceiling areas. They also have the tendency to supply air to more than one controlled area. Therefore the units run much more often that actually required. With proper BMS intervention as well as Variant Refrigerant Volume (VRV) technology these units can become much more efficient.
- **Chiller plant:** Chillers tend to be considered as specialised equipment resulting in very few facilities managers or technical managers are prepared to change set points. It is common practise for set points not to be changed to accommodate seasonal changes. Hence the units continue to produce very cold water even in the middle of our winters. Educated interventions can save the consumer significantly.
- **BMS (Building Management Systems):** Many buildings have very limited BMS systems installed to control the HVAC systems. In most instances the building owner / operator carries no knowledge on how to operate the BMS system.

LIFTS AND ESCALATORS: There is a big drive at this time to use alternative technology in lift motors and cars. These range from smaller, more efficient drives to cars that shut down when not in operation. However there are still many of the older types of machines in operation. It is also considered specialised equipment and therefore the building owners are not aware of any possibilities to make the units more efficient. Only when major refurbishments take place do the owners consider changes on the lifts.

LIGHTS: The biggest drive in the South African market is towards energy efficient lighting. This is partially because it is the cheapest energy efficient solution on the market. It is also the most visible solution that helps with first impressions for corporate buildings. Unfortunately this section of the market is also flooded with cheap, substandard components. The traditional lighting suppliers are finding it increasingly difficult to compete with nameless products from all over the globe. As a result the market is becoming increasingly negative towards LED technology as whole, with unfortunate results for the genuine competitors. Almost all incandescent lights have been changed to compact fluorescent lamps, because of a nationwide drive by Eskom to compel users to change as well as extremely high taxes on the old 40W, 60W and 100W incandescent lamps. The majority of inefficient fittings used today are dichroic down lights and fluorescent tubes. There is currently a big drive on to change downlights, but as mentioned above the market is reluctant to change because of inferior products. Currently there are no proven, reliable alternative to fluorescent tubes, apart from slightly more efficient fluorescent tubes. This market is open for LED technology that can compete against the existing fluorescent tubes.

HOT WATER GENERATION: Heat pumps have grown in popularity over the last few years in this sector of the market and have proven more reliable and efficient, for commercial installations, than solar water energy alternatives. Again, there is a very large variety of products on the market resulting in the consumer being faced with too many choices and often opting not to convert. The technology available is very competitive, but the installation knowledge is still limited. As a result there are many stories of unsatisfied customers that add their weight to the insecurity of the market.

MOTION DETECTORS: There are many opportunities in the commercial market place to install motion detectors. This market needs convincing as security in South Africa still plays a significant part in decision making. The common thought is that a dark environment is unsafe. Even though the opposite is in fact true when motion detectors are installed. If there is no movement, sound or infra-red foot print there will be no light.

The tariff signals and size of operation should form the crux of the decision in these scenarios and this is best determined by undertaking a detailed energy audit from an accredited professional.

3.10 Public Sector Buildings

The 2005 National Energy Efficiency Strategy (NEES) specified an energy savings target of 15% in public buildings to be achieved by 2015. The 2008 revision of the NEES collapsed the specific target for the public sector and the target for commercial buildings into a single sector target of 20%.

Although public buildings include several functions and end-uses, the expectation is for the portfolio of public buildings to be primarily administrative (or similar) use and therefore to have a predominantly commercial use profile. A typical commercial use pattern presents opportunity for high load factor interventions and therefore significant energy savings.

The South African National Government occupies 103,000 buildings across the country of which 75,000 are Government owned. Programmes aimed at improving energy efficiency in public buildings had been implemented in the 1980s, late 1990s and again in 2008. To date however only one Government occupied building has received a Green Star Certification[28] in South Africa and progress towards the 15% efficiency target has been very slow.

2008 figures estimated national Government electricity spend at around R576 million per annum. In the US and UK it is estimated that nearly one-third of the energy used to run typical government buildings goes to waste. A 20% efficiency improvement as proposed by the 2008 revised NEES therefore seems plausible and would suggest a potential cost saving in excess of R115 million per year (with respect to the 2008 consumption estimate). Improving the efficiency to 15%, as required under the original (2005) NEES, would already save more than R86 million per year.

This ‘budget’ amount at the electricity rate in 2008 (R0.45/kWh used) would suggest electricity consumption of approximately 1,280 GWh per annum. 15 or 20% energy savings across the complete portfolio would therefore save between 195 and 250 GWh per annum and between 195 and 250 million tons of CO_2 per annum.

A 2010 report from the Department of Public Works (DPW) provided a list of the 50 highest consuming facilities in 10 areas of activity as defined by the DPW. The schedule included the annual electricity cost for each of these facilities and a total

[28] One government building (SANRAL Corporate Head Office, Tshwane) has been certified by the Green Building Council and achieved a four star rating in January 2012. The City of Cape Town (local government) Electricity Services Head Office also achieved a four star rating in July 2012.

annual spend well over R657 million. Although only for 500 buildings, it serves to confirm that the potential for energy improvements are likely to be significant.

Besides this high level view of savings potential, more detailed information is not readily available. No baseline of the complete portfolio of public buildings is available to enable benchmarking against an industry average.

It is anticipated that the most likely energy efficiency improvements would include, amongst others, the identification and correction of inefficiencies in HVAC and hot water systems, central plants, lighting, process equipment (if/where relevant), and building controls. In addition to the suitable application and sizing of energy efficient equipment and technologies associated with the building envelope and fixed structures, further interventions such as ‘green IT’ and appropriate renewable energy solutions should serve to optimize energy usage.

3.11 Data Collection: Desktop Research

3.11.1 Commercial Building (Offices)

There are no credible or available statistics which provide a definitive figure of how much available office space there is in South Africa. Furthermore, the South African Government is by far the largest owner of buildings in the country. What is certain though is the steady increase in demand for office space over the last 20 years as the South African economy has transitioned from mining and manufacturing into services. The building stock is made up of old and newer buildings. It cannot be assumed that the newer stock performs better from an energy efficiency perspective as this sector faces the same challenges of building owner / tenant scenario detailed under the Barriers and the Shopping Centre Section of this report.

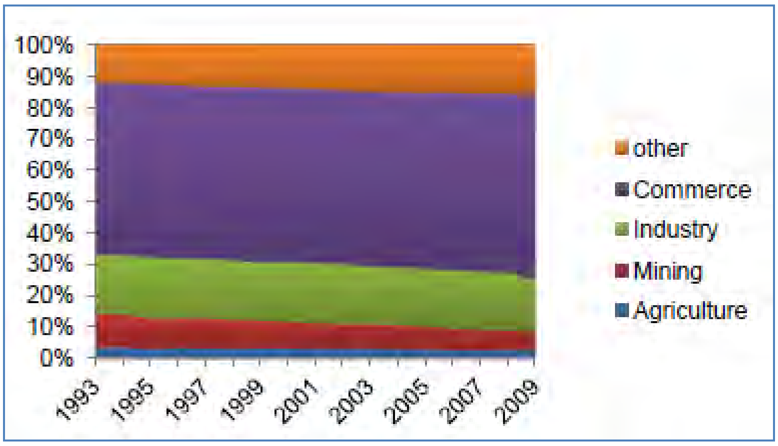
Information gathered by the University of Cape Town’s (UCT) Energy Resource Centre (ERC) provides the following insights. Figure 39 gives the increase in new floor area of commercial space as recorded by Statistics South Africa and uses an assumption of 59 million m² in 1992. Table 11 gives the percentage share of floor area in 1990 by type (De Villiers) and Figure 40 provides a breakdown of how this floor space is broken down across the various sectors. ***Note:*** These figures are estimates.

Figure 39: Estimated Growth of Commercial Floor (1992 base of 59m m²)

Table 11: Percentage share of floor area (1990 million square meteres)

Description	% share of floor area (De Villiers)	1990
Warehouses	11%	7.15
Shops	18%	11.7
Accommodation	4%	2.6
Catering	4%	2.6
Offices	30%	19.5
Education Facilities	12%	7.8
Healthcare Facilities	7%	4.6
Other	14%	9.1
	100%	65
Excluding Warehouses		57.9

Figure 40: Floor space by Sector



Benchmarking

A benchmarking study undertaken in Cape Town in 2010[29] sourced billing data from a sample of buildings taken from the Cape Town municipality database, coupled with building data taken from the Cape Town municipality valuation database. The data was then used to develop preliminary benchmarks for office and retail buildings and then compared with international benchmarks from the USA, Australia and the UK. The study used a bottom-up approach, whole building electricity benchmarks were generated from a sample of 422 commercial buildings. The benchmarks generated in the study represent typical (median) intensities for:

- Retail: 259kWh/m²(gross) annum; where n=40
- Offices: 188kWh/m²(gross) annum; where n=41
- Business Hotels: 15MWh/m²(gross) annum; where n=12
- Other Commercial: 261kWh/m²(gross) annum; where n=20

The findings of the study raised some questions and it is understood that the consumption figures have been underestimated and therefore the results should be treated with ‘caution’. The author of the report was contacted and stated that the benchmarks generated were in the right order the results come with a strong caveat. Further data is required to corroborate the figures.

[29] Energy Benchmarks for Office and Retail Buildings in the City of Cape Town, Caroline Martin, 2010

An alternate benchmarking exercise undertaken in 2009 by the Investment Property Databank[30] (IPD) found that the all retail kWh/m² to be 418 – which it notes is significantly lower than the Pan European average of 819kWh/m² but still much higher than Brazil with which it shares similar climatic and economic conditions. The all office inferred consumption was calculated at 218kWh/m² per annum which is in between the figure of 188kWh/m² but less than an alternate study undertaken in Cape Town by Drew Carey Associates for a UNEP energy efficiency campaign (2009) which recorded a figure of 298kWh/m².

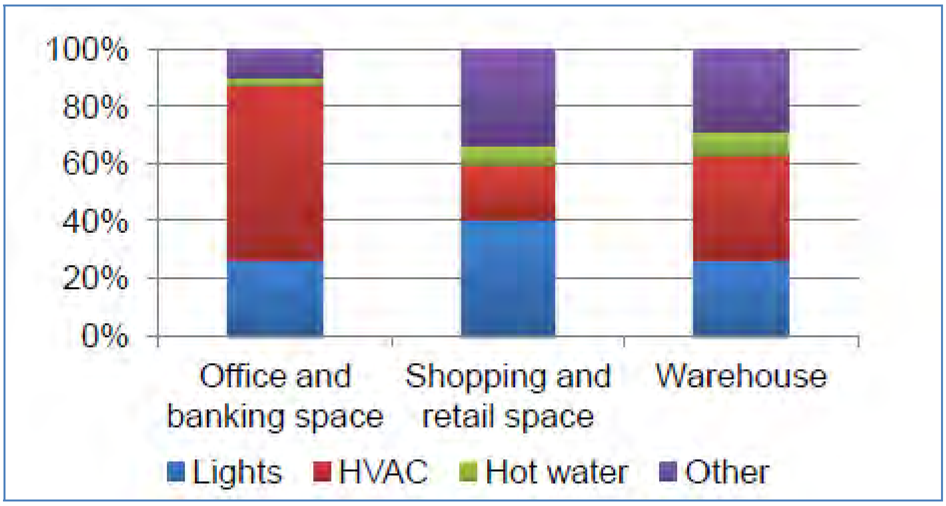
A third benchmarking study was identified, The Energy Barometer Report. This is a commercial initiative whereby companies enrol into the programme and provide specified data. This data is processed and the company is then given their energy intensity and a rating which they can then use to compare their performance against their peers. Categories included in the programme are hospitals, offices, shopping centres, bank branches and hotels.

