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Cost Benefit Analysis of technology-neutral regulations to introduce minimum energy performance standards for general lighting

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List of abbreviations

Acronym	Definition
BAU	Business-as-usual
BCR	Benefit Cost Ratio
CBA	Cost-Benefit Analysis
CFL	Compact Fluorescent Lamp
DoE	Department of Energy
Dti	Department of Trade and Industry
EIRR	Economic Internal Rate of Return
ENPV	Economic net Present Value
GEMS	Greenhouse and Energy Minimum Standards
GHG	Green House Gas
ICL	Incandescent lamp
IEC	International Electrotechnical Commission
IESSA	Illumination Engineering Society of South Africa
LED	Light emitting diode
LOA	Letter of authority
lm	Lumens
MEPS	Minimum Energy Performance Standards
MVE	Monitoring, Verification and Enforcement
NMISA	National Metrology Institute of South Africa
NRCS	National Regulator for Compulsory Specifications
PMT	Project Management Team
SABS	South African Bureau of Standards
SANAS	South African National Accreditation System
SARS	South African Revenue Services
SCHEER	Scientific Committee on Health, Environmental and Emerging Risks
TACS	Testing and Conformity Services Laboratories
UNDP	United Nations Development Programme
VC	Compulsory Specification

1. Abstract

Roughly 80 million general service lamps (GSL) are sold in South African each year; and the total estimated installed stock is approximately 170 million. Most importantly, while a single electric lamp does not consume a large quantity of electricity, the average household has about 15 lamps – which collectively accounts for a significant amount of electricity use during peak consumption periods, when the electricity grid is most vulnerable. Thus, a transition to higher efficiency GSL's which produce the same light while using much less electricity provides an opportunity to both reduce strain on the national grid and save on the electric bills of households. More efficient GSLs will make lighting more affordable and accessible to South Africans, extending the universal usage of lighting and ensuring all consumers will benefit.

Objective of MEPS and problem statement

Minimum Energy Performance Standards (MEPS) aim to improve the efficiency of GSLs; and conducting a Cost Benefit Analysis (CBA) study is a mandatory requirement before regulatory legislation is enacted. Conducting the CBA, several regulatory and market failures inhibiting the uptake of efficient GSLs were identified:

- South Africa's lighting regulation has not kept pace with the rapid technological advancements that have taken place in recent years; and is therefore no longer able to remove the least efficient, lowest quality and potentially hazardous GSLs from the market. And while older lighting technologies, compact fluorescent lamps (CFLs) and incandescent lamps (ICLs) are regulated separately, there are no safety or performance standards for Light Emitting Diode (LED) lamps.
- Consumers are making poor economic choices. Here our analysis shows that consumers are purchasing some of the most expensive and least efficient GSLs, by opting for a lower upfront cost based on familiar (inefficient) technologies, and not considering the full life cycle cost of lighting. By example, in the highest-selling brightness category, a 70W BC Eco Halogen lamp accounted for 52% of sales - costing R20 - but it is one of the most expensive to operate, at ~R1 500 in electricity and replacement lamp costs over a typical 5-year (7 000-hour) period. The same company's LED lamp with the same light output will cost R35 to purchase, will not need to be replaced because of its long lifetime, and will only cost R178 to use in electricity bills over the same five-year period. Thus, R1 520 for halogen versus R213 for LED – halogen is over 7 times more expensive than LED on a lifecycle cost basis.
- Barriers hindering a transition to LED technology persist. Retail sales for the same period show that CFLs dominate at 52%, followed by halogen at 26%. Here, consumers are more familiar and comfortable with halogen lamps, which look like traditional incandescent bulbs, while continuing to associate CFL's with energy-saving, after Eskom's nationwide demand side management program which distributed over 70 million CFLs up to 2016. Also, an added concern is market-spoiling, where if consumers have a poor experience with low quality LED lamps, it may result in them reverting to the familiar (inefficient) technologies. Laboratory tests conducted on 10 popular LED lamps sold in stores, found that three did not meet the efficacy or energy-efficiency specifications stated on their packaging.
- Finally, CFLs pose environmental and health risks when incorrectly disposed or accidentally broken, due to their mercury content. Mercury is a heavy metal that will contaminate landfills and is a neurotoxin in humans. The UN is working to phase out mercury use globally under the Minamata Convention, which South Africa ratified on 29 April 2019.

Approach to the study

The assessment was conducted following a CBA framework, which is an internationally accepted methodology for the economic evaluation of the potential impacts of new regulations. CBA is a comparative approach; and the impacts of the proposed regulation that will establish MEPS for lighting have been defined as the 'policy option' scenario. This is then modelled against the baseline or 'business-as-usual' (BAU) to quantify the impact of the draft policy measure. In addition to economic modelling to assess the potential impact of MEPS, the CBA uses inputs from a market analysis, stakeholder consultations and laboratory testing of lamps sold in the market.

Proposed regulation

The draft Compulsory Specification for General Service Lamps (VC 90XX) covers the safety requirements, energy efficiency and functional performance for general lighting, including both directional and non-directional lamps, and all shapes and finishes. The key technical requirements in VC 90XX fall within four main categories: energy-efficiency (efficacy); functional performance; product safety; and product information (labelling).

The main energy performance requirement of the draft technology-neutral MEPS is a minimum efficacy of 90 lm/W (Tier 1) and then 105 lm/W (Tier 2). The draft VC90XX initially proposed a lower minimum efficacy of 80 lm/W for Tier 1, followed by 95 lm/W for Tier 2. However, at the stakeholder consultation meeting held at NRCS on 25 July 2019, it was collectively agreed by the majority of stakeholders that 90 lm/W for Tier 1 was more appropriate as the market has consistently achieved performance improvements of 5 lm/W a year. In addition, to help ensure continued consumer choice and availability, a power allowance was adopted for lamps below 400 lumens[1]. The CBA and economic impact assessment in this report were based on the original set of minimum efficacy requirements (i.e., 80 lm/W and 95 lm/W). While these levels are more lenient than what has been included in the final draft, they would still result in the removal of halogen and CFL lamps from the market (N.B., general service incandescent lamps are already banned), which is the principle driver of energy and economic savings. It is our assessment that the implication of the slightly higher efficacy requirements in VC90XX will increase the net economic benefits relative to what is presented in this report.

Results of the economic modelling

The results of the CBA study show that introducing MEPS for GSL's is expected to yield significant positive net economic benefits to the South African economy. Under the central assumptions, the net economic benefit is expected to amount to R11.7 billion over the 15-year period; with a benefit-cost ratio of 27.4 to one – meaning that the present value of the benefits is more than 27 times the present value of the costs of introducing and enforcing the regulation.

Electricity cost savings that accrue to South African households once MEPS are introduced, account for most of the R11.7bn benefit realised – with the realised electricity cost savings increasing further in 2023, when the more stringent requirements for minimum efficacy (lm/W) take effect.

In assessing the key risks to the economic case for the introduction of MEPS, these are posed by a potential delay in the implementation of the regulation and very low levels of compliance (33%) – a

[1] DoE/UNDP/NRCS (2019) "Item 8.1 Draft VC 9108,Functional performance" Minutes of the Standards and Labelling: Stakeholder workshop on VC9108 and VC 9110. 25 July 2019. Bambanani Committee Room, SABS, 1 Dr Lategan Drive, Pretoria.

combination of industry non-adherence, compounded by limited or intermittent enforcement by the Regulator. The modelling of a three-year delay demonstrates that the total net benefit associated with MEPS is reduced to R1.9 billion from R11.6 billion. This finding clearly demonstrates the importance of scaling up the South African government's enforcement of this regulation, as it would add nearly 10 billion Rand to the economy.

There is a strong case for implementing MEPS as soon as possible, to maximise the potential economic benefit associated with rapidly switching to energy-efficient lighting.

Key insights and issues raised during the stakeholder consultation process

Over 35 stakeholders, representing five main stakeholder groups (public sector, core technical group, large suppliers, local manufacturers, and others) were interviewed. Overall, stakeholder sentiment towards the proposed MEPS regulation for lighting was positive. Six of the eight stakeholders who completed the questionnaire expect the proposed regulation to have a positive net benefit on the South African economy. These included lighting industry association IESSA, large lighting suppliers Aurora, Signify, Ellies and Eurolux, and international non-profit CLASP. These six stakeholders also believe the regulation will improve the overall quality and safety of lamps sold to the residential market in South Africa. LEDVANCE was more sceptical than the other large suppliers about the potential impact of the regulation, because they felt that given the low levels of enforcement by the responsible government agencies to date, it was difficult to see how this would improve going forward. IESSA, an industry body, concurred with LEDVANCE.

Generally, industry raised several concerns regarding Government's ability to undertake effective MVE. Key amongst these were: 1) enforcement agencies have insufficient resources to introduce and enforce the proposed MEPS regulation; 2) to date these agencies have undertaken very limited market surveillance; 3) reports of non-compliance submitted to the relevant authorities have not been investigated; 4) border control is weak; 5) the Act[2] does not allow penalties to be levied on non-compliant suppliers; and, 6) there is insufficient capacity in South Africa to test LED lamp performance against the specifications.

Finally; the CBA report puts forward recommendations on how to improve MVE. These include: 1) the streamlining and automation of the pre-certification process; 2) improving the human resource capacity of control officers to increase their effectiveness - including communication and awareness; 3) setting a clear strategy for compliance and monitoring - with specific goals and targets, and timely and transparent reporting on the results; and 4) considering whether it is feasible to introduce self-declaration for certain categories of products, where the risks associated with non-compliance are relatively low.

[2] The National Regulator for Compulsory Specifications Act, Act no. 5 of 2008 (NRCS Act)

2. Executive Summary

2.1 Purpose of the study

The Department of Energy (DoE) and NRCS, with support from the UNDP, commissioned Nova Economics to deliver a cost-benefit analysis (CBA) of the proposed regulation to set minimum energy performance standards (MEPS) for household lighting products. The technologies covered by the proposed MEPS include incandescent and halogen lamps (ICLs), compact fluorescent lamps (CFLs), high-intensity discharge, light-emitting diodes (LEDs), and any other household light sources. The intention is that the new regulation will replace the existing compulsory specifications (VCs) for CFLs and ICLs and extend the regulation to cover newer technologies such as LEDs.

The regulation is expected to result in energy savings, to remove inferior quality products from the market, to reduce peak electricity demand, and to yield environmental benefits. The proposed regulation, however, will also be associated with some costs, which may be borne by government, suppliers, and/or consumers, and these also must be assessed.

The purpose of the study is to provide an evaluation of the overall economic impact of the proposed regulation and to make recommendations as to the most cost-effective form of MEPS.

2.2 Problem statement

Changes to the current regulation of household lighting products are under consideration because of the following issues in the market:

- The current regulation is lagging behind technological advancements.
- Consumers make poor choices when purchasing lighting due to imperfect information and are spending more than necessary on electricity as a result.
- There are some barriers to the uptake of LED technology.
- Some potential health risks associated with the use of inferior quality LED light sources, specifically in vulnerable populations such as children under the age of three and in people suffering from conditions like epilepsy.
- There are environmental and health risks associated with the incorrect disposal and accidental breakage of CFLs due to their mercury vapour content.

Each element of the problem statement is explored in greater detail in Chapter 3.

2.3 Summary of the proposed regulation

The draft compulsory specification Compulsory Specification for General Service Lamps (VC 90XX) covers the safety requirements, energy efficiency and functional performance for general lighting directional and non-directional lamps of all shapes and finishes (i.e. incandescent, halogen, fluorescent, high-intensity discharge, light emitting diode (LED), and other light source technologies).

The key technical requirements within the are covered in the following four categories:

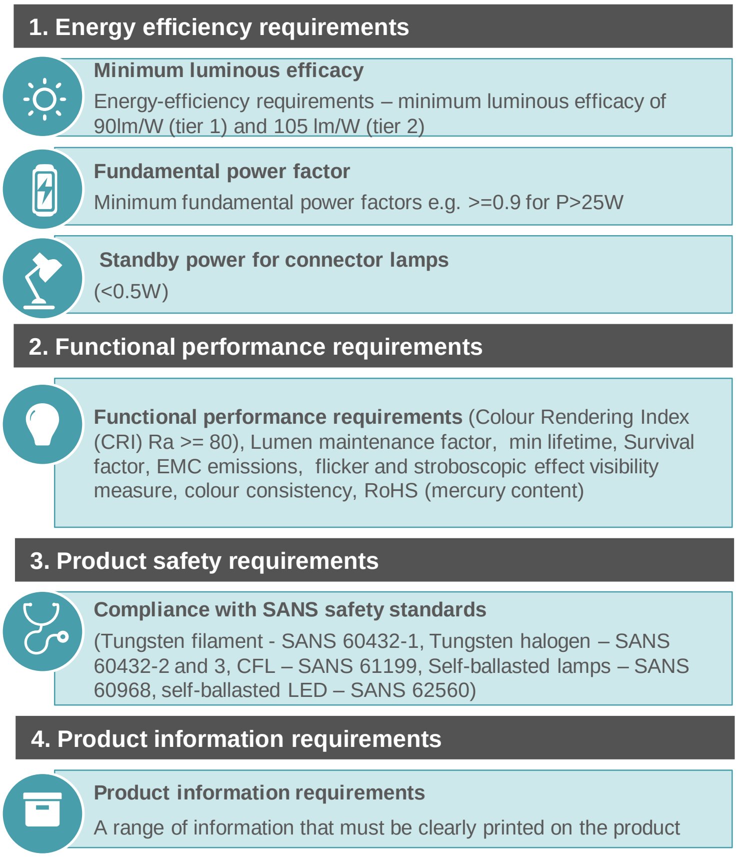
- Energy-efficiency (efficacy) requirement;

- Functional performance requirements;
- Product safety requirements; and
- Product information requirements.

A summary of the key technical elements of the draft regulation is provided in Figure 2. It is envisaged that the energy and performance requirements set out in the regulation will be implemented in two tiers, with initial expectations that initial implementation would take place in January 2020 (Tier 1), with additional, in some cases more stringent requirements taking effect in Tier 2. While the regulation may take effect later than 1 Jan 2020, the time period between Tier 1 and Tier 2 will be about two years.

The main energy performance requirement of the draft technology-neutral MEPs is the requirement that lamps meet a minimum efficacy (unit of light output per unit of electrical power input). This was initially set at 80 lm/W under the first tier of the regulation and 95 lm/W under the second tier but at the stakeholder consultation meeting held at the NRCS on the 25^{th} of July 2019, it was subsequently decided that a minimum efficacy of 90 lm/W for Phase 1 was more appropriate as the market had realised consistent performance improvements of 5 lm/W a year historically. It was decided to increase the minimum efficacy and provide for some leniency for lamps below 400 lm with a correction factor.[3]

Figure 1 Summary of key technical elements of draft technology-neutral MEPS



[3] DoE/UNDP/NRCS (2019) "Item 8.1 Draft VC 9108,Functional performance" Minutes of the Standards and Labelling: Stakeholder workshop on VC9108 and VC 9110. 25 July 2019. Bambanani Committee Room, SABS, 1 Dr Lategan Drive, Pretoria.

2.4 Approach to the study

The assessment was conducted within a CBA framework, which is the internationally accepted methodology for the economic evaluation of the potential impacts of new regulation. CBA is a framework adopted by national governments, the World Bank, and other multilateral institutions for the evaluation of projects and programmes The framework seeks to provide a comprehensive assessment of the net benefit of a project or proposed regulation to society, valued in monetary terms. CBA is also the framework that was specifically recommended by the United Nations Environment Programme for the assessment of regulation via MEPS for lighting in its guidance note on MEPS for policymakers[4].

Our approach to this study draws on the general guidelines provided by UNEP and on the recent study by Australian and New Zealand Governments on the impact of the introduction of the new regulation for the lighting industry, which was also based on a CBA – "Decision: Regulation Impact Statement: Lighting"[5].

CBA is a comparative approach; the impacts of the proposed regulation that will establish MEPS for lighting has been defined in terms of a single 'policy option' scenarios which is then modelled relative to the baseline or 'business-as-usual' (BAU) scenario.

Our approach to the cost-benefit analysis we have produced is based on four main inputs or sets of activities – market analysis, stakeholder consultation, economic modelling, and lamp testing.

2.4.1 Market analysis

We began the study by analysing the available data on the market for electric lamps in South Africa based on trade data (import statistics from SARS Customs & Excise). Since the household lighting sector is the focus of the proposed regulation to set MEPS, it was necessary to understand recent trends in the purchasing behaviour of consumers in this segment at a more granular level. This analysis was based on three years of historical point of sale data from many of South Africa's largest general retailers (e.g. Checkers, Pick n Pay, Game, Spar, Woolworths, Clicks, and Dischem), using aggregated data purchased from Nielsen. The market analysis is presented in Chapter 4.

2.4.2 Stakeholder consultation

The stakeholder consultation process was a key component of the overall economic assessment. Nova Economics ran an extensive stakeholder consultation process beginning in February 2019 and ending in July 2019, to obtain insights into the market for household lighting and the potential socio-economic impact of MEPS. This took the form of a series of face-to-face or telephonic interviews with representatives of all key stakeholder groups identified. Roughly 35 individuals representing 20 organisations were interviewed, either face-to-face or telephonically. A few additional stakeholders were contacted via email. The key insights and recommendations from the stakeholder consultation process are captured in Chapter 5.

The five key stakeholder groups identified were: Public Sector; Core Technical Group; Large Suppliers; Local Manufacturers; and Other.

4 Scholand, M. (2015). Developing minimum energy performance standards for lighting products. *Guidance Note for Policymakers*. UNEP DTIE and UNEP-GEF en.lighten initiative. June 2015.

5 Australian Department of the Environment and Energy. 2018. *Decision Regulation Impact Statement: Lighting*.

A summary of the key stakeholders that were identified and approached for interviews is provided in Table 1 below. A detailed list of all the interviews scheduled and conducted is provided in Appendix A.

Table 1: Summary of key stakeholders identified and approached for interviews.

	Stakeholder Group	Organisations
	Public Sector – Key public sector stakeholders included the DoE, which is the government department responsible for the development of energy policy, and key partners in the national quality system, including the NRCS, the SABS, and NMISA. The SABS is responsible for voluntary standards and for testing compliance.	• NRCS – National Regulator for Compulsory Standards • SABS – South African Bureau of Standards • DoE – Department of Energy • NMISA – National Metrology Institute of South Africa
	Core Technical Group – The core technical group was responsible for giving input into the technical specification of the proposed MEPS for household lighting, and included representatives of NMISA, Eskom, IESSA, and BEKA Schréder – Africa's leading manufacturers of luminaires. They were engaged to give insight into some of the technical issues.	• Eskom • IESSA – Illumination Engineering Society of South Africa • NMISA • BEKA Schréder
	Large Suppliers – Key industry stakeholders identified included a list of the largest suppliers of lighting products for the residential sector in South Africa. They were engaged to give insight into the market for lighting in South Africa and the potential impact of proposed MEPS on the lighting industry and consumers of lighting products. They also gave feedback on issues such as the enforcement of existing regulation. Radiant was subsequently acquired by Eurolux and it appears Voltex only retails products on behalf of other suppliers to the residential market.	• Signify (Philips) • Ellies • Radiant • LEDVANCE (Osram) • Eurolux • Aurora • Voltex
	Local Manufacturers – The firms listed were identified by large suppliers and non-profits as local manufacturers of residential lighting products. The intention was to approach these firms to gain insight into the potential impacts of the new regulations on local manufacturers of LEDs or other lamps. Further research suggested the proposed MEPS is not relevant to this group as they are primarily involved in the manufacture of niche luminaires for the commercial and industrial markets, which is covered by other regulation. A 100% non-response rate for this group also suggests that little, or most likely zero, local manufacturing of lamps is taking place.	• Pioled • G Light (Pty) Ltd • LED Concepts • eLighting • EconLED industries • LEDwise • Afrison

	Other – (Non-profits, Retailers, Industry Associations, Foreign government) – The fifth group of stakeholders identified included industry-associations (IESSA and SAFEHouse), non-profit organisations concerned with the promotion of energy efficiency (UNDP and CLASP), retailers of lighting (Massmart), a privately-owned testing laboratory (TACS Laboratories) and the lighting energy efficiency division of the Australian Department of Energy. These stakeholders were approached for their views on the likely efficacy of the proposed technology-neutral MEPS, for input regarding issues such as effective enforcement, consumer awareness and good practice. The TACS laboratory was approached for input on issues around testing, compliance and effective enforcement as well as existing testing capacity.	• CLASP • IESSA • SAFEHouse • TACS Laboratories • Lighting Energy Efficiency Division (Australian Dept. of the Environment & Energy) • Massmart • UNDP

The purpose of the stakeholder engagement process was firstly to obtain inputs into the design of the policy options to be modelled and key assumptions for the model. Secondly, and perhaps most importantly, it was also to gauge the sentiment of main stakeholder groups towards the regulation and to obtain qualitative insights on the likely economic impact of MEPS.

