INTERNATIONAL ENERGY AGENCY

ENERGY EFFICIENCY IN EMERGING ECONOMIES

Energy Efficiency Outlook for South Africa – Sizing up the opportunity

INTERNATIONAL ENERGY AGENCY

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Highlights

- South Africa is giving due consideration to the energy it needs to fuel its growing economy. While its per-capita GDP has grown at an annual average of 1.7% over the last decade, South Africa remains one of the most energy-intensive economies in the world. Total energy consumption per unit of GDP was more than twice as high as the global average in 2012 and its electricity consumption per capita was 40% higher than the world average. Taking steps to improve efficiency in energy production and consumption can help to improve the security of oil, gas and electricity supply, to cut energy bills and to improve the competiveness of South African business and industry both at home and in international markets. By 2030, tapping the economic potential of energy efficiency leads to a net reduction in primary energy demand and electricity of 15%.
- Coal and oil are the most significant primary fuels in South Africa's energy mix. Policy approaches to improve the energy intensity of its economy should target measures that effect coal and oil, as both are set to remain key primary inputs for power generation, production of synthetic fuels and use in transport. By 2030, oil savings from efficiency measures, notably via the deployment of hybrid vehicles, reach almost 200 000 barrels per day and offsets the need to build a refinery with an equivalent capacity twice that of the Secunda coal-to-liquids plant. Efficiency measures reduce the oil import bill by almost 30%, thereby significantly improving the security of energy supply and the national trade balance. Efficiency gains by 2030 could also supplant about one-quarter of today's level of coal consumption.
- The South African Government, in concert with the energy supply industry, is developing a strategy to address the near-term challenges of a constrained electricity system characterised by insufficient capacity and rolling black-outs. Rising economic activity and household incomes, together with enhanced access to modern conveniences, boost electricity demand by 1.2% per year to 2030. There is enormous potential to make the use of electricity more efficient in a wide array of end-uses from street lighting in communities to refrigerators in homes as well as for minerals processing at mines and aluminium production. The systematic adoption of efficient electric motors, heating systems and appliances could diminish electricity expenditures for end-use consumers. Households, which face electricity prices escalating at almost 3% per year, are the principal beneficiaries of energy efficiency measures. Households could potentially save up to 11% of their electricity bill yearly.
- An effective electricity sector strategy must place emphasis on both improving the efficiency of the power generating fleet as well as that of end-use efficiency. Almost half of the existing coal-fired power generation capacity in South Africa is more than 30 years old and will need to be refurbished or replaced by 2030. As is being demonstrated with the construction of the two large-scale coal-fired power stations that are employing supercritical boiler technology at Medupi and Kusile, it is essential that the power system employs state-of-the-art power plant design and technology in new builds and applies intelligent management systems. By improving the average efficiency of the coal-based power generation fleet, South Africa could avoid burning 25 million tonnes of coal, forestall the need to build almost 10 gigawatts of new capacity, equivalent to the combined capacity of the Medupi and Kusile plants, and save $10 billion in coal power investments by 2030.[1] The reduction in coal power capacity investment largely offsets the investment required to modernise the coal-based generating

[1] An appropriate exchange rate for converting 2013 US dollar to South African RAND (ZAR) is 9.65.

fleet and foster the deployment of renewable capacity. Transformation of the power generation capacity also will reduce substantially the costs of required network infrastructure.

- Pursuing ambitious energy efficiency objectives requires targeted policy measures and fiscal incentives to trigger the necessary investment in all consuming sectors. Cumulative end-use investments to 2030 are on the order of $46 billion, of which 15% needs to be spent by 2020 to meet short-term objectives. About 50% of the cumulative investment in efficiency improvements to 2030 is in transport and largely related to the purchase of efficient vehicles. About 38% is in the buildings sector, notably for the purchase of efficient electrical appliances. Industrial energy savings can be tapped with a more modest share of the required overall investment identified.
- The achievable reduction in primary energy, predominantly in coal used for power generation, brings about important environmental benefits for South Africa. In addition to reducing local air pollution and industrial process emissions, more than 20% of projected energy-related CO_2 emissions could be avoided.
- An essential step to build an effective energy efficiency platform requires much better energy production and consumption data in all end-use sectors than is currently available. From a sounder base, patterns of energy use can be better understood and used to design effective polices and implementation strategies for energy efficiency improvements. Also needed are mechanisms to monitor achievements and short-falls over time in order to appropriately adjust policies and approaches.

Introduction

There is an urgent need for South Africa to undertake strong energy efficiency measures as part of a more inclusive strategy for the country to develop a sustainable energy supply to meet anticipated demand, increase reliability while also addressing price pressures. Effective efficiency measures, based on well-informed data, adequately designed polices and soundly implemented can help to improve the energy supply and demand situation for industrial, commercial and residential consumers alike and to mitigate the risk of acute electricity crisis as currently faced by the country.

This analysis aims to inform government, businesses and other stakeholders about the prospects for energy use in South Africa and the role that energy efficiency improvements offer in the period to 2030. It quantifies the potential energy savings and related carbon-dioxide (CO_2) emission reductions, and the associated costs and benefits of policies aimed at exploiting that potential. The analysis draws on the results of scenarios prepared for the International Energy Agency's *World Energy Outlook 2015 (WEO-2015)* and the WEO special report on *Energy and Climate Change* (IEA, 2015). This South Africa report reviews indicators such as industrial energy intensity and assesses energy efficiency potential by sector. It highlights target setting opportunities for South Africa and underscores the need for improved data collection and analysis which are basic to developing and successfully implementing energy policy. The data, analysis and findings of this report can well serve as input to the preparation for the forthcoming South African strategy on energy efficiency that may come into force by mid-2016.

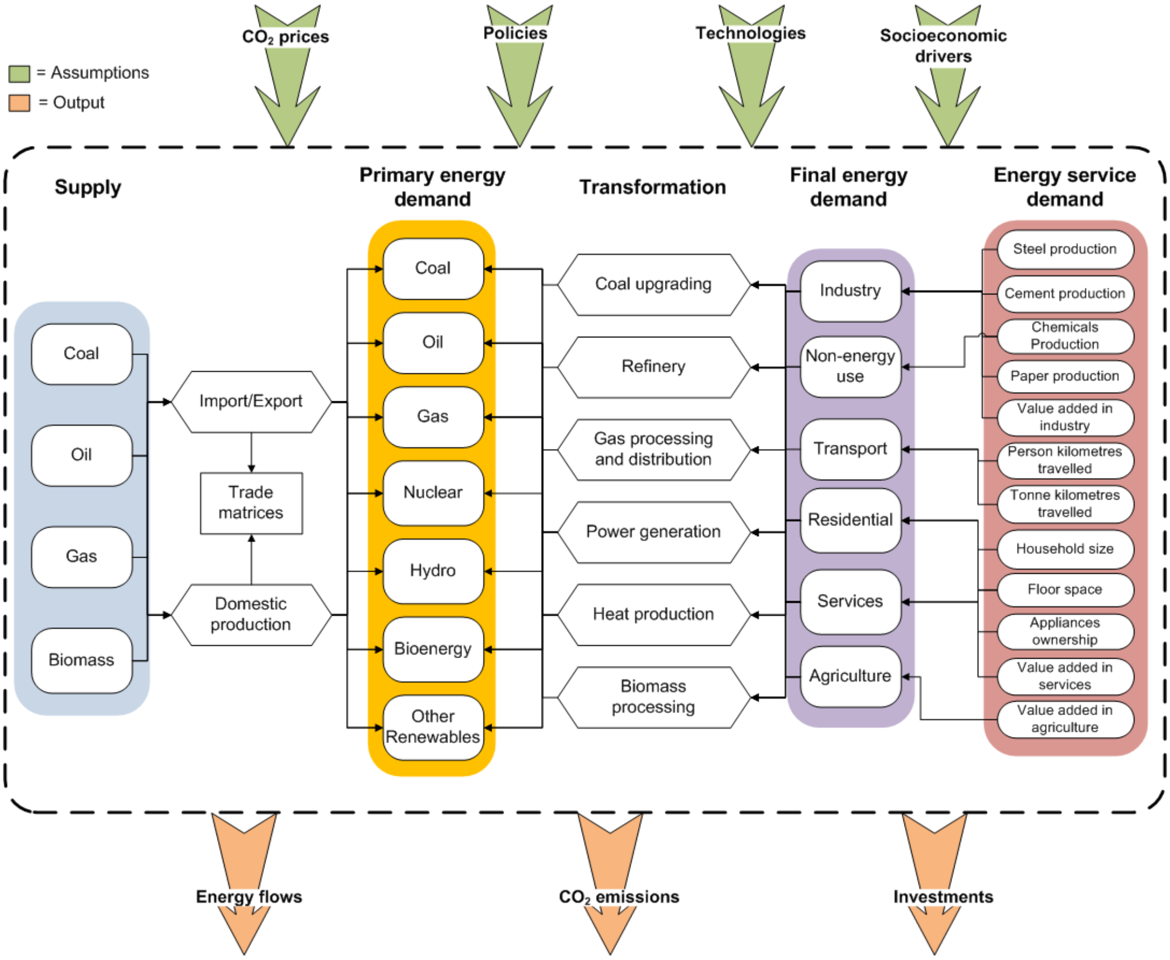
IEA analysis published in the *World Energy Outlook 2012* shows that, while more attention is being paid to the use of energy, existing and planned policies aimed at improving energy efficiency will lead to only a fraction of the potential that exists today for saving energy being exploited (IEA, 2012a). Tapping more of this potential through the deployment of economically viable energy technology and best practices would enable the provision of energy services to be expanded – for example, more people could use air conditioners or light their houses longer with the same energy input – or the same energy services could be provided with less primary energy. Either way, the net effect would be a stimulus to economic growth.

Assessment of Energy Efficiency Potential

The assessment of energy efficiency potential in South Africa for this report was conducted using the IEA's proprietary World Energy Model (WEM), a large-scale simulation model designed to replicate the functioning of energy markets and the impact of energy policies. The WEM brings together a suite of 25 country or regional models. Similar to other country models including the United States, Japan and China, the South African model is based on IEA datasets, represents its entire energy system and factors in interactions with international energy markets. For the purpose of this study, the time horizon is the year 2030. Figure 1 illustrates key components of the WEM. A brief description of the WEM modelling framework and macroeconomic and demographic assumptions are in Annex A.

Two cases are used to highlight the potential for energy savings in each energy-consuming sector of the economy. The ***Baseline Scenario*** assumes only those policies and implementing measures that have been formally adopted as of mid-2014. It therefore provides a baseline of how domestic energy use would evolve if business-as-usual trends in energy demand and supply continue and a reference against which the impact of new efficiency policies can be monitored and assessed. Note that this scenario already factors in some degree of improvement in energy efficiency due to the natural replacement or upgrade of vehicles or equipment with more efficient ones. The ***Efficiency Scenario*** – in the spirit of the *Efficient World Scenario* presented in the *World Energy Outlook-2012* (IEA, 2012a) – assumes that policies and their implementation are adequate to achieve the potential of all known energy efficiency measures which are economically viable in the period to 2030. These measures are assumed to be readily available today, meaning they do not require the identification and implementation of innovative sets of energy policies or the deployment of technologies that have yet to be proven in the market.

Figure 1 • Key components of the World Energy Model



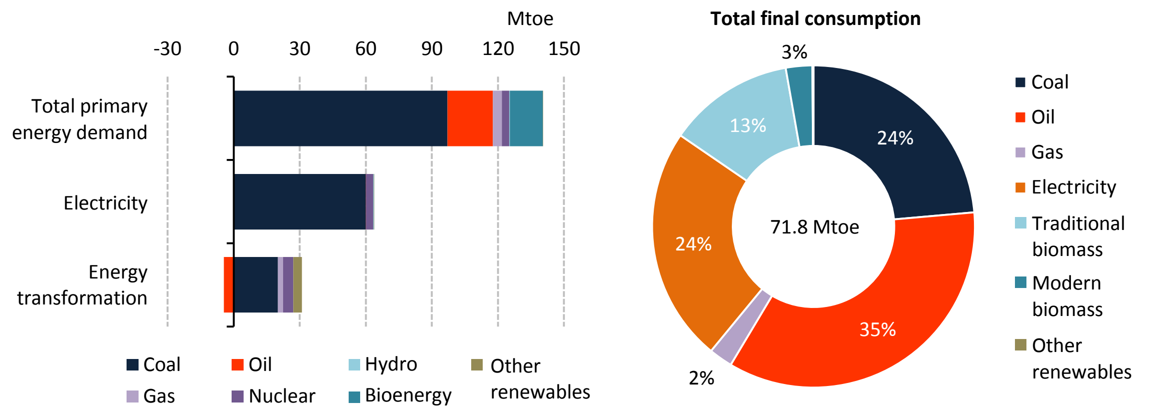
In absolute terms, the size of the South African economy — the second-largest in Africa — is small compared to the large Asian countries. In 2012, South Africa's gross domestic product (GDP) was only 4% of China's GDP. Yet, on a per-capita basis, South Africa was far above many of the large emerging economies and was at a level comparable to Brazil. This has far-reaching consequences for South African future energy needs. Continuing recent trends, the South African economy is projected to grow at 2.8% per year over the next 15 years. This is a moderate rate of growth among the large emerging countries (see Annex B, Table 1).

International comparisons of sector-specific indicators to other fast-growing countries are used throughout this report. These include the BRICS[2] countries and Mexico, an OECD member. A number of these emerging economies will be a forthcoming focus of the IEA's E4 project.

Current Energy Landscape

South Africa's demand for primary energy is chiefly met by indigenous coal. In 2012, coal accounted for 69% of primary energy needs, of which more than 60% was used in the power sector and 5% in the production of synthetic fuels (Figure 2). Other large coal consumers include steel and cement manufacturers and the buildings sector which burns coal for space and water heating. Oil is mainly used in the transport sector; it accounts for 16% of total primary energy and about a third of total final energy use, making it the principal fuel for end-users. Electricity, the second-most important final energy source, currently satisfies about 25% of total final consumption. The use of traditional biomass in households remains common in rural areas, particularly those that still lack access to electricity. Other energy sources are far less developed in South Africa.

Figure 2 • Total primary energy demand, electricity and energy transformation by fuel (left panel) **and total final consumption by fuel, 2012**



Note: Mtoe = million tonnes of oil equivalent.

The wasteful use of energy in South Africa has been identified as a major issue for more than a decade and has become even more pressing in recent years due to the ongoing electricity crisis and the surge in electricity prices. In 2005, the National Energy Efficiency Strategy (NEES) elaborated by the South African Department of Energy formulated a set of aspirational targets to be met by 2015. The NEES advocates the improvement of overall final energy use at a 12% annual rate and differentiates targets by sector including power, industry, mining, commercial and public buildings, residential and transport, with improvement rates ranging from 10% to 15%. However, these national targets were set without sufficient consideration of economic growth over the period or the financing schemes needed to support achievement of the targets. In addition, while energy efficiency remained on the political agenda, other pressing issues were

[2] *BRICS* is an acronym for a group of five major emerging national economies: Brazil, Russia, India, China and South Africa.

priorities for the government, including the necessity to foster economic growth and encourage labour absorbing industrialisation.[3]

Box 1 • Incentivising the uptake of energy efficiency measures in South Africa: combining efficiency and climate policy instruments

Energy efficiency savings can help to decrease energy intensity and enhance the competitiveness of the South African economy. To unlock opportunities that energy efficiency can offer, an appropriate support framework for energy efficiency is required. It should include the appropriate pricing of energy and support measures to facilitate the uptake of energy efficiency measures.

Some economic activities, such as the generation of electricity from fossil fuels, may have negative impacts on the environment which in many instances are not directly priced into the related products and services. To address this, South Africa has an electricity levy on fossil fuel-based and nuclear electricity generation with the revenue directed to demand-side management and to internalise some of the external costs. A restructuring or possible phase-out of this electricity levy is envisaged if a carbon tax is introduced.

A perceived long pay-back period for energy efficiency measures tends to discourage optimal levels of investment. While South Africa has a package of measures in place to help overcome this perception, it plans to enhance it further to encourage energy efficiency savings and decarbonisation of the energy sector. These measures include tax incentives for energy efficiency and renewable energy investments.

For industry and businesses, the Energy Efficiency Savings Tax Incentive, introduced in 2013, provides a tax deduction for savings achieved on a kilowatt-hour equivalent basis. It intends to assist with the perceived high initial capital cost of energy-efficient technologies. There are indications that this incentive has the potential to cost effectively lower the demand for electricity and ease the current pressure on extremely tight power capacity margins. During its first year of operation, this measure recorded preliminary applications of 3 031 gigawatt-hours (GWh) of potential energy savings, which represents approximately 1.4% of total GWh sold in South Africa.

An accelerated depreciation mechanism is already in place for wind, solar, hydro and biomass power generation. An enhanced accelerated depreciation for solar photovoltaic (PV) systems for businesses is being considered to incentivise investment in off-grid renewable energy generation for own consumption.

For the residential sector, measures such as standards and labelling for energy-efficient appliances, installation of smart meters, incentives for solar water heaters as well as solar PV should be considered. Enhancing the efficiency of water heating is one of the main “low hanging fruit” measures. Smart meters would allow time-of-use tariffs whose higher rates can induce end-user behaviour to alter consumption patterns and help to reduce peak demand. They also provide a basis for smart grids whereby in the future people could generate their own power (e.g. PV installations) and sell excess power to the grid. This would also require changes in the regulatory regime.