Reports for all three benchmarking approaches have been included as supporting documentation.

Load Profile

Figure 41 is sourced from a presentation made at the Department of Energy's colloquium of integrated energy planning (2012) provided the following breakdown of how energy is used, on average, in offices, retail and warehousing.

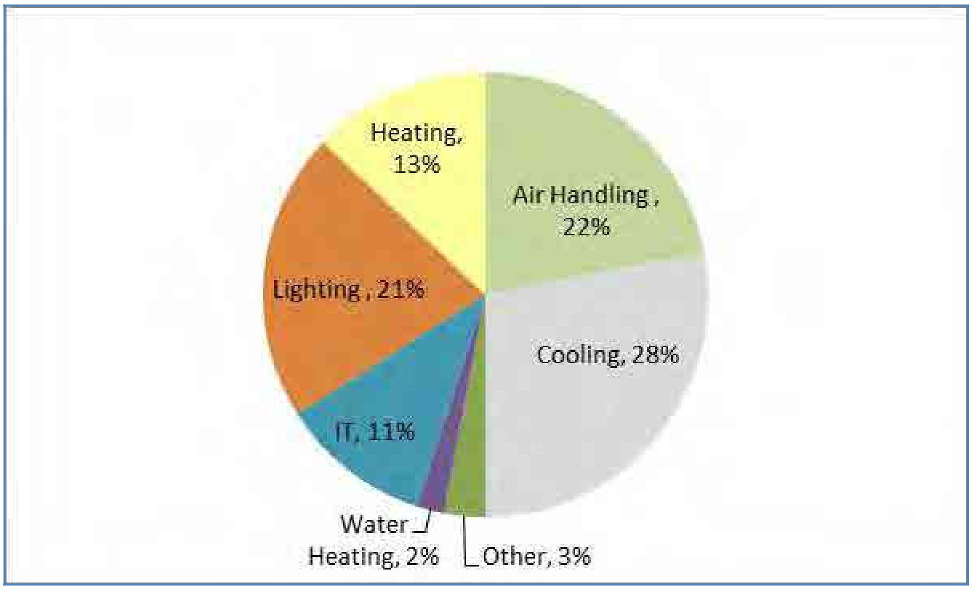
Figure 41: Estimated Energy Usage by Sub-Sector



In contrast to the above, The Green Building Council of South Africa (GBCSA) has broken down energy consumption in offices as shown in Figure 42. These figures are based on Australian surveys but they believe that they are very comparable to South African conditions.

30 Performance Benchmarking: analysis of Retail and Office Properties' Electricity Consumption, Andre Ferreira, 2011

Figure 42: Estimated Energy Usage - Offices



Source: GBCSA and GCX Energy Audits

Final Comment

A report on 'Greening the Built Environment'[31] which is linked to the GBCSA findings in Figure 48 found the following opportunities for energy efficiency in the commercial environment:

Lighting: The building stock in general has not been designed to use natural light and what is available is not usable. The artificial light is typically outdated technology and inefficient. In addition to this there are no control systems and it is left up to staff to switch off lights resulting in them being in use for longer periods. The most typical inefficient lighting found in South African buildings include:

- 3 X 1.2m T8 Magnetic Ballast 123W
- 2 X 1.5m T8 Magnetic Ballast 126W
- 3 X 0.6m T8 Magnetic Ballast 66W
- 50W Halogen Down Lights with Magnetic Transformers 57W

HVAC: Many different types of HVAC systems are found throughout the country. There are many examples of high efficiency equipment being used but again many have low efficiency units. The most common inefficiencies found are:

- Incorrect matching of supply and demand
- Poor control and maintenance
- Multiple split units to cool a building
- Damaged temperature and air flow sensors
- IT Systems – for example equipment being left on overnight

Water Heating: Although a small percentage of total consumption, geysers are not insulated or controlled with unnecessarily high set points.

Energy Audits and Behavioural Change: There is low understanding of energy and a general distrust of new technology, which is often warranted. The use of credible

[31] Greening the Built environment, Ken Ross, 2010

professionals to do energy audits, identify opportunities, make technology recommendations and train staff cannot be over-emphasised.

In conclusion, South Africa is undergoing a difficult period of adjusting to the reality that cheap energy, specifically electricity, is coming to an end. The cheap supply of electricity over many years has resulted in energy being taken for granted with high levels of inefficiency and waste. This should present an opportunity for all commercial companies to invest in energy efficiency to reduce their costs and improve their competitiveness.

3.12 Supporting Documentation

The following reports and supporting documentation have been provided to support and add to this section of the report:

Energy Audits

- Original reports provided by ERO for Commercial building, Hospitals, Hotels, Industrial building, Prison, Resorts, Shopping Centre and Schools

Benchmarking Studies

- Establishing Energy Benchmarks for Commercial Buildings in the City of Cape Town;
- Energy Performance Benchmarking; and
- Energy Barometer

Relevant and Useful Reports

- Eskom Tariff Breakdown
- Energy Digest 2009, Department of Energy

4 Transport Sector

4.1 Overview

South Africa's industrial heartland, unlike most countries which have a coastline, is located inland. Almost 35% of the country's GDP is generated in the Province of Gauteng yet it covers 1.4% of the land area[32]. The majority of the country's mining, manufacturing and financial sectors are situated within or very close to Gauteng, with Johannesburg at the epicentre. The country's transport network, of road, rail and air, tends to spokes outwards from Gauteng, as shown in Figure 43.

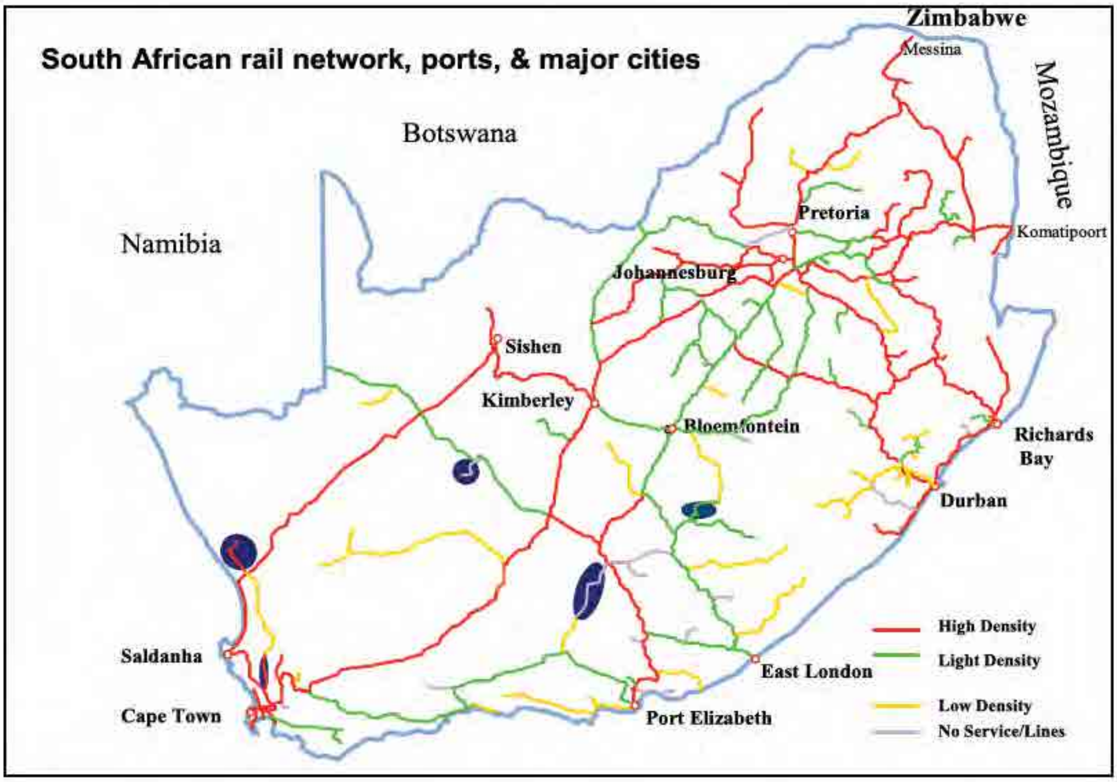
In addition, distances between cities are sizable. South Africa accounts for 0.4% of the world's total GDP, but 0.7% of the world's transport costs and 2.2% of the world's surface freight ton kilometres (road and rail combined). The country has approximately 700,000 kilometres of road but only 18,000 kilometres of rail track[33]. This imbalance means that the vast majority of people and goods rely almost exclusively on the country's roads to be transported, which contributes the country's high GHG emissions.

[32] http://www.info.gov.za/aboutsa/provinces.htm

[33] Transport and Climate Jobs, Jane Barrett Policy Research Officer SATAWU, 2011

It is estimated that transport accounted for 10% of the country's GHG emissions in 2011.

Figure 43: South African Rail Network, Ports and Major Cities



Source: SATAWU

The South African Transport and Allied Workers Union (SATAWU) estimates that 763,000 people were employed in the transport sector in 2011. This number excludes manufacturing and other downstream activities. Table 12 provide a detailed breakdown

Table 12: Direct Jobs in the Transport Sector, 2011

Description	Number
Road Freight	300,000
Taxi Industry (minibuses)	250,000
Ports	60,000
Rail and Rail Engineering	50,000
Bus	50,000
Aviation	50,000
Pipelines	3,000

Source: SATAWU

Official statistics, as at March 2011, by the Road Traffic Management Corporation[34] (RTMC) state that there are 8,686,032 registered vehicles in South Africa, with the breakdown given in Table 13. The RTMC records show that there were 776,275 un-roadworthy or unlicensed vehicles in 2011, compared to 791,721 in 2010. However, NAAMSAs view is that these numbers do not include vehicles which are not on the system and that the number illegal vehicles on the road is 1,5 to 2 million.