Insights from the stakeholder consultation process have informed our recommendations on the initiatives, resources and actions that will be required to successfully implement MEPS, as well as our recommendations on potential changes to the proposed regulation.

2.4.3 Economic modelling

The economic cost-benefit model was developed using data and input assumptions obtained during the market analysis and stakeholder consultation processes. A baseline model was developed for the category of lamps. This represents the energy performance of a typical lamp model in the market and likely usage and uptake without regulation; this is the starting point ('business as usual' model) for the economic analysis.

We then defined the policy option which was based on the introduction of MEPS as it is currently outlined in the draft regulation. We considered analysing a second policy option based on a more stringent form of MEPS (without the current concessions for CFLs) but the modelling showed the differences between the two policy scenarios proposed were not material. The policy option was defined based in consultation with the project management team (PMT) and industry stakeholders.

2.4.4 Lamp testing

A sample of ten LED lamps from nine different suppliers was purchased from retail outlets and tested at Eskom's laboratory to obtain an indication of (i) the quality of lamps currently in the market, and (ii) the consistency of products with the information provided on the packaging.

The lamps were tested against the following performance metrics stipulated in the draft MEPS:

- **Efficacy (lumens/watts)** – this is the main measure of the energy efficiency of a lamp
- **Colour rendering (Ra)** – measures the ability of a lamp to identify colours accurately on a scale of 1 to 100, which is relative to natural sunlight which has a colour rendering score of 100. The minimum Ra specification is 80.
- **MacAdam ellipse calculations** – these calculations test colour consistency against the regulatory requirement that the variation of chromaticity coordinates fall within a five-step MacAdam ellipse or less.
- **Fundamental Power Factor** – the draft VC does not propose to regulate on Power Factor, but Displacement Factor (also called Fundamental Power Factor).

The detailed results of these tests are presented in Appendix C. From this sample of lamps purchased and tested, it would appear that the lamps being imported into South Africa (and sold via major formal sector retailers) are of reasonable quality and that packaging is generally consistent with the product.

All but one of the lamp models already met the minimum energy efficiency requirement (efficacy in lm/W) for Tier 1 of the draft MEPS. The test results showed that two of the models already met the more stringent Tier 2 minimum energy-efficiency requirement, including one of the mid-range priced products.

Three of the ten lamps tested however did not meet efficacy or energy-efficiency (lm/W) implied by the specifications on the packaging. Two of the three were not as bright (in lm) as the packaging suggested and the third was less energy efficient than specifications implied because the power factor was much lower than reported. It would also appear that price is not necessarily a direct indicator of quality since measured performance did not correlate directly with price across the small sample. We could not test lamp life due the extended time this test takes.

2.5 Key findings from the market analysis

In Chapter 4, we provide a comprehensive analysis of the market for electric lamps in South Africa. The analysis is based on two main sources of data:

- Trade data collected by Customs & Excise (SARS), which is the basis for an analysis of the overall market for electric lamps in South Africa.
- Retail trade data collected at the electronic point-of-sale (checkout scanners) at major retailers (including Shoprite, Spar, Pick n Pay, Woolworths, Clicks, Dischem and others) and aggregated by market research firm, Nielsen. Since the household lighting sector is the focus of the proposed regulation to set MEPS, it was necessary to understand recent trends in the purchasing behaviour of consumers in this segment at a more granular level.

Key insights from the analysis of trade data include:

- The total value of electric lamps imported into South Africa in 2018 was US$94 million while the total value of re-exports (mostly into African nations) was US$17 million (Figure 1).
- The bulk of South Africa's lamps come from China, who imported US$67 million, constituting approximately 71% of the total value of imports, followed by Germany (US$8 million, which represents 8.5% of the total value of imports), and Poland (US$3 million, which represents around 3% of the total value of imports).
- Total imports of lamps for general use have consistently increased since 2014. As of 2018, the total market is valued at US$67 million.
- The value of LEDs imported for general use has increased exponentially since 2016, largely displacing the value of sales of CFL and halogen lamps. The value of sales of CFL and halogen lamps have contracted year-on-year since 2017.

The Nielsen data facilitate between insights into the residential market for lighting, though the data are only representative of one supply channel in the residential market, namely, retailers who supply approximately 23% of electric lamps in the domestic market. The major findings of the residential market analysis are summarised as follows:

- The value of LED sales in the residential market overtook those of halogens in May 2018, but CFLs – or what South Africans consider to be 'energy-saving lamps' – are still the most popular.
- There has been a sharp growth in unit sales of LED lamps since January 2018, which has been at the expense of growth in halogens, incandescent and CFLs that have both been contracting on a year-on-year basis since the end of 2017.
- LED lamps have become less expensive relative to other technologies over the past three years, which has probably contributed to relatively sharp growth over the period.
- Consumers continue to make poor choices. They purchase lamps largely based on upfront cost (low price) and inadvertently choose energy inefficient lamps, some of which have the highest lifecycle cost.
- MEPS effectively remove halogen and CFL lamps from the market. There are no incandescent, halogen or self-ballasted CFL lamps among sales of the 177 branded products analysed that

would meet the minimum criteria for luminous efficacy, even with less stringent criteria imposed in 2020.

- Lamps that are relatively energy-inefficient and high-cost (on a lifecycle basis) still dominate sales in the residential market in South Africa – 84% of lamps sold in the first half of 2018 would have failed to meet the minimum energy-efficiency criteria that are outlined for Tier 1 of the draft MEPS (which is lower than the European regulation). Of the rapidly expanding LED lamp sales, however, already 16% of the models sold in the first half of 2018 comply with the Tier 1 criteria and this percentage will increase in the coming years as industry partners invest and improve the performance of LEDs. On average, CLASP has shown that, based on 10 years of data from the US Department of Energy, LED lamp efficacy improves approximately 7.5% per annum.[6]

2.6 Key issues and recommendations from stakeholder consultation

As mentioned above, the stakeholder consultation process was a key component of the overall economic assessment. Over 35 stakeholders, representing five main stakeholder groups (public sector, core technical group, large suppliers, local manufacturers, and other) were interviewed. We obtained a 100% response rate from all groups approached, except for potential local manufacturers, where only two of the seven companies contacted agreed to an interview.

We began each interview by taking the stakeholder through an introductory presentation. The presentation was used to facilitate a discussion around the proposed problem statement, an overview of the regulation, the objectives of the regulation, the market for residential lighting based on an initial analysis of trade data, the approach to the cost-benefit analysis, and a discussion of the potential costs and benefits of the proposed regulation. We also asked representatives of industry (both large lighting suppliers and lighting industry associations) to complete a short questionnaire which was used to consolidate their feedback around the following four main themes:

- Sentiment towards the proposed regulation
- Trends across the residential lamp market
- Considerations around impacts on suppliers
- Support for harmonisation of MEPS with international standards.

The key insights from stakeholder interviews and the key recommendations from the process are summarised in the sections that follow.

2.6.1 Key insights from the stakeholder consultation process

Overall, stakeholder sentiment towards the proposed MEPS regulation for lighting was positive. Six of the eight stakeholders who completed the questionnaire expect the proposed regulation to have a positive net benefit on the South African economy. These include international non-profit organisation CLASP, lighting industry association IESSA, and large suppliers Aurora, Signify, Ellies and Eurolux. These six stakeholders also believe the regulation will improve the overall quality and safety of lamps sold to the residential market in South Africa.

LEDVANCE[7] was more sceptical than the other large suppliers about the potential impact of the regulation because they felt, given the current track record, that it was very unlikely that it would be

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[6] CLASP (2018) Available online: https://www.eup-network.de/fileadmin/user_upload/Lichtquellen_Stellungnahme_CLASP_2018_01_31.pdf

[7] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.

adequately enforced by the NRCS and SARS (Customs & Excise). LEDVANCE supports the proposed MEPS regulation in principle but noted that it was very unlikely that South Africa would realise any of the suggested benefits, including improvements in safety and quality unless there was a significant improvement in enforcement.

SAFEhouse[8], an industry body, strongly disagreed with the notion that the introduction of MEPS will have a positive net benefit on the lighting market and South African consumers. They felt that the pre-certifications by a third-party, which requires suppliers to apply for a letter of authority (LOA), were cumbersome and expensive, and disadvantaged smaller importers and suppliers who would not be able to bear the increased cost of compliance.

2.6.2 Comments on the compliance process (pre-certification with LOAs)

The key issues raised by stakeholders concerning the compliance process are summarised below:

2.6.2.1 The regulator is taking too long to process and issue LOAs and does not have adequate resources.

Several large suppliers, including Eurolux, LEDVANCE, and Aurora noted that the NRCS is taking too long to issue LOAs. Previously, the NRCS issued LOAs within 30 days, but this LOA issuance period has steadily increased over time. The procedural cap allows for LOAs to be processed within a maximum of 120 days[9], but only 74% of applications were processed within this time frame according to an NRCS 2018 newsletter[10].

Aurora[11] and Eurolux[12] noted that a lamp can take up to nine months to test and then it is taking up to six months for the NRCS to process and issue an LOA. This means a significant delay in getting new products and technologies to market.

SAFEhouse[13] felt that given the increasingly wide variety of electrotechnical products being produced internationally, the number of LOA applications would only increase and that the NRCS would not be able to cope with the increasing administrative burden. IESSA[14] noted that the regulator, by its own admission, simply does not have the resources to process LOAs in an acceptable timeframe, let alone to undertake adequate market surveillance and enforcement of MEPS.

2.6.2.2 The LOA process is being abused by some suppliers; test reports obtained cannot be trusted and there are insufficient checks and balances.

SAFEhouse[15] presented some evidence that the LOA process was being abused by some suppliers – an LOA that listed many distinct products for which separate test reports and LOAs should have been issued. They also noted that it was also easy to import a non-compliant product under an LOA issued for a different compliant product.

A private lab, TACS Laboratories[16], noted that while the NRCS required full safety and performance test reports from an independently accredited test laboratory, they often simply accepted the reports at face value. They noted that some of the test reports from international laboratories are obviously fraudulent because they have been issued so quickly that it would

[8] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.
[9] Electrotechnical Letter of Authority Administration Procedure, ET/SCF018 Issue 11, Revised 08 Jan 2018.
[10] NRCS Annual Reports: 2015/16 and 2016/17 (the 2017/18 Annual Report has not been published on the NRCS website).
[11] Alan de Kocks (Aurora), in interview with the authors, May 2019.
[12] Patrick Stuckie and Eben Kruger (Eurolux), in interview with the authors, February 2019.
[13] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.
[14] Alex Cremer and Henk Rotman (IESSA), in interview with the authors, February 2019.
[15] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.
[16] Frederick Nkosi and Joel Ndaba (TACS Laboratories), in interview with the authors, February 2019.

have been impossible to conduct the required tests (such as those for lifetime) in the reported turnaround time.

2.6.2.3 The costs of testing and indirect cost of compliance with the LOA process are high.

While few suppliers expressed concern about the direct cost of LOA applications (about R2,000 per LOA), Eurolux noted that there was a significant indirect cost (time and human resources to apply for new LOAs).

SAFEhouse[17] felt that the pre-certification by a third-party which requires suppliers to apply for a letter of authority (LOA) is unnecessarily cumbersome and expensive, and disadvantaged smaller importers and suppliers of LED lamps who would not be able to bear the increased cost of compliance that came with introducing technology-neutral MEPS.

LEDVANCE[18] noted that one of the main costs to suppliers was testing and accreditation, particularly that it was very expensive to have the same lamp with minor improvements re-tested. Signify[19] anticipate additional costs for reprinting and new package design with the inception of the new MEPS regulation.

2.6.2.4 Most suppliers are in favour of retaining pre-certification to administer and enforce compulsory specifications but one group favours self-declaration.

Eurolux were in favour of keeping a process of pre-certification (LOAs) but suggested that suppliers be allowed to produce test reports that complied with either the International Electrotechnical Commission's (IEC) Standards format or the European Norms (EN) standard (as opposed to just the IEC standard). Eurolux[20], Aurora[21], LEDVANCE and Signify all noted that given very limited market surveillance and enforcement activities, South Africa was not able to introduce self-declaration as an alternative to pre-certification and felt this would only give rise to an increase in imports of inferior and non-compliant lighting products.

SAFEhouse[22], however, favour self-declaration. Under a process of self-declaration, the regulator requires that suppliers provide a declaration of conformity as well as a test lab report to show that a product meets the requirements of the applicable regulation/compulsory specification.

2.6.3 Comments on enforcement – market surveillance, check testing and investigations

While overall stakeholder sentiment towards the proposed MEPS regulation for lighting was positive, major concerns were raised by most of the stakeholders interviewed with regards to the NRCS's capacity to enforce compulsory standards. All seven stakeholders who responded to the questionnaire, including large suppliers and industry associations, were deeply sceptical about the capacity and ability of the NRCS and its partners (such as SARS Customs & Excise) to enforce the existing compulsory standards.

The key issues raised by stakeholders with respect to the monitoring verification and enforcement process are summarised as follows:

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[17] Barry O'Leary and Connie Jonker (SAFEhouse), in interview with the authors, February 2019.
[18] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[19] Maciej Debowski and Nelisiwe Nkosi (Signify), in interview with the authors, March 2019.
[20] Patrick Stuckie and Eben Kruger (Eurolux), in interview with the authors, February 2019.
[21] Alan de Kocks (Aurora), in interview with the authors, May 2019.
[22] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.

2.6.3.1 The NRCS, SARS and their partners do not have sufficient resources or human capacity to introduce and enforce the proposed MEPS regulation.

LEDVANCE[23] supports the proposed MEPS regulation in principle but noted that it was very unlikely that South Africa would realise the suggested benefits unless there was a significant improvement in enforcement.

2.6.3.2 The NRCS undertakes very limited market surveillance.

Stakeholders suggested that the NRCS currently focuses most of its time and resources on the pre-certification process and pays limited attention to monitoring, verification and enforcement activities. Several stakeholders, including LEDVANCE[24] and SAFEhouse[25], noted that there was very little evidence that the NRCS was actively undertaking market surveillance.

TACS Laboratories[26] and the SABS[27] revealed that they had not received any requests from the NRCS to test lighting products against the existing VCs in the last year and TACS had never been contracted by NRCS to test any lamps.

2.6.3.3 The NRCS is not assessing or investigating claims of non-compliance.

SAFEhouse noted that, to date, none of their reported instances of non-compliance have been assessed by the NRCS, and this has created a lack of trust in the regulator's ability to perform their mandate under the VC. LEDVANCE[28] mentioned that they had reported to the NRCS three retailers whom they discovered were selling non-compliant products (based on their own testing), but none of the cases were investigated and no feedback was provided.

2.6.3.4 The borders are porous – Customs & Excise are failing to detect imports of illegal lighting products.

LEDVANCE noted that SARS Customs & Excise were not currently able to prevent the import of products that are illegal under current VCs for incandescent and CFL lamps. Ellies[29] noted that customs officials at the ports appeared to be inadequately trained or equipped to detect imports of illegal or non-compliant lighting products. The NRCS[30] acknowledged that communication between the regulator and customs officials at the ports could be improved.

2.6.3.5 The NRCS has insufficient human resource capacity.

The NRCS[31] mentioned that they are deeply resource-constrained; that the lack of enough inspectors was the main bottleneck. The NRCS currently employs 30 inspectors in the electrotechnical division but has no dedicated inspectors for lighting.

[23] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[24] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[25] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.
[26] Frederick Nkosi and Joel Ndaba (TACS Laboratories), in interview with the authors, February 2019.
[27] Theo Fourie and Sihle Qwabe (SABS), in interview with the authors, February 2019.
[28] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[29] Shaun Nel (Ellies), in interview with the authors, February 2019.
[30] NRCS representatives, in interview with the authors, February and March 2019.
[31] Lancerlot Riyano, Langa Jele and Stephina Teffo (NRCS), in interview with the authors, February 2019.

2.6.3.6 The Act[32] does not allow for the NRCS to impose penalties on non-compliant suppliers.

The NRCS[33] reported that the Act does not currently allow for penalties (fines) to be levied on non-compliant suppliers. They believe that if penalties were incorporated as part of the enforcement process, this would send a signal to regular offenders (importers of non-compliant products).

2.6.3.7 Industry does not currently bear the cost of disposing of used lamps and there are limited funds for crushing of confiscated lamps.

The NRCS[34] reported that there are currently no disposal levies in place for LEDs and that the very limited budget for lamp crushing had been problematic to date.

2.6.3.8 Insufficient capacity in South Africa to test LED lamp performance against the specifications.

Our discussion with the NRCS and SABS revealed that no products had yet been sent for testing against the existing lamp VCs. The SABS[35] does not currently have the testing equipment to be able to facilitate the necessary checks for the new MEPS for LEDs, and they require a supply agreement with the NRCS for consistent volumes to justify the investment in equipment for the new VC.

TACS Laboratories[36] reported that they currently have a lot of the equipment needed for testing products against the new technology-neutral MEPS and have plans to acquire more on their own account. TACS Laboratories mentioned that they have never been contracted by the NRCS to test any lighting products. Eskom[37] also noted that they planned to have their laboratory facilities for the testing of electric lamps accredited, although they could not confirm the timelines.

2.6.4 Comments on local manufacturing

2.6.4.1 There are very few manufacturers that produce self-ballasted GSL lamps for the residential market and they do so in very small quantities.

Local manufacturers of lighting products, including EconLED and eLighting, noted that they do not produce LED lamps for the residential market in any significant quantities, even though they have the capability, as it is not economically viable to do so. They noted that residential consumers are not discerning enough in terms of quality. A representative of eLighting noted that many of LED GSLs imported into South Africa are of poor quality and will fail before an equivalent CFL, but consumers do not understand this and are unwilling to pay more upfront for niche locally produced high-quality LEDs.

2.6.4.2 GSL lamps are imported duty-free but local manufacturers are subject to duties on components required to assemble lamps.

eLighting[38] noted that relaxing the import tariffs on imported components would greatly assist the local manufacturing industry in remaining competitive. There is no need for duties on imported components. They are not produced locally.

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[32] The National Regulator for Compulsory Specifications Act, Act no. 5 of 2008 (NRCS Act)
[33] Patsy Andrews (NRCS), in interview with the authors, March 2019.
[34] Patsy Andrews (NRCS), in interview with the authors, March 2019.
[35] Theo Fourie and Sihle Qwabe (SABS), in interview with the authors, February 2019.
[36] Frederick Nkosi and Joel Ndaba (TACS Laboratories), in interview with the authors, February 2019.
[37] Andre Blignaut (Eskom), in interview with the authors, February 2019.
[38] Craig Smith (eLighting), in interview with the authors, July 2019.

2.6.5 Harmonisation to International Standards

All stakeholders agreed that it made sense to harmonise the technical standards and specifications in the South African MEPS with international regulations. At this stage, the European Union is the only region that is also introducing a technology-neutral MEPS for household lighting and this makes it a natural benchmark for South Africa.

2.7 Key recommendations from the stakeholder consultation process

2.7.1 Recommendations on how to improve monitoring verification and enforcement activities

In this section, we summarise our recommendations (Nova Economics) on how to improve the MVE function at the NRCS and its key partners (including SARS Customs & Excise) drawing on insights about best practice obtained during an interview with David Boughey[39] from the Australian GEMS Regulator, which is based in the Commonwealth Department of the Environment and Energy. Other recommendations come from interviews with local stakeholders.