Therefore, assessing the progress actually made and objectively measuring the degree of achievement of the efficiency targets is difficult. The lack of comprehensive and thorough data to

[3] The various initiatives include: the 2010 New Growth Plan and its Beneficiation for the Minerals Industry by the Economic Development Department; the 2013 Industrial Policy Action Plan 2013-2016 by the Department of Trade and Industry; and the Integrated Resource Plan for Electricity 2010-2030 by the Department of Energy (DoE, 2013).

measure energy consumption on a detailed basis is a significant challenge. This report identifies relevant indicators to measure patterns of consumption and assesses energy efficiency potential in the period to 2030 based on the IEA's World Energy Outlook model.

Although it is difficult to measure progress related to the national targets, a number of public and private initiatives have yielded substantial achievements. For example, Eskom's Integrated Demand Management (IDM) programme was strengthened in recent years. It reported that through the IDM initiatives that energy use had been reduced by the equivalent of six 600 megawatt (MW) power stations in 2012, with some 77% of the total savings coming from the residential and municipal sectors.[4] Various initiatives have been undertaken by private firms financed with their own resources. The Industrial Development Corporation' Green Energy Efficiency Fund, backed by German development bank KfW, promotes efficiency and renewables-based own-use generation primarily within energy-intensive industry and provides project finance. The National Business Initiative, through its Energy Efficiency Leadership Network, plays an important role in guiding energy efficiency projects conducted by the private sector and covering the full spectrum of economic activities. Measures that have helped firms cut energy bills and reduce CO_2 emissions include: process optimisation; adopting efficient lighting and heating systems; installing solar systems; switching fuels and reducing ventilation losses.

Energy Efficiency Improvements to Alleviate Supply Shortages and Reduce Energy Spending: business-as-usual versus enhanced efficiency gains

Overview

Energy intensity

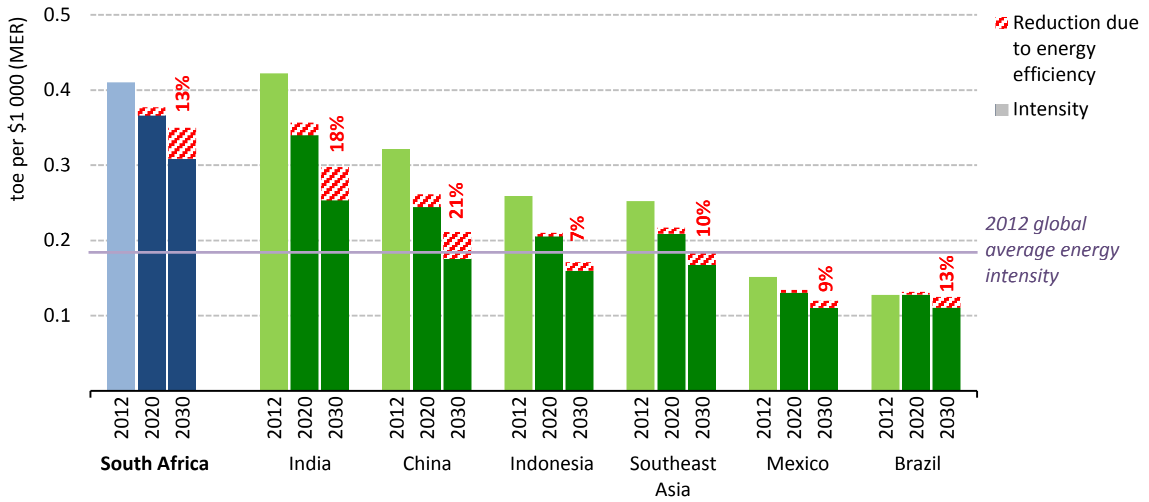
With about 0.4 tonnes of oil equivalent (toe) per thousand dollars of GDP, South Africa is one of the most energy-intensive economies in the word due to the high share of coal in the primary energy mix (69% in 2012), and aging, inefficient infrastructure, in particular for power generation. Among major emerging economies, only India requires more energy per unit of GDP output. The potential to reduce overall energy intensity is directly linked to the pace of economic growth as faster growth is generally accompanied by a progressive shift away from energy-intensive activities, notably to the benefit of the services sector. Overall energy use in South Africa is expected to grow steadily, but because of lower GDP growth over the period to 2030 and the structure of its energy system, South African energy intensity is reduced by 13% in 2030 due to energy efficiency compared with 18% and 21% reduction in India and China respectively (Figure 3).

Intensity of final energy use follows similar patterns to total primary energy demand although levels are generally lower and the scope for improvement is more limited. In 2012, coal fuel requirements for the power and energy transformation sectors alone make up for a hefty 83% of total primary coal consumption in South Africa. This share is ten percentage points lower in China. Moreover, direct fossil fuel use in final energy demand accounts for 31% of total primary demand for fossil fuels, compared with 37% in China, suggesting that efficiency policies, a key

[4] *engineeringnews.co.za/south-africas-energy-saving-iniatives-gain-momentum-2013-06-11.*

instrument to mitigate energy intensity, should cover end-use as well as transformation sectors as part of a national strategy.

Figure 3 • GDP intensity of total primary energy demand in selected countries



Structural changes in energy demand

Government policies and business awareness and action could have a major impact on primary energy consumption in South Africa. In the business-as-usual case, demand for primary energy is projected to increase by around 30 million tonnes of oil equivalent (Mtoe) between 2012 and 2030, a 21% increase compared with current demand levels (Table 1). In the Efficiency case with the adoption of economy-wide measures, additional primary energy demand is 7 Mtoe, only a 5% increase from 2012 levels. Energy savings by sector and by fuel for the Baseline and Efficiency cases for 2020 and 2030 are detailed in Annex B, Tables 3-8.

Efficiency measures prove effective at mitigating demand growth for gas and oil, while coal demand drops by 16%. Decomposition analysis confirms the pivotal role of coal use in power generation and the transport sector to mitigate oil demand.[5] Given its large share in the South African energy mix, coal is a prime target for ambitious efficiency measures. In net terms, efficiency gains by 2030 could supplant about 10% of today's level of coal consumption, or 14 Mtce (million tonnes of coal equivalent) (Figure 4). The economy-wide adoption of energy efficiency measures notably reduces the demand for electricity and has the potential to displace indirectly about 30% of coal used for power generation (25 Mtce). Improving the average efficiency of coal-fired plants contributes about 10% of the net reduction in coal used in power generation by 2030.

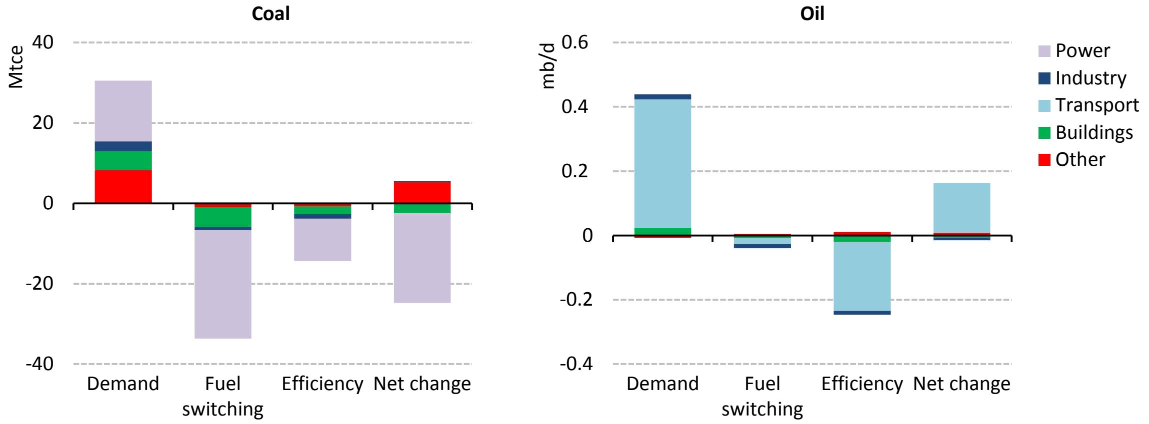
More economic activity and rising household incomes boost demand for freight and personal transport. By 2030, oil savings from efficiency measures, notably via the deployment of hybrid vehicles, reach more than 200 000 barrels per day compared to current levels and offsets the need to build a refinery with an equivalent capacity of almost twice that of the Secunda coal-to-liquids plant.

[5] Decomposition analysis can provide insights that relative contributions of various elements – higher demand, structural factors and energy efficiency – make to changes in primary or final energy consumption.

Table 1 • Total energy savings by sector in South Africa, 2020 and 2030

	Baseline Demand (Mtoe)			Energy savings: Efficiency vs Baseline (Mtoe)		Energy savings: Share of TPED total savings (%)	
	2012	2020	2030	2020	2030	2020	2030
Power generation	**63.7**	**68.0**	**77.1**	**3.7**	**16.7**	**80%**	**64%**
Other energy sector	**26.5**	**28.5**	**31.9**	**0.7**	**4.5**	**15%**	**17%**
Blast furnaces and coke ovens	1.6	1.7	1.7	0.1	0.1	2%	0%
CTL	12.4	12.5	14.4	4.8	7.4	103%	28%
Industry	**24.9**	**27.5**	**29.8**	**0.9**	**2.9**	**19%**	**11%**
Iron and steel	3.7	4.0	4.0	0.2	0.2	3%	1%
Chemicals	2.8	3.1	3.2	0.0	0.1	0%	0%
Cement	1.0	1.2	1.3	0.0	0.0	0%	0%
Paper	1.0	1.4	1.8	0.0	0.2	0%	1%
Aluminium	1.0	1.4	1.5	0.1	0.2	1%	1%
Other industry	15.3	16.4	18.0	0.6	2.3	14%	9%
Transport	**16.7**	**20.3**	**27.9**	**-0.2**	**3.7**	**-3%**	**14%**
Road	15.2	18.7	26.0	-0.2	3.6	-5%	14%
PLDV	5.3	7.1	8.5	-0.3	1.4	-5%	5%
Light commercial vehicles	*3.0*	*5.0*	*8.9*	*-0.2*	*0.5*	*-4%*	*2%*
Medium freight traffic	*0.7*	*1.3*	*2.6*	*0.1*	*0.4*	*2%*	*2%*
Trucks (heavy freight traffic)	*3.1*	*3.8*	*4.2*	*0.0*	*0.5*	*1%*	*2%*
Bus	*1.7*	*1.4*	*1.6*	*0.1*	*0.8*	*3%*	*3%*
Domestic aviation	1.0	1.1	1.3	0.1	0.2	1%	1%
Other (rail, pipeline, navigation)	0.4	0.5	0.6	0.0	0.0	0%	0%
Residential	**16.5**	**17.7**	**20.7**	**0.3**	**1.6**	**7%**	**6%**
Space heating	1.9	1.9	2.4	0.1	0.6	3%	2%
Water heating	3.2	3.9	5.8	0.1	0.6	2%	2%
Cooking	0.9	1.1	1.5	0.0	0.1	1%	1%
Light	0.6	0.6	0.7	0.0	0.1	1%	0%
Appliances	0.8	1.1	1.5	0.0	0.2	1%	1%
Refrigeration	*0.4*	*0.5*	*0.7*	*0.0*	*0.1*	*0%*	*0%*
Cleaning	*0.2*	*0.3*	*0.4*	*0.0*	*0.0*	*0%*	*0%*
Brown goods	*0.1*	*0.1*	*0.2*	*0.0*	*0.0*	*0%*	*0%*
Other appliances	*0.1*	*0.1*	*0.2*	*0.0*	*0.0*	*0%*	*0%*
Cooling	0.1	0.1	0.2	0.0	0.0	0%	0%
Services	**6.3**	**6.8**	**7.6**	**0.1**	**1.0**	**2%**	**4%**
Agriculture	**1.9**	**2.0**	**2.0**	**0.3**	**0.6**	**6%**	**2%**
Non-energy use	**5.4**	**5.7**	**6.0**	**0.0**	**0.0**	**0%**	**0%**
Total primary energy demand (TPED) total	**140.4**	**151.6**	**172.5**	**4.6**	**26.0**	**100%**	**100%**

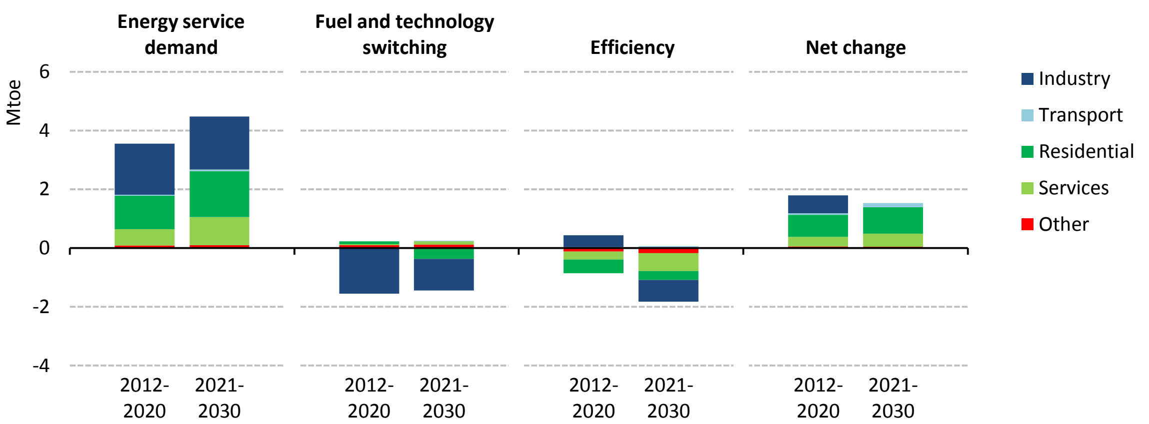
Figure 4 • Impact of fuel switching and efficiency on the change in coal and oil demand in the Efficiency scenario by sector, 2012-2030



Note: Mtce = million tonnes of coal equivalent.

The potential to reduce electricity demand growth is sizeable provided that all end-use sectors adopt appropriate measures (Figure 5). In the longer term, the limited lifetime of appliances and heating equipment which are replaced with more efficient models provides opportunity to improve efficiency in the buildings sector and reduce electricity demand. The introduction of minimum energy performance standards for appliances, air conditioning and lighting reduces demand for electricity in the residential and services sectors and is responsible for the bulk of electricity mitigation after 2020. Capital-stock turnover and the more efficient stock put in place bring sustained savings by 2020 and beyond.

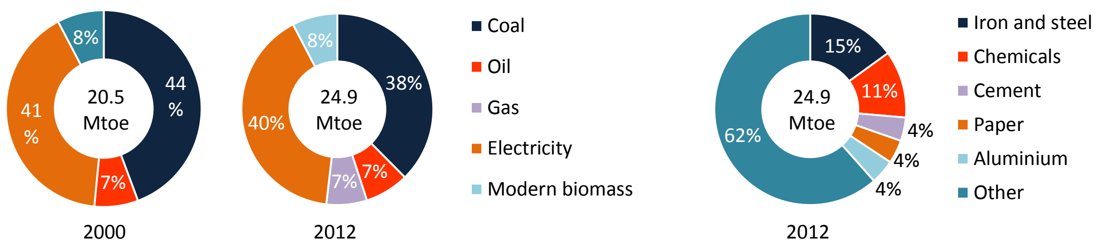
Figure 5 • Change in electricity consumption by end-use sector and contributing factor in the Efficiency case, 2012-2030



Industry

Energy needs in industry have increased by about 20% over the last decade at an average 1.6% per year. This compares with a 3.5% annual increase in GDP over the same period, which, together with decoupling between overall economic activity and industrial production, reflects a degree of reorientation of industrial activity towards less energy-intensive segments and effective measures undertaken to reduce energy intensity. The industrial sector accounts for one-third of total final energy consumption in South Africa. Some effort to reduce the carbon footprint of industries and more availability of natural gas led to some partial substitution away from coal; 7% of industrial energy needs were met with natural gas in 2012 (Figure 6).

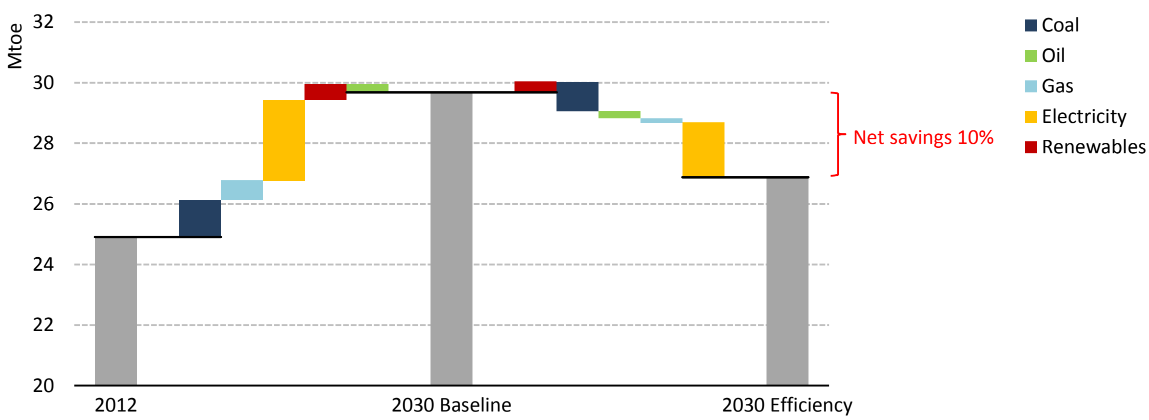
Figure 6 • Fuel use in industry, 2000 and 2012



Without additional efforts to improve the efficiency of production processes, increasing activity raises industrial energy demand by one-fifth by 2030, for the most part due to rising electricity needs (Figure 7). In 2012, coal accounted for 38% and electricity for 40% of shares in industrial energy use. Without demand-side measures in industry and a lack of incentives to shift production modes, coal and electricity remain the principal sources of energy demand in 2030, with electricity alone accounting for more than half of the incremental use.