[34] http://www.rtmc.co.za/RTMC/Files/RTMC%20AR/RTMC%20AR%202010%20-%202011.pdf, page 35

Table 13: Registered Vehicles, March 2011

Description	March 2010	March 2011	% Change
Motorcars	5,472,090	5,675,488	3.72
Mini Buses	282,793	285,858	1.08
Buses	45,858	47,799	4.23
Motorcycles	367,162	331,271	(9.78)
Light Delivery Vehicles	1,965,316	2,025,074	3.04
Trucks	3,321,729	326,721	1.55
Other	231,084	234,337	1.41
Total	8,686,032	8,926,548	2.77

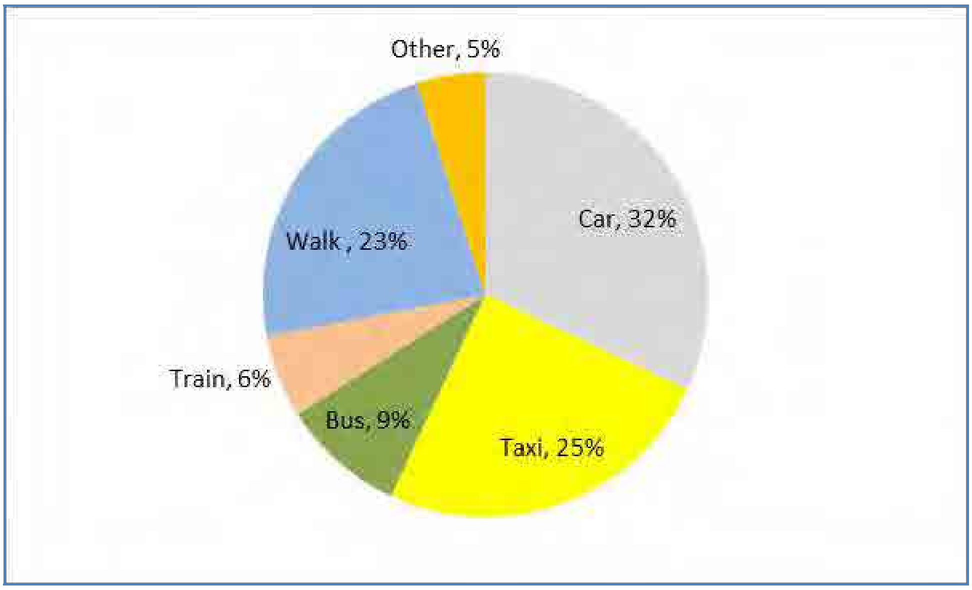
Source: Road Traffic Management Corporation

4.2 General Information on Transport in South Africa

Travel Habits

A national survey undertaken by the Department of Transport[35], which covered 50,000 households, was undertaken in 2003. At the time the population of the country was estimated to be just over 35 million of which approximately 10 million travelled regularly to work. Figure 54 shows the main mode of travel to work and Table 14 shows the reason for transport trips on the given week day.

Figure 44: Mode of Transport used to travel to work (2003)



Source: Department of Transport

Table 14: Main Trip Purposes, by Settlement Type

Settlement Type	% of household members naming trip prupose			
	Education	Shopping	Visit	Work
Metropolitan	32	36	28	37
Rural	37	32	31	31
Urban	51	23	27	16
RSA	41	30	29	27

Source: Department of Transport

Key complaints made against public transport were as follows: 24% the transport is too far or not available, 19% cited safety reasons (including driver behaviour) and a further 19% said it was too expensive.

[35] http://www.arrivealive.co.za/document/household.pdf

The survey also found a very high level of dissatisfaction with the quality of service offered by public transport – shown in Table 15.

Table 15: Dissatisfaction of Public Transport

Mode	Level of Dissatisfaction	Reasons	
Train	42%	Crowding	71%
		Security walk to stations	64%
		Security on trains	63%
Mini Buses	48%	Safety from accidents	67%
		Lack of facilities at taxi ranks	64%
		Unroadworthy vehicles	60%
Buses	33%	Lack of facilities at bus stops	74%
		Crowding on buses	54%
		Low frequency off-peak	51%

Source: Department of Transport

Traffic Congestion

Given the limited infrastructure of public transport and the high levels of dissatisfaction with services provided it is not surprising that the average citizen prioritises to buy a car, which is indeed the case. This growth in the ownership of privately owned vehicles and the prevalence of low occupancy vehicles on the country's roads has resulted in high levels of congestion. The following summarises the situation[36]:

'The most congested cities and towns in South Africa, in order of levels of congestion, are Johannesburg, Cape Town, Benoni, Tshwane, Boksburg, Alberton, and Rustenburg. An estimated 8 million vehicles travel on our roads daily and this figure is growing by a staggering and unsustainable 20% every year. In 2007, the CEO of Sanral, Nazir Ali was quoted as stating that if traffic continues to grow at this pace, by 2027 an impossible 36 lanes would be required on the N1 linking Johannesburg and Pretoria (Ben Schoeman Highway). According to the 2011 South African Tom Tom Traffic Survey, traffic jams are costing South Africa R1.1 billion a month in lost time spent in traffic jams. This is an annual cost of R13.2bn. 78% of Johannesburg's 3.8 million drivers are stuck in severe traffic on a regular basis causing about 342,000 people to regularly cancel meetings and more than 40% of employees who commute by car to arrive at work late. 75% of motorists surveyed reported experiencing high levels of stress due to traffic, with large numbers reporting stress-related illnesses, demotivation and/or exhaustion directly linked to their driving experiences.'

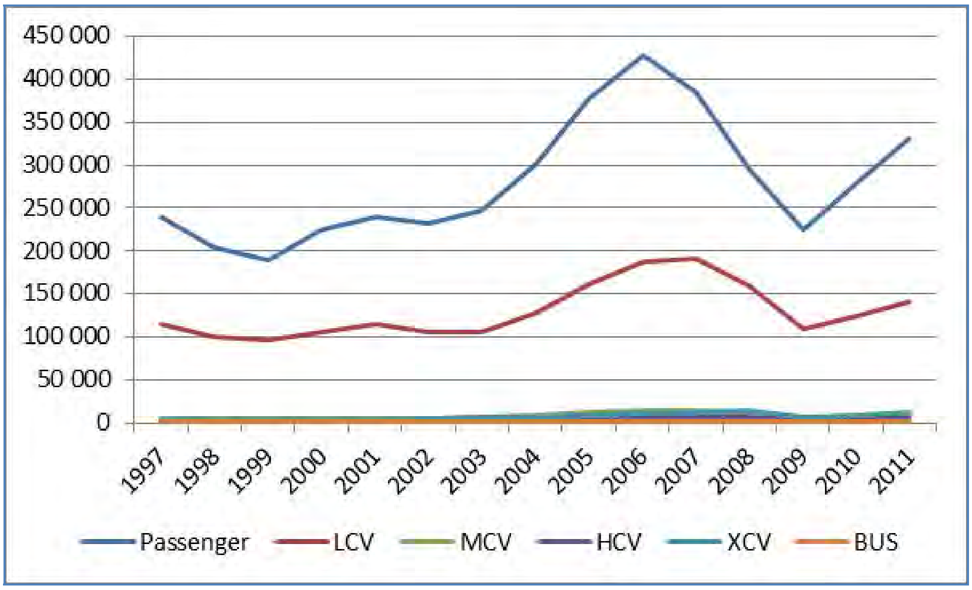
The annual sales figures of vehicles from 1997, and shown in Figure 45, demonstrate the unsustainable growth that the industry experienced from 2002. The global financial crisis (2007) shows just how sensitive and linked vehicle sales are to the national economy. Figure X also provides supporting evidence that the purchase of a vehicle is a one of the highest priorities for individuals.

NAAMSA expects vehicle sales are expected to grow between 6-8% in 2012. At the time of writing this report the July 2012 sales recorded an 18.3% year on year growth '*surging entry-level new car sales, buoyant demand for taxis and light commercial vehicles, and car-hungry rental companies were behind a remarkable 18.3% year-on-year increase in new vehicle sales last month, the National Association of Automobile Manufacturers of South Africa (Naamsa) said today.*'[37]

[36] Transport and Climate Jobs, Jane Barrett Policy Research Officer SATAWU, 2011

[37] http://www.businessday.co.za/articles/Content.aspx?id=177591

Figure 45: Annual Vehicle Sales, 1997 - 2011



Source: NAAMSA

Table 16 was drawn from a study commissioned by SANEDI[38] shows how uneven the distribution of vehicles is in South Africa. The province of Gauteng dominates with a density of 314 vehicles / thousand inhabitants, which is almost double the national average. The study also finds that new vehicles sales tends to track the nation's GDP, with the average growth being between 3-4% in recent years. Although the per capita vehicle ownership is still low in South Africa, even for Gauteng at 314 vehicles it is still significantly lower than industrialised countries where the range is 500 – 800 vehicles per thousand inhabitants. This does raise concerns requires planning should the figures start increasing towards international norms, especially for Gauteng which has the lowest land area but the highest density (population and vehicle).

Table 16: Vehicle Density per Province

Province	Population (2011)	Total Vehicles[39] (Dec 2011)	Share of Vehicles (%)	Motorisation (veh/1000)	Contribution to GDP	Land area (%)
Eastern Province	6,829,958	628,529	7%	92	7.7%	13.8%
Free State	2,759,644	478,546	5%	173	5.5%	10.6%
Gauteng	11,328,203	3,560,678	39%	314	33.7%	1.4%
Kwazulu-Natal	10,819,130	1,268,984	14%	117	15.8%	7.7%
Limpopo	5,554,657	474,225	5%	85	7.2%	10.3%
Mpumalanga	3,657,181	585,628	6%	160	7.0%	6.3%
Northern Cape	1,096,731	195,094	2%	178	2.3%	30.5%
North West	3,253,390	457,286	5%	141	6.7%	8.7%
Western Cape	5,287,863	1,485,018	16%	281	14.1%	10.6%
TOTAL	**50,586,757**	**9,133,988**	**100%**	**181**	**100%**	**100%**

Source: eNatis

[38] Quantifying the energy needs of the transport sector of South Africa, Energy Research Centre, July 2012

[39] www.enatis.com This report and updates can be accessed by clicking here: http://www.enatis.com/newsite/index.php?option=com_content&view=article&id=261:vehicle-population-statistics-year-on-year-comparison-for-2010-and-2011-&catid=13:live-vehicle-population&Itemid=19

Breakdown of Passenger Vehicles

Using AMPS data Table 17 gives a breakdown of how vehicles are distributed across LSM 5-8. Table 18 lists the weighted by sales volume average price for each segment and Figure 46 the weighted average fuel consumption for passenger vehicles.