2.7.1.1 Streamline the pre-certification process where possible.

Develop a product registration database to automate registration.

2.7.1.2 Design and implement a more efficient and effective compliance function based on international best practice and focus on basic market intelligence.

At the Australian GEMS regulator, the compliance team is responsible for ensuring compliance with minimum energy and performance standards (MEPS) for electric lighting, while a separate body ensures compliance with electrical safety.

Boughey[40] noted that the three main categories of activity that are carried out by the compliance team and GEMS inspectors are market surveillance, check testing and investigations. Most of the time of the compliance team is dedicated to market surveillance as testing and investigations are more expensive. Basic market surveillance includes checking product compliance online (over the internet, physical site visits of retail stores and other important channels) and compiling market intelligence – the compliance team compile market intelligence to inform market surveillance activities.

2.7.1.3 Investigate if it is possible to automate aspects of market surveillance using technology.

Once the product registration database has been automated it will open opportunities to develop a range of smartphone-based applications for use by consumers and the regulator.

2.7.1.4 Improve the human resource capacity in the compliance function at the NRCS and adopt a more cost-effective model for resourcing it.

The NRCS[41] noted inspectors are responsible for monitor and enforcing compliance under the Act. Inspectors in South Africa have a technical qualification in electrical engineering and are accredited by SANAS to conduct inspections and evaluations. In Australia, the GEMS inspectors are public servants with varied backgrounds, often with experience in enforcement but they are seldom qualified engineers or technical specialists in the electrical field.

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[39] David Boughey (Australian Department of the Environment and Energy), in interview with the authors, March 2019.
[40] David Boughey (Australian Department of the Environment and Energy), in interview with the authors, March 2019.
[41] Lancerlot Riyano, Langa Jele and Stephina Teffo (NRCS), in interview with the authors, February 2019.

2.7.1.5 Set a clear strategy for compliance and monitoring, with specific goals and targets, and report transparently and timeously on the results.

2.7.1.6 Educate Customs Officials and build better relationships with key partners in the quality system.

Boughey[42] noted that the GEMS regulator had provided the Australian Customs & Excise department with funding to educate officials and raise awareness about the compliance of lighting products with compulsory standards.

2.7.1.7 Conduct training and awareness workshops for customs officials and inspectors on lighting products and the implications of new regulation.

2.7.1.8 Consider amending the NRCS Act to allow for fines and penalties to be levied to aid enforcement.

We understand from the DoE[43] that the process to amend the Act to allow for the NRCS to impose financial penalties is already underway.

2.7.1.9 Consider whether it is feasible to introduce self-declaration for certain categories of products where the risks associated with non-compliance are relatively low.

2.7.1.10 Invest in local laboratories to enable the testing of LED lamps against the compulsory specifications and make better use of existing test facilities.

2.7.2 Recommendations from stakeholders on complementary policies and programmes

Stakeholders interviewed also offered the following suggestions for complementary processes and programmes.

2.7.2.1 Consumer Education

LEDVANCE[44] noted that the most important complementary policies were consumer education; they have produced a consumer awareness infographic that allows consumers to assess and compare the full lifecycle cost of using different lighting technologies and have distributed the poster to several Builder's Warehouse stores. Massmart[45] reported that in partnership with Ellies and other energy-efficient brands, a green product aisle campaign had been very successful in supporting customers to understand the benefits and availability of new technologies.

Consumer awareness campaigns could include traditional and social media campaigns to educate consumers about lifecycle costs of different lamp technologies and the potential electricity costs associated with switching. A consumer awareness brochure has been designed by the UNDP Standards and Labelling programme together with a mark of endorsement from the DoE (see Appendix A).

Consumer education may also include in-store promotions and campaigns such as discounts offered for switching to more energy-efficient products, and posters to explain the relative lifecycle costs of different lamp products.

2.7.2.2 Make energy efficiency labelling mandatory and publish the relative lifecycle cost on the box

[42] David Boughey (Australian Department of the Environment and Energy), in interview with the authors, March 2019.
[43] Maphuti Legodi (DoE), in interview with the authors, February 2019.
[44] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[45] Alex Haw (Massmart), in interview with the authors, March 2019.

It is understood that when MEPS is introduced, energy efficiency labelling for electric lamps (which is voluntary, will become mandatory). A sample of the existing energy efficiency label is provided in Appendix A. The existing label doesn't carry any information about the cost in Rands and of using that particular product for a given period, as consumers will not be aware of the magnitude of potential savings even after checking the energy efficiency rating. It would be useful in the author's view (Nova Economics) if the price tag or packaging could include an estimate of the relative lifecycle cost, in say Rands per 7,000 hours of use, using a standard set of assumptions about the input costs for a given period (e.g. electricity price). The main value would be in the relative cost so it would not be necessary to update the assumptions too often.

2.8 Economic modelling – Cost-benefit analysis results

2.8.1 Policy options modelled

The economic cost-benefit model was developed based on data and input assumptions obtained during the market analysis and stakeholder consultation processes. A baseline model was developed including detail on likely sales in each category of lamp and likely usage and uptake without regulation. This was the starting point ('business as usual' model) for the economic analysis.

We then defined the policy option which was based on the introduction of MEPS as it is currently outlined in the draft regulation. We considered analysing a second policy option based on a more stringent form of MEPS (without the current concessions for CFLs) but the modelling showed the differences between the two policy scenarios proposed were not material. The MEPS policy option was developed in consultation with the project management team (PMT) and industry stakeholders.

2.8.2 Key CBA results

The key results of the economic evaluation of introducing MEPS to GSL in South Africa, based on the central scenario, are summarised in Table 2.

Table 2: Summary CBA results, Social Time Preference Rate (STPR) of 2.3%

Summary of Impact Measures	Central Scenario
Total Benefits (PV)	**R 12 130 115 225**
Total Supplier Costs (PV)	**(R327 189 547)**
Total Regulator Costs (PV)	**(R115 619 493)**
Economic Net Present Value (ENPV)	**R 11 687 306 185**
Benefit-Cost Ratio	**27.4**

The results show that introducing MEPS for general lighting is expected to yield significant, positive net economic benefits to the South African economy. The total present value of the economic benefit is calculated to be just over R12.1 billion over fifteen years. The present value of the costs incurred by suppliers is estimated at R327 million while the present value of costs that will be incurred by the regulator are estimated at R116 million. This results in an estimated Economic Net Present Value (ENPV) of R11.7 billion over the 15-year period of measurement.

2.8.3 Conclusions from the CBA

The results of the CBA present a strong positive case for the introduction of technology-neutral MEPS for general service lighting in South Africa. Taking all results of the CBA into account (central assumptions and sensitivity testing scenarios), an economically viable outcome is highly likely.

Under the central assumptions, the net economic benefit of the project is expected to amount to R11.7 billion over the 15-year period and the benefit-cost ratio is 27.4 to one, which means that the present value of the project benefits is more than 27 times the present value of the costs of introducing and enforcing the regulation.

The sensitivity tests on the analysis show that the economic case for implementation of MEPS remains robust under a range of alternative assumptions, including higher discount rates, lower enforcement, and delaying implementation by three years.

The sensitivity analysis shows that a delay in the implementation of MEPS is one of the most significant risks to the economic case for introducing the regulation as it would greatly reduce the expected net benefit. The modelling of a three-year delay under scenario three demonstrates that by delaying implementation by just three years, the total net benefit associated with MEPS is reduced to R1.9 billion from R11.6 billion, under the central assumptions and the benefit-cost ratio decreases from 27.4 to 5.3. **There is a strong case for implementing MEPS as soon as possible to maximise the potential economic benefit associated with more rapid switching to energy-efficient lighting**.

The results of the low compliance sensitivity analysis scenario also reinforce the view of stakeholders that the lack of adequate market surveillance and enforcement of compulsory specifications in South Africa is one of the major risks to the implementation of technology-neutral MEPS for lighting. In the case of low enforcement (33%), the total net benefit associated with MEPS is reduced to R3.4 billion from R11.7 billion under the central assumptions and the BCR falls from 27.4 to 8.4. This demonstrates that inadequate enforcement would greatly reduce the expected benefit associated with MEPS and that given the relatively low costs associated with improving enforcement (as compared to the expected benefit that can be delivered to consumers), every effort should be made to see that adequate market surveillance and investigation of non-compliance is undertaken by the NRCS and its partners.

A higher discount rate has limited impact on the economic case for regulation as the future stream of costs and benefits are quite evenly distributed over time and the scenario had no impact on the BCR relative to central assumptions.

Considering all the scenarios discussed above, we concluded that there is a strong and positive economic case for the introduction of technology-neutral regulations to set MEPS for general household lighting in South Africa. The economic case for implementation of MEPS remained positive and robust under a range of alternative assumptions. The key risks to the economic case for the introduction of MEPS are a potential delay in the implementation of the regulation and very low levels of enforcement (33%) of the compulsory specifications. Modelled in isolation, the impact of each of these scenarios was that they reduced the expected net economic benefit by more than two-thirds relative to the central scenario.

3. Background to the study

3.1 The problem statement

Changes to the current regulation of household lighting products are under consideration because of the following issues in the market:

- The current regulation is lagging behind technological advancements.
- Consumers make poor choices when purchasing lighting due to imperfect information and are spending more than necessary on electricity as a result.
- There are some barriers to the uptake of LED technology.
- Some potential health risks associated with the use of inferior quality LED light sources, specifically in vulnerable populations such as children under the age of three and in people suffering from conditions like epilepsy.
- There are some environmental and health risks associated with the incorrect disposal and accidental breakage of compact fluorescent lamps (CFLs) due to their mercury vapour content.

These five issues are discussed in greater detail in the sub-sections that follow.

3.1.1 The current regulation is lagging technological advancements

The regulation of lighting products in South Africa has not kept pace with the rapid advancements in lighting technology and international best practice and is therefore no longer achieving the objective of removing the least efficient, lowest quality and potentially hazardous lamps from the market.

- While regulations (VC 9008) that specified MEPS for household appliances (also requiring EE labelling) were introduced in 2014, household lighting products are not regulated under VC 9008.
- CFLs and ICLs are currently regulated separately under compulsory specifications VC9091 and CV8043 respectively – which stipulate mainly basic safety and performance requirements.
- There are currently no safety and performance standards for LEDs. Self-ballasted LEDs (<50w) are not regulated and are only subject to voluntary standards i.e. SANS 62612 and SANS 62560.

3.1.2 Consumers make poor choices due to imperfect information

There is a market failure in the household lighting market caused by "imperfect information". This issue is a common feature of the market for household lighting in many countries internationally and is not unique to South Africa.

Technological advancements and the globalisation of the lighting industry have led to a proliferation of lighting products. An increasingly wide variety of lighting products, brands, and technologies have also become available in South Africa. Consumers, however, cannot easily assess the quality and performance of different lamp technologies. There is limited information that allows consumers to accurately compare the energy-efficiency and full life-cycle costs of different lamps.

A lamp is also a relatively small purchase in a consumer's total basket, so they are unlikely to invest much time in researching and comparing the options to make a better-informed choice (unlike, for example, researching the relative cost and performance of a large household appliance or a vehicle).

However, some lamps in a household may be operational for many hours every day providing the opportunity for significant energy savings.

An estimated 25% of all lamps sold in the residential market are sold through major general retailers such as Pick n Pay, Shoprite, Clicks, Game, and the like. Our analysis (in Section 4.4) of data from these general retailers suggests that the upfront cost of a lamp (or the price) is one of the main factors South African consumers consider when purchasing a lamp.

While lamps range in price from R7 to R99, our analysis shows that cheapest 20% of lighting products (those that cost less than R27 per lamp) account for 39% of total sales and 85% of lamps sold by general retailers in the first half of 2018 cost less than R30.

It is also clear from the analysis in Section 4.4 that consumers do not factor the full life-cycle costs of using a lamp into their purchase decisions (comparable information on the lifecycle costs is not readily available). For example, the best-selling lamp in the 800 to 1300 lm brightness category is Osram's 70W BC Eco Halogen lamp. It accounted for 52% of sales by volume in the first half of 2018 (of total sales by general retailers in the Nielsen dataset). While the lamp costs just R20 per unit to purchase, it is among the most expensive to operate and will cost a consumer nearly R1500 in electricity and replacement lamp costs over a typical 5-year (7000-hour) lifecycle. Osram has an equivalent LED lamp that costs R35 to purchase (nearly twice as much as the halogen lamp up front) but will cost only R178 to use over the same five-year 7000-hour life-cycle – effectively only 11% of the life-cycle cost of the equivalent 70W halogen lamp.

Figure 2: Comparison of the lifecycle costs of a best-selling halogen lamp and LED equivalent

	Energy Saver 8W BC Osram **LED**	Osram Globe 70w Bc Eco **Halogen**
Price	R35	R20
Life cycle cost Based on 7,000 hours of use	**R178**	**R1,470**
Wattage	8 W	70 W
Lumens	806 lm	1,172 lm
% lamps sold by volume (800 to 1300 lm) in 1H18	**1%**	**52%**

The data, therefore, support the notion that when it comes to purchasing household lighting products, consumers are making poor choices due to imperfect information. The data show that consumers are inadvertently purchasing some of the most expensive and least energy-efficient lamp technologies because they primarily select products with a relatively low upfront cost and perhaps also a familiar technology. Consumers are also not able to make a more rational choice because they do not have sufficient information on the relative merits and life-cycle costs of different lamp technologies.

3.1.3 There are some barriers to the uptake of LED technology

Sales of LED lamps via major general retailers increased at an average rate of 73% y/y in the 12 months to July 2018. While the sharp growth in volumes of LED sold has been associated with a contraction in sales of halogen and CFL lamps - halogen lamps (which are considerably less energy-efficient) still accounted for 26% of the total units sold in the first half of 2018 while CFLs remained very popular and accounted for more than half (52%) of total sales. LEDs, by contrast, accounted for just 20% of the total sales of household lamps in the first half of 2018 (Section 4.4.2).

One of the possible explanations for the relatively slow uptake of the considerably more energy-efficient LED technology is that consumers in South Africa are still more familiar with Halogen and CFL technologies. In 2010 Eskom, the national utility, launched an energy-efficiency and demand-side management campaign (EEDSM) and in a mass-roll-out programme targeting households, distributed and exchanged energy-inefficient incandescent lamps with CFLs for free. The programme which officially ended in 2017/18 distributed over 73 million CFLs and entrenched the understanding among consumers that CFLs were the far more energy-efficient lighting choice (when compared to incandescents and halogens at the time). There have been few initiatives from government since the Eskom mass rollout to promote awareness of advances in energy-efficient lighting and feedback from interviews with stakeholders in the lighting industry is that South African consumers, particularly households, still strongly associate CFLs with ‘energy-saving’ as a result.

There is also a wide variation in the quality and efficacy of LED lamps sold in South Africa because unlike halogen and CFLs, they are not subject to regulation. Consumers who inadvertently purchase a poor-quality LED lamp may be deterred from buying an LED product in future – a phenomenon referred to as “market spoiling”. To assess the quality of lamps that are currently in the market and the extent to which the specifications reported on the packaging are accurate, we took a sample of ten different LED lamps and submitted them to the Eskom laboratory for testing. The results are presented in Appendix C. From this sample of lamps purchased and tested, it would appear that the lamps being imported into South Africa (and sold via major formal sector retailers) are of reasonable quality and that packaging is generally consistent with the product. Three of the ten lamps tested however did not meet efficacy or energy-efficiency (lm/W) implied by the specifications on the packaging. Two of the three were not as bright (in lm) as the packaging suggested and the third was less energy efficient than specifications implied because the power factor was much lower than reported. It would also appear that price is not necessarily a direct indicator of quality since measured performance did not correlate directly with price across the small sample.

We could not test lamp life due the extended time this test takes, but one of the local manufacturers interviewed[46] suggested that this is one of the major issues with poor quality LEDs – they fail much sooner than reported lamp life on the packaging and often before an equivalent CFL lamp would fail.

3.1.4 There are some potential health risks that have been associated with the use of inferior quality LED light sources

The most recent international literature suggests that there are two main areas where LEDs may present some health risks or concerns: 1) Blue-light hazard; and 2) Temporal light artefacts (flickering).

[46] Craig Smith (eLighting), in interview with the authors, July 2019.

According to Hatori *et al*.[47], LED lighting delivers a much higher amount of blue light compared to other light sources (e.g. incandescent, halogen). Blue light hazard refers to the risk that blue light emitted from a light source close to a person's eyes may represent a risk for retinal damage. In addition, the blue light component from cold white lights can disrupt the sleep cycle (i.e. circadian rhythm) of the user. Certain population subgroups such as children and young adults have a more transparent crystalline lens in their eyes which makes them more susceptible to blue light effects on the retina[48].

There is also a risk of Temporal Light Artefacts – including both visible flicker and non-visible flicker (i.e., the stroboscopic effect) – causing undesired effects in the visual observer. The SCHEER report[49] notes that both visible flicker and stroboscopic effect, also called temporal light modulation (TLM), have been measured at potentially harmful levels from some LED lamps. It is not possible for consumers to identify which LED lamps exhibit flicker and TLM at the point of purchase. Since some LED lamps have TLM of almost 100%, this can result in stroboscopic effects (for example a waved hand appears as a series of stationary images). Studies have shown that people, particularly those who are sensitive to TLAs, report adverse health effects such as migraine or headaches when exposed to these light sources. People with epilepsy are at risk of having seizures triggered by flicking light source. Whether or not a light source flickers is a function of the quality of the design of the driver electronics that operate the LEDs in the lamp. In addition, certain 'dimmable' LED lamps may exhibit flicker when they are dimmed, depending on the type of dimmer switch on which they are operated. In other words, the use of a dimmer switch that is not compatible with some lamp models that may introduce temporal modulations in LED lamps that do not flicker on full power. This is an area of ongoing research[50], and manufacturers are currently trying to develop a LED driver that is universally compatible with dimmer switches[51].

According to European Commission's Scientific Committee on Health, Environmental and Emerging Risks[52], there are several variables to be taken into account when referring to LEDs and their potential effects on human health: 1) spectrum of an LED light source, 2) intensity of the light exposure, especially in the blue wavelengths, 3) duration of exposure, 4) health of the eye, and 5) staring directly at the light source without deviation versus active eye movement. [53]

The SCHEER study group concluded however that there is no evidence of direct adverse health effects from LEDs in normal use (lighting and displays) by the general healthy population[54]. The SCHEER noted that there is some evidence that exposure to blue light in the late evening, including that from LED lighting and/or screens, may have an impact on a user's circadian rhythm. At the moment, it is not yet clear if this disturbance of the circadian system leads to adverse health effects in the general population.

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[47] Hatori, M., Gronfier, C., Van Gelder, R. N., Bernstein, P. S., Carreras, J., Panda, S., … Tsubota, K. (2017). Global rise of potential health hazards caused by blue light-induced circadian disruption in modern aging societies. *NPJ aging and mechanisms of disease*, *3*, 9. doi:10.1038/s41514-017-0010-2.

[48] Wilkins, A. J., Veitch, J. A. & Lehman B. 2010. LED lighting flicker and potential health concerns: IEEE Standard PAR1789 update. Proceedings of the Energy Conversion Congress and Exposition (ECCE) 2010 IEEE, 12-16 Sept. 2010. New York, NY: Institute of Electrical and Electronics Engineers.

[49] SCHEER, 2018

[50] Michael Scholand (CLASP), in interview with the authors, March 2019.

[51] SCHEER, 2018

[52] SCHEER, 2018

[53] https://ec.europa.eu/health/sites/health/files/scientific_committees/scheer/docs/scheer_o_011.pdf

[54] SCHEER, 2018

Vulnerable and susceptible populations (including children, adolescents and elderly people) were considered separately by the SCHEER study group[55]. Children were found to have a higher sensitivity to blue light and although emissions may not be harmful, blue LEDs (between 400 nm and 500 nm) including those in toys may be dazzling and may induce photochemical retinopathy, which is a concern especially for children below three years of age. Older people may experience discomfort with exposure to light that is rich in blue light. Either discomfort glare or disability glare can be temporarily caused by vehicle LED lights, and particularly daylight running lights and headlights.