The industry sector accounts for the bulk of potential savings in final energy consumption in the short term. By 2030, 10% of additional energy demand in industry relative to today's level could be avoided, with electricity accounting for two-thirds of the total reduction. Extra coal consumption by 2030 could almost entirely be offset by appropriate efficiency measures, in addition to fuel switching from coal to electricity. Other fuels play a marginal role.

Figure 7 • Industry energy consumption and savings by fuel

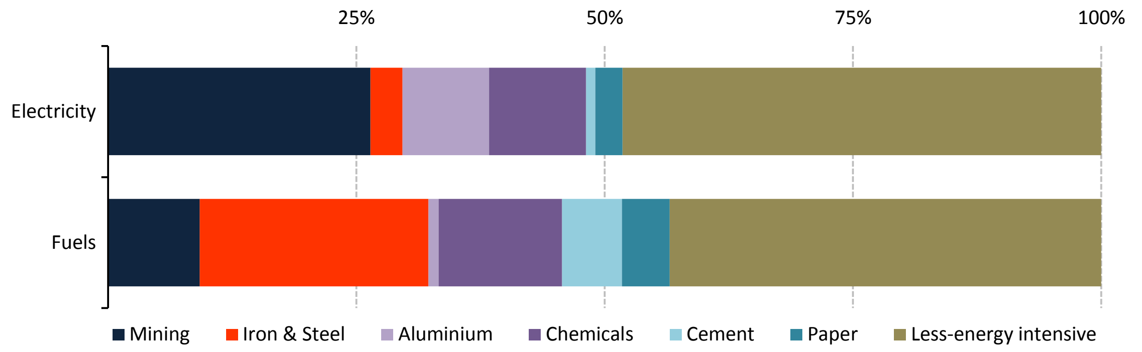


Meeting additional demand for electricity and fuels requires the simultaneous development of energy supply infrastructure and imports, which translates into higher energy prices in the future. Investing in more efficient supply infrastructure raises unit prices of energy for by industrial users. Given current capacity shortages, electricity prices are set to ramp-up steadily at

4.4% per year through to 2030.[6] Coal prices develop at a similar pace. Oil product prices reflect expected development of international fuel prices. An economy-wide adoption of energy-efficiency measures induces a further increase in prices. In particular, electricity prices then develop at a 2.9% per year reflecting domestic investments into more energy-efficient power generation capacity. (See the Energy Savings Potential and Economic Benefits section for a discussion on prices.)

In South Africa, a handful of industries that are large coal and electricity consumers account for a sizeable amount of consumption. These industries can deliver a large proportion of energy savings potential. About one-third of total electricity requirements in industry are for primary aluminium manufacturing and mining activities, while a third of industrial coal use is for iron and steel production (Figure 8). In 2012, mining alone accounted for 16% of total final electricity use in South Africa, of which half was for gold mining. While these industrial sub-sectors have structural and economic challenges, they are prime candidates for energy efficiency improvements.

Figure 8 • Electricity and fuel consumption by industry, 2012



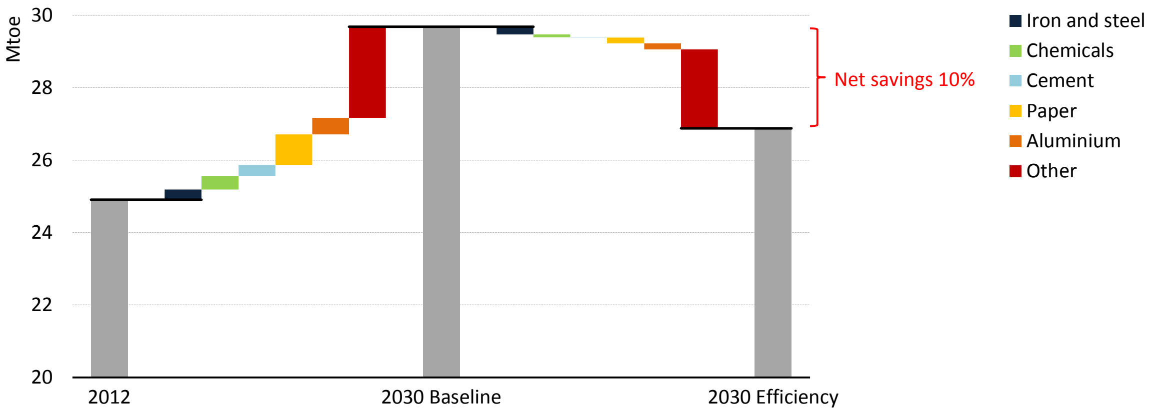
Note: Fuels include coal, oil, natural gas and biomass. Sources: IEA Extended Energy Balances database (2014) and IEA analysis.

Tapping the full potential of energy savings requires the optimisation of energy systems in each industry segment. Across the industrial sector, the savings are primarily realised among iron and steel production, aluminium smelting, and mining and quarrying activities.[7] Other energy-intensive sub-sectors combined, such as chemicals, whose current energy use is similar to that of iron and steel, offer more limited savings potential. But less energy-intensive industries such as fabricating metal products or manufacturing electrical machinery also have key role to play to realise energy savings (Figure 9). The mining industry and the less energy-intensive ones will maintain their share of industrial energy consumption through to 2030 and will also account for more than half of the incremental energy demand in the industry sector.

[6] In 2013, the National Energy Regulator of South Africa granted Eskom an 8% average annual increase over the next five years. South Africa's current electricity prices are comparable to the other BRICS countries. According the Chamber of Mines of South Africa, over a five-year period to 2012 diesel prices increased at an annual average of 15.7%, due to higher international oil prices, while the mining sector faced an annual average 26% increase in electricity prices from ZAR 0.18 per kilowatt-hour (kWh) in 2007 to ZAR 0.61 per kWh in 2012.

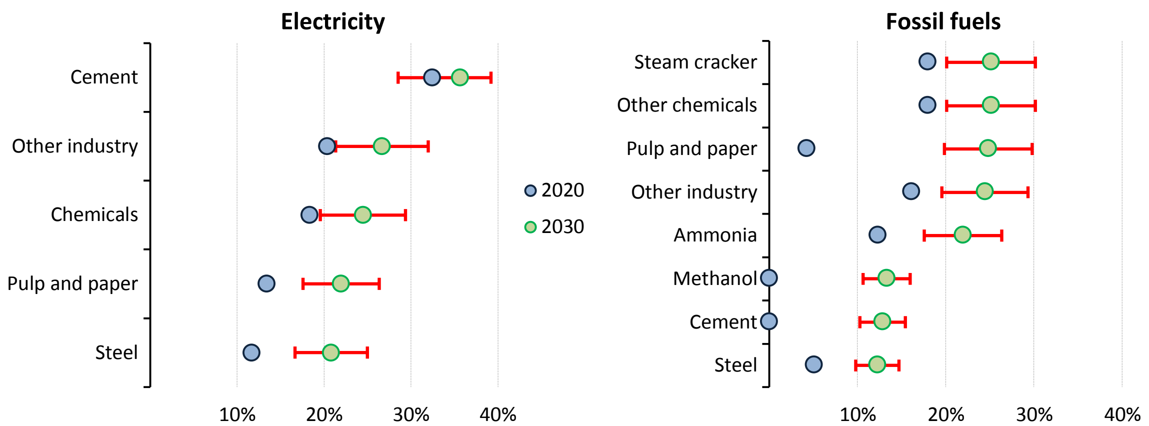
[7] Aluminium production and mining are reported as part of "other" industries, a broad IEA statistical category which contains two-thirds of total industrial consumption of electricity and 40% of total end use of energy.

Figure 9 • Fuel consumption and energy savings in industry



Energy is a key input in many industrial activities. As a significant cost component, particularly in energy-intensive industries such as primary production, its efficient use may have been a focus for attention and energy management techniques for some time (IEA, 2013a). In production facilities where significant steps have been taken, remaining efficiency potential may only be tapped incrementally. In other cases, some efficiency measures that are economic can be taken swiftly, with typical payback periods of 2 to 5 years. By 2020, energy input per unit of production could be cut by roughly 10% to 30% in the case of electricity; about 10% of fuel input could also be saved for a number of industries as illustrated in Figure 10. Technologies and systems with longer payback periods can further cut energy demand, reduce network losses and boost the efficiency of own-generation in industrial facilities.

Figure 10 • Electricity and fossil-fuel saving potential by industry relative to 2012



Note: Red horizontal lines show typical ranges for alternative sets of parameters on technology diffusion, payback periods and fuel choices in 2030.

A large selection of technical solutions can be deployed in industries to moderate electricity consumption, notably in the chemical and mining sub-sectors. These solutions include the systematic replacement of old motors with high efficiency ones with adjustable speed drives, convert motors to inverter control and the technique of pole amplitude modulation. Other opportunities include optimised refrigeration systems, use of heat pumps and retrofitting lighting systems with light emitting diodes (LED) lamps. Eskom, the state-owned national electric utility, estimates that lighting accounts for 2% to 10% of electricity consumption depending on the industry segment (Eskom, 2010). Air leakage in defective compressed air systems, 40% in some cases, should be controlled.

The production of iron and steel uses the largest proportion of coal input among energy-intensive industries in South Africa, so maximising its efficiency is essential to reduce domestic energy intensity. While some plants still are using aging coke plants and basic oxygen furnaces with low grade coal, there has been progress. According to the South African Iron and Steel Institute, the steel industry has reduced its energy consumption per tonne of steel produced by half in the last three decades. Obstacles can be overcome to gain an additional 20% improvement, particularly from the top producers using coal-based Direct Reduced Iron (DRI) units. ArcelorMittal's Saldanha factory is a unique example of a steel mill, partially natural gas based, combining the Corex/Midrex process into a continuous chain, replacing the need for coke ovens and blast furnaces (with the additional benefit of lower emissions). The other two large production units, ArcelorMittal's Vanderbijlpark and Scaw Metals' Germiston, both use coal-based DRIs. Fuel switching to natural gas and the adoption of alternative process routes constitute important options to reduce the energy input per unit of output provided that gas import infrastructure can be further developed in South Africa.

Switching to gas-based DRIs can halve energy consumption depending upon on the coal quality (Institute for Industrial Productivity).[8] Experience in India suggests that coal-based DRI with low-grade coal, (which has a much higher proportion of non-combustible constituents than average South African coal), can be detrimental to DRI performance and eventually reduces the benefits of DRIs' adoption. All companies in the iron and steel sub-sector express concerns about escalating energy expenses and environmental regulatory measures. Therefore, rationalising the conventional steel manufacturing processes by deploying efficient heat and exhaust gas recovery systems delivers energy savings and also improves productivity.

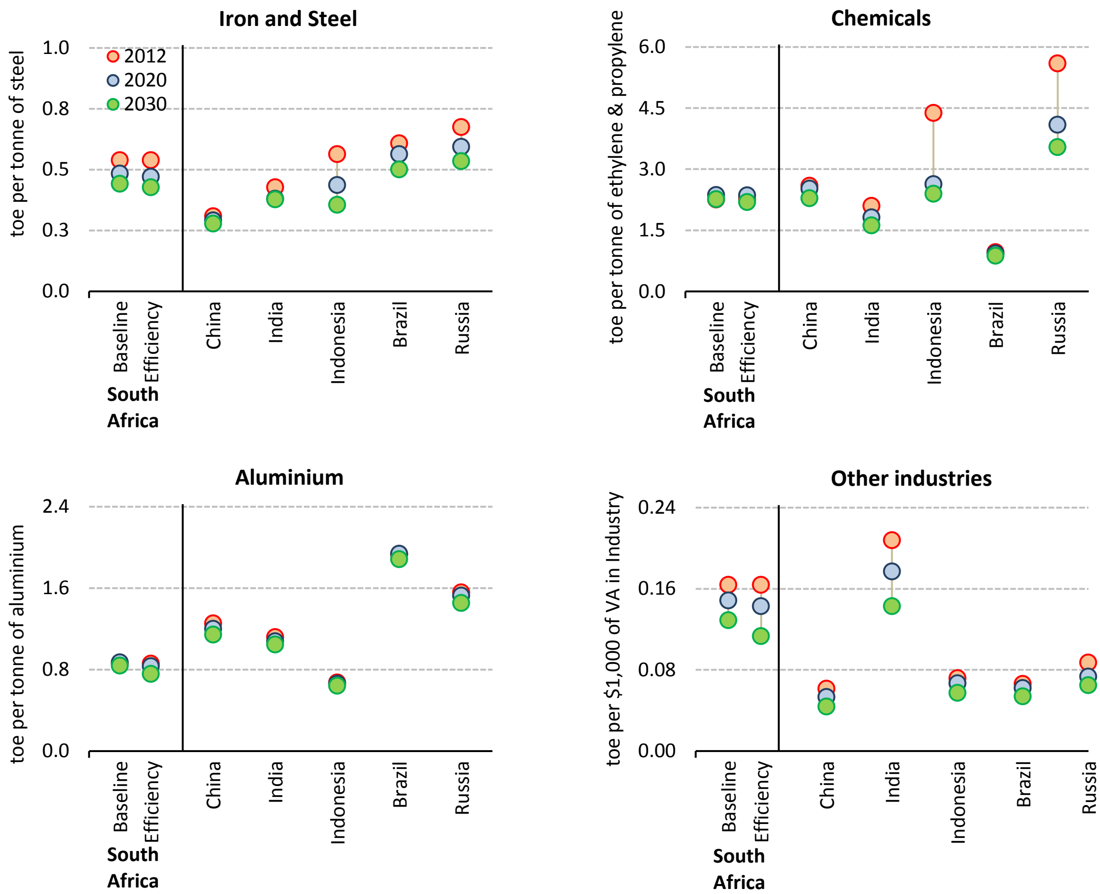
The concentration and existing structure of South Africa industries puts them at a disadvantage in efforts to reduce energy intensity compared with other fast-growing economies with larger and more numerous industries. However, holistic efforts to address wasteful use of energy will help the industries that are most exposed to international competition, such as iron and steel, chemicals and mining industries, to boost their competitiveness by reducing their energy intensity. Despite significant improvements, industries in South Africa may find it difficult to match the performance indicators of countries like China, India or ASEAN countries (Figure 11).

Over the period to 2030, each industry sub-sector modelled sees a progression in production volumes, but there is uncertainty regarding future activity levels and possible shifts for some industry segments, which has implications for future energy demand and setting targets for energy savings. In the Baseline case with the absence of enhanced efficiency measures over the next 15 years, annual steel production is foreseen to rise to 9.1 million tonnes, a 31% increase. In this timeframe, steel markets may shift. For example, fuel-economy standards and labelling are influencing car manufacturers to use lighter materials, so less steel and more aluminium. In a context of less global demand for steel products, the Efficiency case suggests that South African steel producers will maintain their market share, but production volumes are 2% lower. Continuous efforts to improve energy efficiency in iron and steel production, which currently accounts for 15% of total industrial energy use, maintains energy intensity at comparable levels to that of other fast-growing economies. High production and shipping costs of its steel production, together with persistent reliance on imported coking coal, affect the international

[8] http://ietd.iipnetwork.org/content/direct-reduced-iron

competitiveness of steel making companies in South Africa, which may put the industry at risk. Expensive steel production could further incentivise measures to cut fuel requirements per unit of output or a shift to specialise in niche markets such as hot rolled coil. Such strategic repositioning along the value chain is supported by the government's minerals beneficiation strategy.[9]

Figure 11 • Energy intensity indicators by industrial sector



Aluminium and steel manufacturers, among others, are particularly exposed to shifting economics and strong international competition. In South Africa, electricity prices are rising and will continue to do so in the near term in order to strengthen power supply, reliability and delivery. This may have noticeable effect on huge electricity consumers such as the BHP Billiton's aluminium smelter operation at Richard's Bay. The high value of aluminium scrap is a key incentive for the company to invest in recycling activities and cut electricity expenses sharply. The outlook for energy savings potential in the other industry category, which includes aluminium, assumes that the production of primary aluminium is maintained at current levels, thus allowing for savings in incremental production via secondary aluminium processing. Phasing out the primary process translates into the upper estimate in electricity saving potential in other industries.

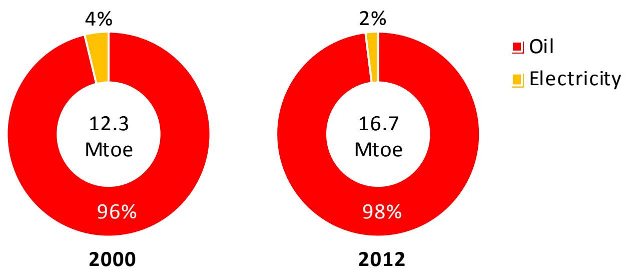
[9] Minerals beneficiation, or value-added processing, involves the transformation of a primary material (produced by mining and extraction processes) to a more finished product, which has a higher export sales value. www.dmr.gov.za/beneficiation-economics

Non-energy use of fossil fuels, such as petroleum products used for feedstock, bitumen or lubricants, leave little room for energy efficiency improvements due to the very nature of materials processing. Production volumes are directly linked to overall industrial and chemical activity and are thus rising at a similar pace.

