Harnessing appliance energy efficiency in South Africa: Policy gaps and recommendations to address actor-specific barriers

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Abstract

The residential sector is the second largest consumer of electricity in South Africa. Peak loads that often exceed supply and related power blackouts are persistent concerns. Electricity tariffs for residential consumers tripled over the period 2008-2012 and will increase by a minimum of 12% per annum up until 2017. In contrast, scenario calculations show that significant amounts of energy could be saved with the most efficient appliances. In combination with ambitious sustainability targets, strong arguments exist for the broad usage of efficient appliances and the implementation of adequate policies. As every country, South Africa has implementation barriers, which need to be tackled by specific policies and measures to adjust market-inherent incentives. Thereby, single policies have to be combined to create an appropriate policy package addressing demand and supply side.

The South African government began establishing policies for energy efficiency in 2005. Since then, the country has already developed a considerable energy policy framework, including a mandatory Standards and Labelling Programme for residential appliances which will come into effect in 2015. However, compared to other countries, South Africa's overall policy package for energy efficiency is still less comprehensive. This paper will analyse the current situation in South Africa and compare it with the recommended appliance-specific policy package developed by bigEE.net [1]. Policy gaps will be assessed and actor-specific barriers described. As a result, strategies will be identified to advice national policy makers how to increase energy efficiency with innovative new policies and with the further development of existing policies.

Introduction

Energy Background

Due to the fact that coal is widely and cheaply available in South Africa, the country was able to generate electricity at very low prices. Electricity costs for consumers were traditionally very low and electricity tariffs in South Africa were amongst the lowest in the world in 1995 [2]. Between 1960 and 1990, the government built large, coal fired electricity plants with a nominal generation capacity of 35 GW. When the new democratically elected government came into power in 1994 the country had excess supply and was able to undertake a massive electrification programme. Access to electricity meant that more households were now in a position to use electrical appliances, which resulted in a boom for the overall market of these products.

With a share of 17.2%, the residential sector is the second largest consumer of electricity in South Africa. However, in recent years the country had to deal with several bottlenecks in the supply of electricity due to rising overall energy demand. The South African government was forced to increase energy production and to balance energy demand at the same time to stabilise the power grid. Nevertheless, occurring peak loads with a magnitude that often exceed available generation capacities and related power blackouts remain persistent concerns. To fund two new coal-fired power stations (9.6 GW), which are over-budget and five years behind schedule, electricity tariffs tripled over the period 2008-2012 and will increase by at least 12% per annum until 2017. In 2015, a residential customer in South Africa has to pay about 10 Eurocent per kilowatt-hour [2].

For that reason, first regulations for the diversification of the energy market and the integration of renewable energies were developed in the last 10-15 years. The South African government has defined the aim to make the energy market more sustainable in the future – to guarantee energy security and emission reductions – and to focus also more on renewable energies and energy efficiency. However, to cover the high demand, South Africa still increases the use of national coal reserves and with about 85% of the country's electricity generation, coal nevertheless dominates the energy market. This trend is also closely related to the energy-intensive economic sectors in South Africa, such as mining and metal refining industries. Another characteristic of the energy market is the monopolistic structure of the energy utilities. The state-owned utility Eskom supplies up to 95% of the South African energy market with electricity, whereas the liberalisation of the electricity market has just begun [3].

South Africa in the face of Energy Efficiency

The omnipresent shortage of supply, the energy intensive industry, the overstrained coal fired power generation, ambitious national climate goals and especially the resulting surge of electricity prices pushed the energy topic on the political agenda in South Africa. As consequence, energy efficiency has been identified as one of the essential measures to overcome this situation. In this context, the South African government adopted the "National Energy Efficiency Strategy" (NEES) in 2005 and the "Electricity Regulation Act" in 2008 to promote energy efficiency and to minimize energy consumption. Among other aspects, the NEES defined a national voluntary target for energy efficiency improvement of 12% by 2015 compared to a 2000 baseline. Furthermore, sector-specific targets were set e.g. for industry, the residential sector and transport [3]. Since then, South Africa has already developed a considerable energy policy framework, including a forthcoming mandatory Standards and Labelling Programme for 12 appliance groups.

Despite these efforts, compared to other countries, South Africa just begun to focus on energy efficiency and thus the overall policy package has several shortcomings and is still less comprehensive. However, to initiate and foster market transformation towards energy-efficiency it is highly advisable for policymakers to overcome country-specific market barriers and to take necessary measures. In order to tackle each of these obstacles as well as to adjust market-inherent incentives, specific policies and measures are required. To address the demand and supply side actors at the same time, individual policies have to be thoughtfully combined in order to create an appropriate and powerful policy package.

This becomes even more relevant for the appliances sector, as results from scenario calculations carried out by bigEE.net show that significant amounts of energy could be saved with the most efficient appliances available today [4]. These savings are usually very cost-effective. Therefore and in combination with ambitious sustainability targets, strong arguments exist for the broad usage of efficient appliances and the implementation of adequate product-specific policies. The next chapters will further elaborate these topics and focus on refrigerators and freezers.

Energy efficiency potentials for appliances in South Africa

Current situation

As recently as the late 1980s the electrification rate for residential households was low in South Africa, whereby almost all white households had electricity and non-white households did not. An electrification programme was successfully implemented in the early 1990s, which expanded the market for electrical appliances considerably. Nevertheless, the country's persisting and significant income inequality means that the middle to lower end of the market chooses appliances almost exclusively based on price and brand. These appliances typically have less functionality and are often higher consumers of electricity. Conversely, upper income households choose their appliances based on functionality, design, brand, guarantees and after sales service, aesthetics and to a lesser extent and only more recently on their energy consumption. Consequently, South Africa has developed a pronounced two-tier consumer base, with each group supporting different brands, models and efficiency levels [2]. Exemplarily, this paper analyses the energy efficiency potentials for refrigeration appliances as case study.