Overall, there is no evidence that LEDs lead to increased photosensitivity risk when compared with other lighting technologies. In fact, the SCHEER report[56] notes that the absence of ultraviolet radiation from general LED lamps may reduce the risk of photosensitivity for a number of these conditions relative to conventional light sources.

3.1.5 There are environmental and health risks associated with the continued and unnecessary use of compact fluorescent lamps

There are some environmental and health risks associated with the incorrect disposal and accidental breakage of compact fluorescent lamps (CFLs) due to their mercury vapour content. Roughly a decade ago (in 2010) the European Union's Scientific Committee on Health and Environmental Risks (SCHER) determined that the benefits of using CFLs (which were at the time among the most energy-efficient lighting technologies available) outweighed the costs[57]. The potential environmental costs include the release of mercury into the environment if CFLs are disposed of in general waste (the original SCHER opinion noted this risk could be mitigated if CFLs were collected and disposed of separately). LEDs however are now preferred as they are more energy-efficient than CFLs and contain no mercury vapour, posing fewer health and environmental risks.

In August 2017, the Minamata Convention on Mercury – a global treaty to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds – came into force. The convention recognises that Mercury is a neurotoxin that produces significant adverse neurological and other health effects, with particular concerns expressed about its harmful effects on infants and unborn children[58]. The global transport of mercury in the environment was a key reason for taking the decision that global action to address the problem of mercury pollution was required. By September 2019 113 countries, including South Africa had lodged an application to ratify the convention meaning there are 113 parties to the convention. Parties to the Convention have pledged their political and financial support to help reduce and eliminate the use of mercury and mercury compounds. While the parties to the convention seek to curtail the largest sources of mercury emissions which are artisanal and small-scale gold mining, followed closely by coal combustion, they are also committed to phasing out all items that contain mercury, including some compact fluorescent lamps. Under the convention, the import, export and sale of all CFLs containing more than 5mg of mercury per lamp must be phased-out by all parties by 2020 (unless a 5-year exemption is obtained).

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55 SCHEER, 2018
56 SCHEER, 2018
57 SCHER (2010) " Opinion on Mercury in Certain Energy-saving Light Bulbs". Available online: https://ec.europa.eu/health/scientific_committees/environmental_risks/docs/scher_o_124.pdf
58 UNEP (2017) "Minamata Convention Booklet" Available online: http://www.mercuryconvention.org/Portals/11/documents/Booklets/COP1%20version/Minamata-Convention-booklet-eng-full.pdf

3.2 Overview of the regulatory process in South Africa

The National Regulator for Compulsory Specifications (NRCS), is the agency of the Department of Trade and Industry (the dti) that is responsible for developing, administering and ensuring compliance with compulsory product specifications and technical regulations. In carrying out these responsibilities, the NRCS' mandate is to promote public health and safety, environmental protection and ensure fair trade.

Compulsory specifications and technical regulations are required to protect South African consumers from unsafe products or to address market failures such as "imperfect information" that lead consumers to make poor choices and/or to unwittingly purchase inferior quality products or products that are harmful to the environment.

3.2.1 Pre-certification by third-party

The NRCS currently follows a traditional "pre-certification process" to administering and maintaining mandatory product specifications. Under the pre-certification by third-party approach, the NRCS requires that all suppliers or manufacturers who wish to bring regulated products (those to which compulsory specifications apply) into the South African market apply to have a product certified before it can be imported or distributed. The test-report to demonstrate compliance must be issued by a test laboratory accredited to SANS 17025 and the relevant product standard. The accredited laboratory can be an independent third-party conformity assessment body, or it can be a manufacturers/in-house testing laboratory that is supervised (monitored) by national certification bodies (NCB) under certification schemes such as the IECEE scheme. The pre-certification process for electric products such as lighting involves[59]:

1. The importing or manufacturing company must register with the electrotechnical division of the NRCS by completing the application for registration form.
2. A Letter of Authority (LOA) application form must be completed and submitted to the electrotechnical division of the NRCS for every type or model of the product the supplier wishes to import/produce.
3. The LOA application must be accompanied by full safety and performance test report(s) that comply with the relevant compulsory safety and performance standards applicable to that product(s). The test report(s) must be from an accredited test laboratory – either accredited by a national accreditation body affiliated to the International Laboratory Accreditation Cooperation (ILAC) and/or be an IECEE CB Scheme member. The test report must also be in the International Electrotechnical Commission's (IEC) Standards format (IEC format) or any other format that is acceptable to the NRCS. Other standards such as the European Norms (EN) are only accepted if an accredited conformity body declares it to be technically equivalent to the IEC standard. The test report must not be older than 36 months for an initial LOA application and 60 months for a renewal. Tests can often take several months to perform.
4. The LOA application must include photographs of the product(s) from all views, the interior and power cord. A representative sample of the product may be required for further evaluation.
5. A non-refundable fee of R2 067 (VAT exempted) for the financial year of 2018/2019 per application is payable prior to the evaluation of the application, irrespective of the outcome of the evaluation (approval or rejection). An application for a LOA for safety and energy-efficiency costs

[59] NRCS (2014) Electrotechnical Letter of Authority (LOA) administration procedure https://www.nrcs.org.za/siteimgs/Electrotec/LOA.ADMIN.PROC.2014.04.01.issue%207.2.pdf

R4 133 (2018/19). These fees are subject to an annual increase as negotiated by the NRCS with the regulated industry.

6. The evaluation of the LOA application will under normal circumstances, take ± 120 working days from the date of registration.
7. If the application is successful a LOA issued with a reference number and detail of the product and the product is registered on the LOA database.
8. The LOA is valid for three years, after which renewal is possible on application to the NRCS for another three (3) years provided the necessary proof can be provided that the product is still the same.
9. Should during the evaluation process, findings (non-compliances) arise, those findings will be sent to the client to clear within a period of 30 days. Should the client fail to clear the findings within the stipulated time, the application will be terminated, invoiced and a rejection letter will be issued to the client.

A memorandum of agreement between SARS (Customs & Excise) and the NRCS dictates that no importer will be granted market entry into South Africa for commodities that fall under the scope of the relevant compulsory specifications unless they are in possession of an original valid LOA for the specific commodities. The NRCS is also mandated to undertake Monitoring, Verification and Enforcement (MVE): Monitoring the market to identify and penalize non-compliant products.

International studies[60] show that effective market regulation is only possible if both pre-certification and MVE take place. Without MVE, compliance levels average 40% increasing to 80% when both instruments are in place and effective.

3.2.2 Criticisms of the regulatory process in South Africa and potential solutions

Some of the key criticisms of the regulatory process in South Africa, with respect to alternative certification options include:

- The NRCS currently focuses its time and resources on the pre-certification process and pays limited attention to monitoring, verification and enforcement activities.
- Industry has complained that the NRCS is taking too long to issue LOAs. Previously the NRCS issued LOA's within a 30-day period, but this LOA issuance period has steadily increased over time. As noted above? the procedural cap allows for LOAs to be processed within a maximum of 120 days[61], but only 74% of applications were processed within this time frame according to a NRCS 2018 Newsletter[62]. It should be possible to streamline this pre-certification component - Australia issues registration certificates within two weeks, while in China a successful application means that a system generated certificate is issued immediately.
- A project to develop a product registration database that will automate the registration process for household appliances with respect the MEPS component of compliance is underway, and it has been proposed that it be extended to lighting.
- Although the tests proposed in the draft regulation are in line with international norms and standards, the cost of testing was raised as a concern by industry. Test reports will be required

[60] (i) Zhou, N., Romankiewicz, J., Fridley, D., Zheng, N. 2012. International Comparison of Product Certification and Verification Methods for Appliances. China Energy Group Environmental Energy Technologies Division Lawrence Berkeley National Laboratory. (ii) Final report on the 4th joint cross border EMC market surveillance campaign (2011); LED lighting products. EMC Administrative Cooperation Working Group;

[61] Electrotechnical Letter of Authority administrative procedure, ET/SCF018 Issue 11 Revised 08 Jan 2018

[62] NRCS Annual Reports: 2015/16 and 2016/17; The 2017/18 Annual Report has not been published on the NRCS website.

with respect to both the MEPS (including quality and performance) and the required safety standards.

3.2.3 Reform of the regulatory process – self-declaration as an alternative

Several major countries/regions including the European Union and China have moved away from compulsory or pre-certification to a process known as self-declaration. In China, the regulator is running both processes – it still requires compulsory certification for some products but increasingly adds products to the list of those that can comply under self-declaration[63]. Under a process of self-declaration, the regulator requires that suppliers provide a declaration of conformity that a product meets the requirements of the applicable regulation/compulsory specification. The test reports that accompany the declaration can be from in-house test laboratory (accredited or non-accredited) rather than an independent and accredited third-party lab.

The advantages of self-declaration are that it reduces the direct costs to the supplier of testing and the indirect costs associated with delays in bringing new products to market with pre-certification. The regulator may also save time and resources processing LOAs. The main disadvantage is that this approach requires the regulator to undertake a more active and consistent market surveillance in order to ensure compliance. Scholand[64] noted that self-declaration is not working particularly well in Europe, it has been demonstrated that levels of compliance with compulsory standards are much lower in jurisdictions that lack market surveillance and there have been many complaints in Europe from industry about the lack of sufficient market surveillance. The overarching regulatory framework and legislation also must allow for product liability laws whose penalties are of a magnitude that they serve as a strong deterrent to suppliers making incorrect attestations of conformity. Enforcement practices and penalty systems vary across countries; however, it is noted that South Africa's regulator currently lacks the legislative authority to impose fines, prison sentences and other enforcement deterrents which are afforded to other regulatory authorities internationally.

3.3 Overview of the proposed regulation

The draft compulsory specification Compulsory Specification for General Service Lamps (VC 90XX) covers the safety requirements, energy efficiency and functional performance for general lighting directional and non-directional lamps of all shapes and finishes. The key technical requirements within the regulation are outlined in the following four categories:

- Energy-efficiency (efficacy) requirement;
- Functional performance requirements;
- Product safety requirements; and
- Product information requirements.

A summary of the key technical elements of the draft regulation is provided in Figure 3. The main energy performance requirement of the draft technology-neutral MEPs is the requirement that lamps meet a minimum efficacy (unit of light output per unit of electrical power input) of 80lm/W under the first tier of the regulation and 95lm/W under the second tier.

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[63] China CNCA Amends the List of Products and Self-declaration Mode under CCC Certification System https://www.qima.com/regulation/03-19/mar2019-china-cnca-amends-list-ccc-certification
[64] Michael Scholand (CLASP), in interview with the authors, March 2019.

Figure 3: Summary of key technical elements of draft technology-neutral MEPS

1. Energy efficiency requirements

Minimum luminous efficacy
Energy-efficiency requirements – minimum luminous efficacy of 80lm/W (tier 1) and 95 lm/W (tier 2)

Fundamental power factor
Minimum fundamental power factors e.g. >=0.9 for P>25W

Standby power for connector lamps
(<0.5W)

2. Functional performance requirements

Functional performance requirements (Colour Rendering Index (CRI) Ra >= 80), Lumen maintenance factor, min lifetime, Survival factor, EMC emissions, flicker and stroboscopic effect visibility measure, photobiological risk (blue light and UV), colour consistency, RoHS (mercury content)

3. Product safety requirements

Compliance with SANS safety standards
(Tungsten filament - SANS 60432-1, Tungsten halogen – SANS 60432-2 and 3, CFL – SANS 61199, Self-ballasted lamps – SANS 60968, self-ballasted LED – SANS 62560)

4. Product information requirements

Product information requirements
A range of information that must be clearly printed on the product

3.3.1 Scope of the regulation

The draft regulation applies to general lighting directional and non-directional lamps of all shapes and finishes; using incandescent, halogen, fluorescent, high-intensity discharge, light emitting diode (LED), and other light source technologies; and having:

a) One or more input voltages up to 300V of direct current or alternating current with frequency of 50 or 60 Hz;

b) Emitting light with a total luminous flux of 60 to 3300 lumens;

c) Light emission with the chromaticity coordinates (x, y) that are within the range: $0{,}250 < x < 0{,}570$ and $-2{,}3172\,x^2 + 2{,}3653\,x - 0{,}2400 < y < -2{,}3172\,x^2 + 2{,}3653\,x - 0{,}1400$; and

d) a lamp base which can be connected to one of the following general service lamp sockets: screw, bayonet, pin, R7S, and alternative base types which can be connected to the above lamp base sockets by using commercially available passive adaptors.

3.3.2 Exemptions

There are some lamp exemptions from energy efficiency and functional requirements, for example: when illumination is not the primary purpose of the lamp, the spectral distribution of the light is adjusted to the specific needs of particular technical equipment such as studio lighting and other special considerations. However, the lamps exempted from energy efficiency and functional requirements are still required to comply the safety standards as indicated in the proposed regulation.

3.3.3 Entry into Force

It was initially envisaged that the energy and performance requirements set out in the regulation would take effect from 1 January 2020 (Tier 1), with additional, in some cases more stringent requirements taking effect from 1 January 2023 (Tier2). While the regulation may take effect later than 1 Jan 2020, the draft regulation has subsequently been amended to reduce the time period between Tier 1 and Tier 2 from three years to two.

3.4 Summary of the intended outcomes of the proposed regulation

The NRCS' mandate is to maintain mandatory specifications in the interest of promoting public health and safety, environmental protection and to ensure fair trade.

- The overarching aim of the proposed regulation to set technology-neutral MEPS for household lighting is to provide lower-cost, better quality lighting for the people of South Africa.
- A secondary objective of MEPS for lighting is to improve the safety of lighting to protect consumers from potential health (including flicker and mercury-containing lamps), fire and electrical hazards that may be associated with the use of inferior products.
- A third objective is to reduce peak electricity consumption to improve reliability of the national grid and to reduce the carbon footprint of the residential sector by promoting the uptake and use of more energy-efficiency lighting products.

If effective, the regulation is expected to result in a reduction in energy consumption and associated greenhouse gas emissions which will support South Africa in achieving its stated climate change goals.

4. Market analysis

4.1 Introduction

In this chapter, we provide an analysis of the market for electric lamps in South Africa. The analysis is based two main sources of data: trade data collected by Customs & Excise (SARS), and retail trade data collected at the electronic point-of-sale (checkout scanners) at major retailers and aggregated by market research firm Nielsen. In Section 4.2, we discuss the data sets and the limitations and merits of each dataset.

In Section 4.3 provide an analysis of the overall market for electric lamps in South Africa based on trade data. While these data provide a good overview of trends in the local market for electric lamps, it is not possible to distinguish between lamps imported for general use in the commercial/industrial sector from those imported for residential use. We were only able to distinguish lamps that are for specific use in the commercial/industrial sector from those that are for general use.

Since the household lighting sector is the focus of the proposed regulation to set MEPS it was necessary to understand recent trends in the purchasing behaviour of consumers in this segment at a more granular level. In Section 4.3 we provide an overview of the residential market for electric lamps and attempt to size the market based on data from the general household survey. In Section 4.4 we presented a more detailed analysis of retail sales of electric lamps sold via one of the four major channels (general retailers). The retail sales data are aggregated across a group of major general retailers (including Shoprite, Spar, Pick n Pay, Woolworths, Clicks, Dischem and others) and enable us to analyse the sales of electric lamps to households by price brand, technology, brightness, efficacy and lifecycle costs.

4.2 Description of the data

The analysis presented in this chapter is based on two sources of data: trade data collected by Customs & Excise (SARS) and retail trade sales data collected at the electronic point-of-sale of major general retailers (checkout scanners) and then aggregated by Nielsen. A description of the key features of the two data sources is provided in Table 3.

4.2.1 Trade data

The trade data provide detail on the type and value of electric lamps imported into South Africa. Until 2017 there was no data on the number of units imported (only in some instances in tons). The trade data are extracted from the ITC Trademap database, which since 2017 has sourced trade data directly from the South African Revenue Service (SARS) and prior to that from the UN Comtrade database.

The trade data, collected by Customs & Excise division of SARS, includes the value and volume of imports and exports of lighting products at the tariff line level. Volumes are reported in units for all lamps except for LED lamps. For LED lamps, SARS still record the volume by weight (kilograms or tons) so as a result, we had to estimate the number of LED lamps units imported. The trade data also only reflect the number of lamps imported (rather than sold) in a given year and the value represents the landed cost of a lamp rather than the retail price faced by the consumer.

Some further limitations of the trade data are the lamps are aggregated into quite broad categories based on the HS 8-digit level tariff codes (most detailed level available) and as such there is no information in the trade data on most of the technical specifications of the lamps imported, such as brightness, lifetime, wattage, efficacy, etc.

Analysing the trade data at the tariff line (most detailed level available) it is possible to distinguish lamps imported for general use from those imported for specific industrial or commercial uses. It was not however possible determine whether the lamps identified as "general-use" had been sold to residential, commercial or industrial sectors or to comment on differences in purchasing patterns across these segments of the market.

While the analysis of lamps imported into South Africa based on trade data was a useful starting point, it was necessary to supplement this with an analysis of point-of-sale data from major retailers. The point-of-sale data enabled us to analyse trends in the residential segment of the market in greater detail and to comment on trends in consumer preferences and drivers of demand for household lighting in South Africa with respect a number of the dimensions that were most relevant to assessing the potential impact of MEPS such as technology choice; brightness; upfront cost and life-cycle costs and energy-efficiency.

Table 3: Description of data

Import statistics (SARS)	Retail trade data (via Nielsen)

• Data from SARS (Customs & Excise) and UN Comtrade prior to 2017
• Long time-series (>10 years)
• Includes aggregate data on lamps imported for household, commercial or industrial use:
    ○ Type of lamp
    ○ Total import value (and re-export)
    ○ Country of origin
    ○ The total value of all lamps imported (net) in a given year
    ○ Total units of lamps imported in 2018 (excl. LED)
	• Data aggregated from retailers including Shoprite, PnP Group, Woolworths, Spar, Clicks, Dischem, Pep, Boxer, Game.
	• 3 years of historical data until July 2018
	• Includes aggregate data on lamps imported for household, commercial or industrial use:
	    ○ Type of lamp (LED, ICL, Halogen ICL, CFL, decorative)
	    ○ Brand & wattage (or equivalent)
	    ○ Unit sales
	    ○ Average price
	• Data were cleaned, the type of lamp and wattage and multi-pack size was extracted from the description.
	• We augmented the data by adding information on lumens (brightness) and lifetime by finding each lamp model in online catalogues.

4.2.2 Retail sales data

The Nielsen dataset includes monthly sales of electric lamps over the three-year period from July 2015 to July 2018. The sales data are aggregated from major grocery and general retailers including Shoprite, PnP Group, Woolworths, Spar, Clicks, Dischem, Pep, Boxer and Game. The data include information on the brand and model of each lamp purchased, the value and volume of sales volume of those units, the average price of per unit, and a general description of the product which included wattage, type and pack size (Table 3).

The original Nielsen dataset was cleaned, transformed and augmented as follows:

- The original dataset included monthly sales for over 1300 types of electric lamps, however, most of these sold in very low volumes so we limited our analysis to the 178 types of lamp that comprise 85% of the sales volume over the three-year period.

- Important fields such as the wattage, type of lamp technology and pack size were not recorded as a separate field in the original dataset and had to be determined from a field containing a general description of the product. An average price variable was created by dividing the value of sales by unit sales.
- There was no information on the brightness of the lamps (in lumens) or the lifetime hours in the original dataset but there are important indicators of quality and energy-efficiency. We decided it was necessary to augment the dataset by finding information on each of the 177 lamp types that comprise most of the volumes sold in the online product catalogues and we entered this information into the sales database.

According to large suppliers such as Ellies, Osram (LEDVANCE) and Philips (Signify), that were interviewed during the stakeholder consultation process, an estimated 20 to 25% of total lamps that are sold to the residential market are sold via general retailers such as those represented in the Nielsen dataset (The major sales channels for the residential market are discussed further in Section 4.3.4). A limitation of the analysis based on this data is that it potentially only represents roughly one quarter of the volumes sold to the residential market. A concern, therefore, was that the nature of sales to households via the other three main channels (hardware/bulk-retailers, independent stories and wholesalers/contractors) could be quite different. To mitigate against this risk, we surveyed suppliers asking them to provide estimates of the composition of sales in the other three channels and comment on to which they differ (e.g. by technology preference) from the sales in the general retailers. The feedback from suppliers is discussed in Section 5 and was used to calibrate some of the economic model assumptions (discussed further in Section 6)

Another limitation of the Nielsen dataset is that the single-largest volume seller of the 178 lamp types in the truncated dataset is “own brands”. These are lamps sold by retailers under their own brand name (for example, the *Pick n Pay’s* No Name brand). Nielsen, however, has aggregated several different stores’ own brands and lamps into one category, so it was not possible to extract any information on the type or nature of lamps sold in this category other than volume and price.