Transport

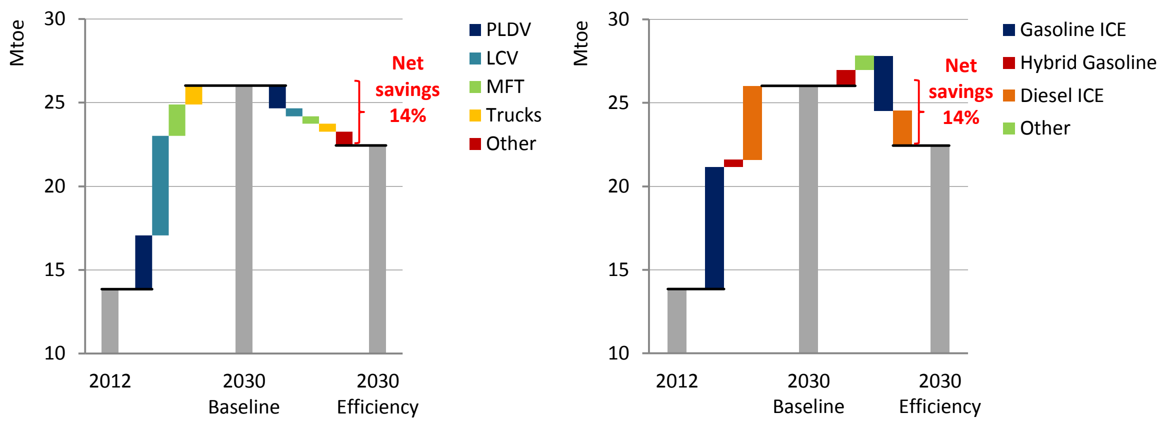
Intensifying freight and commercial activity, including domestic aviation, as well as increased car ownership driven by rising average incomes among households all led to a 35% increase in transport energy demand in the period 2000 to 2012, an average annual increase of 2.6%. Transport accounts for almost a quarter of total final energy use in South Africa. That consumption is almost all as gasoline and diesel products (Figure 12).

Figure 12 • Fuel use in transport, 2000 and 2012



In the outlook to 2030, the transport sector, a key driver of economic development, sees one of the fastest growth rates in energy consumption among end-use sectors. Consequently, transport has the potential for the largest source of primary energy savings in South Africa. Absent a policy push for efficiency gains, energy used in road transport, essentially oil products, increases by around 80% through to 2030, an annual average 3.5% increase. One approach — setting stricter fuel economy standards — could deliver a 14% reduction in oil use in road transport (Figure 13).

Figure 13 • Energy consumption and savings by road transport segment (left panel) **and by vehicle type** (right panel)

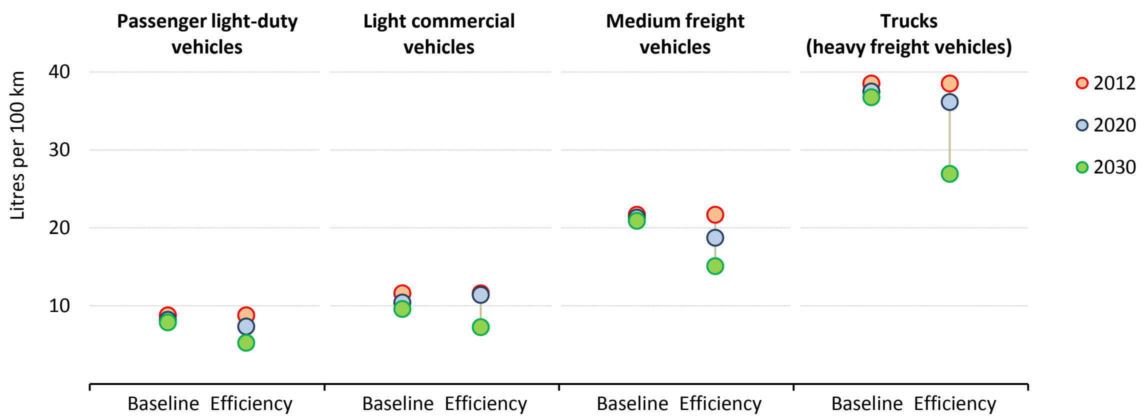


Notes: PLDV = Passenger light-duty vehicles; LCV = light commercial vehicles; MFV = medium freight vehicles; ICE = internal combustion engine; other category (right panel) is primarily electricity consumption in rail transport.

The evolution of the transport fleet character in terms of vehicle size and mode determines potential savings by fuel type. Fuel efficiency policies targeted to lighter vehicles could offset two-thirds of additional gasoline consumption by 2030 compared with today's level. Medium and heavy freight vehicles will account for about 60% of the increase in diesel consumption to 2030. Progressive deployment of hybrid vehicles, substituting for conventional internal combustion engines (ICE), is one key to constrain future fuel use regardless of vehicle fleet expansion. By 2030, total potential savings from conventional gasoline and diesel vehicles (5.4 Mtoe) offsets three-quarters of additional gasoline consumption in ICE vehicles in the Baseline case. Road transport fuel demand is also expected to be partially dampened in response to escalating gasoline prices. In 2030, the gasoline price is 14% higher than in 2012, but efficiency policies implemented worldwide reduce global demand for oil, mitigating the increase in gasoline price for end-users by 20% (See Table 4).

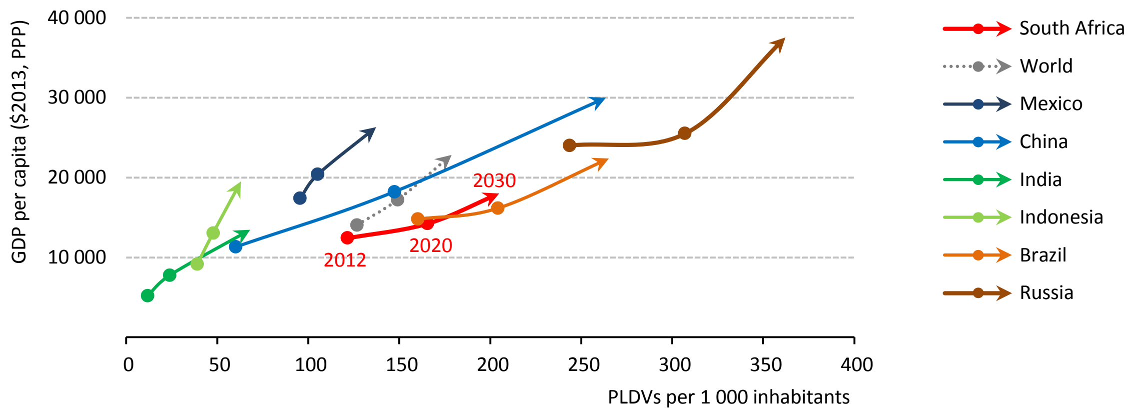
Fuel-economy improvements are critical to shape South Africa's energy use in transport in the coming decades. Well-designed transport policies foster improvements and reduce fuel consumption. The measures need to be differentiated based on vehicle types. With effective implementation of fuel-economy standards, average consumption of passenger light-duty vehicles (PLDVs) could be reduced by 15% in the short-term (by 2020) and by 40% by 2040, down to 5.3 litres per 100 km, similar to European Union levels (based on a moderate policy ambition EU case (Figure 14).

Figure 14 • Fuel economy: on-road vehicle stocks in the Baseline and Efficiency cases



Economic growth tends to drive overall energy consumption up and impacts the size and pace of turnover of on-road vehicle fleets. Rising per-capita income increases car ownership and freight activity. Car ownership in South Africa is expected to expand at a pace roughly similar to that of Brazil, from 120 vehicles per thousand inhabitants in 2012 to 200 vehicles per thousand inhabitants in 2030 (Figure 15). The natural fleet turnover which brings in fuel-economy improvements such as vehicle light-weighting and powertrain optimisation gradually reduces new vehicle fuel consumption per kilometre driven. Developing and implementing effective transport policies must give due consideration to both increased demand for transport fuel to support economic activities and the need for it to go hand-in-hand with fuel-economy improvements and the broad aspects of transportation system planning and development. A careful assessment of future transport energy needs requires the anticipation of domestic and international trends related to innovation in vehicle technology and transport policy package.

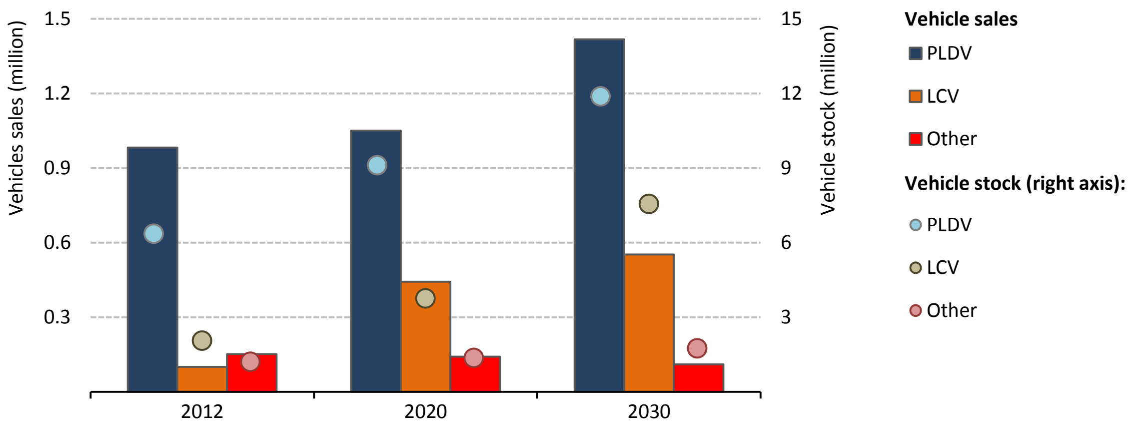
Figure 15 • Relationship between car ownership and per-capita GDP, 2012-2030



Note: PPP = purchasing power parity.

In South Africa, road transport accounts for the lion's share of transport energy consumption because of rising household incomes and the increasing concentration of economic activity around urban areas, a trend that persists in the next two decades. Passenger light-duty vehicles are expected to rise from 6.4 million today to about 11.9 million within the next 15 years. Sustained economic development induces more services sector activity and more trade of manufactured products, thereby leading to an almost three-fold increase in the number of on-road light commercial and freight vehicles (Figure 16).

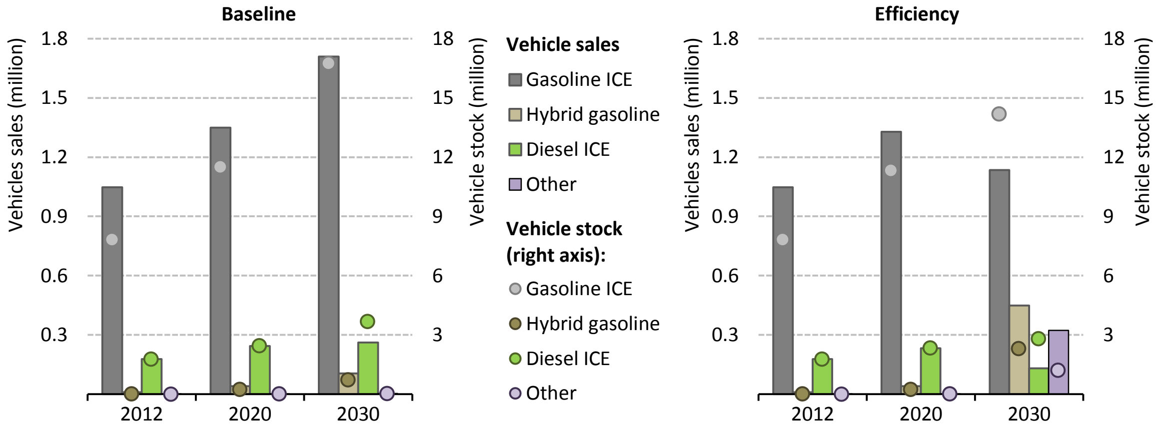
Figure 16 • Vehicles sales and on-road stock by transport segment



Note: The volume of vehicles sales is assumed to be unaffected by policy choices. These sales apply to both Baseline and Efficiency cases.

Stringent fuel-economy measures may shift the market to increase uptake of hybrid vehicles. By 2030, the stock of on-road vehicles equipped with gasoline-fuelled internal combustion engines will be 15% lower than in a business-as-usual situation, allowing for an annual sale of 450 000 hybrid vehicles or 140 000 plug-in hybrids PLDVs (Figure 17). Advances in diesel engine consumption would play a limited role in the mitigation of overall fuel use.

Figure 17 • Sales and on-road stock by vehicle type in the Baseline and Efficiency cases



Taping the full potential of transport energy savings necessitates the activation of multiple policy levers. These may include: implementation of fuel-economy standards; mandatory fuel-economy labels for vehicles; scrappage schemes; incentives for purchase of most-efficient vehicles; penalties on least-efficient new vehicle registration and use; obligation for companies to report their fuel consumption to allow for better monitoring and various fuel levies such as tax on heavy freight to incentivise rail freight.

Other policy and regulatory measures, particularly related to local air pollution, land-use planning and climate change mitigation, can complement transport sector efficiency measures. For example, efficiency-oriented measures often fall short of providing sufficient incentives to deploy low-carbon electric vehicles. Air pollution and greenhouse-gas emissions objectives, supported by appropriate fiscal incentives and green taxation (e.g. tax credits for the purchase of electric vehicles), can help to stimulate swifter market diffusion of advanced vehicles such as plug-in hybrids or full-electric cars, while also cutting gasoline and diesel consumption. Public transportation measures should also be part of broad integrated urban planning to serve mobility needs and to anticipate future commuting schemes between home and urban/peri-urban areas. This also calls for enhanced transport infrastructures.

Buildings

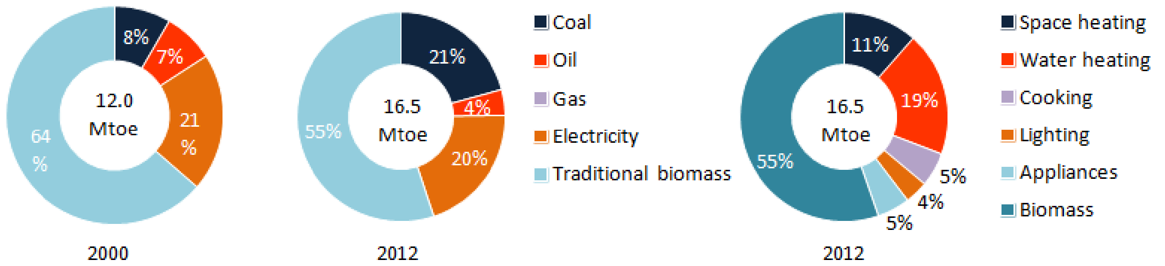
The buildings sector includes energy used in residential, commercial and institutional buildings. Building energy use includes space heating and cooling, water heating, lighting, appliances and cooking equipment.

A number of initiatives to address wasteful use of energy in private and public buildings have been discussed at municipal and provincial levels, especially in Gauteng province, South Africa's economic and industrial hub where activities are concentrated between Pretoria and Johannesburg. These initiatives, however, have resulted in limited impacts so far. This is due to financial and capacity obstacles, lack of dedicated appliance standards or labelling and certification programmes, and auditing capacity and equipment. Complementary measures such as tax exemptions or other fiscal incentives could also provide effective mechanisms to spur adoption of energy-efficient measure and equipment by households. Distributional issues and income inequality should also be taken into account to optimise fiscal revenues (See energy savings potential and economic benefits section).

Residential

In 2000, two-thirds of residential energy needs were met by traditional biomass. In recent years, residential energy demand increased by 37% despite on-going inequality in household disposable income and the rise in per-capita GDP. Government efforts to reduce energy poverty and increase access to electricity proved effective at cutting the use of traditional biomass from 64% to 55% of household energy consumption. In parallel, rising living standards are often associated with more energy use. This is particularly relevant in the case of coal for space and water heating purposes in South Africa. Overall coal use is estimated to have more than doubled since 2000. Only electricity broadly maintained its share of about one-fifth of total household energy consumption, equivalent to that of coal (Figure 18).

Figure 18 • Fuel use in residential, 2000 and 2012



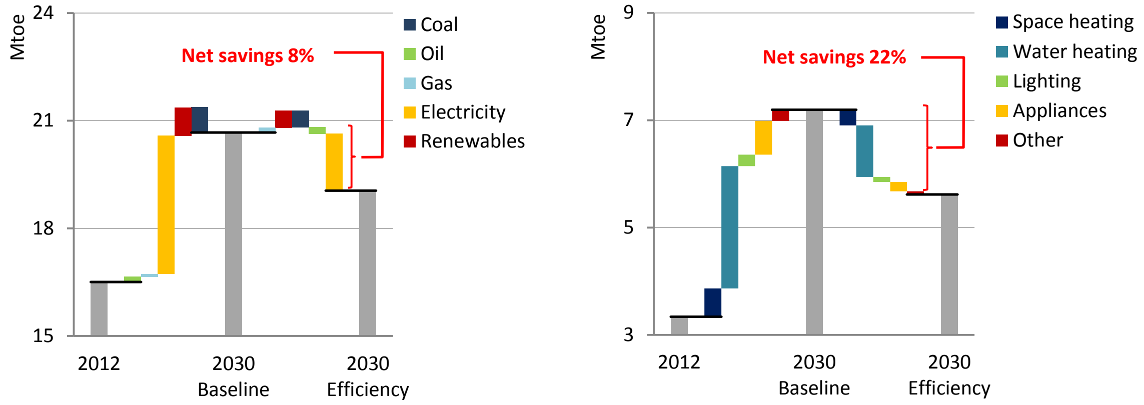
The residential sector, with energy consumption equivalent to total oil use in transport, is the single most important driver of incremental electricity demand in South Africa in the period to 2030. Adequate efficiency measures to mitigate future electricity needs in households are thus of prime importance, in parallel with the transformation of power supply infrastructure. In the Baseline case without additional efficiency measures, the residential sector represents 20% of the increase in total end-use energy demand through 2030 (4.1 Mtoe, including 3.9 Mtoe of electricity) (Figure 19, left panel). Almost 60% of this residential electricity demand is driven by the deployment of electricity-based water heating systems that substitute for coal. The scope to moderate this increase is significant: opting for the most efficient electric water heating equipment results in 25% lower additional electricity demand in 2030 (Figure 19, right panel). If efficiency measures are put in place for appliances, cooking and space heating purposes, then the net savings reach 22%.