Case study: Saving potential for refrigeration appliances

As cold appliances have a very high household penetration rate (> 80%), operate 24/7 and have also a technical product lifespan of more than 10 years, a reduction of the unit energy consumption (UEC) of appliances will result immediately in relevant energy and cost savings for the country and the consumers. This paper focuses on the two most popular product sub-categories of the refrigeration market in South Africa: Fridge/Freezers and Freezers.

Fridge/Freezers

Approximately 7.4 million Fridge/freezers were in use in South Africa in the chosen reference year 2010 (starting year of the scenario analysis). The average annual consumption of each of these Fridge/freezers amounted to about 472 kWh. In total, this caused an annual electricity consumption of 3.5 TWh (see Figure 1). The calculations of the Efficiency scenario (B) are based on the assumption that every time a new Fridge/freezer is bought, the most efficient “Best Available Technology” (BAT) model is chosen and that the improvements of the most efficient models over the years are taken into account. For comparison, the baseline or “Business As Usual” (BAU) scenario (A) assumes a development without further ambitious energy efficiency policies and therefore a continuation of current tendencies regarding size, use and efficiency of appliances sold on the market.

By this means, in the Efficiency scenario (B), an absolute decoupling of the annual energy consumption and the increasing stock of Fridge/freezers can be achieved. While the stock is expected to grow by 55 % between 2010 and 2020, in the efficiency scenario the energy consumption can be reduced by 21 %. Although the stock is expected to grow by another 41 % until 2030, in the efficiency scenario the energy consumption would further decrease by 20 % (see figure 1). Thereby, higher living standards (e.g. increasing appliance ownership rates and household numbers) have been anticipated. In contrast, in the baseline scenario with only moderate assumed efficiency gains the energy consumption would increase by 17 % until 2020 and by 7 % between 2020 and 2030 [2].

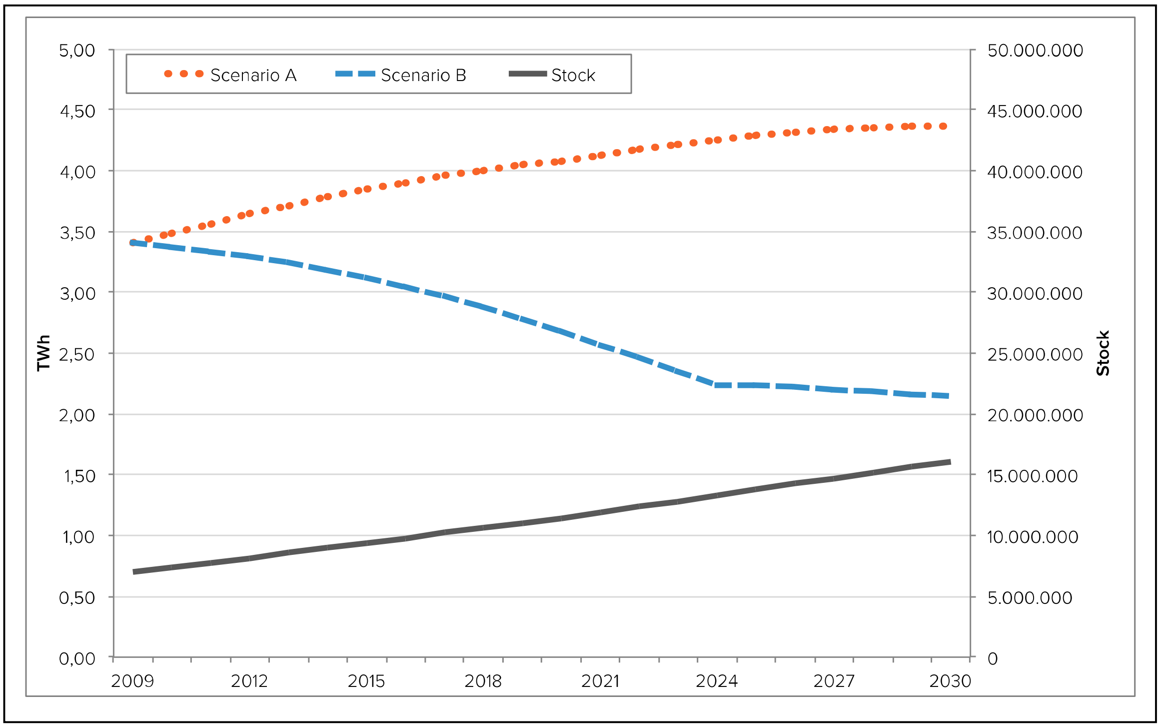

Figure 1: Total electricity consumption and stock of Fridge/freezers in South Africa

Source: [2] Note: Baseline Scenario (A) vs. Efficiency Scenario (B)

Freezers

In respect of freezers, about 3.5 million appliances were in use in South Africa in 2010. With an average annual unit consumption of 473 kWh the total annual electricity consumption amounted to 1.6 TWh. Based on the performed model calculations, efficiency improvements can also be achieved for this product group, especially if old inefficient models are replaced by modern efficient ones.