Lastly, it is worth noting that the Nielsen data provide no information about the profile of customers that purchase the lamps via major general retailers who sell products to a wide range of customers and income groups. It was therefore not possible to comment on the preferences in terms of household lighting of different consumer groups. These data are also not publicly available. Some inferences about the lighting preferences of different customer groups could potentially be drawn from analysis of loyalty card data (e.g. PnP Smartshopper data or Makro card data) but access to the data is restricted by retailers that own the data. While the retailers do sometimes give third parties access to their loyalty programme data on a commercial basis, it each use-case must be motivated and negotiated.

4.3 Analysis of the South African market for electric lamps

Our analysis of the overall market for electric lamps in South Africa is based on trade statistics. We analysed trade data at the tariff line level (most disaggregated) and then reaggregated data into broader categories based on main technology and whether they were for general or specific uses. Lamps for ‘general use” are all those categories of imported lamps that could not be identified as having a specific commercial or industrial use (e.g. mining headlamps).

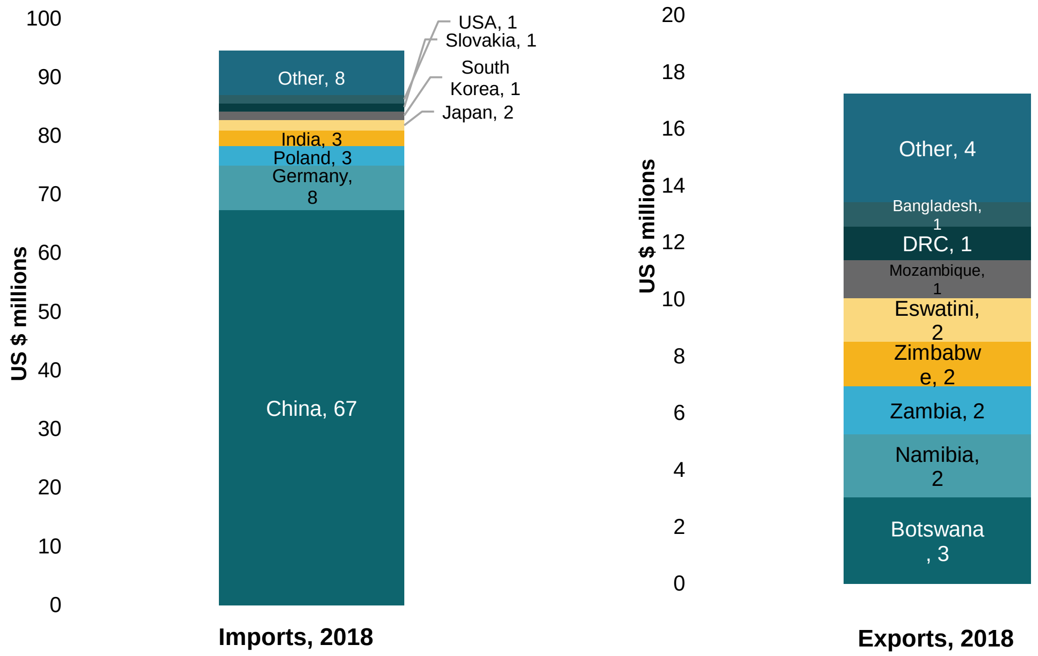
4.3.1 Size of the market electric lamps in South Africa

Net imports of electric lamps into South Africa totalled US$77 million in 2018 – total imports were around US$94 million while re-exports to neighbouring countries totalled about US$17 million (Figure 4). The bulk of South Africa’s lamps come from China, who imported US$67 million, constituting approximately

71% of the total value of imports, followed by Germany -$8 million, which represents 8.5% of the total value of import and Poland (3%).

The US$77 million of net imports is a reasonable estimate of the total value of the market for electric lamps in South Africa (at wholesale prices) as feedback from a range of stakeholders and further investigations suggest there is no significant manufacturer of electric lamps in South Africa, any volumes that might be produced for niche markets or specific contracts are very small. We made attempts to contact some of the small firms that had been identified as manufacturers of LED lamps by larger suppliers and industry associations. However further investigation revealed that they were either manufacturers of LED luminaires (fittings) or had previously assembled lamps from imported components based on Eskom contracts that had local content requirements but had since discontinued production (See Section 4.3.3).

Figure 4: South Africa's imports and exports of electric lamps, USD 2018



Source: Own analysis based on data from SARS Customs & Excise, extracted from ITC Trademap database

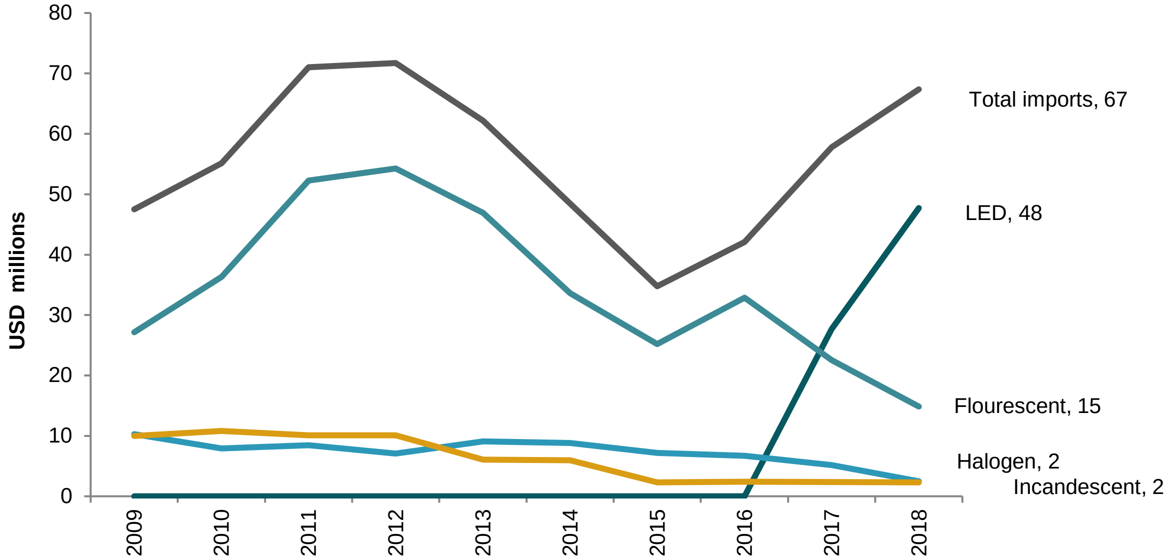
4.3.2 Trends in the composition of the electric lamp imports for general use into South Africa, by technology

The trend in the composition of electric lamps imported into South Africa by technology is presented in Figure 5. To produce the trends depicted in Figure 5, we analysed trade data at a tariff-line level and *removed lamps that were clearly imported for specific commercial and industrial uses.* We then reaggregated the remaining tariff-level data on electric lamp imports into the four categories depicted in the graph (LED, fluorescent, halogen and incandescent). This was necessary because of the large volumes of halogen lamps for use in motor vehicles (over 80 million units) that were imported in 2018 and were severely distorting the picture of the market for general lighting in South Africa. Total imports represent the sum the values for each of these categories in each year.

The value of LEDs imported for general-use has increased sharply since 2016 albeit initially off a very low base (there are almost no imports of LEDs recorded in 2015) While the total value of lamps imported has also increased sharply since 2016, it is clear that LED lamps have started to displace sales of CFL and halogen lamps – the growth in value of both has contracted year-on-year since 2017 (Figure 6.)

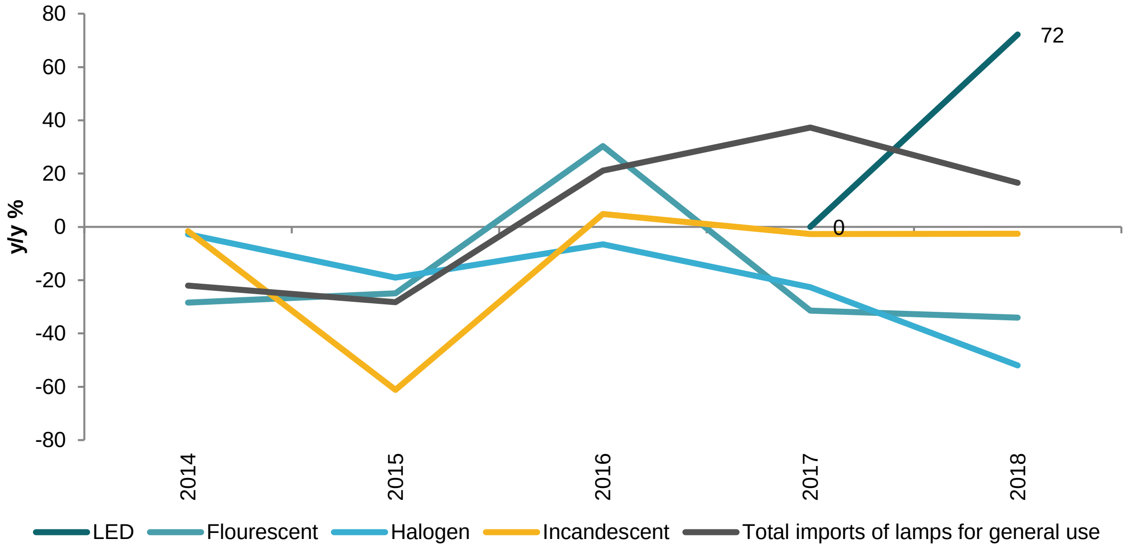
Cumulatively, the trends demonstrate increased demand for LEDs by consumers across the residential, commercial and industrial sectors.

Figure 5: Trend in value of imports of electric lamps for general use into SA, 2009-18 (in USD)



Source: Own analysis based on data from SARS Customs & Excise, extracted from ITC Trademap database

Figure 6: Growth in the value of imports of lamps for general use by technology, 2014 -2018



Source: Own analysis based on data from SARS Customs & Excise, extracted from ITC Trademap database

Data on the type and number of lighting units imported into South Africa for general use in 2018 is provided in Table 4. As noted above lamps imported for general use (residential, commercial or industrial) exclude lamps that could be identified based on their tariff codes as being for specific commercial and industrial uses.

Importantly, while SARS began to report the units of electric lamps imported in 2018, LED lamps imports are still reported in kilograms or metric tons. No explanation is given on the ITC trade map database (which is where we extracted the data) as to why this is the case. Attempts to contact SARS for an explanation where unsuccessful.

In order to compare unit imports across all lamp categories in 2018, we estimated the units of LEDs imported. To do this conversion, we found the weight of a LED lamp to be ~0.1 kilograms and used this to calculate the number of units per kilogram and then per metric ton. Our calculations show that, if each LED lamp weighs 0.1 kilograms, then 10 LED lamps weigh one kilogram and 10 000 LED lamps weigh one metric ton.

We estimate that a total of 36.8 million LEDs were imported in 2018 which means there were a total of around 78.4 million lamps (of all technologies) imported for general use (Table 4). Imports of LEDs are followed by CFLs (25.3 million units or 32% of the estimated total unit imports for general use) and then halogens (4.8 million units, or 6% of the estimated total unit imports for general use).

Table 4: Imports of electric lamps for general use (residential, commercial or industrial), 2018

Imports of electric lamps for general use (residential, commercial or industrial)						
Tariff code	**Technology**	**Detailed description**	**Imports volume (2018)**	**Unit**	**Imports Value ($'000s)**	**R per unit (R/$ 13.50)**
85395010	LED	Light emitting diode (screw-in or bayonet)	25786	Tons		
85395090	LED	Light emitting diode (other)	11007	Tons		
85395010	LED	Light emitting diode (screw-in or bayonet)	25.8	Million units (author's estimates)	25439	10.8
85395090	LED	Light emitting diode (other)	11.0	Million units (Author's estimates)	22273	22.1
85393190	Fluorescent	Fluorescent, hot cathode (other)	17.8	Million units	11170	8.5
85393145	Fluorescent	Fluorescent lamps (600mm to 2500mm) incl. mercury vapour	7.3	Million units	3591	6.7
85392145	Halogen	Halogen lamp (Other between 5w and 1000w)	3.6	Million units	1484	5.5
85392190	Halogen	Halogen lamp (Other between 5w and 1000w)	1.2	Million units	999	11.2
85392245	Incandescent	Electric filament lamps (<=200w)	1.8	Million units	673	5.1
85392915	Incandescent	Projector lamps	0.1	Million units	592	126.7
85392220	Incandescent	Projector lamps	0.0	Million units	430	344.9
85392910	Incandescent	Carbon filament lamps	0.3	Million units	391	17.4
85392925	Incandescent	Torch lamps	0.7	Million units	129	2.4
85393945	Fluorescent	Fluorescent lamps (600mm to 2500mm) excl. mercury vapour	0.2	Million units	94	5.1
85392290	Incandescent	other (<=200w)	0.0	Million units	76	37.4
85392957	Incandescent	>200 w but <1000w	0.0	Million units	8	73.0
85392950	Incandescent	<15w vacuum type	0.0	Million units	3	16.7
85393245	Other discharge lamp	Mercury or sodium vapour lamps or metal halide (600mm to 2500 mm)	0.0	Million units	3	173.1
Total			**78.4**			

SARS recorded that a further 137.8 million units were imported for specific commercial and industrial uses (not for general use) – Table 5. For the remainder of this chapter we focus on the residential market for electric lamps which comprises a portion of the estimated 78.4 million units that were imported for general use in 2018. We recommend that the NCRS approach SARS and request that volumes of LED imports be captured in units in future to allow for more consistent and reliable analysis of trade data.

Table 5: Imports of electric lamps into SA for specific industrial or commercial use, 2018

Imports of electric lamps for specific uses (commercial or industrial)						
Tariff code	**Technology**	**Detailed description**	**Imports volume (2018)**	**Unit**	**Imports Value ($'000s)**	**R per unit (R/$ 13.50)**
85393290	Other discharge lamp	Mercury or sodium vapour lamps; metal halide lamp (other)	1.8	Million units	5545	41.6
85392120	Halogen	Halogen lamp for use in motor vehicles	8.7	Million units	4922	7.7
85392945	Incandescent	Electric filament lamps for use in motor vehicles	20.5	Million units	3772	2.5
85392125	Halogen	Quartz iodide lamps for use in motor vehicles	82.2	Million units	3502	0.6
85393990	Parts	Other	7.3	Million units	3441	6.4
85394910	Ultra-violet	Ultraviolet lamps	0.2	Million units	1666	122.8
85394920	Infra-red	Infra-red lamps	0.4	Million units	1342	51.3
85394100	Arc-lamps	Arc-lamps	0.3	Million units	1335	65.6
85391000	Sealed beam lamp units	Sealed beam lamp units	0.2	Million units	825	49.3
85392990	Parts	Other	0.1	Million units	493	51.5
85399000	Parts	Other	16.1	Tons	295	0.2
85392920	Incandescent	Radiator lamps	0.0	Million units	47	33.1
85392960	Incandescent	Mining headlamps	0.0	Million units	2	818.2
Total			**137.8**			

While the national trade data provide an overview of the overall market for electric lamps based on import statistics, a more in-depth analysis of trends in the market for residential lighting, including data on the prices and volumes sold to the end-consumer was needed to assess the potential economic impacts of the regulation. It was necessary therefore, to supplement the analysis of the overall market based on trade data with a more detailed analysis of the residential market for electric lamps. The following section presents this analysis which is based on point of sale data from major national retailers operating across South Africa.

4.3.3 Extent and nature of local manufacturing activity

Our research has found that there are no significant manufacturers of electric lamps for the household market in South Africa. Based on interviews with stakeholders (See Section 4.3.3 later in the report for a discussion of the stakeholder consultation process) including industry association SAFEhouse and large suppliers such as Eurolux and LEDVANCE, we established that there are a few small volume manufacturers of LED luminaires/fittings or housings in South Africa (Table 6). The regulation with which these "lighting products" must adhere to is the compulsory specification for electrical luminaires (VC 9012), rather than the proposed MEPS for electric lamps for household use. We contacted most of the firms that had been identified as potential manufacturers of electric lamps and requested an interview, but we did not receive a response from any of the firms we approached (Table 6).

Table 6: Firms that were identified as potential local manufacturers of lighting products

Company name	Products	Description of activity	Website/ Contact	Contacted?	Location
G Light (Pty) Ltd	• LED Luminaires • Commercial/Industrial market	Manufacturer and importer of LED fittings or luminaires for hotel, warehousing and shopping malls.	https://g-light-sa.myshopify.com/pages/contact-us	Yes but no response	Edenvale, Gauteng
eLighting	• LED tubes, industrial floodlights, streetlamps and panel lights	Produces high quality LED tubes, floodlights and panels for the industrial and commercial markets. Can produce LED lamps for residential applications	https://www.elighting.co.za/led-products-1.html	Yes	Kempton Park South Africa
LED Concepts	• None at present	Previously assembled some LED lamps and tubes locally for large contracts with Eskom that had local content requirements in place that required local assembly. They are no longer manufacturing any lamps/tubes.	http://colstaprojects.co.za/ ledconcepts@gmail.com	Yes, no response, contacted for a previous UNDP engagement	Elandsfontein, Alberton
EconLED industries	• LED Luminaires • Commercial/Industrial market	Econ Led Industries claims to be the leading manufacturer of LED lighting in South Africa, but they also import products. Output is limited to 1 500 units per day.	http://econled.co.za/Default.asp barry@econtrading.co.za	Yes	Kempton Park, Gauteng
LEDwise	• Designs and assembles LED luminaires • Commercial/Industrial & Retail market	Designs and manufactures LED lighting solutions/products for the retail, commercial and industrial sectors. LEDwise procures the high-quality components and assembles them locally onto printed circuit boards and into housings.	https://www.ledwise.co.za/products technical@ledwise.co.za	Yes but no response	Maitland Cape Town
Pioled	• Supplier of lamps, doesn't appear to manufacture any longer	No mention of manufacturing but is a supplier of LED lamps and accessories to residential, industrial and commercial market.	http://www.pioledlighting.co.za/	Yes but no response	Port of Durban, Kwa-Zulu Natal
Afrison	• Designs and assembles LED luminaires for mining and industry	In 2015 Afrison opened a manufacturing plant, specialising in developing and manufacturing of industrial and mining LED lights. Its manufactured product range includes specialist luminaires for use in mining, industrial and commercial applications.	http://www.afrison.co.za/	Yes but no response	Centurion, Gauteng

Based on the descriptions of products and activities listed on the respective manufacturing company websites we established the manufacturing of lighting products in South Africa is limited mainly to the design and assembly of niche LED luminaires (fittings and arrays). These luminaires are assembled from imported components for commercial / industrial applications. We spoke to a representative from

EconLED[65], who claim to be the leading manufacturer of LED lighting in South Africa. They stated that they manufacture lamps for customised applications – mainly industrial and commercial warehousing – on a project-by-project basis. They also noted that, to their knowledge, there are no local manufacturers of LED lamps for the residential market. In their view "*they would have to be mad*" because South African companies can simply not compete with cheaper imported products, despite the fact that the imported products are often of very low quality. This is because residential consumers' primary purchase decision is based on price and, because they have a limited understanding of LED lamps, they are not able to recognise that the claimed performance standards (such as lifetime) are not achieved. EconLED's production output is approximately 1 500 lamps a day, but they are not operating at full capacity.