Electric appliances account for 16% of the incremental electricity used in the residential sector through to 2030 and for 15% of its total final energy use. Future lighting needs are largely addressed by current policies, including international initiatives such as the United Nations Environment Program's "en.lighten initiative"[10], to incentivise the purchase of alternatives to incandescent light bulbs. Strengthening efficient lighting system adoption, most notably through wide-scale adoption of LED lamps, is sufficient to fully offset additional electricity for lighting.

Meeting ambitious energy efficiency targets mitigates the increase in overall residential electricity consumption by 22%, yet electrical consumption in 2030 is still 70% higher than in 2012 (Figure 20). The introduction of modern biomass to supplement traditional use increases total biomass consumption by 10%, but the total share of biomass in the residential energy stays roughly the same around 50% by 2030. With appropriate incentives, the steady diffusion of solar-based water heaters for households, complemented by a modest penetration of natural gas, allow for a slight substitution away from coal for such energy end-uses.

[10] www.enlighten-initiative.org

Figure 19 • Residential energy consumption by fuel (left panel) **and electricity consumption and savings by end-use** (right panel)



Households in rural areas have distinctive characteristics in relation to energy. Fuel stacking, the use of multiple fuels, is common practice in rural areas with only partial access to electricity. Only partial fuel substitution occurs after changes in market conditions or ease of access to local resources (i.e. between traditional biomass and liquefied petroleum gas). Generally, gaining access to electricity does not displace alternative fuel use but comes in addition to it.

The composition of residential energy demand in 2030 in South Africa relates to current and anticipated characteristics of dwellings. As income and population rise, the number of occupied dwellings is set to rise at 1.1% per year to reach 19 million by 2030 (Table 2), with an electrification rate maintained at 85%. By contrast with other fast-growing economies with much larger populations, the number of dwellings remains modest in South Africa, thus rendering the regulation and the monitoring of efficiency standards, especially electricity-related ones, somewhat easier.

Electricity has a prominent role in how energy use in the residential sector will evolve in the outlook to 2030. Significant factors are the level of appliance ownership in relation to increasing household incomes as well as energy prices and characteristics such as dwelling size and occupancy rates. How devices change over time in size and energy performance, for example refrigerators, contributes to the intensity of residential electricity use. As household incomes increase, over time appliance penetration rates can reach a degree of saturation.

Figure 20 • Residential energy use relative to 2012 and fuel mix

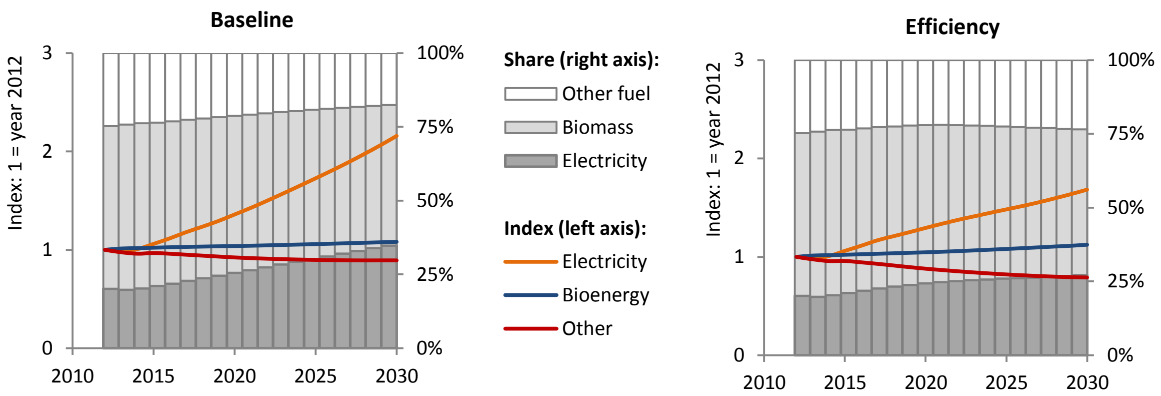


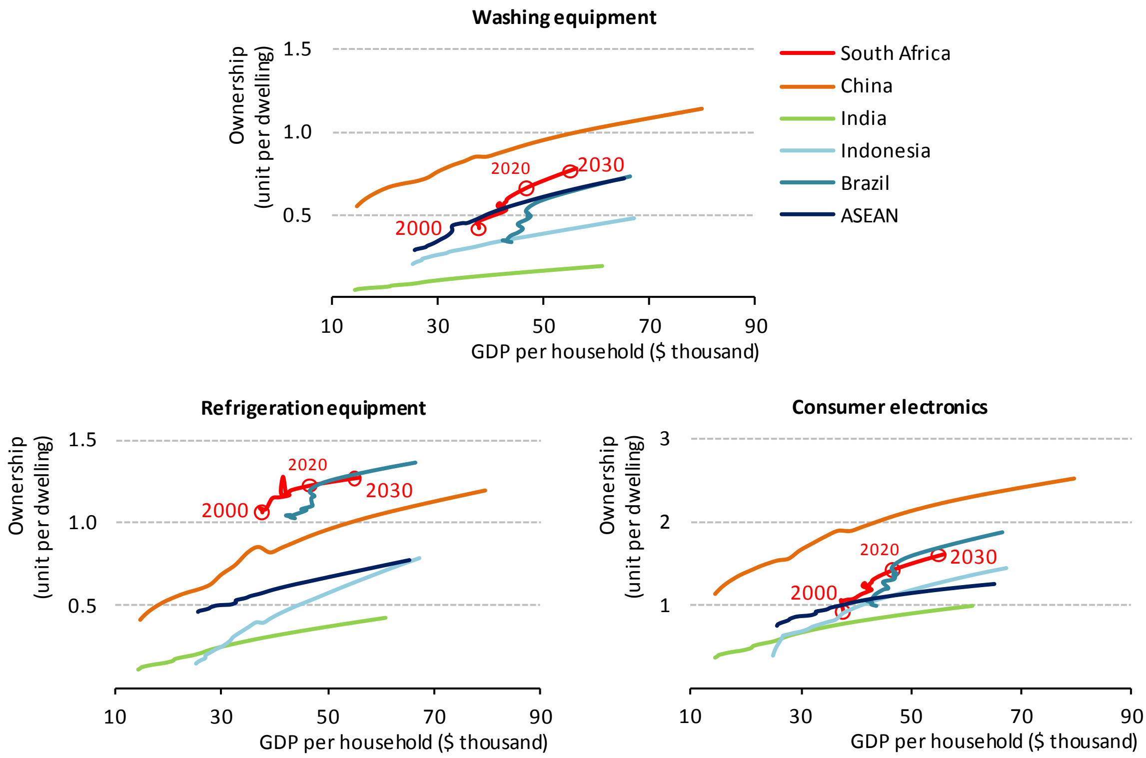
Table 2 • Dwelling characteristics

	Number of electrified dwellings (million)			Dwelling occupancy					
				Occupied Dwellings (million)			Population per occupied dwellings		
	2012	2020	2030	2012	2020	2030	2012	2020	2030
South Africa	13	14	16	15	17	19	3.4	3.3	3.1
China	416	474	538	416	474	539	3.3	3.0	2.7
India	184	212	246	244	281	326	5.1	4.8	4.5
Indonesia	47	55	65	62	72	85	4.0	3.7	3.4
ASEAN	71	82	95	91	105	122	4.0	3.7	3.5
Mexico	29	34	40	29	34	40	4.0	3.7	3.5
Brazil	63	68	75	64	69	75	3.2	3.1	3.0

Average appliance ownership per dwelling varies depending on the type of appliance and the initial level of ownership. Washing equipment, i.e. clothing washing machines, and consumer electronics see the fastest progression, on the order of 30% to 40% relative to current ownership levels in South Africa. In absolute terms, cooling systems develop at a similar pace, but account for a small proportion of incremental electricity demand (not shown). Anticipating the use and development of appliances, in particular smaller equipment such as consumer electronics is currently a crucial concern to power utilities which strive to manage electricity demand during peak periods with extremely tight capacity margins.

A comparison with similar emerging economies suggests relatively fast diffusion rates of appliances in South Africa, such as in Brazil or China (Figure 21). In contrast, lower rates of urbanisation and electrification, such as in India, Indonesia or in South East Asia, slow the diffusion of appliances among households.

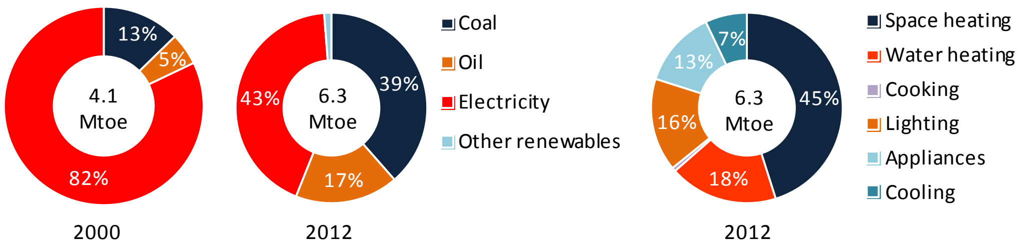
Figure 21 • Relationship between appliance ownership and increased household income



Services

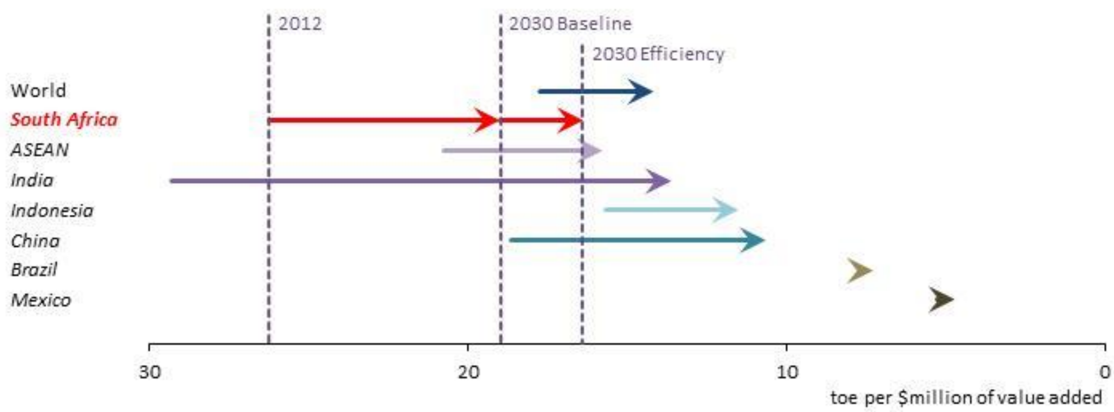
Energy used in the services sector[11], albeit small in relation to other key consuming sectors, has increased by more than half since 2000 (Figure 22). It is the largest increase in proportion to other sectors and is in-line with the economic growth rate. The shift from an industry and manufacturing sector-based economy to a service-based economy, including a growing number of small businesses, led to a sizeable diversification of the sector's fuel mix, notably in favour of oil and most importantly coal, which often remains the most affordable and thus preferred option for space and water heating. Electricity saw a net reduction in consumption (20%) thanks to widespread adoption of efficient lighting systems and appliances, notably in public buildings.

Figure 22 • Fuel use in services, 2000 and 2012



A cross-country comparison of energy intensity in the services sector suggests quite an inefficient use of energy in South Africa, and therefore a lot of room to improve the energy profile of its value-added creation (Figure 23). According to historical data, current energy intensity in South Africa's services sector is among the highest in the world, after India.[12] Tapping the full potential of energy efficiency in the sector only brings its energy intensity to a level slightly above the current global average, but falls short of matching other fast-growing economies performance.

Figure 23 • Energy intensity in the services sector



Note: Arrows in countries other than South Africa only show the Baseline case progression between 2012 and 2030 and do not reflect their actual potential for efficiency improvement.

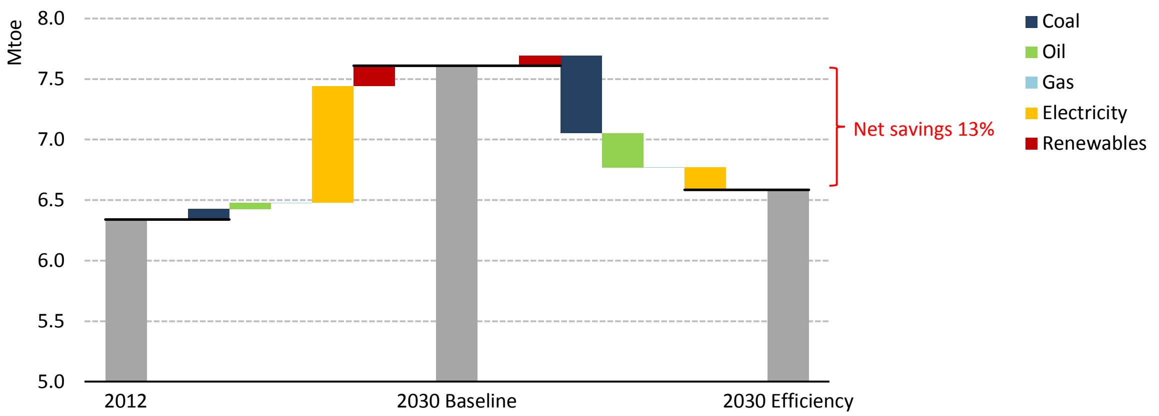
While a key contributor to the economic development of South Africa, the services sector adds a modest 6% of incremental growth in total final energy use in 2030. For comparison, the

[11] Services sector includes energy used in commercial and institutional buildings. This energy use includes space heating and cooling, water heating, lighting equipment, appliances and cooking equipment.

[12] The low intensity level indicated by statistics suggests a particularly under-performing services sector in South Africa, which may reflect some degree of inaccuracy in the data.

residential sector adds almost 20%. In the Baseline case, total energy use in the services sector increases by 20% by 2030, of which 80% is electricity consumption (Figure 24). By 2030, electricity covers almost half of the sector's total energy needs. Lighting devices account for about 40% and appliances for 30% of total electricity consumption. The rest of the increased electricity demand is for cooling and space heating systems. Effective policies already in place to adopt efficient lighting systems, notably in public buildings, limit the scope for additional savings from lighting. Still, there is scope to avoid 13% of total energy consumption in the services sector, notably by substituting coal use with efficient electricity-based space heating systems. Given the sheer size of public sector building ownership in South Africa, the government and local municipalities have an important role to play in better energy demand management.

Figure 24 • Services sector consumption and savings by fuel



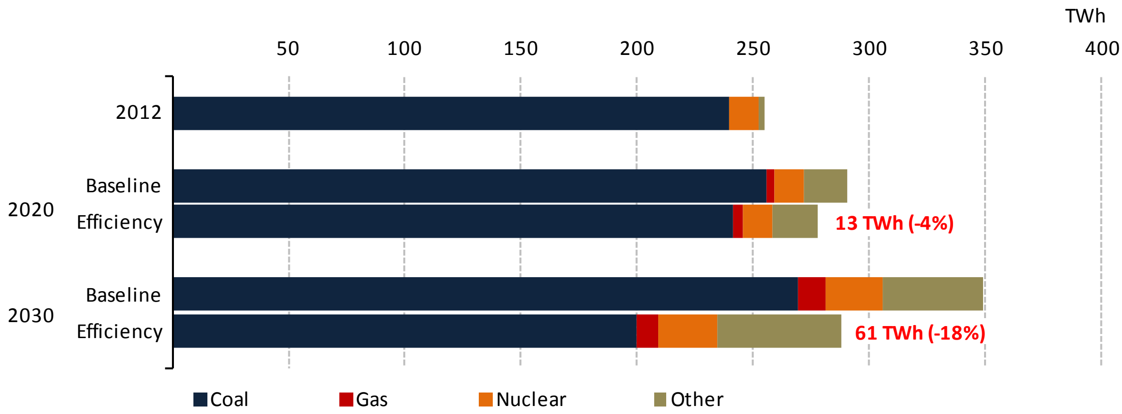
Power generation

The power supply in South Africa is almost entirely based on large-scale coal-fired capacity often co-located with the mines. Much of this capacity is aging, maintenance has been inadequate and today's performance is comparatively inefficient. The power sector faces an acute crisis because of insufficient investment in new capacity to meet rising electricity demand resulting in utility load shedding though rolling black-outs which impedes economic activities and has even caused traffic chaos in Johannesburg by disrupting road signal systems.

The transition to a more energy efficient economy goes hand-in-hand with the need to transform power generation capacity and its operation. Continuous efforts are needed to develop additional capacity and to plan for projected electricity demand. In the Baseline case without economy-wide energy efficiency enhancements, electricity generation is set to increase by almost 15% by 2020 and 37% by 2030 (Figure 25). The diffusion of more energy-efficient equipment, such as appliances, electric motors and variable speed drives, reduces the need for additional generation capacity (16% by 2020 and more than 20% by 2030), which in turn, alleviates consumer electricity spending. Under-estimating future electricity needs and delaying capacity addition investment decisions would reinforce the impact of current shortages. The increase in electricity needs in the IEA Baseline case corresponds to the lower limit of scenarios in South Africa's Integrated Resource Plan for Electricity (DoE, 2013), corresponding to the *Weathering the Storm* scenario which was derived from similar underlying assumptions.[13]

[13] The Council for Scientific and Industrial Research *Weathering the Storm* scenario assumes a 2.9% GDP growth to 2030 and results in a 1.8% average annual electricity demand growth to 2030, analogous to the IEA Baseline scenario.