Table 17: Household Ownership of Passenger Vehicles

Category	Number of HH All LSM (000)	Number of HH LSM 5-8 (000)	Penetration Rate All HH LSM1-10 (%)	Penetration Rate LSM 5-8 (%)
No motor vehicles in HH	9,217	5,386	65.5	66.2
One motor vehicle in HH	3,031	2,047	21.4	26.5
Two motor vehicles in HH	1,341	481	9.5	5.9
Three or more motor vehicles	485	122	3.4	1.5

Source: AMPS

Figure 46: Weighted Average Passenger Vehicle Sales – Consumption (l/100km)

Table 18: Weighted Average Price of Passenger Vehicles by Segment

NAAMSA Standard	Type	Segment Weighted Average Price - July 2012 (ZAR)
A - Entry	TOYOTA Etios	126 647
	VW Polo Vivo	
	FORD Figo	
	RENAULT Sandero	
	CHEV Spark	
AB - sub-Small	VW Polo	172 886
	CHEV Sonic	
	TOYOTA Yaris	
	FORD Fiesta	
	CHEV Aveo	
B - Small	TOYOTA Corolla	248 433
	BMW 1-Series	
	VW Golf/Jetta 6	
	CHEV Cruze	
	FORD Focus	
C - Medium	BMW 3-Series	393 629
	MERCEDES C-Class	
	AUDI A4	
	LEXUS IS	
	VW Passat	
D - Large	MERCEDES E-Class	560 003
	BMW 5-Series	
	VOLVO S60	
	AUDI A5 Coupe/Cabriolet	
	JAGUAR XF	
E - Luxury	PORSCHE Panamera	1 106 028
	BMW 6-Series	
	MERCEDES S-Class	
	BMW 7-Series	
	AUDI A8	
F - MPV	TOYOTA Avanza	283 726
	MERCEDES B-Class	
	CHRYSLER Voyager	
	TOYOTA Innova	
	MAZDA 5	
G - SUV	TOYOTA Fortuner	489 455
	CHEV Captiva	
	L-R Discovery 4	
	VW Tiguan	
	JEEP Grand Cherokee	
SE - Sport and Exotics	PORSCHE 911	516 732
	BMW Z4	
	MERCEDES SLK	
	PEUGEOT RCZ	
	AUDI TT	
X - Crossover	NISSAN Qashqai	340 450
	NISSAN Juke	
	DODGE Caliber	
	MITSUBISHI ASX	
	AUDI Q3	

4.3 Transport Strategy

It is evident that the country cannot continue on a path where every member of the population aspires to own and operate a vehicle. This has been recognised by the Government of South Africa, as stated in Section 1, where its primary focus has moved from 'affordable' to 'public and safe' transport. The following section provides an overview of some of the initiatives being considered or implemented.

4.3.1 Public Transport Strategy (2007 – 2020)

The strategy [40], which was made public in March 2007, has two 'key thrusts': Accelerated Modal Upgrading and Integrated Rapid Public Transport Networks (IRPTN).

Accelerated Modal Upgrading

This refers to initiatives to transform bus, taxi and rail service delivery in the short to medium term. Some of the initiatives proposed include:

- Taxi recapitalization programme which provides states assistance to upgrade old and unsafe vehicles;
- Consolidating the passenger rail sector;
- Upgrading bus services and vehicles;
- Extending the frequency and hours of operation; and
- Improving and upgrading taxi ranks and bus stops

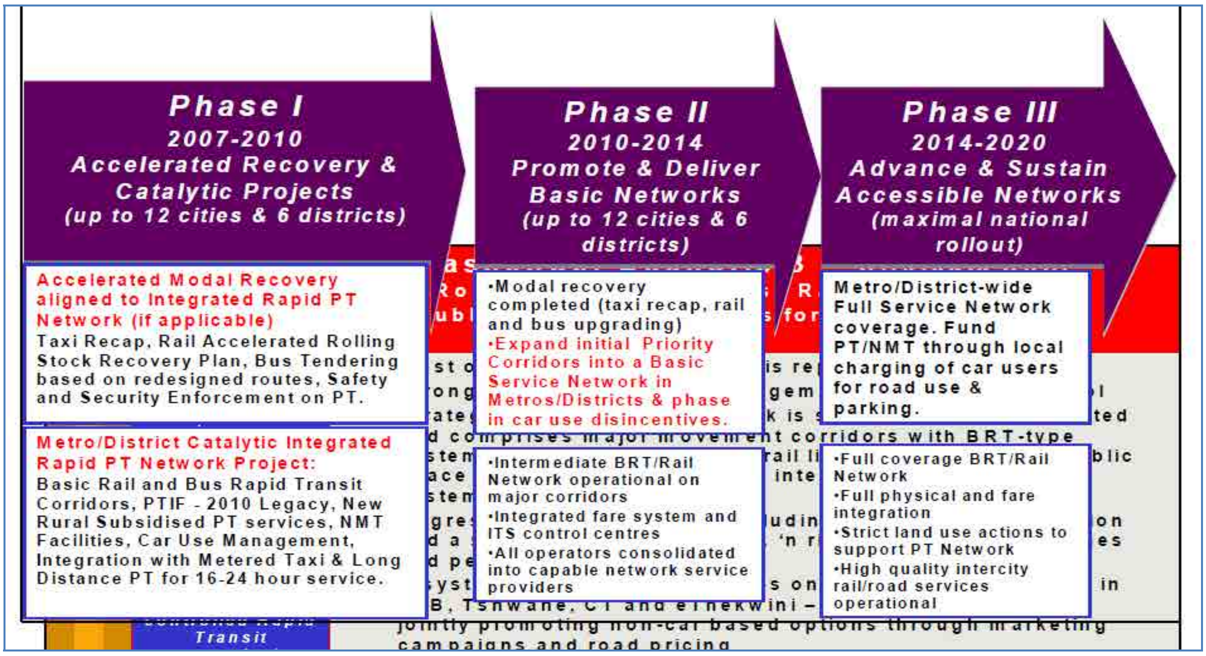
IRPTN

The strategy aims to achieve a 'phased but accelerated' implementation with operating systems in place for 12 cities and at least 6 rural districts by 2014. The longer-term vision to 2020 is to develop a system that places over 85% of a metropolitan city's population within 1 kilometre of an IRPTN trunk (road and rail) or feeder (road) corridor. A further goal for 2020 is a mode shift of 20% of car work trips to public transport networks.

Figure 47 provides a diagrammatic representation of the planned implementation schedule of the Strategy. Although there are numerous other programmes being discussed, planned or tested at national and provincial level, the Public Transport Strategy is the official plan which is being implemented and funded by Government.

[40] http://www.info.gov.za/view/DownloadFileAction?id=127080

Figure 47: Phased Stratrgy Public Transport Strategy 2007-2020



Source: Department of Transport

4.4 Road Transport

South Africa extensive road network requires high levels of maintenance and upgrading as it is the primary mode of transport of both passengers and freight. The South African National Roads Agency Limited (SANRAL) is responsible for the national road network of 16 750 km. About R70 billion was budgeted in 2007 for road infrastructure, maintenance and upgrading and an additional R3 billion for the Expanded Public Works Programme for access roads, all of which is an attempt by government to alleviate traffic congestion while creating jobs. As upgrades and improvement projects are continuous they are not listed in this report but can be found in the National Roads Agency Strategic Plan 2012 – 2017[41].

4.5 Concluding Comment

South Africa has come to rely almost exclusively on its road transportation system for the transport of people, freight and services. As a result 28% of final energy consumed by the country is for transport – 97% of which is liquid fuels. Even with large investments in the road infrastructure the situation is likely to become untenable sooner rather than later. South Africa also imports almost all of its fuel which has a negative impact on its foreign reserves. The Government is aware of the situation and has formulated the Transport Strategy to address the problem – but even so this may be too little too late and there are signs that further action will be taken, for example a R35 billion investment to expand and upgrade the state owned freight logistics group, Transnet between 2013 – 2019 is likely to be increased. [42] A key component of the strategy must include the implementation of energy efficiency interventions to reduce

[41] http://www.nra.co.za/content/Strategic_Plan__2012_13_2016_17~1.pdf

[42] newsletters.creamermedia.co.za/servlet/link/14/48799/241501/1115627

existing and remaining consumption. For example, high traffic volumes and unsynchronised traffic lights in large cities result in 'stop-start' trips and larger than necessary traffic jams which waste time, increase travel times and passenger frustration with avoidable emissions and higher fuel usage.

4.6 Supporting Documentation

The following reports and supporting documentation have been provided to support and add to this section of the report:

Modelling Tool

- Tool developed by NAAMSA which predicts future vehicle, emissions and emission levels based on future growth estimate scenarios

Vehicle Statistics

- Four files (excel) which provide historic data for all vehicle types found in South Africa. It includes fuel consumption and emissions; and
- Official Statistics of Vehicle Population – December 2011

Relevant and Useful Reports

- Results of National Household Travel Survey (2003);
- Public Transport Strategy (2007); and
- Road Traffic Management Report (2010/11)

5 Annexes

5.1 Quantitative Analysis

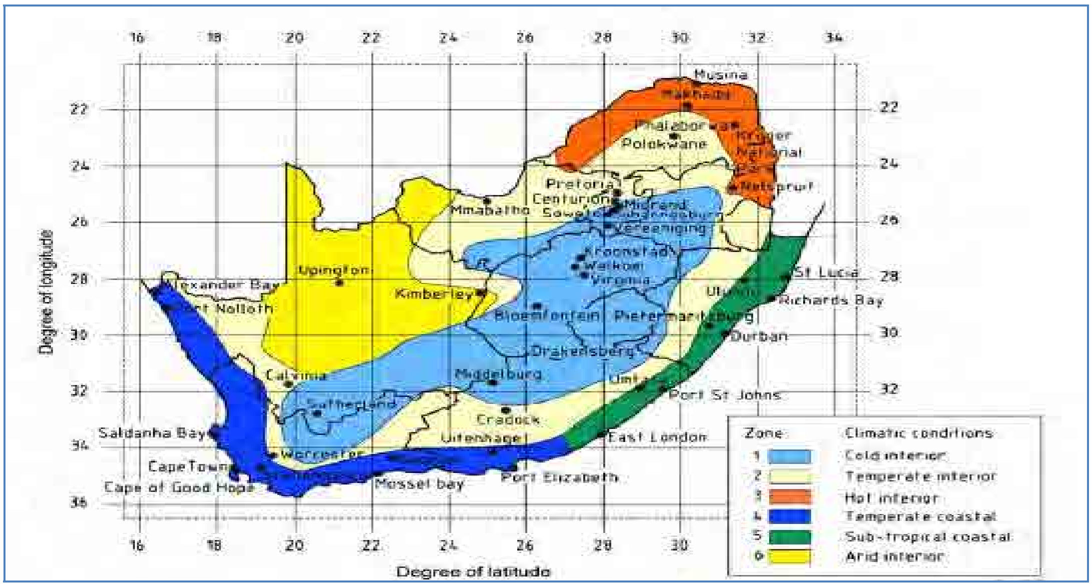
5.1.1 Methodology

A quantitative methodology was employed. Respondents were interviewed using a face-to-face CAPI (computer assisted personal interviews) approach. KLA uses Galaxy tablets to conduct their personal interviews.