A representative of Ellies[66] noted in an interview, that it is not economically viable to manufacture LED lamps in South Africa. While they design some of their lamps locally, they outsource manufacturing to factories in China where economies of scale in production can be realised and lamps produced at much lower cost. We conclude that there are no local manufacturers who produce electric lamps in significant volumes in South Africa.

eLighting[67] noted, that they mainly produced high quality LED products for the commercial and industrial segments only, and do not serve the residential market. They noted that manufacturing locally and investing heavily in testing equipment had allowed them full control over the quality of their lighting products. They noted that most of the GSL LEDs on the market (residential) in South Africa were of poor quality and preyed on residential consumers ignorance and tendency to purchase lamps based on the upfront cost alone. While having the capacity to produce lamps for the residential market (up to 600 a day), they are not able to compete with cheaper imported products on price alone and produce far fewer than that. They noted that fully assembled GSL lamps are imported duty-free whereas they must pay import duties on components to assemble and manufacture LED lamps, which further hampers their competitiveness. Overview of the residential market for electric lamps in South Africa

4.3.4 Major retail channels

According to large suppliers interviewed[68], households in South Africa purchase electric lamps through four main channels – general retailers, bulk/hardware retailers, wholesalers/electrical contractors and independent stores:

- General retailers include major grocery stores such as Checkers, Spar, Pick n Pay, Game and Woolworths as well as the country's two major pharmacy, health, household appliance and beauty retailers (Clicks and Dischem).
- Bulk/hardware retailers include stores such as Builders Warehouse, Makro, KaapAgri, Agrimart etc.
- Wholesalers and electrical and building contractors
- Independent includes owner run retail and hardware stores, informal stores.

Information obtained from large suppliers suggests that bulk retail and hardware stores are the most important channel in the residential market, accounting for between 37% and 50% of the total volume sold (Table 7). Between 15% and 25% of sales go via general retailers (covered by the Nielsen data)

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[65] Barry Tree (EconLED), in interview with the authors, March 2019.
[66] Shaun Nel (Ellies), in interview with the authors, February 2019.
[67] Craig Smith (eLighting), in interview with the authors, July 2019.
[68] Ellies, Signify (Philips), Ledvance, and (OSRAM) and Eurolux. See Appendix A for list of interviewees.

and a further 25% via electrical contractors or wholesalers or building contractors. The remaining volumes are sold in independent stores. Data obtained from Ellies shows, that some consumers also purchase electric lamps from online stores (e.g. Takealot) but at this stage this only represents a very small percentage of total volume sold.

Table 7: Volumes of electric lamps sold via different channels – actual or estimated

	General retailers	Bulk retail/hardware	Electrical contractors/builders	Independent stores	Online
Ellies (Actual)	23%	37%		40%	0.1%
LEDVANCE (estimate)	15%	40%	30%	15%	
Eurolux (estimate)	25%	50%	25%		

Source: stakeholder interviews

4.3.5 Size of the residential market for electric lamps

As noted in Section 4.3, import data suggest that a total of ~78.4 million lamp units were imported for general use in the residential, commercial and industrial sectors (but this includes our estimates of LED unit volumes derived from tonnage). Most lamps imported for general use would probably be used in the residential sector (as opposed to commercial and industrial), which means that the residential sector probably purchases at least 50 million electric lamps a year.

To estimate the total stock of lamps in the residential sector in South Africa we adapted the approach used in Harris, Baran and Hazard[69]. The General Household Survey 2017[70] provides estimates of the number of rooms in each household in South Africa and the number of households using electricity for lighting. To estimate the total number of lamps in use across households we had to make assumptions about the number of lamps per room. We assume that small (and usually poorer) homes of less than three rooms (in total including living areas) use 1.5 lamps per room. We assume that medium size homes use an average of two lamps per room and homes with more than six rooms (usually middle-class to high income) use an average of three lamps per room. On this basis, the total stock of electric lamps in households in South Africa is estimated at roughly 171 million. If annual sales are roughly 60 million it would mean that the stock is currently being replaced every three years.

Table 8: Estimating the total stock of electric lamps in SA households

	Number of rooms per household			
	1–3 rooms	4–5 rooms	6+ rooms	Total
Households using electricity for lighting (millions)	4.2	4.4	6.6	15.2
Assumed no. of rooms per household[1]	2	4.5	6	12
Total no. of rooms (millions)	6.3	19.7	39.5	65.5
Assumed no. of lamps per room[2]	1.5	2	3	
Total lamps per household	3	9	18	
Assumed hours of use per lamp per day3	6	3	1.5	
Total no. of lamps in use (millions)	12.6	39.6	119	**171**
Estimate of average hours use of a lamp in South Africa	**2.2**			

Source: Own analysis based on data form the StatsSA General Household Survey 2017 and Australian residential lighting report 2016

Notes: 1) Midpoint of the category. 2) Homes with 1 to 3 rooms tend to be poorer households so we assume one lamp per room, Homes with 4 to 5 rooms may be lower middle income so we assume 1.5 lamps per room. Homes with 6 or more rooms are likely to be middle to high-income so we assume at least 3 lamps per room (including side lamps, down-lighters). 3) In Australia a survey found that only 22% of lamps installed in households are switched on for more than 2 hours a day. The average house has 36.6 lamps. The average living area has 14 which burn for 1.8 hours a day. This is based on this survey http://www.energyrating.gov.au/sites/new.energyrating/files/documents/2016-Residential-Lighting-Report-Final.pdf

We also estimated the hours the average lamp (in the total stock) is switched on per day. In Australia a survey[71] found that only 22% of lamps installed in households are switched on for more than 2 hours a day, but because it is a relatively affluent country the average house has 36.6 lamps. We estimate that the average household in South Africa has 14.8 lamps. In Australia, the average living area has 14 lamps which burn for 1.8 hours a day. Since there is no comparable survey for South Africa, we have used the estimates from Australia as a guide. We assume that in poorer and smaller households with fewer lamps, the lamps burn much longer on average – for six hours a day in homes with a total of three lamps, three hours a day in homes with a total of nine lamps and 1.5 hours a day in middle income homes with 18 or more lamps (Table 8). Based on a weighted average, lamps installed in sockets in homes in South Africa burn for an average of 2.2 hours per day.

4.4 A detailed analysis of sales of electric lamps via general retailers

[69]Harris, Baran and Hazard[69] (2017) Identify, Assess and Design a market-based economic incentive for energy-efficient appliances in South Africa. Development Associates APS, Denmark.

[70] Statistics South Africa (2018) Statistical Release P0318, General Household Survey 2017.

[71] Residential Lighting Report (2016) Energy Rating Australia. Available at: http://www.energyrating.gov.au/sites/new.energyrating/files/documents/2016-Residential-Lighting-Report-Final.pdf

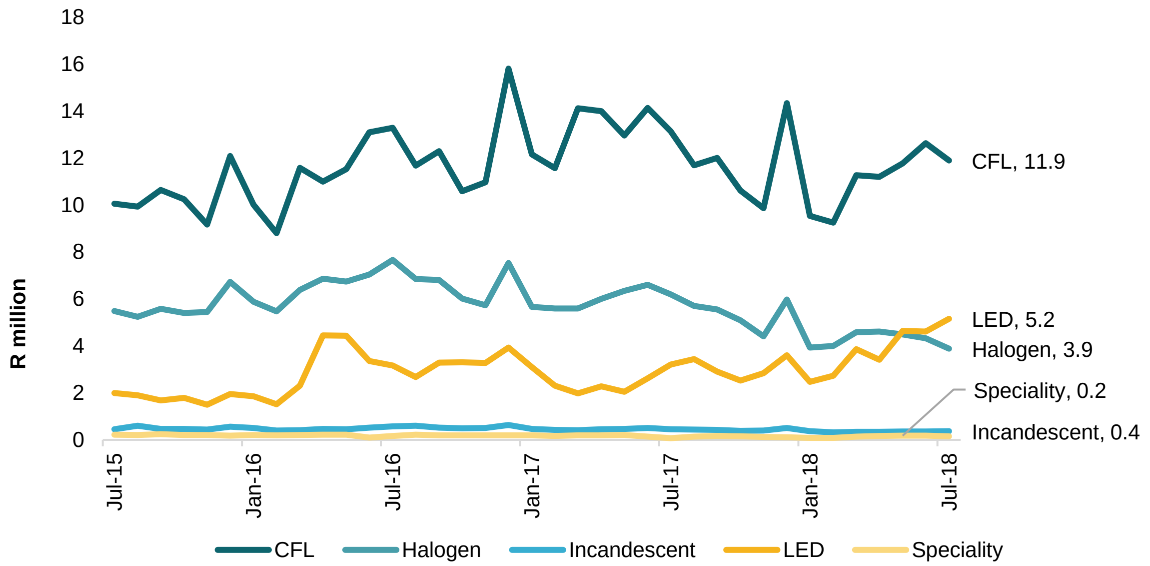
4.4.1 Introduction

The analysis in this section is based on the retail sales data described in 4.2.2. The dataset purchased from Nielsen includes monthly sales of electric lamps over the three-year period from July 2015 to July 2018. The sales data are aggregated from major grocery and general retailers including Shoprite, PnP Group, Woolworths, Spar, Clicks, Dischem, Pep, Boxer, Game. This data represents sales via general retailers which represent 25% of total sales to the residential market and it is only one of the four main channels. Second, the data disaggregate by lamp type for "own brand" name products (for example, the *Pick 'n Pay's* No Name brand).

4.4.2 Analysis of monthly lamp sales by value, volume and technology

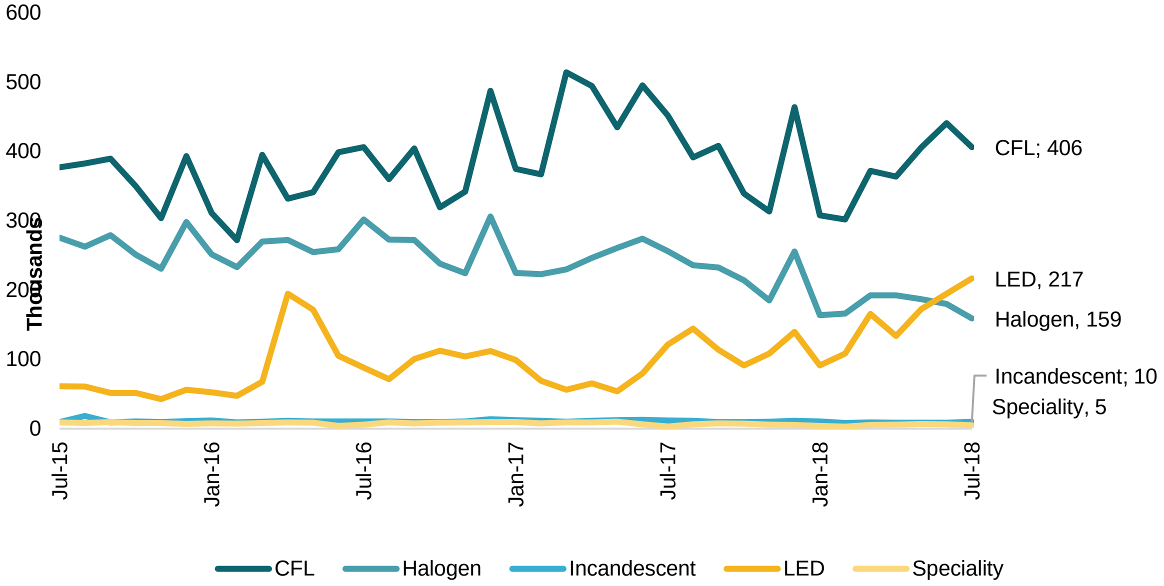
Over the three-year period from July 2015 to July 2018, the value of total retail lamp sales increased by 12.55%, while unit sales declined by 2.78%. The trends in value and volume of lamp sales by technology are shown in Figure 7 and Figure 8 respectively. CFLs were sold in the highest value and volumes throughout the period. For most of the period, halogens exhibited the second-highest sales by both value and volume followed by LEDs the third place. However, in May 2018, LED unit sales overtook those of halogens by value and in June by volume with these trends continuing in the final month of the sales data, July 2018. It is expected that this trend continued beyond July 2018. Comparing the rate of LED adoption in the residential market (Figure 7) with those in the overall market (residential, commercial and industrial) in Figure 5 (Section 4.3.2) it appears that residential consumers have been much slower to adopt LED technology.

Figure 7: Value of monthly sales by technology, July 2015 – July 2018



Source: Own analysis based on Nielsen trade desk dataset

Figure 8: Monthly unit sales by technology, July 2015 – July 2018

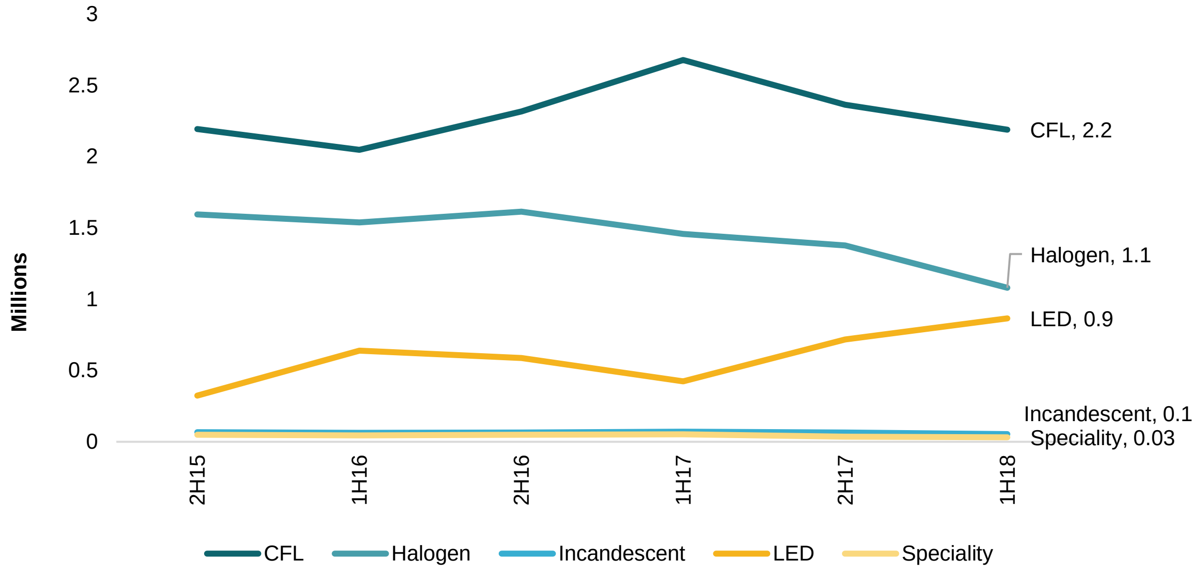


Source: Own analysis based on Nielsen trade desk dataset

While our analysis of the retail sales data shows that LEDs have been gradually displacing sales of CFLs and halogen lamps since about mid-2017, the increase in LED sales both in value and volume is much less marked than what the analysis based on the trade data suggested. Much of the apparent discrepancy can be explained by the fact that the trade data show the import of all LED lamps for general use which includes industrial and commercial use while retail store sales only reflect the trends in the purchases of residential consumers. As has been the experience internationally, we expect much more rapid adoption of LEDs in the commercial and industrial sectors as these segments are better informed than households about the energy-cost savings associated with switching to more energy-efficient technologies. In addition, the import data reflect lamps imported but not necessarily sold, and there is likely to be a lag of several months between imports and sales.

Interestingly, when we smooth out monthly fluctuations by averaging sales volumes per lamp technology on a bi-annual basis it is clear that LED lamps are the only technology category that experienced growth in unit sales between Jan 2017 and July 2018 (Figure 9). Total unit sales by South African retailers doubled from 423,000 to 886,000 units over this 18-month period, while unit sales of CFLs and halogens declined by 18.23% and 25.86%, respectively.

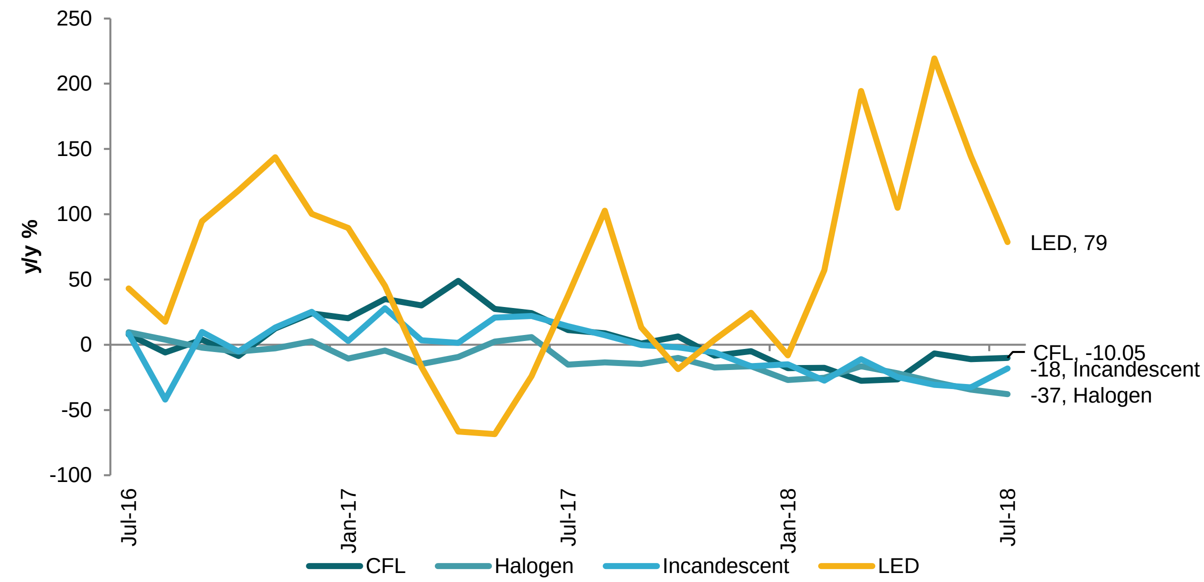
Figure 9: Biannual unit sales by technology, July 2015 – July 2018



Source: Own analysis based on Nielsen trade desk dataset

An analysis of year-on-year growth in monthly unit sales by technology indicates that the sharp growth in unit sales of LED lamps since January 2018 has been at the expense of growth in halogens, incandescent and CFLs, both of which have been contracting on a year-on-year basis since the end of 2017 (Figure 10).

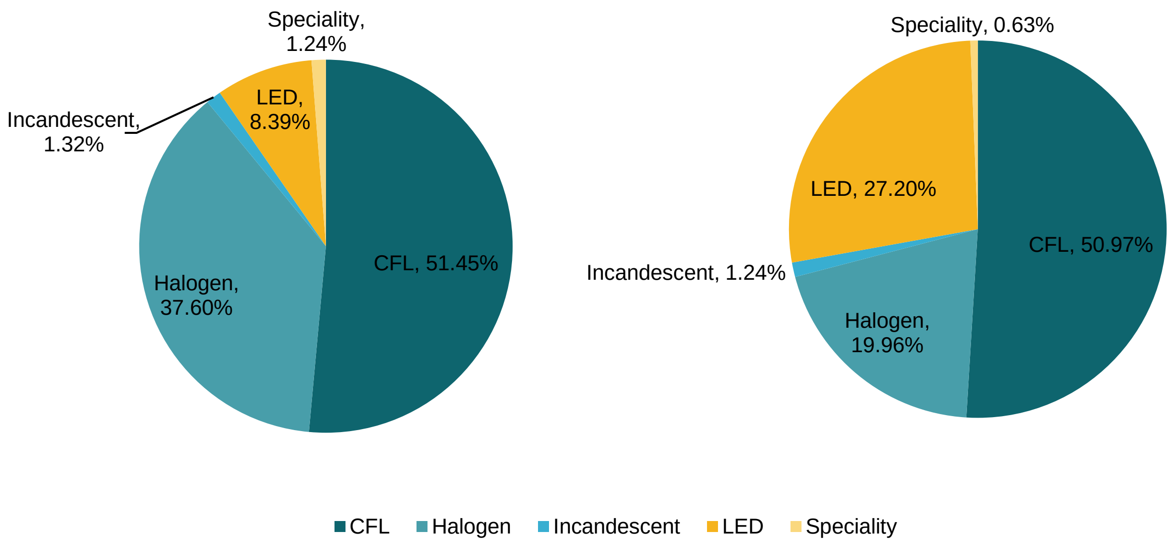
Figure 10: Year-on-year growth in monthly sales by technology, 2016-2018



Source: Own analysis based on Nielsen trade desk dataset

The net impact of the recent growth in LED unit sales is evident when comparing the market share held by each lamp technology in July 2015 with that in July 2018 (Figure 11). While LED sales only comprised 8.4% of total unit sales in July 2015, this had increased to 27.20% by July 2018. It is clear from Figure 11, that the increase in LED sales over this period has largely been at the expense of the halogen lamp. As consumers substituted away from halogens and towards LEDs the market share of halogens declined by almost 18 percentage points in three years.