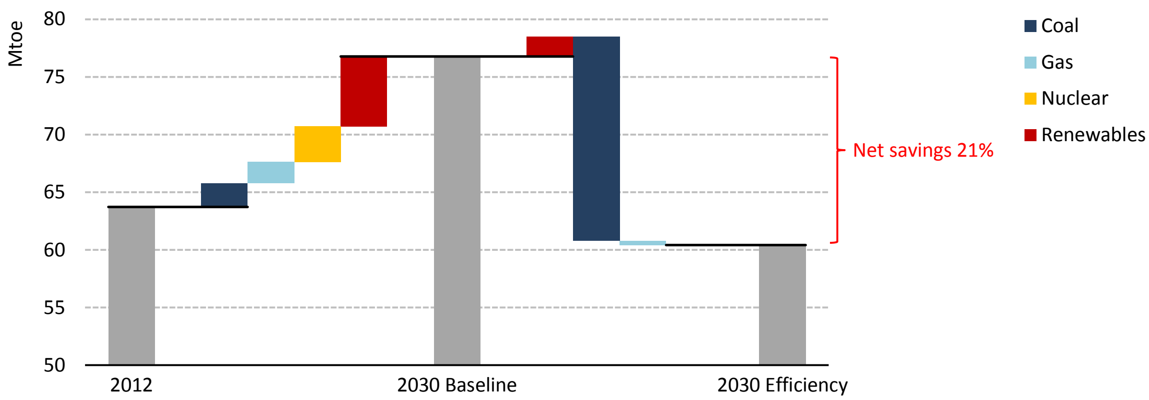
Figure 25 • Savings in electricity generation



In the Baseline case, around 90% of electrical capacity added in the medium term is coal plants along with renewable capacity. In the longer run, the natural replacement of aging capacity gives room to diversify the electricity fuel mix decisively towards additional renewables, nuclear and gas-fired power generation. With full operation planned for 2020, the two large-scale coal plants at Medupi and Kusile will ramp-up generation by 17 terawatt-hours (TWh) relative to 2012. Renewables electricity sources will provide another 15 TWh, driven by large solar power developments (4.9 TWh from PV and 1.6 TWh from concentrating solar power plants), wind generation (4.4 TWh), biomass (2.7 TWh) and hydro (1.6 TWh). Renewables and nuclear generation more than double by 2030 compare to 2020 level while natural gas adds about 8 TWh to supply. By 2030, efficiency measures influence diversification of the fuel mix in power generation which leads to a decrease in coal generation by 17% (40 TWh) relative to the current level, almost 80% of the increase in renewable-based electricity.

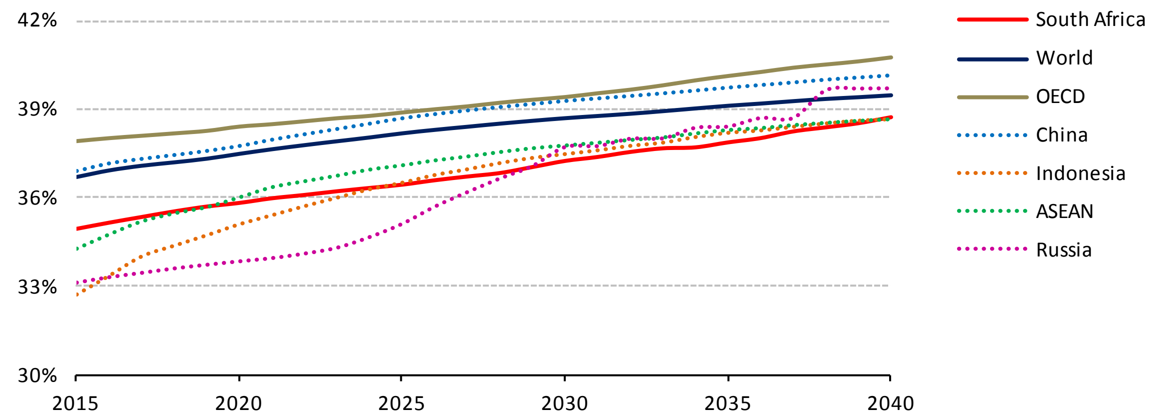
The full range of efficiency measures reduces overall electricity needs across all end-users, induces fuel substitution in the power sector and translates into considerable coal savings (Figure 26). More than a quarter (18 Mtoe) of coal needed to meet electricity demand under business-as-usual conditions could be saved in 2030. By comparison, end-use savings in 2030 total 4 Mtoe.

Figure 26 • Overall fuel consumption and savings in power generation



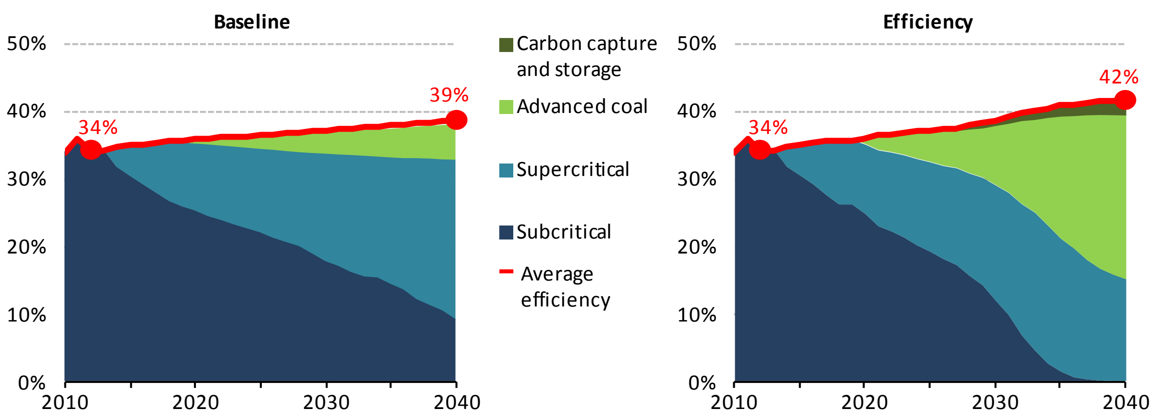
Almost half of coal power capacity currently operating in South Africa is at least 30 years old.[14] The average efficiency of the existing fleet is below 35%. More than 35% of total coal capacity will have to be replaced by 2030, thereby providing a unique opportunity to improve the average efficiency of the fleet. In the Baseline case, insufficient uptake of more efficient technology in South Africa only improves average coal power plant efficiency by 0.5% per year to reach 37% in 2030. Other countries with a large share of inefficient coal plants in their electricity mix, such as Indonesia, India and Russia will see a yearly improvement of around 1% by 2030 (Figure 27).

Figure 27 • Average coal power plant efficiency in selected countries, Baseline case



Upgrading coal generation capacity with advanced technologies as they become available accelerates the improvement in average fleet efficiency to 0.7% per year. The sustained diffusion of efficient technology delivers benefits in the long run: the average efficiency of coal power plants reaches 42% by the time a large fraction of the currently operating capacity has been replaced (Figure 28). Mitigating future electricity demand reduces the need for coal capacity additions by a third (10 gigawatts) in the coming 15 years, with the share of cumulative new-builds as advanced coal designs increasing from 13% to around 35% (See Annex B, Table 8).

Figure 28 • Decomposition of improvements in coal average efficiency by plant type

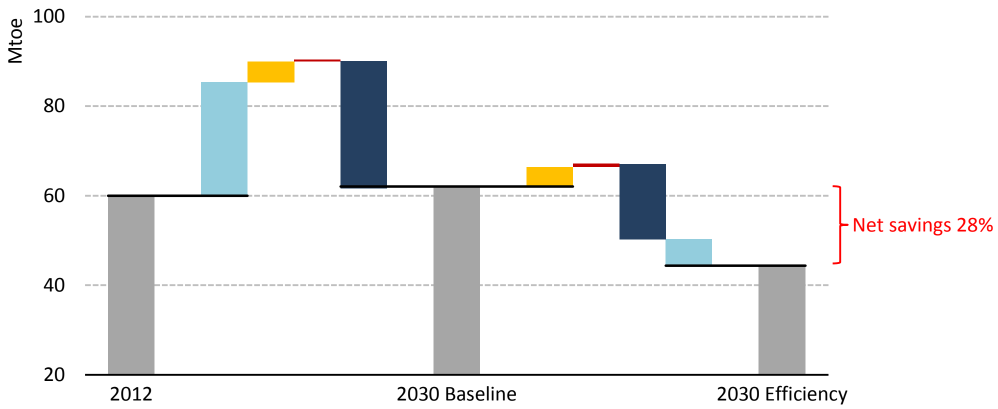


The transition to state-of-the-art coal generation capacity cuts coal consumption by around 30% in 2030, equivalent to more than one year of coal use by industries and households combined,

[14] Platts database (2013) and IEA analysis.

and strongly alleviates coal reliance of the South African energy system (Figure 29). Savings are primarily achieved through two channels: lower demand for electricity and reduced need for subcritical plants which operate at lower capacity factors. There is also scope for improving the transmission and distribution network in parallel to the modernisation of the power generation fleet. The development of distributed generation capacity, especially for buildings equipped with solar water and space heating systems, eases pressure on the grid. Additional efforts to reduce transmission losses, particularly for low and medium voltage lines, are included.

Figure 29 • Coal consumption and savings in power generation by plant type



Other transformation: Synthetic fuels production

Coal-to-liquids (CTL) production in South Africa, initially encouraged by large coal availability and then bolstered by escalating oil prices, is set to prolong its unique, half-a-century-long history. Synthetic fuel production remains a hefty component of South Africa's energy balance through to 2030. The production of synthetic fuels and derived chemical feedstock requires significant volumes of low-grade coal and imported natural gas. In 2012, coal input to Sasol's Secunda synthetic fuel production (synfuel) plant amounted to 5Mtoe of coal (7 million tonnes of coal), corresponding to 5% of national coal consumption. It is estimated that Petro SA's production of gas-to-liquids (GTL) in its Mossel Bay refinery necessitated 1.5 Mtoe of natural gas in 2012, or about half% of South Africa's gas demand. Together CTL and GTL met 14% of total demand for liquids in South Africa in 2012. (According to the World Coal Association, about 30% of South Africa's gasoline and diesel requirements are produced from coal).[15]

Despite continuous efforts to improve process efficiency, the other transformation sector is set to remain very energy-intensive due to the very nature of its activities. A diversification of fuel input in favour of natural gas may moderate energy requirements, as suggested by recent strategic orientations of historical market players. CTL production is projected to stabilise at current levels, with an average rate of efficiency improvement of 5% per year. Natural gas shipped from Mozambique via a pipeline with a capacity of 5 bcm is expected to progressively substitute for coal and overcome the lack of domestic gas resources. By 2030, the production of synthetic fuel still represents 12% of demand for liquid fuels, but the corresponding energy footprint could be cut by 9%, in the case of GTL, if process efficiency measures would be fully tapped (Table 3).

[15] www.worldcoal.org/coal/uses-of-coal/coal-to-liquids

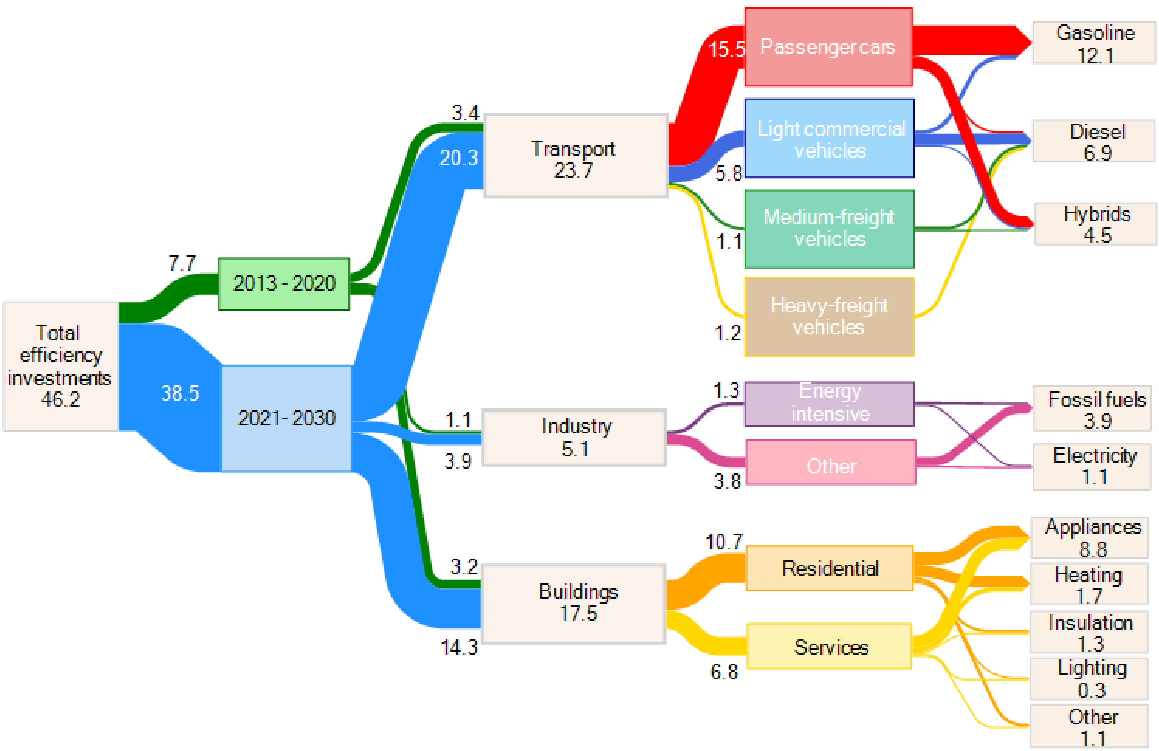
Table 3 • Fuel use and potential savings in CTL and GTL production

	Baseline			Potential savings (%)	
	2012	2020	2030	2020	2030
CTL production (kb/d)	73	73	73	2%	5%
Coal use for CTL production (Mtoe)	15.9	15.9	15.9	2%	5%
GTL production (kb/d)	25	20	20	4%	9%
Gas use for GTL production (Mtoe)	1.7	1.8	1.8	4%	9%
CTL+GTL production. as share of demand for liquids	18%	15%	12%	-	-

Efficiency Investment by Sector

Pursuing ambitious energy efficiency objectives comes at the expense of additional targeted investments, in parallel to the reduction of end-user energy bills. Cumulative end-use investments, or expenses in the case of households purchasing energy-efficient goods such as appliances which do not require specific financing scheme, are on the order of $46 billion (Figure 30). About 15% ($7.7 billion) of total investment needs be spent by 2020 to meet short-term objectives. This amount calls for the parallel implementation of finance support schemes, notably to help poorer households to adopt energy-efficient devices. Half of total needed investment is for the purchase of vehicles by households and small businesses, generally financed by savings and debt. Another 38% is allotted to energy use in buildings.

Figure 30 • Cumulative efficiency investments by end-use sector, 2013-2030



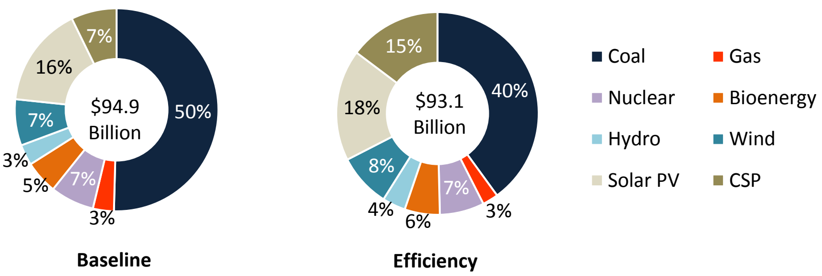
Note: Investments are expressed in billion US dollars.

Households, through the adoption of efficient cars (including hybrids), appliances and heating systems, play a key role to reduce growing demand for energy in South Africa and therefore face the largest proportion — more than half — of expenditures for efficiency improvements. The public sector, which owns a large portion of buildings and a large vehicle fleet, also represents a primary source of energy efficiency investment.

The potential reduction of energy intensity in industry could be achieved at moderate costs estimated at $5.1 billion. Short-term potential can be tapped via low-cost means such as effective energy management and adopting best practice techniques.

Overall investment in power generation capacity is on the order of $95 billion (Figure 31). Given the urgent need to increase capacity in the short term overall investment by 2020 accounts for almost 40% of total investment over the projection period, irrespective of the degree of policy action. However, the transformation of the power capacity structure towards more efficient capacity results in a 32% reduction of cumulative coal power plant additions which, in turn, translates into $10.6 billion avoided investment. In the Efficiency case, coal investments as a share of total investments are reduced by 10 percentage points and are compensated by increased investment in of solar installations. The ramp-up of renewable-based and distributed capacity has substantial implications in terms of network investment. In particular, distribution investment costs decrease by a third, thus easing the overall financing requirements for network infrastructure. The projected increase in electricity prices better allows utilities and retail entities to cover more moderate investment needs in the power sector.