In contrast to the fridge/freezers, the freezer market in South Africa was almost exclusively supplied by local manufacturers until 2010. These low-cost local freezer products were mainly built for the South African market and were characterized by poor energy efficiency ratings compared to international standards. In recent years local manufacturers have upgraded their product lines to improve the efficiency and at the same time international companies have increased their market share [2]. The calculations of the Efficiency scenario (B) are also based on the assumption that every time a new freezer is bought, the most efficient “Best Available Technology” (BAT) model is chosen and that the improvements of the most efficient models over the years are taken into account. As for fridge/freezers, also the baseline (BAU) scenario (A) for freezers assumes a development without further ambitious energy efficiency policies and therefore a continuation of current tendencies regarding size, use and efficiency of products sold on the market.

By this means, in the Efficiency scenario (B), an absolute decoupling of the annual energy consumption and the increasing stock of freezers can be achieved until 2030. While the stock is expected to grow by 55 % between 2010 and 2020, in the efficiency scenario the rise of the energy consumption can be mitigated to 11 %. Although the stock is expected to grow by another 44 % until 2030, in the efficiency scenario the energy consumption would even decrease by 19 % (see Figure 2). Thereby, higher living standards, represented by increasing appliance ownership rates and household numbers, have been anticipated. In contrast, in the baseline scenario (A) with moderate efficiency gains the energy consumption would increase by 26 % until 2020.

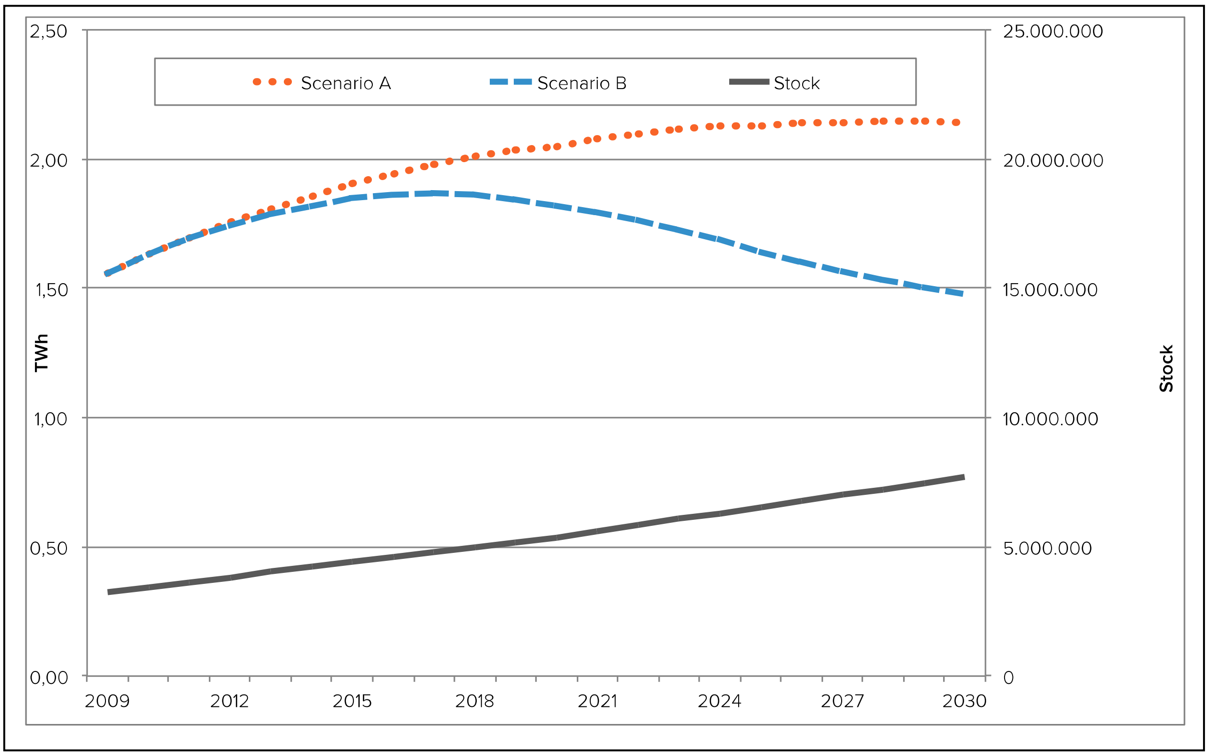

Figure 2: Total electricity consumption and stock of Freezers in South Africa

Source: bigEE.net [2] Note: Baseline Scenario (A) vs. Efficiency Scenario (B)

The above-presented results from bigEE.net scenario calculations for Fridge/freezers and Freezers show that significant amounts of energy could be saved with the most efficient appliances. These savings are usually also very cost-effective for the country and the consumers. Therefore and in combination with ambitious sustainability targets, strong arguments exist for the broad usage of efficient appliances and the implementation of adequate policies to support a much faster diffusion of the most innovative technologies.

Barriers in the appliance sector

The previous section and the example of refrigeration appliances have shown that enormous saving potentials can be realised by improving the energy efficiency of appliances. Most of the available improvement options are also cost-effective from a life-cycle perspective if they are realised during the purchase of new products or as integral part of normal reinvestment cycles. Nevertheless, many studies have also illustrated that these energy savings are often not realised by market forces alone, due to a variety of barriers and market failures [1]. By knowing the country specific barriers and possible incentives, the policy package can be adapted to guarantee desired results and achieve the greatest possible energy savings. Some of the main barriers for further energy efficiency gains in South Africa are listed below. The barriers are ranked from the most critical to the less critical.