5.1.2 Sample

The sample was selected to be representative of the South African population as informed through the All Media and Products Survey (AMPS) data 2011. Two major metropolitan areas were selected to represent the sample, due to the different climactic zones present, where Johannesburg is classified as 'cold interior' and Durban is subtropical. South Africa has six climatic zones which are shown in Figure 48.

Figure 48: South African Climatic Zones



Source: SANS 204

The SAARF Living Standards Measure (LSM) has become the most widely used segmentation tool in South Africa, and is endorsed by the Southern African Market Research Association (SAMRA). The SAARF LSM divides the population into 10 LSM groups, based on various living standards criteria (such as degree of urbanization and ownership of cars and major appliances) where LSM 1 is the most basic and LSM 10 is the most sophisticated and effectively also indicates the most affluent. A detailed breakdown of each classification has been provided as an Annex[43].

Race was quota'd to be representative of the South African population, while LSM, Age and Gender were quota'd to allow for an even split across the stratifications, which allowed for reliable analysis across these demographics

[43] LSM Description 2012 (www.saarf.co.za)

This study employed a quantitative, face-to-face, CAPI (Computer Assisted Personal Interview) methodology. Within this methodology, respondents are approached in public areas such as malls, shopping centres, taxi ranks etc. Respondents are screened to ensure that they fit within the demographic criteria and the specified quota's. Respondents who fit into the required quotas are then interviewed. The structure of the sample of people interviewed in this survey, as defined by the various demographic splits, is represented in Table 19.

Interviews are conducted using Android Tablet devices. Responses are then captured onto the device and sent through to a central system, allowing researchers to monitor the progress of fieldwork as and when interviews are conducted.

Table 19: Survey Sample Structure

Demographic type	Demographic	% as represented in the sample	Count (n: 415)
Race	Black	84%	348
	White	8%	35
	Indian	5%	22
	Coloured	2%	10
LSM	5 -6	58%	240
	7 - 8	42%	175
Gender	Female	52%	217
	Male	48%	198
Age	18 - 34	50%	207
	35 +	50%	208
Region	Johannesburg	62%	258
	Durban	38%	157

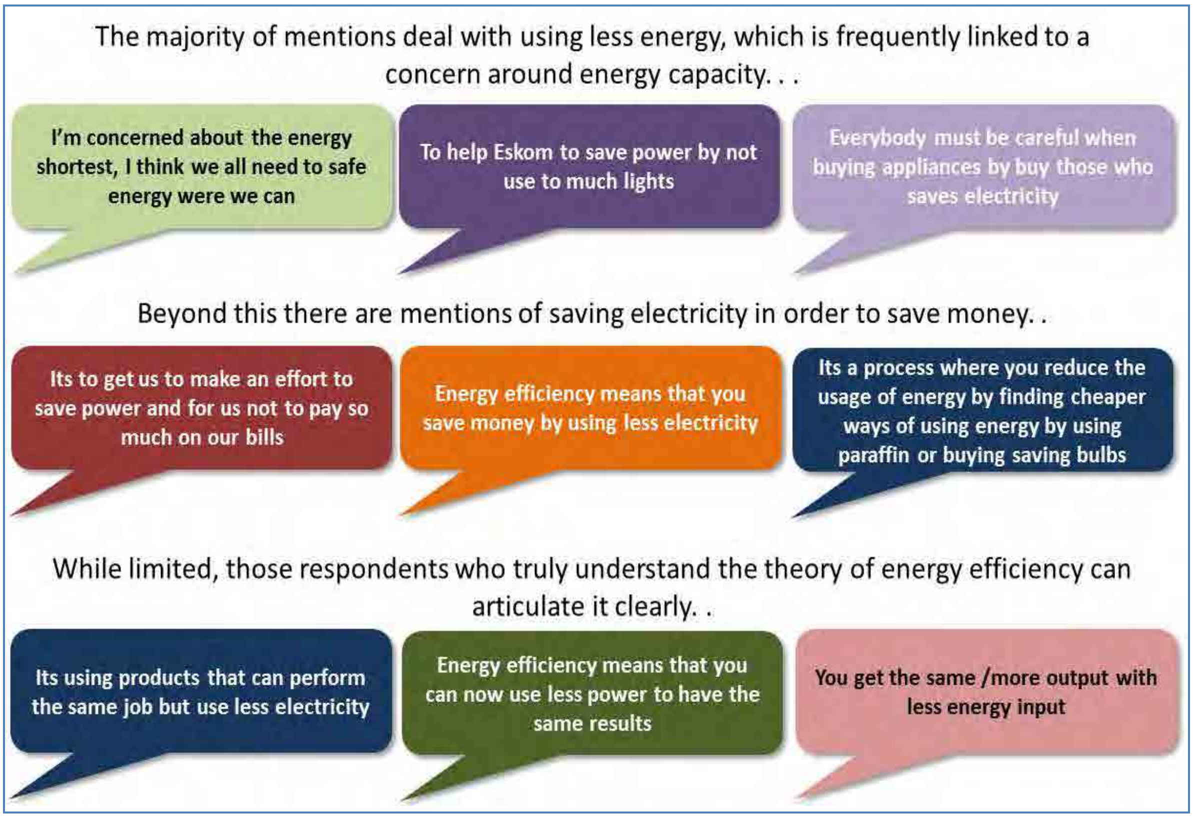
5.1.3 Results

Energy Efficiency in Context

Understanding of 'Energy Efficiency'

When asked to define 'energy efficiency', the concept is understood at a very generic level, with the majority citing "*using less energy or electricity*" in explanation of the term. Understanding of "*using less energy to get the same results*" is articulated at very low levels, indicating a need for market education around the concept of energy efficiency. Once consumers are in a position to fully understand what energy efficiency means, there is greater potential for a behavioural shift within this context. Figure 49 provides examples of some of the responses received.

Figure 49: Selected responses to Understanding of Energy Efficiency



<u>Attitudes towards the energy crisis</u>

A high awareness of the energy crisis is evident, and with this, there is strong awareness and understanding of the need to save energy, and the need to change personal behaviour in this light. While a concern for the country and for Eskom's predicament is evident, respondents tend to make the link between saving energy and saving money. Throughout the study, a trend is evident whereby the more energy saving has a personal impact on consumers (and on their spend), the more engaged they are with the process.

<u>Electricity Billing</u>

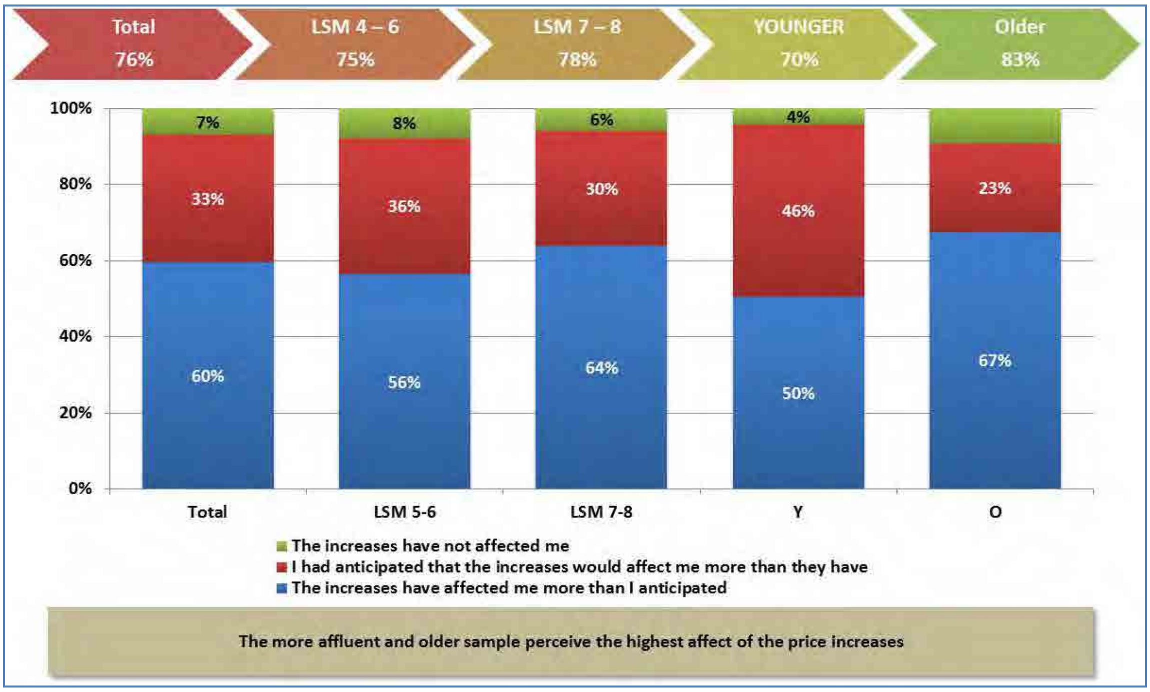
A high distrust of the billing process is evident. Consumers don't appear to fully understand how they are billed, both in terms of what is owed and how this is calculated, although the calculation elicits lower understanding as compared to what is owed. At a total level, 6% of respondents do not look at their bills at all. This trend is seen most strongly in the older sample who are the most disengaged from the concept of energy efficiency.

<u>Perceptions towards Billing and Usage</u>

Within this context, there is a very high incidence (61%) of people feeling that they are being over-billed. Electricity price increases are strongly noted at 76%, with the majority claiming that these increases have affected them more than anticipated. Due to the effect these increases have had, electricity monitoring has become far more stringent over the past 4 years, and consumers are generally much more careful with their electricity usage.

This again highlights the trend that where a personal impact is felt, the likelihood of changing behaviour is greater, demonstrated in Figure 50 below.