Figure 31 • Cumulative efficiency investments in the power sector, 2013-2030



	Baseline	Efficiency
Transmission	$9 billion	$7 billion
Distribution	$41 billion	$28 billion

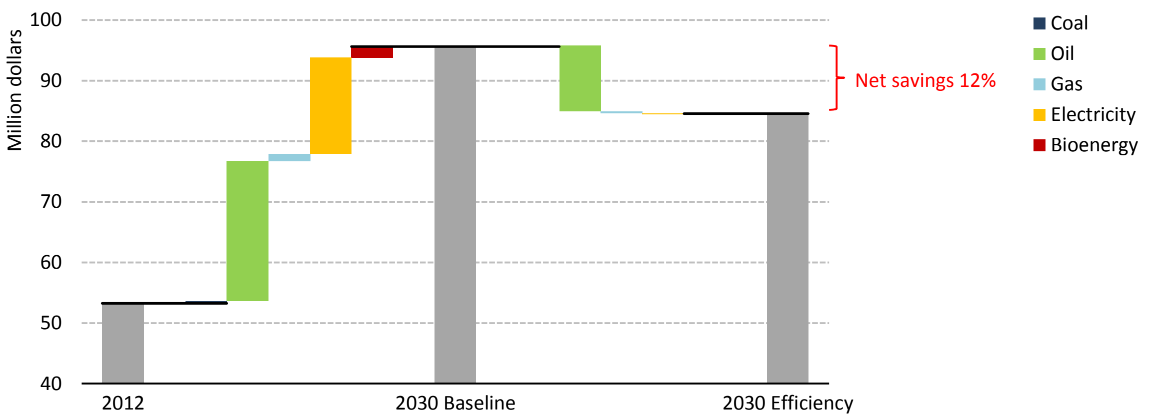
Energy Savings Potential and Economic Benefits

Deploying energy efficient solutions across the South African economy and transforming the structure of energy supply accordingly deliver multiple micro and macroeconomic benefits. It reduces energy bills as well as energy import needs.

The main implication of robust implementation of energy efficiency measures is a change in fuel and electricity prices in response to the expected behavioural changes from consumers. In general terms, efficiency measures boost energy prices and discourage wasteful energy consumption. In the short-term, industrial and residential electricity prices are expected to increase the most due to the need to build coal and renewable power generation capacity to ease the supply constraints. In the longer term, the impacts on prices are more contrasted and depend on the fuel suppliers' degree of exposure of to international markets. Importantly, electricity prices follow a steady increase after 2020.

Energy-saving measures lead to a net 12% reduction in overall energy spending by end-use customers (Figure 32). Most of the reduction comes from reduced oil spending, which is diminished by $10.9 billion or 20%. Overall expenditure on other fuels and electricity is coincidentally more or less left unchanged. It is notably the case for electricity spending even though the outcome for households is opposite to that of industries and services. Households save $1.4 billion on their electricity bill which is offset by increased spending by industries and services due to more economic activity and rising electricity tariffs.

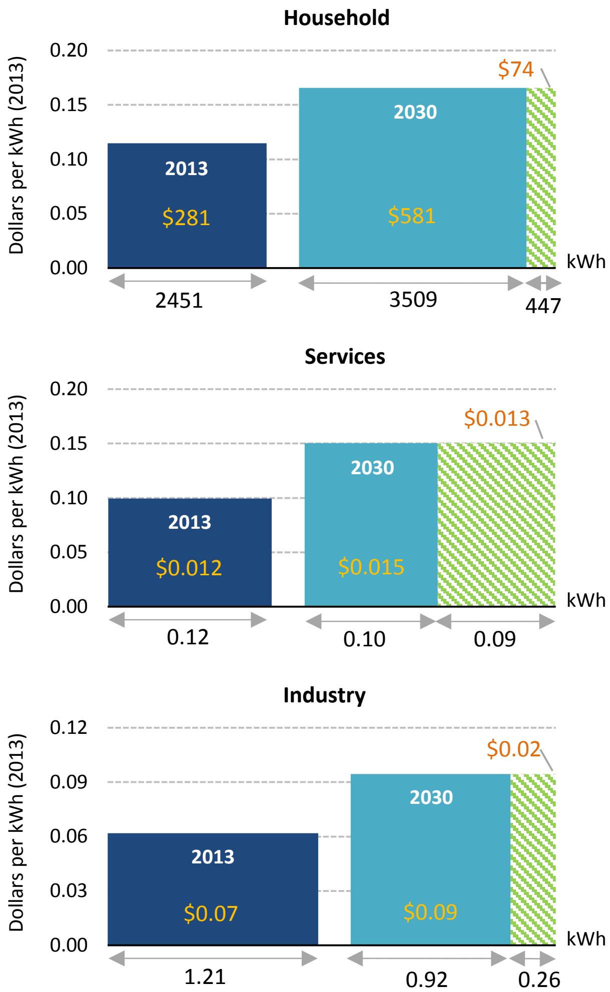
Figure 32 • End-use energy spending by fuel



In order to assess the actual impact on electricity bills for each end-user type, it is informative to derive spending per household or per unit of value added in the industry and services sectors (Figure 33). In 2012, an average South African household spent $281 for their electricity consumption. By comparison, and although consumption patterns may be different due to distinct climate conditions and equipment ownership, an average Chinese household, which also has significant potential to improve its use of electricity, spent almost $170 a year on electricity, about one sixth of the amount spent by an average European household. Households are among the main beneficiaries of energy saving measures. In the Efficiency scenario, factoring in future electricity prices and more demand, an average South African household cuts its electricity bill by $74 per year such that in 2030 the average spending for electricity is $581.

Every dollar of value added generated in the services sector currently requires 0.12 kilowatt-hour (kWh) of electricity which yields electricity costs of about $1.2 cents per dollar of value added. In 2030, spending on electricity is reduced by about half on the per unit of value-added basis compared with a business-as-usual development thanks to the adoption of efficient electric devices which more than compensate for rising electricity prices. In the industrial sector, electricity costs per unit of value are also lower compared to a situation without efficiency gains.

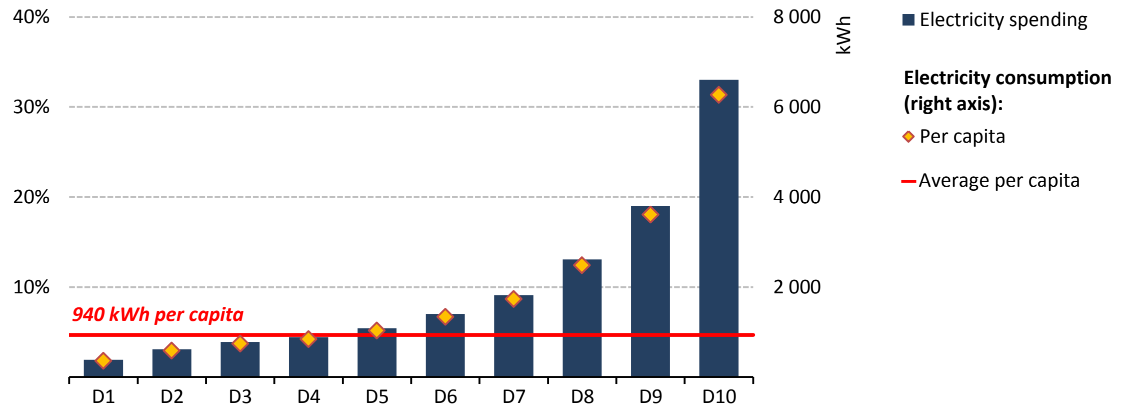
Figure 33 • Electricity bills and potential savings for household, services and industry sectors, 2013 and 2030



Note: Savings on energy bills in the services and industry sectors are expressed per dollar of value added. The green shaded area indicates the electricity bill reduction in the Efficiency case relative to the Baseline case. Figures on horizontal axis correspond to the average electricity consumed for each dollar of income or for the creation of one dollar of value added.

South Africa has demonstrated good economic performance in recent years. Nevertheless, sizeable inequalities in household income and energy use levels remain. These inequalities have implications for setting energy efficiency objectives and pricing. In 2011, average residential electricity consumption was about 940 kWh per capita (Figure 34). About 20% of the better-off households accounted for half of total electricity spending in 2011, with an annual average consumption of about 5 000 kWh, suggesting large inequalities in electricity consumption levels and heterogeneous levels of affordability. Energy policies that aim to rein in demand growth should also factor in income inequality and ensure that electricity tariff structures are compatible with the objective of universal electricity access.

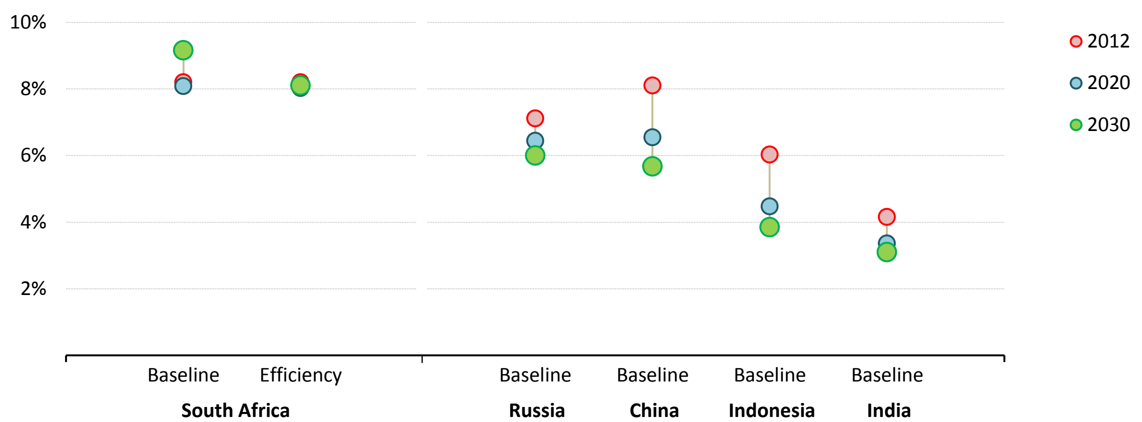
Figure 34 • Distribution of household electricity consumption and spending by income decile in South Africa, 2011



Sources: IEA Extended Energy Balances (2014) and IEA analysis.

As illustrated by the current difficulties, South Africa's plentiful indigenous coal resources alone cannot guarantee a sustainable and affordable supply of energy. In 2012, end-use spending on energy represented about 8% of South Africa's GDP (Figure 35). In a business-as-usual case without sufficient improvement in energy efficiency, end-use spending on energy as a share of GDP increases by 1 percentage point by 2030. While the economic burden of energy consumption in other fast-growing countries tends to reduce significantly, adopting energy-efficient technologies only maintains the share at current levels in South Africa.

Figure 35 • End-use energy spending as share of GDP



Notes: Trends in energy spending in countries other than South Africa correspond to the Baseline case between 2012 and 2030 and do not integrate their full potential for efficiency improvements.

Effective deployment of energy efficiency measures also improves South Africa's energy security, reduces overall oil and natural gas imports and alleviates the trade balance. By 2030, effective policies translate into an almost 30% reduction in crude oil import bill and an overall $10.9 billion reduction of oil and gas imports, corresponding to half of current import value. The volume of crude oil and natural gas imports are cut by 14% and 64% respectively (Table 4).

Table 4 • Oil and gas energy imports and potential savings

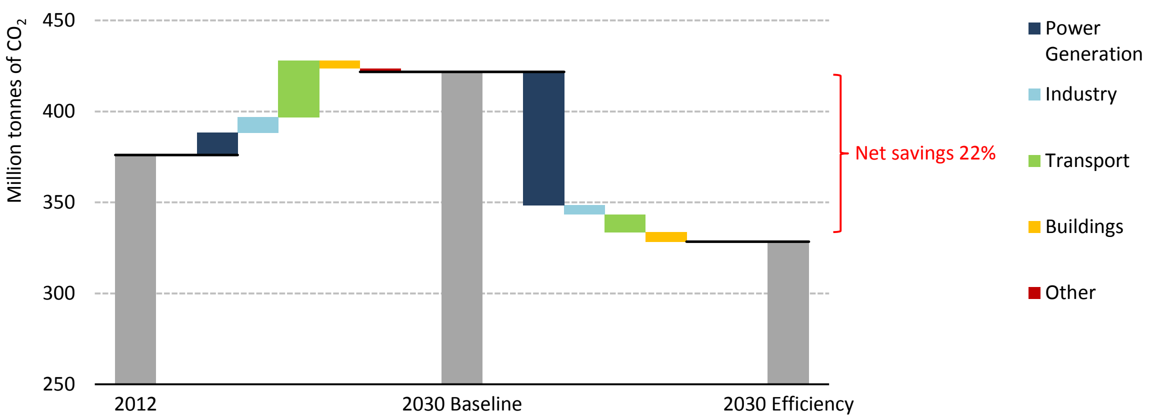
	Baseline			Efficiency		Savings	
	2012	2020	2030	2020	2030	2020	2030
Oil import volume (kb/d)	497	624	742	601	637	23	105
Gas import volume (bcm)	3.8	4.9	0.8	4.8	0.3	0.2	0.5
Oil import bill ($ billion)	20.1	22.6	36.6	20.7	25.9	1.9	10.7
Gas import bill ($ billion)	1.5	1.7	0.4	1.6	0.1	0.2	0.3
Total import bill ($ billion)	**21.6**	**24.3**	**36.9**	**22.3**	**26.0**	**2.0**	**10.9**

Given the scope of energy efficiency potential in South Africa and the size of the required investment, broad economic benefits are expected. The savings on energy spending resulting from energy efficiency measures bring further economic boost through increased household disposable income and spending elsewhere in the economy. Increased economic activity reflects a gradual reorientation of the South African economy, encouraging production and consumption of less energy-intensive goods and services, stimulating the manufacturing sector, accompanied by a shift in employment across sectors (Chateau, 2013).

Environmental Benefits

Efficiency measures deliver critical environmental benefits, especially in terms of greenhouse-gas (GHG) emissions mitigation, particularly CO_2 emissions. Energy efficiency policies and actions are complementary to effective climate policy action and maximised returns. In the absence of efforts to accelerate the deployment of energy efficiency and reflecting rapid growth in electricity consumption and energy used in transport, energy-related CO_2 emissions increase by 44 million tonnes by 2030, an additional 12% of emissions (Figure 36). Demand-side energy management and, importantly, the systematic replacement of aging inefficient coal power plants with best available technology and plant designs leads to a net 21% reduction, so that energy-related CO_2 emissions in 2030 are under 335 million tonnes in 2030, 11% below current emissions level. The contribution of the power sector assuming adequate investment makes up around 80% of the total reduction.

Figure 36 • Energy-related CO_2 emissions by sector



Cutting energy demand generates additional environmental benefits, for instance by reducing process emissions such as from the cement manufacturing. The operation of modern coal power plants equipped with scrubbers and more efficient car engines also reduces fine particle emissions and contributes to better local and regional air quality.

Annex A: World Energy Model

Since 1993, the IEA has provided medium- to long-term energy projections relying on the World Energy Model (WEM). The model is a large-scale simulation model designed to replicate the functioning of energy markets and impact of energy policies, and is the principal tool to generate detailed energy and emissions projections for the *World Energy Outlook* (WEO). The WEM is a partial-equilibrium model consisting of three main modules: final energy consumption (covering the residential sector, service sector, agriculture, industry, transport and non-energy use), energy transformation (covering power generation, heat production, refiner and other transformation) and energy supply (covering coal, oil, natural gas and biomass). Much of the data on energy supply, transformation and demand, as well as energy prices, is obtained from the IEA's own databases and economic statistics. The current version of WEM includes energy developments up to the year 2040 in 25 regions with twelve countries being individually modelled.[16]

The same macroeconomic and demographic assumptions are used in all scenarios unless otherwise specified. Projections are based on the average retail prices of each fuel used in final uses, power generation and other transformation sectors. These end-use prices are derived from assumptions about the international prices of fossil fuels and subsidy/tax levels.

Rates of population growth for each WEM region are based on the most recent medium-fertility variant projections contained in the United Nations Population and Development Database. The South African population is projected to grow steadily by 0.6% per year on average, from 52.3 million in 2012 to 58 million in 2030. South African GDP is expected to grow on average by 2.7% per year over the projection period. That rate is similar to the last two decades. Growth is assumed to accelerate slightly after 2020 from 2.4% over 2012-2020 to 2.9% over 2020-2030.

Demand for energy service (useful energy in the case of the buildings sector) of the WEM is price-elastic and econometrically projected based on multiple factors. The demand for energy service is satisfied by a set of technologies chosen according to their specific costs, technology availability and market barriers. The efficiency of end-use devices, their adoption and the demand for energy services are all affected by different policies.

[16] More details can be found in the model documentation: www.worldenergyoutlook.org/weomodel/

Annex B: Data Tables

Table 1 • Key assumptions: GDP and international fuel prices for selected countries

	GDP ($2013 billion, PPP)			**Per capita GDP** ($2013, PPP)		
		CAAGR			**CAAGR**	
	2012	**2012-2020**	**2021-2030**	**2012**	**2012-2020**	**2021-2030**
South Africa	650	2.4%	2.9%	12,440	1.7%	2.4%
China	15,366	6.7%	5.2%	11,316	6.1%	5.0%
India	6,452	6.3%	6.5%	5,217	5.1%	5.6%
Indonesia	2,258	5.7%	4.9%	9,148	4.5%	4.1%
ASEAN	5,625	5.3%	4.7%	9,246	4.2%	3.9%
Mexico	2,037	3.1%	3.4%	17,403	2.0%	2.6%
Brazil	2,940	1.9%	3.9%	14,798	1.1%	3.4%

Notes: PPP = purchasing power parity; CAAGR = compound average annual growth rate

		International fuel prices (real terms)				
			Baseline		**Efficiency**	
		2012	**2020**	**2030**	**2020**	**2030**
IEA crude oil import price	$2013 per barrel	111	99	135	92	100
OECD Steam coal	$2013 per tonne	101	99	115	82	78
OECD coking coal	$2013 per tonne	165	153	177	127	121
Natural gas	$2013 per MBtu	11	10	13	9	10
CO_2 price	$2013 per tonne	0	0	0	7	15

Notes: CO_2 price only applies to power generation and industry. MBtu = million British thermal units.