Electricity prices

Almost all residential appliances in South Africa are electrical. As historically there was a low unit price of electricity, many customers got used to cheap energy as a minor input cost factor and are therefore not motivated to reduce energy consumption. This is a strong barrier because interventions cannot be justified in case of lengthy payback periods [5]. However, in 2009 the South African government started increasing the electricity tariffs to reflect their true costs with the Multi Year Price Determination (MYPD). The costs increased by 31.3 % in 2009/10, 24.8 % in 2010/11, 25.8 % in 2011/12 and by 16 % in 2012/13 [3], reaching about 10 Eurocent per kilowatt-hour for consumers in 2015.

Institutional barriers

In the public sector, the lack of co-ordination mechanisms is a problem in many countries. As long as there is a lack of resources and capacities in the public sector, policies will not be as effective as possible. Some measures in South Africa have also performed poorly because key positions are poorly staffed, under resourced and not adequately skilled. Furthermore, policies should be mandatory because as long as programmes remain voluntary, several actors will take little notice of them.

Institutional barriers can also exist within the application of policies. E.g. companies often do not have a dedicated department responsible for energy efficiency improvements and the management of energy consumption [6]. Furthermore, according to the Department of Minerals and Energy (2004) “there is a frequently encountered misconception […] that energy efficiency will disrupt production processes and that changes should not be made unless absolutely necessary. There is a fear of interrupting running processes as long as they work” [3].

Lack of financial incentives

Capital constrains and risk aversion of investors can inhibit uptake of energy efficiency measures. On the demand side of energy efficiency markets, these barriers relate to the required upfront investment and the relatively lengthy payback periods, combined with uncertainties about the future. For suppliers there is a risk of new energy-efficient solutions not meeting with sufficient demand [1].

Lack of awareness and information

Consumers are often unaware that energy efficiency potentials exist. Most people and companies in South Africa are simply not yet aware of the energy saving options and even if they know about, they are usually not sufficiently informed about the real costs and benefits [1]. There is also an uncertainty that the energy savings may not be actually realised. Even obvious “low hanging fruits”, which could be implemented with little investment and technical effort, are therefore often not realised. Besides the misjudgement of the financial efforts, the knowledge of consumption data is often only rudimentary. This prevents the identification of saving potentials and the success verification of energy efficiency investments [3].

Low priority

South Africa as an emerging country has to struggle with different national challenges, like ensuring the quality of life and education. Consequently, energy efficiency has not had the highest priority in the country. Business-as-usual practices remain where energy efficiency has a low priority [6].

Investor-user barrier

So-called split incentives occur when the investor bearing the costs of an energy efficiency improvement is not the one directly benefitting from it. This remains a key barrier in the residential, commercial and public building sectors. For the former the tenant is often unwilling to make a capital investment in a rented property even if the returns are positive as it is seen to be enriching the landlord. Conversely the landlord will not upgrade equipment as no direct financial benefit accrues. This barrier is not unique to South Africa. However, the problem is even more acute e.g. in the South African public sector as the structural arrangements are such that all buildings are owned and controlled by a specific department, for example the Department of Public Works (DPW) for the national Government. Ministries occupying these buildings are generally not charged for energy usage and thus have no interest or incentive to use them efficiently.

The recommended policy package approach

To move the South African market towards the best available technologies, policy makers have to pay attention to the specific barriers for the different market actors. Several policy instruments need to interact and reinforce each other in a comprehensive policy package. As pro-active countries have demonstrated (see bigee.net), a comprehensive and coherent policy package for energy efficiency will usually provide a sound balance between clear ambitious mandatory measures, incentives, information as well as capacity building. It also needs a well functioning governance framework to enable an effective implementation of these policies. Figure 3 illustrates an “ideal” policy package for appliances, which consists of the governance framework and specific instruments. The governance framework includes the categories “targets and planning”, “infrastructure and funding” and “eliminating distortions”. Furthermore different sub-categories of these three categories are shown. These sub-categories are possible instruments to increase energy efficiency in appliances. Furthermore there are specific policies and measures, which are illustrated in the lower part of the figure. These are “regulation”, “transparency and information”, “incentives and financing”, “capacity building and networking” as well as “RD&D and BAT promotion”. Some of the sub-categories (e.g. MEPS as a sub-category of regulation) are explained in the next section.