Figure 50: Awareness of Electricity Price Increases

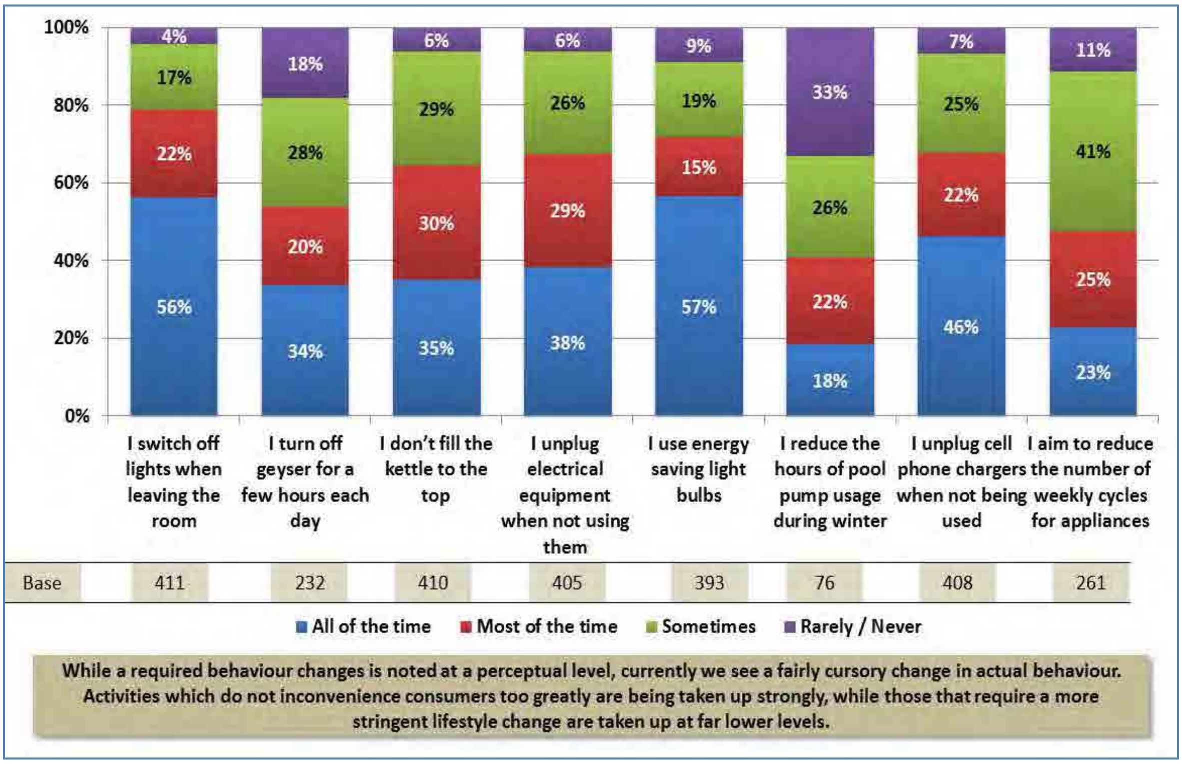


Energy Saving Behaviour

<u>Activities in Home</u>

In keeping with an understanding that personal behaviour needs to change, everyday activities such as turning off lights and using energy savings bulbs are taken up at fairly high levels. The less affluent and younger sample, display the highest incidence of these everyday behaviour changes. We see a lack of engagement amongst the more affluent sample – while these respondents do notice electricity price increases, the impact on their lives is evidently not strong enough, and thus the incentive for real behavioural change is lower. The energy saving activities undertaken by each group is shown in Figure 51.

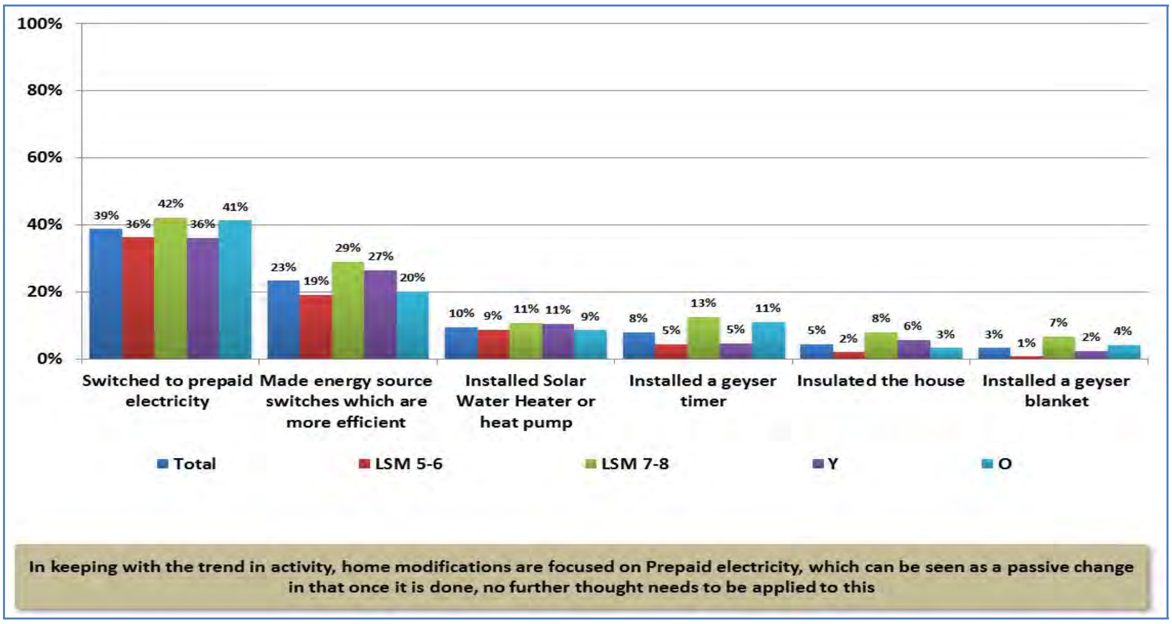
Figure 51: Energy Saving Activities



Home Modifications

Home modifications are by no means yet the norm. The respondents who appear the least engaged in everyday activities are also the respondents who display the highest incidence of having changed to prepaid electricity. This is indicative of a trend whereby consumers, who can afford to, are more inclined to make a once-off change with a higher cash outlay but lower hassle factor, as opposed to making smaller everyday changes. The mentality here is one of "I have done my bit, and I have solved my personal problem. Now I don't need to worry about the energy crisis". Figure 52 shows what each group are prepared to do.

Figure 52: Energy Saving Modifications Made to Home



Activities in the Workplace

While behaviour is changing in a personal space, active engagement in a work space is limited, due to activities having less of a personal and financial impact. Beyond this, energy saving behaviour in communal spaces is even less prominent. We see again, that where a personal impact is perceived, energy saving behaviour is more prominent and consumers are more engaged with finding ways to reduce their electricity usage and spend. As personal impact decreases, so too do efforts to save energy.

Transport and Vehicle Ownership

Mode of Transport

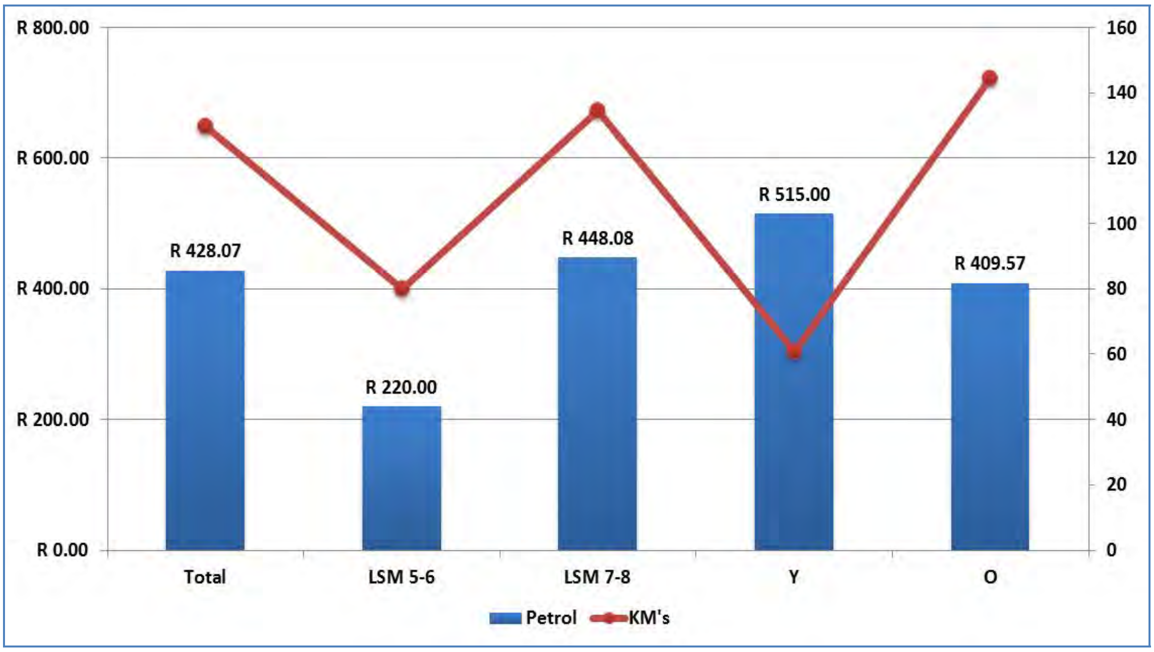
The majority of the sample (75%) uses public transport, predominantly taxi's. Of those who own a vehicle, the majority own small passenger vehicles. Very low incidence of diesel cars is noted (8% of total vehicle ownership), with no ownership of hybrid cars.

Mileage and Petrol Spend

There appears to be a disconnect between perceived petrol spend per week, and kilometres travelled, which begs the question as to which metric vehicle owners are actually paying more attention to. The assumption is that petrol price spend is more accurate, while kilometres travelled are not read or recorded accurately.

Both items are shown in Figure 53.

Figure 53: Average Petrol Spend and Distance Travelled



Petrol and Diesel Price Increases

The increase in petrol price is noted at 69%, with respondents citing making fewer trips and sacrificing other areas of spend as the key behavioural changes in addressing the increase.