Table 2 • Energy intensity for selected countries

Baseline

	TPED/GDP (toe per $1000, MER)			TFC/GDP (toe per $1000, MER)		
		CAAGR			CAAGR	
	2012	2012-2020	2021-2030	2012	2012-2020	2021-2030
South Africa	0.409	-1.4%	-1.7%	0.208	-1.0%	-1.2%
China	0.321	-3.4%	-3.2%	0.189	-3.1%	-3.3%
India	0.422	-2.7%	-2.9%	0.285	-2.6%	-3.1%
Indonesia	0.259	-2.9%	-2.4%	0.193	-3.2%	-2.8%
ASEAN	0.252	-2.3%	-2.2%	0.177	-2.4%	-2.3%
Mexico	0.151	-1.9%	-1.6%	0.093	-1.5%	-1.8%
Brazil	0.127	0.0%	-1.5%	0.103	-0.1%	-1.5%

Efficiency

	TPED/GDP (toe per $1000, MER)			TFC/GDP (toe per $1000, MER)		
		CAAGR			CAAGR	
	2012	2012-2020	2021-2030	2012	2012-2020	2021-2030
South Africa	0.409	-1.8%	-2.8%	0.208	-1.2%	-2.2%
China	0.321	-4.3%	-4.7%	0.189	-3.7%	-4.4%
India	0.422	-3.3%	-4.3%	0.285	-2.9%	-3.8%
Indonesia	0.259	-3.3%	-2.8%	0.193	-3.5%	-3.4%
ASEAN	0.252	-2.8%	-2.8%	0.177	-2.7%	-3.0%
Mexico	0.151	-2.3%	-2.3%	0.093	-2.1%	-2.7%
Brazil	0.127	-0.4%	-2.6%	0.103	-0.4%	-2.4%

Note: MER = market exchange rate.

Table 3 • Coal savings by sector in South Africa

	Baseline Demand (Mtoe)			Energy savings: Efficiency vs Baseline (Mtoe)		Energy savings: Share of TPED coal savings (%)	
	2012	2020	2030	2020	2030	2020	2030
Power Generation	60.0	61.6	62.4	3.9	18.0	77%	71%
Other energy sector	20.1	20.7	25.2	0.6	5.4	11%	21%
Blast furnaces and coke ovens	1.6	1.7	1.7	0.1	0.1	1%	0%
Coal-to-liquids	15.9	16.0	19.8	4.8	9.3	93%	36%
Industry	9.4	10.1	10.6	0.4	1.0	7%	4%
Iron and Steel	3.2	3.4	3.4	0.2	0.2	3%	1%
Chemicals	0.9	1.0	1.1	0.0	0.1	0%	0%
Cement	0.9	1.1	1.1	0.0	0.0	0%	0%
Paper	0.7	1.0	1.3	0.0	0.1	0%	0%
Aluminium	0.1	0.2	0.2	0.0	0.0	0%	0%
Other industry	3.6	3.5	3.5	0.2	0.6	4%	2%
Transport	0.0	0.0	0.0	0.0	0.0	0%	0%
Residential	3.4	3.1	2.7	0.2	0.5	3%	2%
Space Heating	1.5	1.3	1.2	0.1	0.3	2%	1%
Water Heating	1.8	1.7	1.4	0.1	0.1	1%	1%
Cooking	0.1	0.1	0.1	0.0	0.0	0%	0%
Light	0.0	0.0	0.0	0.0	0.0	0%	0%
Appliances	0.0	0.0	0.0	0.0	0.0	0%	0%
Cooling	0.0	0.0	0.0	0.0	0.0	0%	0%
Services	2.4	2.5	2.5	0.0	0.6	1%	3%
Agriculture	0.3	0.3	0.2	0.0	0.0	1%	0%
Non Energy Use	1.4	1.5	1.6	0.0	0.0	0%	0%
TPED Coal	**97.1**	**99.7**	**105.1**	**5.1**	**25.5**	**100%**	**100%**
TFC Coal	**16.9**	**17.4**	**17.6**	**0.6**	**2.1**		

Note: TPED = total primary energy demand; TFC = total final consumption.

Table 4 • Oil savings by sector In South Africa

	Baseline Demand (Mtoe)			Energy savings: Efficiency vs Baseline (Mtoe)		Energy savings: Share of TPED oil savings (%)	
	2012	2020	2030	2020	2030	2020	2030
Power Generation	0.0	0.0	0.0	0.0	0.0	0%	0%
Other energy sector	-4.5	-2.2	-4.1	1.1	-0.6	130%	-16%
Blast furnaces and coke ovens	0.0	0.0	0.0	0.0	0.0	0%	0%
Coal-to-liquids	-3.5	-3.4	-5.4	0.0	-1.9	0%	-51%
Industry	1.9	1.8	1.6	0.1	0.2	9%	6%
Iron and Steel	0.0	0.0	0.0	0.0	0.0	0%	0%
Chemicals	0.0	0.0	0.0	0.0	0.0	0%	0%
Cement	0.0	0.0	0.0	0.0	0.0	0%	0%
Paper	0.0	0.0	0.0	0.0	0.0	0%	0%
Aluminium	0.0	0.0	0.0	0.0	0.0	0%	0%
Other industry	1.8	1.7	1.5	0.1	0.2	9%	6%
Transport	16.4	19.5	26.9	-0.6	3.3	-65%	88%
Road	15.2	18.3	25.4	-0.6	3.1	-72%	83%
PLDV	*5.3*	*7.1*	*8.5*	*-0.3*	*1.4*	*-29%*	*37%*
Light Commercial Vehicles	*3.0*	*5.0*	*8.9*	*-0.2*	*0.5*	*-22%*	*13%*
Medium Freight Traffic	*0.7*	*1.3*	*2.6*	*0.1*	*0.4*	*8%*	*12%*
Trucks (Heavy Freight Traffic)	*3.1*	*3.8*	*4.2*	*0.0*	*0.5*	*3%*	*13%*
Bus	*1.7*	*1.4*	*1.6*	*0.1*	*0.8*	*16%*	*22%*
Domestic aviation	1.0	1.1	1.3	0.1	0.2	7%	5%
Other (rail, pipeline, navigation)	0.1	0.1	0.2	0.0	0.0	0%	0%
Residential	0.7	0.7	0.8	0.0	0.2	5%	5%
Space Heating	0.1	0.2	0.3	0.0	0.0	-1%	1%
Water Heating	0.2	0.3	0.4	0.0	0.1	1%	2%
Cooking	0.2	0.2	0.2	0.0	0.1	4%	3%
Light	0.1	0.1	0.0	0.0	0.0	0%	0%
Appliances	0.0	0.0	0.0	0.0	0.0	0%	0%
Cooling	0.0	0.0	0.0	0.0	0.0	0%	0%
Services	1.1	1.1	1.2	0.0	0.3	4%	8%
Agriculture	1.1	1.1	1.0	0.2	0.3	18%	9%
Non Energy Use	4.1	4.2	4.4	0.0	0.0	0%	0%
TPED Oil	**20.7**	**26.2**	**31.8**	**0.9**	**3.7**	100%	100%
TFC Oil	**25.1**	**28.3**	**35.8**	**-0.3**	**4.3**		

Table 5 • Natural gas savings by sector in South Africa

	Baseline Demand (Mtoe)			Energy savings: Efficiency vs Baseline (Mtoe)		Energy savings: Share of TPED gas savings (%)	
	2012	2020	2030	2020	2030	2020	2030
Power Generation	0.0	0.6	1.8	0.0	0.4	0%	-34%
Other energy sector	2.3	0.7	0.7	-1.5	-1.5	101%	130%
Blast furnaces and coke ovens	0.0	0.0	0.0	0.0	0.0	0%	0%
Gas-to-liquids	2.3	0.7	0.7	-1.1	-1.1	74%	92%
Industry	1.7	2.1	2.3	0.0	0.1	-2%	-12%
Iron and Steel	0.2	0.2	0.2	0.0	0.0	-1%	-4%
Chemicals	0.9	1.0	0.9	0.0	0.0	1%	2%
Cement	0.0	0.0	0.0	0.0	0.0	0%	0%
Paper	0.0	0.0	0.0	0.0	0.0	0%	0%
Aluminium	0.0	0.0	0.0	0.0	0.0	0%	0%
Other industry	0.5	0.8	1.2	0.0	0.1	-1%	-10%
Transport	0.0	0.0	0.0	0.0	0.0	0%	4%
Residential	0.0	0.0	0.1	0.0	-0.1	1%	12%
Space Heating	0.0	0.0	0.0	0.0	0.0	0%	2%
Water Heating	0.0	0.0	0.0	0.0	-0.1	1%	10%
Cooking	0.0	0.0	0.0	0.0	0.0	0%	0%
Light	0.0	0.0	0.0	0.0	0.0	0%	0%
Appliances	0.0	0.0	0.0	0.0	0.0	0%	0%
Cooling	0.0	0.0	0.0	0.0	0.0	0%	0%
Services	0.0	0.0	0.0	0.0	0.0	0%	0%
Agriculture	0.0	0.0	0.0	0.0	0.0	0%	0%
Non Energy Use	0.0	0.0	0.0	0.0	0.0	0%	0%
TPED Gas	**4.0**	**3.4**	**5.0**	**-1.4**	**-1.2**	**100%**	**100%**
TFC Gas	**1.7**	**2.1**	**2.4**	**0.0**	**0.0**		

Table 6 • Electricity savings by sector in South Africa

	Baseline Demand (Mtoe)			Energy savings: Efficiency vs Baseline (Mtoe)		Energy savings: Share of total electricity savings (%)	
	2012	2020	2030	2020	2030	2020	2030
Other energy sector	4.6	4.9	5.5	0.3	1.2	29%	24%
Blast furnaces and coke ovens	0.0	0.0	0.0	0.0	0.0	0%	0%
Coal-to-liquids	0.0	0.0	0.0	0.0	0.0	0%	0%
Industry	10.1	11.3	12.8	0.5	1.9	43%	38%
Iron and Steel	0.3	0.4	0.4	0.0	0.0	0%	0%
Chemicals	1.0	1.0	1.1	0.0	0.0	0%	1%
Cement	0.1	0.1	0.1	0.0	0.0	1%	0%
Paper	0.3	0.4	0.5	0.0	0.0	1%	1%
Aluminium	0.9	1.2	1.3	0.1	0.2	5%	3%
Other industry	7.5	8.3	9.5	0.4	1.6	36%	32%
Transport	0.3	0.4	0.4	0.0	-0.1	-1%	-1%
Road	0.0	0.0	0.0	0.0	0.0	0%	-1%
Other (rail, pipeline, navigation)	0.3	0.3	0.4	0.0	0.0	-1%	-1%
Residential	3.3	4.5	7.2	0.2	1.6	18%	31%
Space Heating	0.3	0.4	0.8	0.0	0.3	3%	6%
Water Heating	1.1	1.7	3.4	0.1	1.0	8%	19%
Cooking	0.6	0.6	0.7	0.0	0.0	0%	1%
Light	0.5	0.6	0.7	0.0	0.1	3%	2%
Appliances	0.8	1.1	1.5	0.0	0.2	3%	3%
Refrigeration	*0.4*	*0.5*	*0.7*	*0.0*	*0.1*	2%	2%
Cleaning	*0.2*	*0.3*	*0.4*	*0.0*	*0.0*	0%	0%
Brown goods	*0.1*	*0.1*	*0.2*	*0.0*	*0.0*	1%	1%
Other appliances	*0.1*	*0.1*	*0.2*	*0.0*	*0.0*	0%	0%
Cooling	0.1	0.1	0.2	0.0	0.0	0%	1%
Services	2.7	3.1	3.7	0.0	0.2	4%	4%
Agriculture	0.5	0.6	0.8	0.1	0.2	7%	4%
Non Energy Use	0.0	0.0	0.0	0.0	0.0	0%	0%
TFC Elec	**16.9**	**19.9**	**25.0**	**0.8**	**3.8**	**71%**	**76%**

Table 7 • Biomass savings by sector in South Africa

	Baseline Demand (Mtoe)			Energy savings: Efficiency vs Baseline (Mtoe)		Energy savings: Share of total biomass savings (%)	
	2012	2020	2030	2020	2030	2020	2030
Other energy sector	3.9	4.3	4.5	0.1	0.0	26%	14%
Blast furnaces and coke ovens	0.0	0.0	0.0	0.0	0.0	-1%	-17%
Coal-to-liquids	0.0	0.0	0.0	0.0	0.0	0%	0%
Industry	1.9	2.1	2.3	-0.1	-0.2	-25%	-243%
Iron and Steel	0.0	0.0	0.0	0.0	0.0	0%	0%
Chemicals	0.0	0.0	0.1	0.0	0.0	0%	14%
Cement	0.0	0.0	0.0	0.0	0.0	-2%	-30%
Paper	0.0	0.0	0.0	0.0	0.0	-1%	-25%
Aluminium	0.0	0.0	0.0	0.0	0.0	0%	0%
Other industry	1.9	2.1	2.1	-0.1	-0.1	-22%	-202%
Transport	0.0	0.4	0.6	0.4	0.6	120%	945%
Road	0.0	0.4	0.6	0.4	0.6	120%	945%
Other (rail, pipeline, navigation)	0.0	0.0	0.0	0.0	0.0	0%	0%
Residential	9.1	9.4	9.8	-0.1	-0.4	-20%	-616%
Space Heating	0.0	0.0	0.1	0.0	0.0	-1%	-32%
Water Heating	0.0	0.2	0.5	0.0	-0.4	-13%	-584%
Cooking	0.0	0.2	0.6	0.0	0.0	-7%	1%
Light	0.0	0.0	0.0	0.0	0.0	0%	0%
Appliances	0.0	0.0	0.0	0.0	0.0	0%	0%
Cooling	0.0	0.0	0.0	0.0	0.0	0%	0%
Services	0.0	0.0	0.0	0.0	0.0	0%	0%
Agriculture	0.0	0.0	0.0	0.0	0.0	0%	0%
Non Energy Use	0.0	0.0	0.0	0.0	0.0	0%	0%
TFC Bio	**11.0**	**12.0**	**12.7**	**0.3**	**0.1**	**74%**	**86%**

Table 8 • Power generation installed capacity, retirements and additions (GW)

Baseline

	Installed Capacity			Retirements		Additions	
	2012	2020	2030	2013-2020	2021-2030	2013-2020	2021-2030
Coal	38.5	47.1	54.2	4.3	10.2	13.0	17.3
Subcritical	*38.5*	*35.7*	*32.9*	*4.3*	*10.2*	*1.5*	*7.4*
Supercritical	*0.0*	*10.8*	*17.5*	*0.0*	*0.0*	*10.8*	*6.7*
Advanced coal	*0.0*	*0.6*	*3.6*	*0.0*	*0.0*	*0.6*	*3.0*
CCS	*0.0*	*0.0*	*0.2*	*0.0*	*0.0*	*0.0*	*0.2*
Natural gas	0.4	2.7	6.2	0.0	0.0	2.1	3.5
Oil	2.9	2.9	2.5	0.1	0.7	0.1	0.4
Nuclear	1.9	1.9	3.6	0.0	0.0	0.0	1.7
Biomass	0.2	0.8	2.6	0.0	0.0	0.7	1.7
Hydro	2.3	3.5	3.8	0.0	0.0	1.2	0.3
Wind	0.0	1.9	3.9	0.0	0.0	1.9	2.0
Solar	0.0	3.4	9.8	0.0	0.0	3.2	6.4
Other renewables	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**46.3**	**64.2**	**86.6**	**4.4**	**10.9**	**22.0**	**33.3**

Efficiency

	Installed Capacity			Retirements		Additions	
	2012	2020	2030	2013-2020	2021-2030	2013-2020	2021-2030
Coal	38.5	44.4	42.9	5.1	11.0	11.0	9.5
Subcritical	*38.5*	*33.4*	*22.4*	*5.1*	*11.0*	*0.0*	*0.0*
Supercritical	*0.0*	*10.1*	*13.4*	*0.0*	*0.0*	*10.1*	*3.3*
Advanced coal	*0.0*	*0.9*	*6.5*	*0.0*	*0.0*	*0.9*	*5.6*
CCS	*0.0*	*0.0*	*0.6*	*0.0*	*0.0*	*0.0*	*0.6*
Natural gas	0.4	2.1	4.6	0.0	0.0	1.5	2.6
Oil	2.9	2.9	2.5	0.1	0.7	0.1	0.3
Nuclear	1.9	1.9	3.6	0.0	0.0	0.0	1.7
Biomass	0.2	0.9	2.6	0.0	0.0	0.7	1.7
Hydro	2.3	3.6	3.9	0.0	0.0	1.3	0.3
Wind	0.0	1.9	4.4	0.0	0.0	1.9	2.5
Solar	0.0	3.7	12.8	0.0	0.0	3.4	9.1
Other renewables	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**46.3**	**61.4**	**77.4**	**5.2**	**11.7**	**19.9**	**27.6**

Annex C: Definitions

Acronyms and abbreviations

ASEAN	Association of Southeast Asian Nations
CO_2	carbon dioxide
CCS	carbon capture and storage
MER	market exchange rate
TFC	total final consumption
TPED	total primary energy demand

Units of measure

bcm	billion cubic metres
EJ	exajoule
Gt	gigatonne
Gtoe	gigatonnes of oil-equivalent
GW	gigawatt
MBtu	million British thermal units

Annex D: References

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