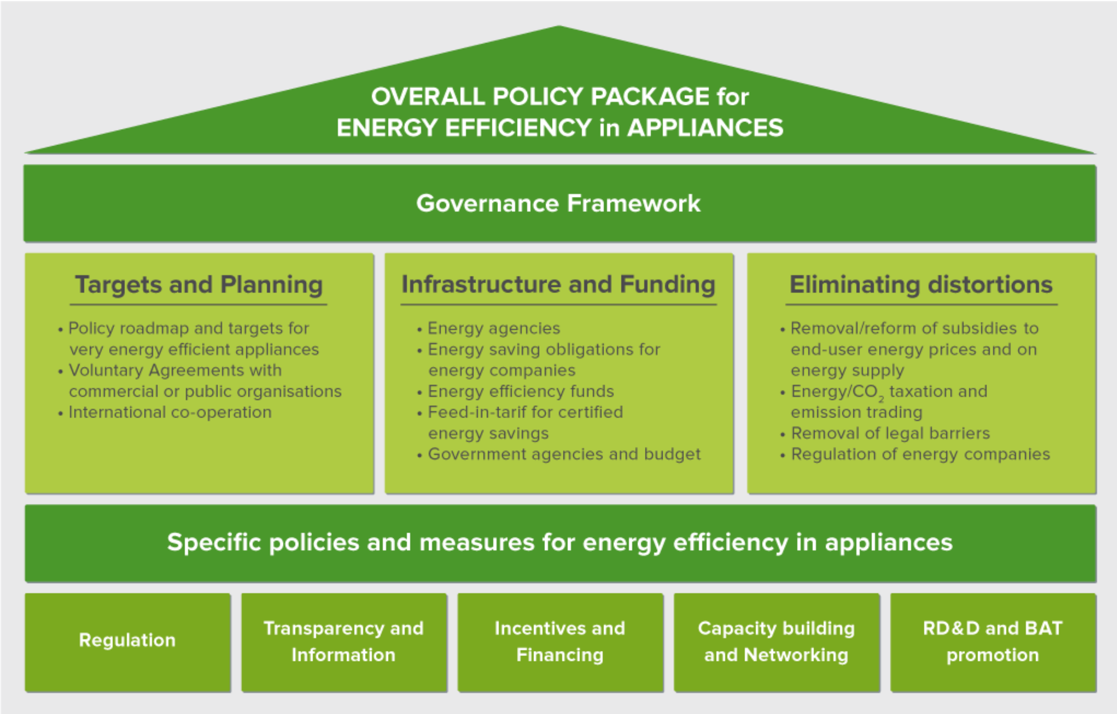

Figure 3: The recommended policy package

Source: [1]

Legal provisions on minimum energy performance standards (MEPS) reduce search and transaction costs and help to reduce the investor-user dilemma. They are a cost-effective way to eliminate the segment of the worst energy-performing products from the market. However, they do not harness additional savings potentials due the most energy-efficient products in such cases. Therefore minimum standards are often combined with labelling and rebate schemes. This gives additional incentives for investments beyond the level required by the MEPS. Financial or other incentives can give the decisive impulse that makes people opt for the more energy-efficient investments. In addition, financing instruments such as soft loans are often needed to overcome potential incremental costs for BAT products and to enable investors to make more sustainable upfront investments.

To intensify effects towards energy efficiency, information programmes, training of sales staff and manufacturers, and especially green (public) procurement programmes can also influence positively the market to promote energy efficient appliances. With procurement programmes but also with bulk purchasing projects and competitions it is even possible to go beyond the BAT and to support a market development towards the most innovative technologies with very high energy-efficiency levels.

The next chapter will present the existing instruments of the current country-specific policy package in South Africa with a focus on Standards & Labelling and Financial Incentives, as well as selected complementary instruments also illustrated in Figure 3 under “Specific policies and measures for energy efficiency in appliances”. Furthermore a gap analysis will be included to highlight the missing policy package components and to demonstrate also opportunities for national policy making.

The appliances-related policy package in South Africa – Gap analysis

The opportunity for energy efficiency in the appliance sector was recognised by the South African government as far back as the mid-1990s. However, electricity tariffs in the country were amongst the lowest in the world at that time, resulting in little incentives to act. Thus, although the South African Energy White Paper identified specific programmes and measures already in 1998, it was the introduction of the National Energy Efficiency Strategy (NEES) in 2005 that marked the actual beginning of dedicated policy formation, when the security of power supply deteriorated and energy prices began to rise [7]. Thus, an earlier implementation of adequate policies could have mitigated or even avoided large-scale power failures, which affected the economy negatively [8]. Furthermore voluntary policy targets do not express a strong political commitment to energy efficiency and some key measures are still waiting to be implemented.

To enable further progress, the government commissioned the South African National Energy Development Institute (SANEDI) as the national energy agency and gave the national utility Eskom the responsibility for financing energy efficiency measures under a Demand-Side-Management (DSM) programme.

Standards and Labelling

In 2005/06, the government of South Africa introduced a voluntary label for refrigerators, which was the intended precursor to a mandatory standards and labelling programme. It was decided to adopt the EU energy label format and a label was designed for the South African market. The voluntary programme had very limited impact. In 2008, the South African Bureau of Standards (SABS) formed therefore a working group to develop a new South African National Standard (SANS 941), which identifies energy efficiency requirements, energy efficiency labelling, measurement methods and the maximum allowable standby power for a set of appliances as basis for introducing a mandatory regulation.

However, due to barriers such as lack of funding and a low priority assigned to this initiative, it took a long period between the planning of the performance standards and the actual implementation. Finally, the South African Minister of Trade and Industry published mandatory performance standards in the 'Compulsory Specification for Energy Efficiency and Labelling of Electrical and Electronic Apparatus' [9] on 28 November 2014, coming into force as of 2015. The first set of appliances selected for the programme includes refrigerators, washing machines, dryers, dishwashers, electric water heaters, ovens, A/C and heat pumps.

To illustrate the effects of the delayed policy process, again the example of refrigerating appliances is presented as case study.

S&L case study: Refrigeration appliances

The South African S&L programme sets the MEPS implementation date for refrigerators and freezers on 28 August 2015, with label class B as the highest to remain on the market for refrigerators and C for freezers [9]. In order to analyse the potential impact of the new S&L programme, it is essential to evaluate the preceding market baseline. It must be assessed whether and when a potential improvement in energy performance has already resulted or will result from the new regulation. For this purpose 2010 is used as the baseline year and 2014 for comparison (as preceding year before MEPS come into effect).

Regarding the general distribution of the stated energy rating, it was found for the covered product energy classes that the concentration of models were at A and better or D and worse, with few models being found in the classes B and C [2]. This may be explained by the characteristic two-tier consumer base, whereby imported models account typically for the A and better energy classes and locally manufactured low-cost models (which were only sold in SA) for the other end of the energy efficiency scale.