Appliances

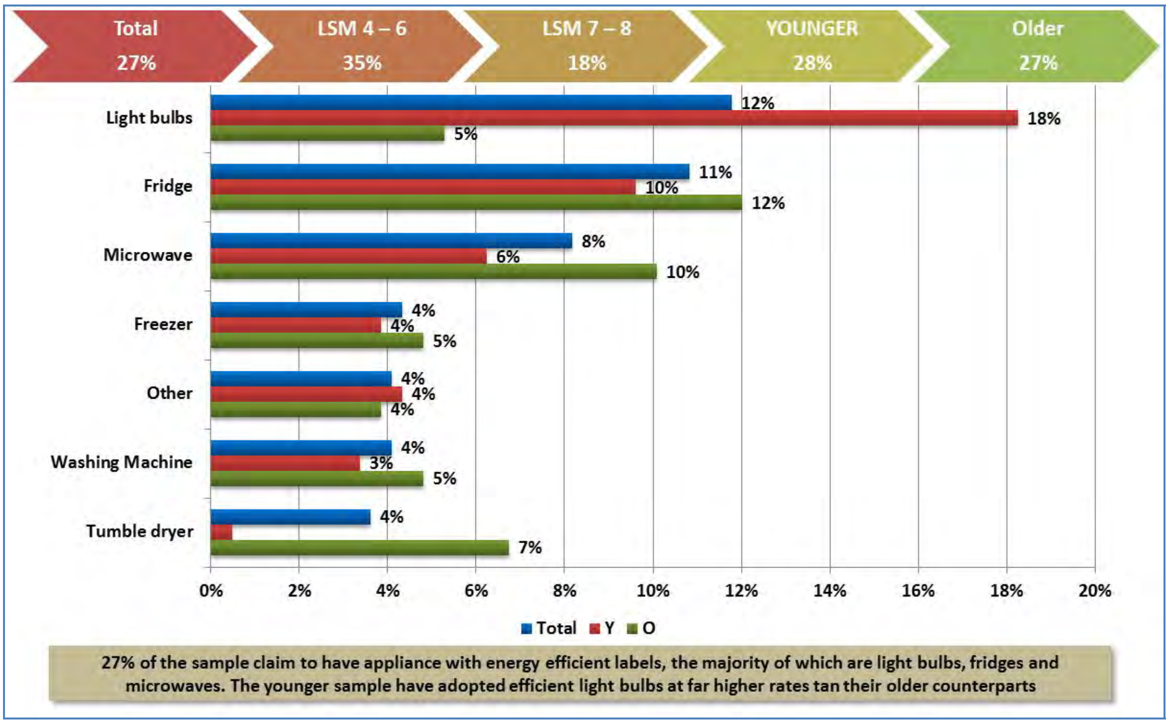
Understanding of 'Energy Efficient Appliances'

Understanding of energy efficiency within the context of an appliance speaks to using less electricity than another appliance, or to using less energy to get the same result. Where on a conceptual level, "energy efficiency" was understood in generic terms, the concept is better understood when applied to an appliance. Once consumers have understood and bought into the benefit of an energy efficient appliance, this could be used in leveraging education around energy efficiency at a broader level.

Energy Efficient Appliances in Home

The incidence of having energy efficient appliances in the home is still quite low, at 27% on a total level, shown in Figure 54. This is driven predominantly through energy saving light bulbs, although fridges and microwaves are the most prominent large appliances that have energy savings labels. The younger sample drives ownership of energy efficient appliances, which is in keeping with their far higher engagement with the energy crisis and the need to change personal behaviour in combatting this.

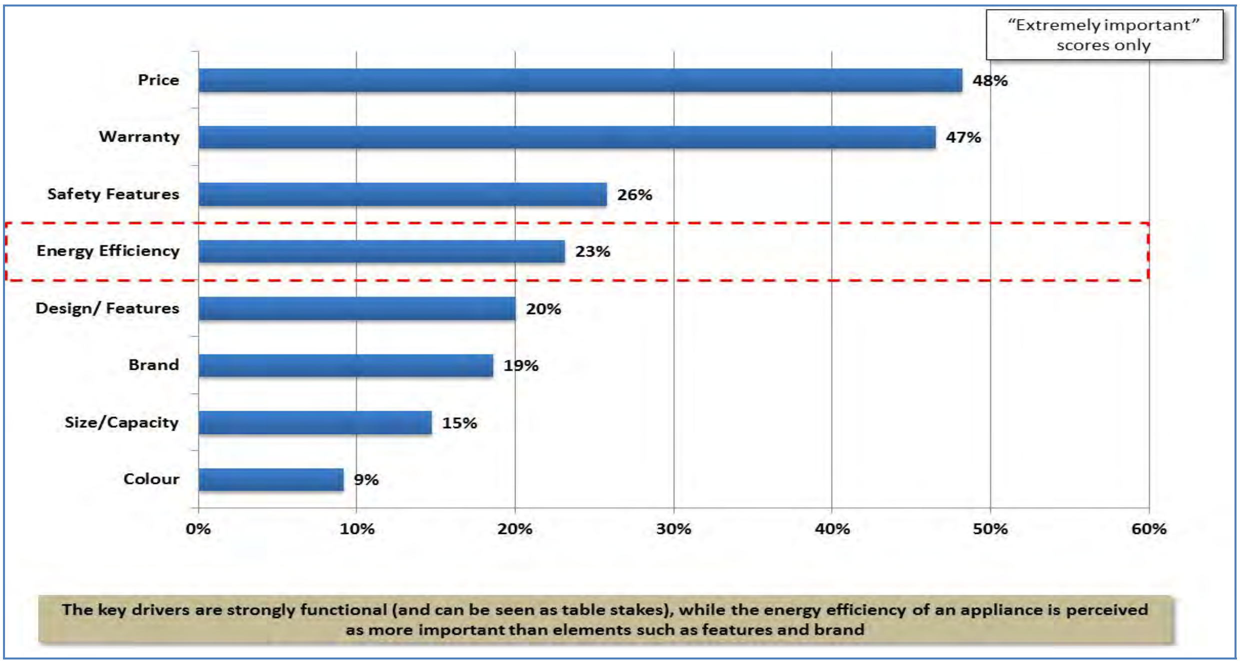
Figure 54: Appliances with Energy Efficient Label in Home



Appliance Purchase Drivers

As expected, price is the key driver to appliance purchase choice. Warranty is of key importance as well. Energy efficiency comes in as the fourth most important driver, indicating that there is awareness of the long-term benefits of purchasing an energy efficient appliance. As buy-in to the benefit of energy efficient appliances increases, so too should the relative importance of energy efficiency when purchasing a new appliance. The various decision making criteria are shown in Figure 55.

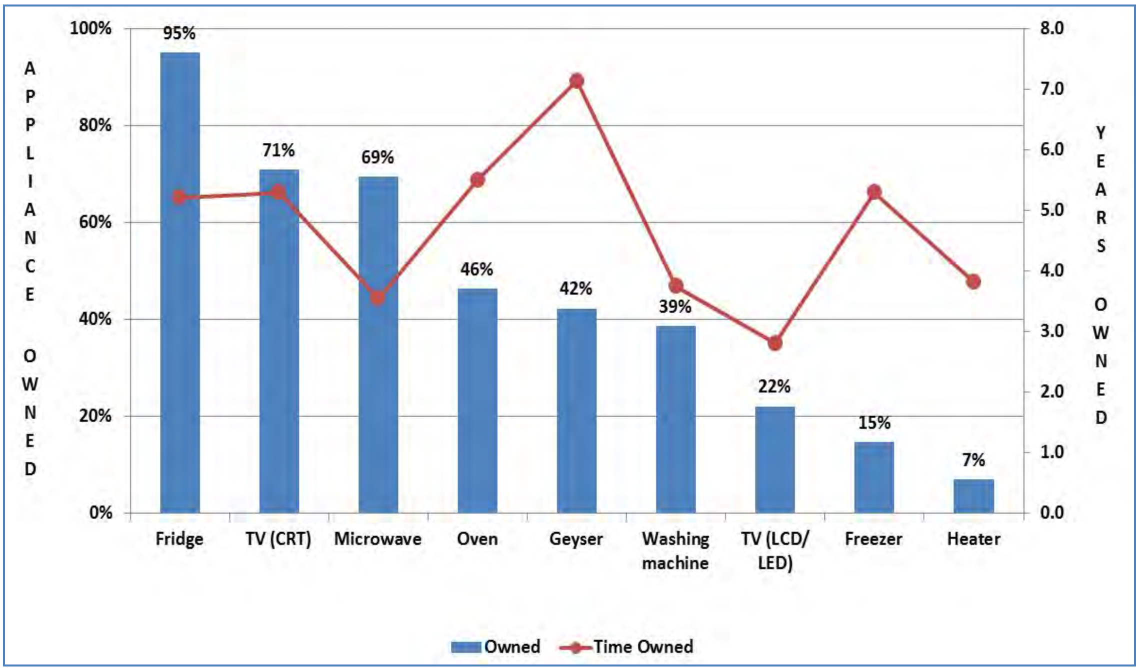
Figure 55: Criteria used in Purchase Making Decision for Appliances



<u>Appliances in Home</u>

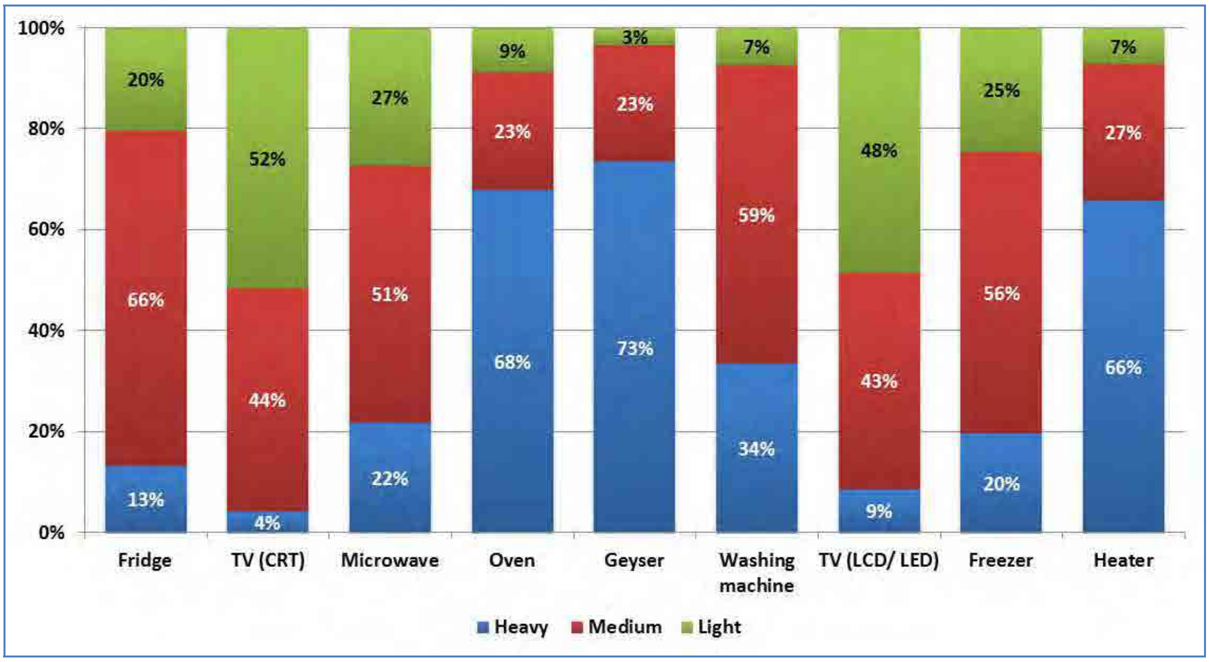
Fridges, followed by CRT TV's and microwaves are the most commonly owned appliances. Ovens and geysers are owned predominantly by the more affluent sample. These two appliances are also perceived as using the highest amount of electricity. Figure 56 provides the full list.