Figure 11: Composition of total unit sales by technology, July 2015 vs July 2018



Source: Own analysis based on Nielsen trade desk dataset

4.4.3 Trends in lamp prices by technology

Recent strong growth in sales of LED units is likely to have been supported by the steady decline in the absolute and relative price of LED lamps in the two years to July 2018. The average price of LED lamps sold in major retailers fell by 26% in the two years, from an average of R51.50 per lamp in July 2016 to just R37.80 per lamp by July 2018. In addition, LED lamps became cheaper on average than CFLs in January 2017 and became less expensive on average then halogens in October 2017. In fact, by mid-2018 the price of LED lamps had fallen to such an extent that they had become least expensive lighting technology sold, on average, to South African consumers shopping at general retailers.

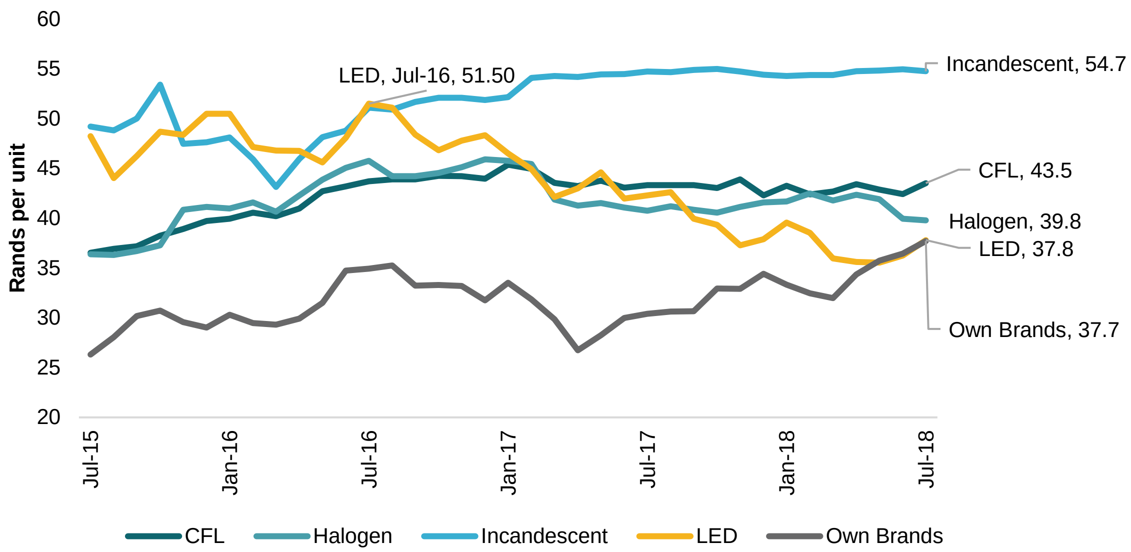
4.4.4 Range of lamp prices by technology

Lamp prices in the Nielsen sample range between R7 and R99 per lamp. The distribution of lamp prices by technology is given for the top 177 branded models of lamp that made up 85% of total sales in our Nielsen trade desk sample in the first half of 2018 (Figure 13).

The cheapest CFL and halogen lamps available were R7 and R10 respectively while the least expensive LED lamp available in the sample of 177 bestselling products was R19. The analysis shows that 75% of LED lamps currently sold in large volumes cost R37 or less while, 75% of CFLs are less than R44. Halogen lamps range in price from R10 to R99 (large 150W reflector lamp or spotlight at the high-end) while LEDs range in price from 19 to R83 and CFLs from R7 to R70. There were only four incandescent lamps in the sample of 177. This is not surprising as from February 2015,

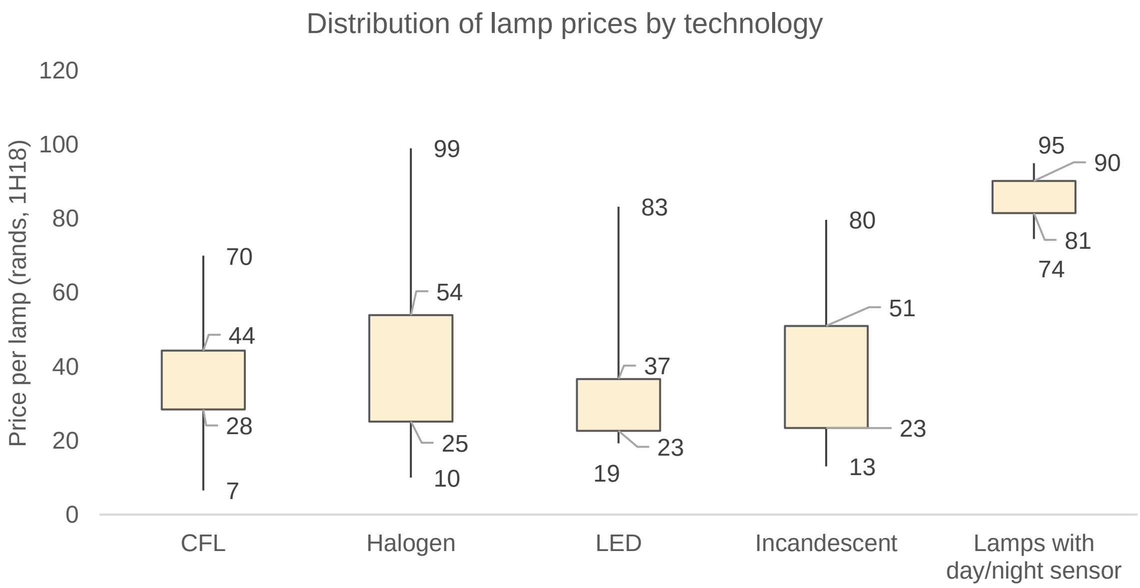
The South African government, in an effort to reduce the use of inefficient lighting, banned most of the traditional incandescent lamps including 40W, 60W, 100W, 150W and 200W globe, candle and golf ball shapes. Incandescent lamps that are still available and excluded from the ban, are special purpose lamps, including rough service lamps, oven lamps, reflector lamps and coloured incandescents. Of the four in this sample, the one that cost R80 is a reflector lamp (or spotlight), there was one oven lamp that cost R41. The other two incandescents in the sample that cost R13 and R27 respectively are relatively unknown brands (Edison and Britolux) and appeared to be regular incandescent lamps of the golf ball shape and thus are possibly supplied illegally. Lamps with a day/night sensor are more expensive on average and fall in a relatively narrow range between R74 and R95.

Figure 12: Trend in average price per unit by technology (monthly)



Source: Own analysis based on Nielsen trade desk dataset[72]

Figure 13: Distribution of lamp prices by technology



Source: Own analysis based on Nielsen trade desk dataset

[72] A limitation of the Nielsen dataset is that the single-largest volume seller of the 178 lamp types in the truncated dataset is "own brands". These are lamps sold by retailers under their own brand name (for example, the Pick n Pay's No Name brand). Nielsen, however, has aggregated several different stores' own brands and lamps into one category, so it was not possible to extract any information on the type or nature of lamps sold in this category other than volume and price.

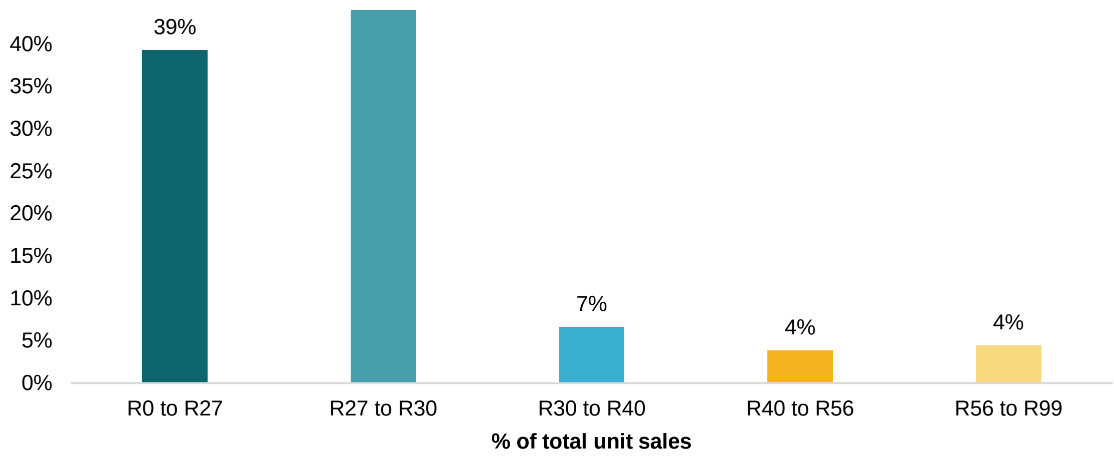
4.4.5 Analysis of lamp sales by price bracket and technology

To further understand the influence of the upfront cost or price of a lamp on sales volumes we analysed total unit sales in the first half of 2018 by price bracket and by technology. We used quintiles as the price brackets -the lowest quintile is R27 meaning that the cheapest 20% (35 of the 177 lamp models analysed) cost less than R27, the next 35 cheapest models cost between R27 and R30 and the next 35 between R30 and R40 and so on.

The data show that the vast majority of LED and halogen lamps sold to consumers cost less than R27 per lamp, while the vast majority of CFLs cost between R27 and R30 (Figure 11). It is not clear why LEDs cost a few Rand less on average than CFLs, but it may be a deliberate strategy to promote switching from historically more popular CFLs to LEDs on the part of suppliers.

Overall the data suggest that consumers strongly prefer lamps that cost less upfront - 85% of all retail lamps sold (by volume and excluding own brands) cost less than R30. Only 8% of the total lamps sold in the first half of 2018 cost more than R40 per unit.

Figure 14: Total retail sales by price quintiles and lamp type six months t 2018 (excl. own brands)
Source: Own analysis based on Nielsen trade desk dataset



% of total sales volumes (the first half of 2018)

Figure 15: Percentage of total retail lamp sales in each price quintile, (R/lamp, the first half of 2018)
Source: Own analysis based on Nielsen trade desk dataset

4.4.6 Analysis of the full lifecycle cost of top-selling 25 lamps by volume

The analysis in the previous section suggest that residential consumers have a strong preference for lamps that have a low upfront cost (i.e. retail price). However, since all electric lamps consume electricity and some technologies are far more energy-efficient than others, the upfront cost of a lamp is often only a fraction of the total overall cost for the lighting service provided. The true cost of a lamp is termed its ‘lifecycle cost’ and this includes the upfront cost of the lamp, the cost of electricity that it will consume and the replacement cost over a given assessment period (usually assessed for fair comparison as 4 hours a day over five years or 7,000 hours)

International evidence shows that residential consumers do not generally consider the expected lifetime or lifecycle costs when making purchasing decisions about lighting. In a recent survey conducted in nine countries[73] LEDVANCE found that only a third of respondents could correctly identify the most important measurements to consider when purchasing a lamp and only around 50% knew what Lumens or Kelvins were.[74] As a result , the European regulator has decided to use the terms warm white (2,200 to 3,500K) , neutral white (3,500 to 4,500K) and cool white (4,500 to 6,500K) to describe lamp colour temperature (Kelvin) but has kept the lumen measure[75]. Moreover, the LEDVANCE survey found that 66% of consumers had at some time purchased the incorrect lamp despite intending to purchase a “smart” LED lamp.

This points to a market failure in the household lighting market caused by “imperfect information”. While there is an increasingly wide variety of lighting products and technologies available, consumers cannot easily compare the lifetime costs or assess the quality and performance of the different lamp technologies. This means that they often make a poor choice based largely on the purchase price of the product. As a result, many consumers are losing out on substantial life-cycle cost savings from both electricity and replacement lamp savings. To assess the extent to which the phenomenon of imperfect information is present in the South African market for household lighting, we estimated the full lifecycle costs of the 177 bestselling lamps and then analysed the sales by volume. The methodology used to estimate the lifecycle cost of each lamp is outlined in Figure 16.

Figure 16: Calculating the lifecycle cost of a lamp

Calculation and example
Life-cycle cost = Costs of lamps + Cost of electricity + Replacement cost Cost of lamps: The cost of the expected number of lamps required over the assessment period Cost of electricity: The cost of electricity consumed by the lamp over the assessment period Assessment period = 7000 hours (based on assumed use of roughly 4 hours a day for 4.8 years) Electricity price* = R2.55 per kWh For example, for a 12-Watt lamp with a price of R20.00 and an expected lifetime of 2,000 hours the LCC would be: Cost of lamps = Expected number of lamps** x Price of a single lamp = (7,000 / 2,000) x 20.00 = R70.00 Cost of electricity = Lamp Wattage x Assessment period x Electricity price. = 12 x 7,000 x 0.00255 = R214.20 Life-cycle cost = R284.20 *Notes:* ** Based on the City of Cape Town electricity tariff for monthly consumption exceeding 600 kWh* *** Not rounded up to avoid lamps with expected lifetimes close to the assessment period are not penalised excessively with replacement cost*

Unit sales for the top 25 electric lamps that were sold (by volume) in major retailers in the first half of 2018 are presented in Table 9. These 25 products constituted 81% of total sales in the six-month period.

[73] Germany, Great Britain, France, Italy Sweden, USA, China, Canada and Brazil.

[74] Ledvance. 2017. *International consumer survey: what do consumers know about light*? Available: https://www.ledvance.com/news-and-stories/stories/international-consumer-study/index.jsp [2018, March 20]

[75] Michael Scholand (CLASP), in interview with the authors, March 2019.

The single largest category was retailer's own brands, which made up 23% of the total volumes sold in this period.

The Osram 70W and 42W Eco halogen lamps were the single-largest sellers among the 177 branded products that sold in the first half of 2018. Together they accounted for 14% of total sales. It is also worth noting that they are inexpensive on a first-cost basis at R20 a lamp but are among the least energy-efficient lamps in the sample, costing R1 470 and R910 to operate over 7 000 hours (roughly five years). CFLs dominate the top 25 bestsellers list, taking 15 places (54% of sales volumes excl. own brands). Halogen lamps take 5 spots on the list (32% of volume).

While we recognise that it may reflect the product offering from the sample of stores represented in the Nielsen data, there are only four LED lamps among the 24 branded bestsellers, all of which are Eurolux brands. LEDs only accounted for 13% of volumes even though they all have the lowest life-cycle costs (less than R132 over 7 000 hours).

The analysis confirms that consumers continue to make poor choices, they do not appear to understand the technical factors that contribute to the implicit lifecycle costs of electric lamps and as such do not factor these into their decisions and purchase mainly based on upfront price and historical technology preference.

Table 9: LCC calculation for the Top 25 selling lamps, sorted by sales volume in the first half of 2018

	Item	Watt	Lifetime	Type	Efficacy (lm/W)	Ave. Price	Life Cycle Cost	% of total volume	Cum. % sales volume
1	OWN BRANDS (RETAILER)	n/a	n/a	None	14	32		29%	29%
2	OSRAM GLOBE 70W BC ECO 1S	70	2 000	Halogen	53	20	1470	9%	38%
3	OSRAM GLOBE 42W BC ECO 1S	42	2 000	Halogen	40	20	910	8%	47%
4	OSRAM ENERGY SAVER 15W BC WW	15	8 000	CFL	56	28	325	7%	54%
5	OSRAM 3U BC 15W CFL CW 1 S	15	8 000	CFL	55	28	325	7%	61%
6	EUROLUX 6W LED A60 B22_480L	6	15 000	LED	54	21	131	5%	65%
7	OSRAM 11W BC C/W E/SAVER HAL	11	8 000	CFL	53	28	246	4%	69%
8	PHILIPS PH11W BC GEN WW CFL 1 S	11	8 000	CFL	53	28	245	3%	72%
9	PHILIPS GENIE 14W WW BC S 1 S	14	10 000	CFL	54	28	300	3%	74%
10	PHILIPS GENIE 11W CW SES 1 S	11	10 000	CFL	14	28	240	2%	77%
11	PHILIPS PH 11W BC GENIE CW 1 S	11	10 000	CFL	55	29	240	2%	79%
12	OSRAM GLOBE 70W ES ECO 1S	70	2 000	Halogen	54	20	1471	2%	81%
13	PHILIPS GENIE14W CW BC 1 S	14	10 000	CFL	53	28	300	2%	84%
14	EUROLUX A60 LED 6W BC G641BC 1 S	6	15 000	LED	85	21	130	2%	86%
15	OSRAM GLOBE 42W ES ECO 1S	42	2 000	Halogen	53	20	911	2%	88%
16	PHILIPS 11W WW ES SINGLE 1 S	11	10 000	CFL	14	29	240	2%	89%
17	PHILIPS PH 14W ES GENIE WWBX 1 S	14	10 000	CFL	53	28	300	1%	91%
18	PHILIPS GENIE 14W CW ES 1 S	14	10 000	CFL	53	28	300	1%	92%
19	OSRAM ENERGY SAVER 15W ES CW	15	8 000	CFL	60	28	326	1%	94%
20	EUROLUX A60 LED 6W ES G641ES 1 S	6	15 000	LED	50	21	130	1%	95%
21	EUROLUX ENERGY SAVER GU 10 6 S	6	25 000	LED	53	38	131	1%	96%
22	OSRAM 15W ENERGY SAVE ES	15	8 000	CFL	16	28	325	1%	97%
23	BONUS 42WATT EDISON SCREW ECO	42	2 000	Halogen	56	27	936	1%	98%
24	OSRAM ENERGY SAVER 15W ES WW	15	8 000	CFL	80	28	325	1%	99%
25	PHILIPS GENIE 11W WW SES 1 S	11	10 000	CFL	54	28	240	1%	100%

4.4.7 Analysis of market share by lamp brightness in lumens

We also analysed the market shares of total lamp volumes sold in major retailers to understand consumer preferences for lamp brightness which is measured in lumens (Figure 17 and Figure 18). In the past consumers would have purchased a standard incandescent lamp of around 60W for household use and this gives a brightness in lumens of around 700+. An LED that creates equivalent brightness will use about 10W.

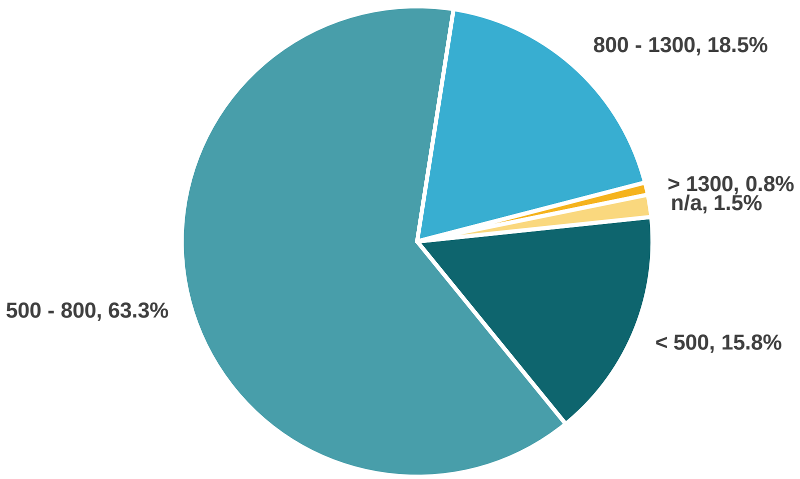
The retail store data suggest that consumers continue to prefer lamps with brightness of between 500 – 800 lumens as these accounted for almost two-thirds of total sales in the first half of 2018 (63%). The second most popular category in terms of brightness was were lamps in the 800 to 1 300 lumen range. The average life-cycle cost of lamps increases with brightness as the wattages also increase.