The long absence of mandatory performance standards and little interest from consumers meant that no energy performance improvements were made especially to the poorly performing local models. However, it must be noted that the 2010 numbers of models and the energy class levels were provided by the six major manufacturers with no additional research. For 2014, energy classes of appliances are based on manufacturer responses and information available on product websites. As each manufacturer may have also interpreted the request for data differently, it is assumed to be a representative but not a full list of models available per manufacturer in the reference years. For example, ranges which were coming to an end or which had been discontinued may have been excluded even though they were still widely available. Due to the lack of mandatory information requirements in SA, the provided data also cannot be officially verified by other sources. Nevertheless, although not a complete list, it is believed to cover reliably the majority of the market in South Africa.

The market distributions of the available models per energy rating for the 2010 baseline year and for 2014 are displayed in the following figures 4 and 5.

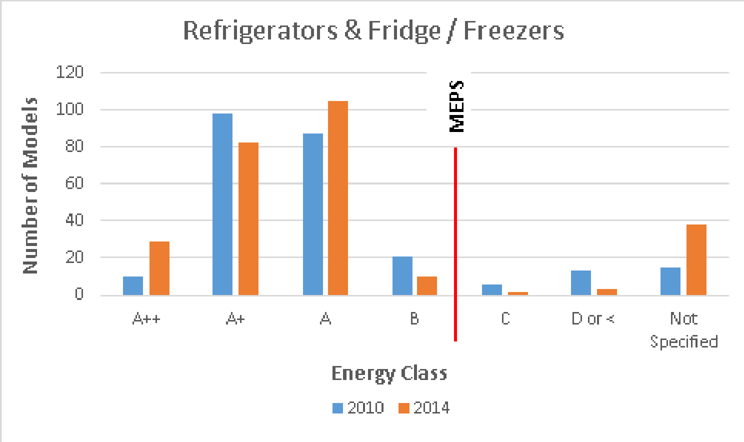

Figure 4: Comparison of 2010 and 2014 stated energy rating of Fridge/freezer models

Source: [2]

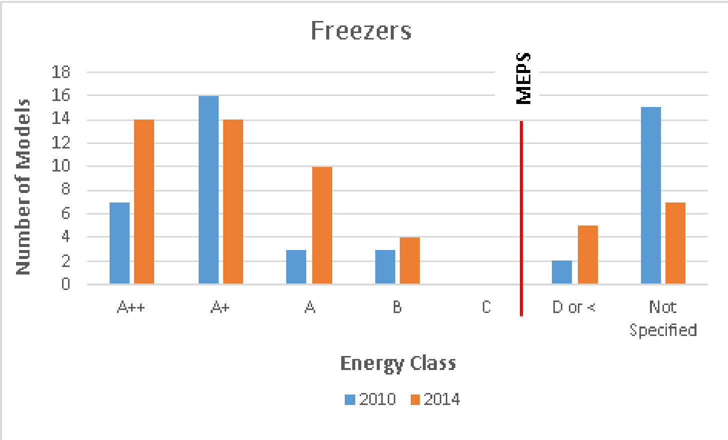

Figure 5: Comparison of 2010 and 2014 stated energy rating of Freezer models.

Source: [2]

The surveyed manufacturers have furthermore indicated that for the appliances that are to be included in the S&L programme their product ranges meet the MEPS and that they would like to see the programme to come into effect as soon as possible. Until 2015, it was with the retailers where the uncertainty mainly persisted, as the delayed implementation of the mandatory S&L programme meant that stores remained unclear on the required information to be provided with the products. This resulted in a situation where it was left up to the individual store manager, who may not be familiar with the programme, to decide as to whether appliances labels are displayed and how to best deal with appliances where the energy efficiency rating was not supplied by the manufacturer. Up to 2015, the consequence is that in the stores some appliances have labels, others do not and actually used labels are still not standardised (as they are commonly the different label versions from the originating countries of the appliances).

A comparison of the 2010 and 2014 energy class distributions shows that:

- In 2014 the majority of the models meets the MEPS, few do not and a certain number includes 'unspecified products', whereas in 2010 there were less qualifying models. In both cases the number of non-qualifying models makes up only a small percentage of the total number of models available, but what can be inferred is that the manufacturers have already started the phasing-out of models, which do not meet the 2015 MEPS.

- Conversely, the number of available efficient and very efficient models increased also significantly from 2010 to 2014.

- The high number of 'unspecified' models in 2010 for the freezer category was primarily made up of locally manufactured models, which had never been tested according to international standards as there was no requirement to do so and no accredited testing laboratory existed. Manufacturers accepted that these low-cost units would fare poorly (energy class E or less). Thus, setting the MEPS for freezers at energy class C, and not B, can be also interpreted as concession to support the local manufacturing industry, based on the 2010 product lines.

- Nevertheless, the figures show a distinct decrease in the number of unspecified freezer models from 2010 to 2014 as well as increases in the A and B energy classes. This suggests that local models have also been improved in the meantime to meet the MEPS. Interestingly, with no more available models found actually in the C category, a 2015 MEPS level of B for freezers would have been obviously also possible for local manufacturers**.**

- Finally, it is not exactly known to what extent the currently remaining unspecified models are poor performing models or whether these models have just not been labelled as there is no requirement to do so. In all likelihood it is a combination of the two reasons.

The overall numbers of available refrigerating appliances found on the South African market for 2010 and 2014 are very similar. Since the model numbers originate from the same market-leading manufacturers, similar brands are represented and thus the resulting market overviews can be considered as normalized and sound data sets. As noted above, the changes in the efficiency range of the models between 2010 and 2014 may be most likely attributed to model ranges that have been upgraded and shifted in direction of higher efficiency classes. E.g. where a manufacturer may have had more A+ models in 2010, the current stock representation may have shifted in that there are currently fewer A+ models but more A++. Although the delay of the S&L programme has also resulted in a persisting market share of appliances whose energy rating is still unknown or unspecified, it can be concluded that the market average efficiency has already improved significantly within the analysed time period.