Figure 56: Appliances in Home – Total



The perception that geysers use the most electricity, while accurate, is clearly driven through the communication regarding switching off geysers when not in use. Figure 57 gives the perceived energy consumption of selected appliances.

Figure 57: Perceived Energy Usage per Appliance



Future appliance purchase

Washing machines drive future purchase intent, while geysers and ovens are cited strongly as a subsequent desired purchase, after the more ‘essential’ washing machine and microwave.

Communications and Promotions

Interest in Energy Efficiency Communication

Claimed interest in finding out more about energy efficiency and savings is high at 75% on a total level. Interest is significantly higher in the younger sample (84%) as compared to the older sample who only displays an interest at 64%. Mass media is cited as the most preferred channels for education and communication. It is evident that a two-tiered communication approach is required; mass media is required to inspire the nation to pull together in assisting with the energy shortage. However, a more tactical, ‘on-the-ground’ approach is required to underpin the mass media.

In store activity promoting Energy Efficiency

In store activity promoting energy efficiency is not strongly noted. Promotions around energy efficiency are noted higher than salespeople promoting appliances due to their energy efficiency credentials, with only ¼ of the sample having been exposed to this. There is a higher incidence of energy efficiency activity in stores catering to the less affluent market.

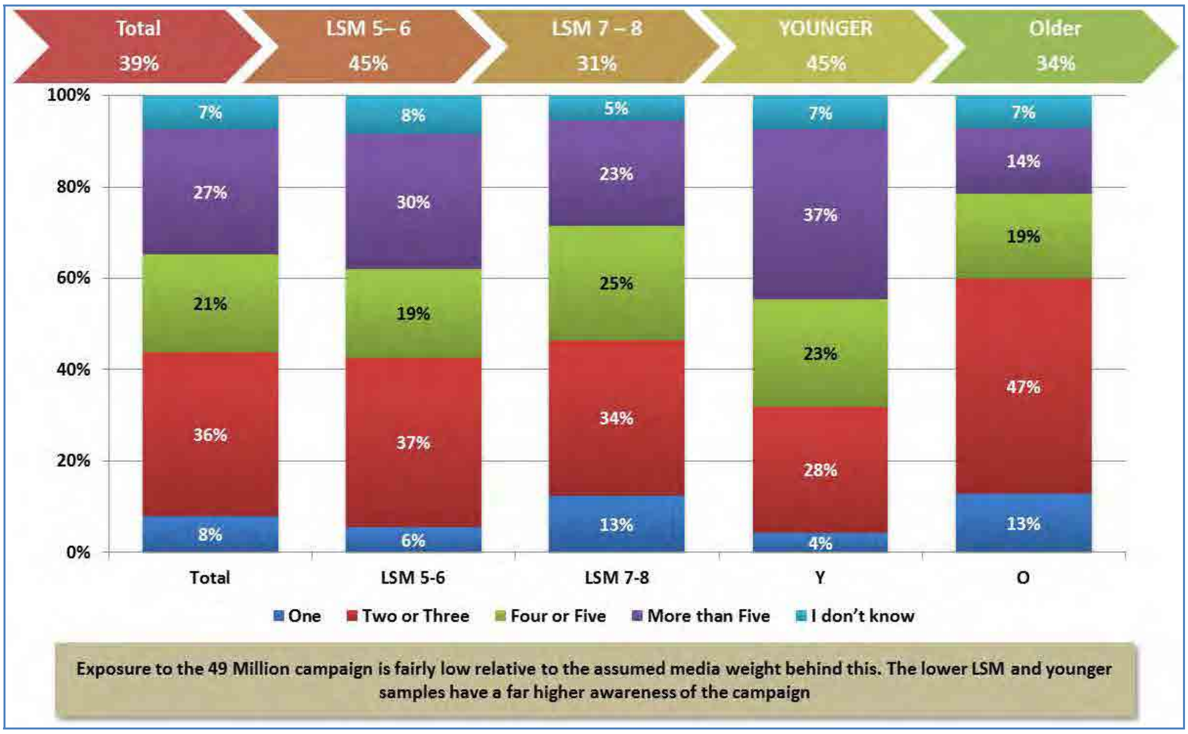
Eskom Communication Awareness

Claimed awareness of Eskom communication is at 68%. Again, the younger sample displays a far higher awareness of Eskom branded communication at 80% (as opposed to the older sample at 55%). Awareness is driven predominantly through TV, Radio and print media (newspapers and magazines).

Eskom 49 Million Campaign Awareness

In contrast to the relatively high brand awareness, awareness of the 49 Million campaign is lower, at 39% at a total level – shown in Figure 58. For those aware of the campaign, claimed frequency of exposure is fairly high, ranging between 2 to more than 5 times that of respondents who have seen or heard the campaign.

Figure 58: Eskom's *'49M'* Campaign

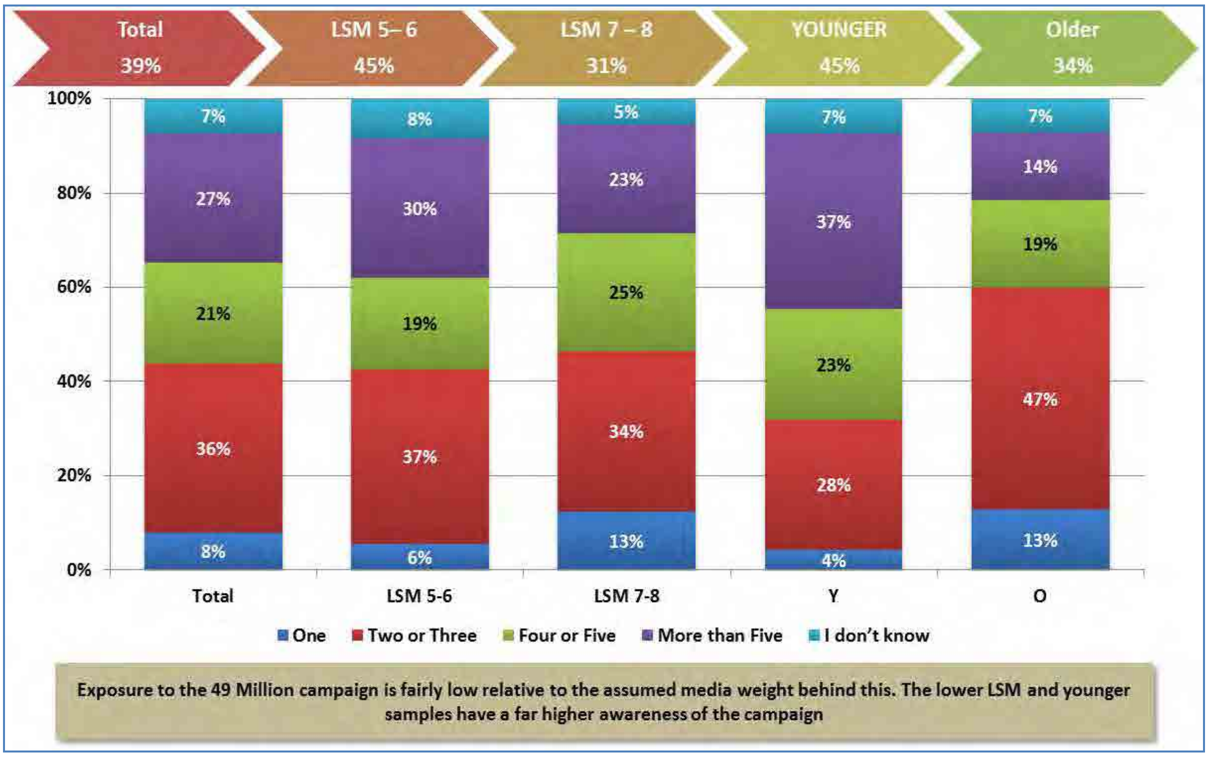


While the campaign has created high awareness of the electricity problem and the need for a collective behaviour change, this has not directly translated into an actual change in behaviour. (64% of the total sample claim that they are much more aware, while only 43% state that their behaviour has changed in everything that they do).

Power Alert Awareness

The power alerts are noted at high levels (84%), with the majority claiming that these alerts instigate an instant action, either in turning off all unnecessary lights or appliances, or in turning off some of these – Figure 59. The strong, functional 'call-to-action' nature of this communication resonates well, and works in effecting real-time behaviour change.

Figure 59: Eskom's *'Power Alert'* Campaign



<u>Government involvement in Energy Efficiency</u>

Eskom is perceived as doing a better and more active job in promoting energy saving than is Municipal or National Government. However this is to be expected as the majority of communication around energy efficiency is Eskom branded.

Conclusions and Recommendations

<u>Barrier: Consumer Mindset</u>

The significant impact of electricity price increases coupled with a lack of clarity around the billing process leads to increased scepticism. In this context, there is a need for greater transparency and consumer education around electricity billings and price increases. Electricity bills are already seen as a grudge spend, and the challenge is to ensure that energy saving behaviour is not consequently perceived as a grudge activity. This suggests the need to clearly link the benefits to the type of energy saving behaviour the government is trying to instil.

<u>Opportunity: Address the billings process</u>

The market does not appear to have a solid understanding of why Eskom is in this predicament. There appears to be a strong sentiment that Eskom has brought this on themselves through inefficient resource management. In an article titled "Power Crisis Eskom's Problem" (www.fin24.com), Investec Securities strategist Brian Kantor says "Power utility Eskom needs to realise that the electricity crisis is "their problem" and that the government must intervene and take on expensive solutions".

Eskom is also perceived as having prevented private corporations from getting involved in a solution. "If the private sector had been able to respond to the energy crisis –

rather than all Eskom's dithering and faffing as well as their laws, regulations and tariff increases – we would have fixed it a long time ago, says Border-Kei Chamber of Business Executive Director Les Holbrook, in the article "Eskom rates cuts a significant relief" (www.theweekendpost.com).

Eskom therefore has an educational job to do in terms of clarifying the following:

- The reasons behind the rates increase
    - What are the factors that have played into the rates increase
    - What has precipitated the current energy crisis
    - Why rates increases are needed within the context of the energy crisis
- The billing process
    - How the bill is calculated
    - What consumers should be pay attention to on the bill
    - What channels are available to consumers to query their bills

<u>Barrier: Current Behaviour</u>

The further removed consumers are from seeing and experiencing the personal impact of saving electricity (most notably in money savings), the less engaged they are with energy saving activities. Those who have switched to prepaid are less involved in everyday activities, indicating a mindset of "I have solved my personal issue, and therefore I don't need to be concerned on a broader scale". A generational impact is noted in the younger sample who are far more engaged in the crisis and subsequent energy saving behaviours. In order to effect real behaviour change, there is a need to demonstrate the personal impact of energy savings through functional, single-minded communication.