Consequently, no substantial further energy savings from residential cold appliances can be expected anymore when the S&L programme comes finally into effect, as the 2015 MEPS level is already mostly obsolete due to the observed development of the average market weighted unit energy consumption and the related efficiency class distribution.

Financing programmes and financial incentives

Under its umbrella programme "Energy Efficiency and Demand-Side Management" (EEDSM), the South African utility company Eskom offered financing support and is able to recover related expenses through the tariff revenues it generates. Sub-programmes (see figure 6) are e.g. contracting programmes, residential mass rollout projects and standard offer models. E.g. small projects under 250 kW are supported with the standard product programme. It provides pre-approved rebates for technologies like efficient lighting, shower heads, air conditioners, heat pumps etc. The payment is between R0.5 and R1.0 per kWh and based on the product installed as well as on a standard value per item.

Another programme under the EEDSM scheme is a solar water heater (SWH) rebate programme to install one million SWH, as the current broad provision of electric domestic hot water consumes as much as 40% of the average energy use in a middle-income home in South Africa [10]. This means that the right products were targeted. Other measures are the Residential Mass Rollout (RMR) and the Compact-Fluorescent Lamp (CFL) programme. For the latter, Eskom bulk-purchased and distributed CFLs for free to households between 2004 and 2012. During that period, 54 million lamps were replaced resulting in 2,173 MW demand savings. Larger energy savings from 50 kW to 5 MW were also incentivized through the "Standard Offer Programme (SOP) launched in 2010. Eskom approved projects receive around 0.55 South African Cent per kWh over a three-year period. Technologies, which qualified for SOP funding, include lighting and hot water systems. Since savings must be achieved within a defined period of the day (between 06:00 am and 10:00 pm), the programme has aimed at reducing peak demand in particular [11] [7]. According to [12], the SOP overall energy savings amounted to 209 GWh between 2010 and 2012.

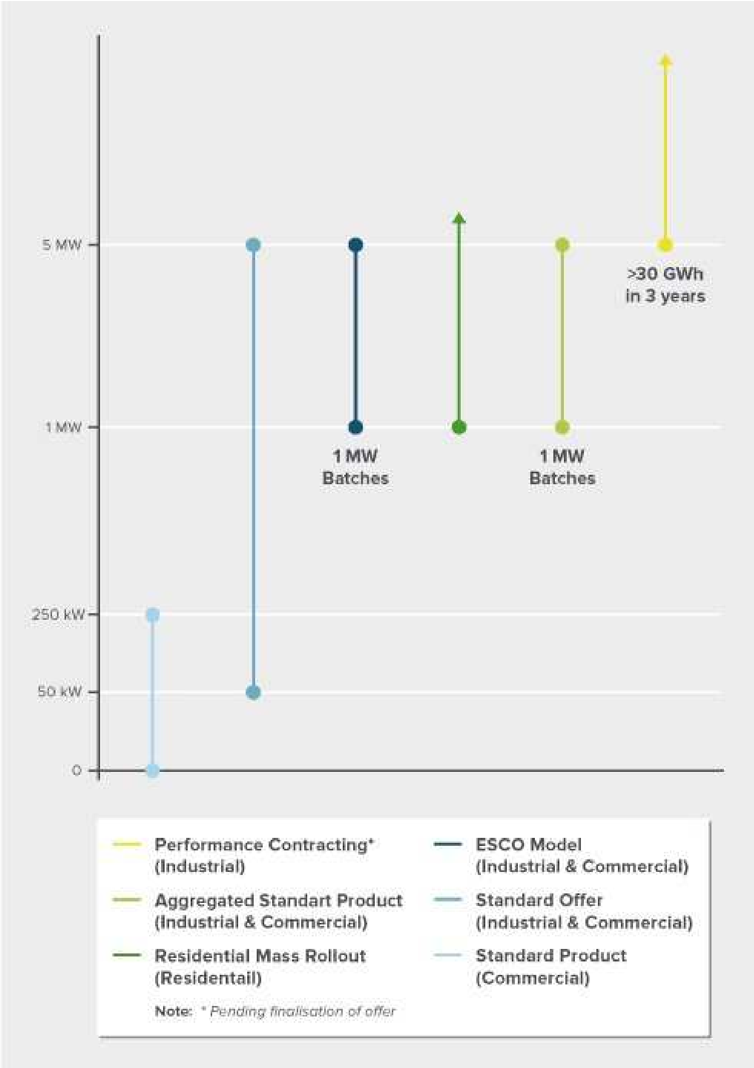

Figure 6: Eskom Funding Models

Source: [15]

In the context of energy efficiency financing, it is important to notice again that the state-owned utility Eskom generates almost all of South Africa's electricity. The resulting conflict of interest between DSM and revenue generation within Eskom has been a big barrier. For example, there was a greater support for load shifting rather than overall load reduction. Finally, besides other general funding problems, this was one reason why Eskom abandoned the EEDSM in October 2013. Another problem of the programme was also a general lack of process transparency. Criteria for financing support in South Africa have been largely non-transparent, which has "led to substantial delays and costs to the project developers, and often erected a major disincentive [13]".

An indirect successor of the DSM programme is the 12L initiative. This programme provides incentives for businesses that can show measureable energy savings. A tax deduction, claimable until 2020, is valid for all energy forms (not only electricity) and energy efficiency projects that reduce energy use. However the effective rebate is just R 0.126 (less than 0.01 EUR) per kWh [16] making it financially unattractive for many companies. Additionally, the related measurement and verification (M&V) requirements are also onerous making them time consuming and expensive.

Complementary policies: information campaigns and public procurement

Positive examples for additional measures are the energy efficiency information campaigns in South Africa. One of Eskom's core awareness raising measures is the "49M Initiative" (referring to the country's 49 million inhabitants) launched in 2011. The aim of the campaign is to inform people about energy efficiency, to change their consumption habits and to, eventually, realise energy savings. Between March and December 2011, the 49M Initiative reached more than 500,000 people directly and several millions through radio commercials and newspaper articles [14]. A second and more direct campaign is Eskom's Power Alert initiative, which uses television adverts during peak periods that show the current status of the power grid and requests households to switch off non-essential appliances when the grid is overloaded or unstable. However, as with the EEDSM programme, Eskom's complementary energy efficiency campaigns have been reduced recently due to financial constraints of the company.

Another relevant opportunity for policy making in the context of supportive measures would be to address the missing implementation of energy efficiency programmes in the public sector of South Africa. Although there are already plans to introduce e.g. public procurement programmes, no actual measure has been developed to date. Again, delays are partly the result of a lack of skills and resources for policy implementation. Introducing energy efficiency programmes in public buildings has already proven to be difficult due to many bureaucratic and procedural obstacles. There appears also to be limited political will in certain areas and consequently, e.g. after multiple years of not spending its allocated budget, the National Treasury withdrew the reserved funding from the Department of Public Works.

Conclusions

Overall, the South African energy efficiency policy and the related market for energy efficiency technologies are on the rise. The adoption of the national energy efficiency strategy and the associated introduction of efficiency targets as well as several financial support programmes established a first foundation for an energy efficiency policy framework. The shortage of electricity and the rising energy price until at least 2018 should already provide strong incentives for policy makers and other stakeholders to implement a more comprehensive overall policy package and to further increase energy efficiency with additional measures. Investors also begin to understand that energy consumption is a highly relevant cost factor that should be minimized, also to strengthen the international competitiveness.

However, the performed gap analysis demonstrated that due to missing, ineffective or already abandoned policies and measures, South Africa is still at the beginning of a more comprehensive energy efficiency strategy and much remains to be done to ensure a fast and successful transition of the energy market.

- The Eskom EEDSM can be considered as very successful programme, yielding about 3,500 MW of demand savings. However, as it was still not comprehensive enough (e.g. to directly support the S&L programme for appliances), it is also an example for the lack of coordination between government institutions.

- Despite the enormous saving potentials, the successful EEDSM programme has been suspended since 2013 and to date no direct and adequate successor has been announced to replace or even to extend it. The country is rightly focusing on energy security, but if energy efficiency as elementary aspect is neglected all the gains made since 2007 will be marginalised, which would make it even much harder to achieve the national development targets.

- Other programmes are postponed or less ambitious than required. E.g., although the delay in implementing the S&L for appliances may have supported old products of the local manufacturing industry for a very limited period, it was regarding the lost local innovation potential and the cost disadvantages for all the other national stakeholders a definite drawback. Any further improvement in the average appliance efficiency classes would have directly translated into savings for the society and consumers, which have now been lost and related GHG emissions have been also locked-in for years. Additionally, at least some of the S&L requirements are already out-dated and not ambitious enough to realise the significant energy and cost saving potential and to transform the market.

- Another example is the planned carbon tax in SA. The original Carbon Tax Policy Paper issued by the National Treasury announced 2015 as the starting year for the taxation scheme [17]. However, in two successive national budgets the start date has been postponed. Due to a very strong general opposition to the carbon tax from different interest groups, there is a reasonable chance that this programme (which could provide major incentives to act) may be finally abandoned.

To address the identified policy gaps, a selection of policy recommendations is given below.

Policy recommendations

Political commitment to Energy Efficiency and the Policy Package approach

- Strengthen in general the good governance framework in the public sector
- Address doubts regarding possible positive economic effects of energy efficiency and the related lack of implementation motivation and capacities.
- Optimize capacities and responsibilities for the design and implementation of new energy efficiency measures.
- Better connection and coherence between policies and measures in different programmes
- Reduce the duration from programme development to the actual implementation

Close specific policy gaps

- Address the energy market to break monopolistic structures
- (Re-)establish and develop further successful energy efficiency programmes, based on the good experiences from the EEDSM
- Phase-out energy-wasting technologies, promote the most energy-efficient ones in order to stimulate innovation as well as to strengthen in particular also local manufacturers by creating ambitious product-specific policy packages in the general energy efficiency context
- Increase attractiveness of investments in energy efficiency with reduced payback periods
- Provide affordable and efficient appliances to the whole society

S&L case study: Recommendations for refrigeration appliances

The findings of the case study provide strong evidences for the recommendation that the S&L requirements for refrigerating appliances in South Africa should be revised as soon as possible to harness the available additional efficiency potential. Nowadays, an upward revision of the MEPS should also in particular not hold any considerable cost implications for manufacturers and consumers. The market obviously contains already a more than sufficient number of - also locally manufactured - efficient appliances that perform much better than required by the 2015 MEPS level.

To avoid that consumers and manufacturers lose faith in the reasonability and effectiveness of the entire S&L programme, similar considerations should be also made for all other product groups.

Furthermore, it is important that the DOE develops a reliable Measurement and Verification (M&V) scheme to ensure that at the end the market is actually compliant with the new requirements.

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