Figure 17: Wattage required to generate given brightness in lumens for each technology

BRIGHTNESS IN LUMENS	220+	400+	700+	900+	1300+
ICL	25W	40W	60W	75W	100W
HALOGEN	18W	28W	42W	53W	70W
CFL	6W	9W	12W	15W	20W
LED	3W	5W	7W	9W	12W

Source: Nerd Power

Figure 18: Category of brightness measured in range of lumens, unit sales data for the first half of 2018



4.4.8 Analysis of the full lifecycle cost of lamps in 500 to 800 lumen range

Table 10: Volumes of lamps sold (500 – 800 lm) in the first half of 2018

Sales Rank	Manufacturer and Lamp	Wattage	Lifetime	Lumens	Type	Efficacy (lm/W)	Average Price (June 2018)	Life Cycle Cost (LCC)	LCC rank	% of total volume	Cumulative % of total sales
1	Osram Globe 42w BC Eco 1 S	42	2 000	580	Halogen	14	20	910	10	15%	15%
2	Osram Energy Saver 15w BC WW 1 S	15	8 000	800	CFL	53	28	325	15	13%	27%
3	Osram 3u BC 15w CFL CW 1 S	15	8 000	600	CFL	40	28	325	15	11%	39%
4	Osram 11w BC C/W E/Saver Hal 10s	11	8 000	620	CFL	56	28	246	33	6%	45%
5	Philips Ph11w BC Gen WW CFL 1 S	11	8 000	600	CFL	55	28	245	37	5%	50%
6	Philips Genie 14w WW BC S 1 S	14	10 000	760	CFL	54	28	300	21	5%	55%
7	Philips Genie 11w CW SES 1 S	11	10 000	580	CFL	53	28	240	38	4%	59%
8	Philips Ph 11w BC Genie CW 1 S	11	10 000	580	CFL	53	29	240	38	4%	63%
9	Philips Genie14w CW BC 1 S	14	10 000	760	CFL	54	28	300	21	4%	67%
10	Osram Globe 42w ES Eco 1 S	42	2 000	580	Halogen	14	20	911	9	4%	70%
11	Philips 11w WW ES Single 1 S	11	10 000	600	CFL	55	29	240	38	3%	73%
12	Philips Genie 14w CW ES 1 S	14	10 000	760	CFL	54	28	300	21	2%	75%
13	Osram Energy Saver 15w ES CW 1 S	15	8 000	800	CFL	53	28	326	14	2%	78%
14	Eurolux Energy Saver Gu 10 6 S	6	25 000	510	LED	85	38	131	47	2%	80%
15	Osram 15w Energy Save ES Coolwht Imp 1 S	15	8 000	800	CFL	53	28	325	15	2%	81%
16	Bonus 42watt Edison Screw Eco Halog 1 S	42	2 000	590	Halogen	14	27	936	6	2%	83%
17	Osram Energy Saver 15w ES WW 1 S	15	8 000	800	CFL	53	28	325	15	2%	85%
18	Philips Genie 11w WW SES 1 S	11	10 000	580	CFL	53	28	240	38	2%	86%
19	Philips 11w E/Saver White BC Amb Globe	11	8 000	660	CFL	60	36	252	32	1%	88%
20	Supalux E/Saver 11w BC 1ea	11	6 000	550	CFL	50	32	259	31	1%	89%
21	Bonus 14w GlobES ESl BC WW 1 S	14	8 000	740	CFL	53	7	286	24	1%	90%
22	Lumaglo Dichroic Globe 50w 1 S	50	4 000	775	Halogen	16	20	1037	3	1%	91%
23	Osram 11w ES W Energy Saver 1 S	11	8 000	620	CFL	56	29	246	33	1%	92%
24	Lumaglo Globe 10w BC Led WW 1 S	10	25 000	800	LED	80	23	207	44	1%	93%
25	Bonus GlobES ESl BC CW 11w 1 S	11	8 000	590	CFL	54	9	228	43	1%	94%
26	Eurolux 42w Halogen BC G559 1 S	42	2 000	630	Halogen	15	35	964	4	1%	94%
27	Osram Energy Saver Cool White 11w ES 1 S	11	8 000	620	CFL	56	28	246	33	0%	95%
28	Eurolux -E/Saver 15w ES Globe 1 S	15	6 000	800	CFL	53	40	347	13	0%	95%
29	Philips Eco Globe 42w BC Bli 1 S	42	2 000	526	Halogen	13	69	1082	1	0%	96%
30	Eveready 11w Energy Lamp 1 S	11	6 000	570	CFL	52	42	271	27	0%	96%
31	Lumaglo Globe 10w ES Led WW 1 S	10	25 000	800	LED	80	23	207	44	0%	97%
32	Bonus 11w GlobES ESl BC WW 1 S	11	8 000	590	CFL	54	16	235	42	0%	97%
33	Redisson Energy Saver 8w 1 S	8	25 000	630	LED	79	23	167	46	0%	97%
34	Philips Eco Globe 42w ES Bli 1 S	42	2 000	526	Halogen	13	69	1082	1	0%	98%
35	Philips Eco Classic 42w BC 1 S	42	2 000	630	Halogen	15	26	930	7	0%	98%
36	Eurolux 42w Halogen E27 G560 1 S	42	2 000	630	Halogen	15	29	941	5	0%	98%
37	Bonus 14w GlobES ESl BC CW 1 S	14	8 000	740	CFL	53	39	315	20	0%	98%
38	Eveready 11w Energy Lamp 1 S	11	6 000	570	CFL	52	42	271	27	0%	99%
39	Eurolux Energy Saving 15w BC WW 1 S	15	6 000	800	CFL	53	44	353	11	0%	99%
40	Energy Saver 12w Es Spiral 1 S	12	10 000	650	CFL	54	58	281	25	0%	99%
41	Philips Led Spot Gu10 3.5w 3 1 S	3.5	15 000	545	LED	156	20	80	48	0%	99%
42	Osram Energy Saver 15w BC 3s	15	8 000	800	CFL	53	23	321	19	0%	99%
43	Energy Saver 12w BC Spiral 1 S	12	10 000	650	CFL	54	58	281	25	0%	99%
44	Eurolux E Saving 11w B22 WW 1 S	11	6 000	550	CFL	50	39	266	30	0%	99%
45	Philips Eco Classic Halogen 42w ES 1 S	42	2 000	630	Halogen	15	25	929	8	0%	99%
46	Eurolux Energy Saving 15w E27 WW 1 S	15	6 000	800	CFL	53	44	353	11	0%	100%
47	Energy Saver 11w ES Osram WW 1 S	11	8 000	600	CFL	55	28	246	33	0%	100%
…	Eurolux E Saving 11w E27 WW 1 S	11	6 000	550	CFL	50	40	268	29	0%	100%

We also analysed unit sales for lamps of brightness between (500 and 800 lumens), which as discussed in the previous section, is the most popular category of brightness (Table 10). Lamps sold in the largest volumes are relatively inexpensive CFLs and halogens. The lamp with the highest sales

accounting for 15% of total sales in this category of brightness - is one of the least expensive lamps in terms of its upfront purchase price of R20 but has a very high lifecycle costs as it is estimated to cost R910 to operate over a five-year (7 000 hour) period.

These data show that 77% of total volume of lamps sold in the 500 to 800 lm brightness category cost less than R30. Consumers still appear to choose CFLs and halogens over similarly priced LEDs. Consumers generally don't buy lamps that cost more than R40 upfront – lamps with a price of greater than R40 account for less than 3% of total sales volumes in the first half of 2018.

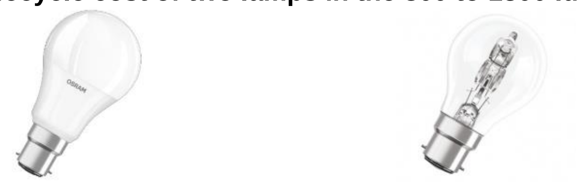
An example of a lamp that is very energy-efficient but only ranked 14 is the Eurolux energy saver. This lamp is sold in a 6-pack and costs R36 per lamp, but its long life (25 000 hours) means that its life-cycle cost for 5 years is only R131 (Table 10). This analysis confirms that consumers base their purchasing decisions chiefly on the upfront cost of the lamp and as such may make poor choices because of insufficient awareness, understanding or information about the full life-cycle cost.

4.4.9 Analysis of the full lifecycle cost of lamps in 800 to 1 300 lumen range

We produced a similar analysis for lamps in the 800 to 1 300 lumens category (Table 11). More than half the sales (65%) in this category were of two Osram halogen lamps that have the highest lifecycle cost of any lamp in this category – that is they are the among the most expensive lamps in the category to use when electricity and replacement costs are factored in.

While each Osram halogen lamp costs only R20 to purchase, it will cost the consumer ~R1 470 to run this lamp for four hours a day for five years. The Osram LED equivalent (no.13 on the list) by comparison will cost twice as much upfront (R35 a lamp) but costs only R178 to run over five years – essentially 12% of the cost (Figure 19). Ultimately these data show that consumers purchase lamps largely based on upfront cost (low price) and familiarity with and may inadvertently choose energy inefficient lamps, some of which have the highest lifecycle cost.

Figure 19: Comparison of the lifecycle cost of two lamps in the 800 to 1300 lumen range



	Energy Saver 8W BC Osram **LED**	Osram Globe 70w Bc Eco **Halogen**
Price	R35	R20
Life cycle cost Based on 7,000 hours of use	**R178**	**R1,470**
Wattage	8 W	70 W
Lumens	806 lm	1,172 lm
% lamps sold by volume (800 to 1300 lm) in 1H18	**1%**	**52%**

Table 11: Volumes of lamps sold (800 – 1300 lm) in the first half of 2018

Sales Rank	Manufacturer and Lamp	Wattage	Lifetime	Lumens	Type	Efficacy (lm/W)	AvPrice June 2018	Life Cycle Cost	LCC rank	% of total volume	Cumulative % of total sales
1	Osram Globe 70w Bc Eco 1 S	70	2000	1172	Halogen	14	20	1470	6	52%	52%
2	Osram Globe 70w Es Eco 1 S	70	2000	1172	Halogen	53	20	1471	5	13%	65%
3	Philips Ph 14w Es Genie Wwbx 1 S	14	10000	810	CFL	40	28	300	34	8%	74%
4	Globe Led 9w Bc Cw Lumaglo Econo 1 S	9	10000	900	LED	56	22	196	36	2%	76%
5	Bonus Lamp Eco Hal Bc 70w 1 S	70	2000	970	Halogen	55	28	1498	4	2%	78%
6	Osram 14w Energy Saver Bc Box 1 S	14	8000	827	CFL	54	30	307	32	2%	79%
7	Philips Eco Globe 70w Bc Bli 1 S	70	2000	1070	Halogen	53	74	1660	1	2%	81%
8	Flash 11v E/Saver Globe 1 S	20	8000	1150	CFL	53	33	430	16	1%	82%
9	Flash 15v E/Saver Globe 1 S	20	8000	1150	CFL	54	42	438	15	1%	83%
10	Osram 14w Energy Saver Bc Cw 1 S	14	8000	827	CFL	14	32	309	30	1%	84%
11	Bonus Lamp Eco Hal Es 70w 1 S	70	2000	970	Halogen	55	28	1499	3	1%	85%
12	Phillips Ph 50w 12v Dic Hal2p 1 S	50	2000	1200	Halogen	54	52	1183	7	1%	86%
13	Energy Saver 8w Bc Osram Ww 1 S	8	15000	806	LED	85	35	178	38	1%	88%
14	Globe Led 9w Es Cw Lumaglo Econo 1 S	9	10000	900	LED	53	23	196	36	1%	89%
15	Bonus 18w Globes Esl Bc Ww 1 S	18	8000	1000	CFL	14	49	404	19	1%	90%
16	Eurolux 20w Cfl 3u Bc 1 S	20	6000	1155	CFL	53	45	454	11	1%	90%
17	Philips Eco Globe 70w Es Bli 1 S	70	2000	1070	Halogen	53	74	1659	2	1%	91%
18	Bonus 18w Globes Esl Bc Cw 1 S	18	8000	1000	CFL	60	49	404	19	1%	92%
19	Eurolux 16w Coolwhite 2d Tube 1 S	16	8000	1030	CFL	50	69	382	22	1%	93%
20	Energy Saver 8w Es Osram Ww 1 S	8	15000	806	LED	53	35	178	38	1%	93%
21	Eurolux 20w Energy Saving Globe-Bc 1 S	20	6000	1155	CFL	16	45	454	11	1%	94%
22	Osram Energy Saver 8w Bc Ww 1 S	8	15000	806	LED	56	35	178	38	1%	94%
23	Osram Cla60 9.5w Warm White Bc	10	15000	806	LED	80	49	214	35	1%	95%
24	Reddison Energy Saver 18wbc 1 S	18	8000	1070	CFL	54	22	380	23	1%	96%
25	Osram Energy Saver 18w Es Spiral 1 S	18	8000	900	CFL	15	43	399	21	1%	96%
26	Eveready 15w Screw Esl Tube 1 S	15	8000	810	CFL	56	43	338	24	0%	97%
27	Osram 14w Energy Saver Es Cw 1 S	14	8000	827	CFL	53	32	309	30	0%	97%
28	Flash 11v E/Saver Globe 1 S	20	8000	1150	CFL	13	31	428	17	0%	97%
29	Osram 15w Cfl 3u Bc Cw 1 S	15	8000	900	CFL	52	35	332	27	0%	98%
30	Eurolux 20w Energy Saving Globe-Es 1 S	20	6000	1155	CFL	54	46	456	10	0%	98%
31	Osram Energy Saver Globe 1 S	15	8000	900	CFL	79	32	328	28	0%	98%
32	Osram 20w Energy Star B22 1 S	20	8000	1180	CFL	13	63	457	9	0%	99%
33	Philips Ph 50w 12v Dic Hal 5p 1 S	50	2000	1200	Halogen	15	17	1061	8	0%	99%
34	Osram 14w Energy Saver Bc Ww 1 S	14	8000	827	CFL	15	30	307	32	0%	99%
35	Eurolux -E/Saver R38 Reflector Globe 1 S	14	15000	920	LED	52	83	322	29	0%	99%
36	Ellies 20w M Spiral E27cool Lamp 1 S	20	8000	1150	CFL	53	30	427	18	0%	99%
37	Philips Ph 20w Es Tornado Ww 1 S	20	8000	1200	CFL	54	50	445	13	0%	99%
38	Philips Ph 20w Bc Tornado Ww 1 S	20	8000	1200	CFL	156	48	443	14	0%	99%
39	Energy Saving Lamps 15w Bc	15	8000	900	CFL	53	40	336	25	0%	99%
40	Energy Saving Lamps 15e Es	15	8000	900	CFL	54	40	336	25	0%	99%

4.4.10 Analysis of the luminous efficacy (energy-efficiency) of lamps sold

The overarching aim of introduction the proposed MEPS for lighting is reduce electricity consumption in the residential sector by promoting the uptake and use of more energy-efficiency lighting products. And a secondary objective is to remove inferior products to improve the safety and quality of lighting.

An analysis of the luminous efficacy of lamps sold, provides a link to the minimum energy-efficiency requirements that are set in MEPS. Luminous efficacy (η_v or Φ_v), expressed in lm/W, is the quotient of the luminous flux emitted by the power consumed by the source. It measures how energy-efficient a lamp is and is also one of the main indicators of quality.

We use two thresholds of luminous efficacy in our analysis of the 177 brands of lamps sold across general retailers, each corresponding with the time-bound limits promulgated in the proposed MEPS regulation (Table 12). Specifically, we used the minimum energy-efficiency requirements that were initially proposed in the draft MEPS regulations. The first phase becomes effective in the first year and was to impose a limit of 80 lm/W (subsequently adjusted higher to 90lm/W) with limits adjusted even lower for certain technologies by stipulated correction factors (C) summarised in Table 13.

The second tier introduces more stringent limits on minimum efficacy (plus correction factors), and is expected to become effective two years after MEPs is introduced – the base level was proposed at 95 lm/W (but was adjusted higher subsequent to the analysis to 105lm/W). Lamps in the scope of this proposed technology-neutral MEPS for lighting will thus have energy efficiency requirements (set out as minimum efficacy in lm/W) (Table 12 and Table 13) .

Table 12: Proposed technology-neutral MEPS energy efficiency requirements

Product Type	Minimum efficacy (lm/W) Tier 1	Minimum efficacy (lm/W) Tier 2
Non-directional lamp	80	95

Table 13: Proposed technology-neutral MEPS correction factors by lamp type

Lamp Characteristics	C
Directional lamps	-15%
Compact Fluorescent Lamp (CFL)	-20%
Colour-tuneable lamps (CTL)	-10%
Connected LED Lamps – rated luminous flux Φ (lm)	
60 lm ≤ Φ ≤ 300 lm	-15%
300 lm < Φ ≤ 650 lm	-10%
650 lm < Φ ≤ 1200 lm	-7.5%
1200 lm < Φ ≤ 2000 lm	-5%
2000 lm < Φ ≤ 3300 lm	-2.5%

The analysis in Table 14 shows that 16% of the total electric lamps units that were sold in the first half of 2018 would have met the minimum criteria for energy-efficiency that will become effective in 2020 under MEP (14% of sales only meet the 2020 requirements while a further 2% of sales that would also meet the 2023 requirement). Only 2% of the total volumes electric lamps sold in the first half of 2018 would have met the stricter energy-efficiency criteria to be introduced in 2023 (or three years after regulation is effective).

While incandescent lamps are already banned (with few exceptions mentioned above), MEPS effectively also removes halogen, and CFL lamps from the market. There are no halogens or self-ballasted CFLs among the 177 branded products sold that would meet the minimum criteria for luminous flux in tier 2, even if the less stringent criteria in imposed in 2020 (Tier 1). The 20% correction factor for CFLs was designed to allow them to remain on the market for Tier 1 (2020), as 80 x 0.80 = 64 lm/W which is a reasonable efficacy for a CFL. But since MEPS only covers the self-ballasted CFLs and there are no self-ballasted CFLs that meet even the more lenient MEPS criteria for efficacy, no self-ballasted CFLs will meet the requirement for Tier 2 (2023), as 95 x 0.80 = 76 lm/W which is higher than the efficacy that a CFL can achieve, thus this technology would be eliminated from the market. That step – eliminating CFLs is in keeping with the European regulation which is phasing out CFLs in 2021 and would have the added benefit of removing a mercury-based lamp from South African homes and potentially landfills (at end of life). And is in line with South Africa's (Department of Environment and Forestry) recent ratification of the Minamata Convention, an international treaty designed to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds.

While most of the LED lamp models and volumes that sold in the first half of 2018 meet the adjusted criteria in 2020 (41 of the 44 models that were sold), only 16 of the 44 models will still quality if the stricter criteria come into effect, as proposed, in 2023.

Table 14: Percentage of total lamp units that were sold in the first half of 2018 that would have met the minimum energy-efficiency requirements in lm/W stipulated in MEPS

	No MEPS	2020 lm/W >80 *	2023 lm/W >95 *	Total %
CFL	52	0	0	52
LED	0	14	2	16
Halogen	30	0	0	30
Incandescent	1	0	0	1
Speciality	1	0	0	1
Total	84	14	2	**100**

* Correction factors which allow for greater leniency in the criteria by lamp type have been applied (e.g. for CFLs lm/W can be 20% lower)

Table 15: Number of current lamp models (out of total of 177 branded products sold) that will meet MEPS minimum lm/W

	No MEPS	2020 lm/W >80 *	2023 lm/W >95 *	Total	% that meet criteria in 2023
CFL	81	0	0	81	0%
LED	3	25	16	44	36%
Halogen	43	0	0	43	0%
Incandescent	4	0	0	4	0%
Speciality	2	0	0	2	0%
Total	133	26	18	**177**	

To understand consumer demand for lamps based on their luminous efficacy, we examined which lamps sold in the first half of 2018 had the highest luminous efficacy and compared these with their market share.

These data show that the ten lamps (of a total of 177) that have the highest calculated efficacy (lm/W), contributed ~1% to total sales volumes in the first half of 2018. Of the 20 most energy-efficient lamps, 19 are LED models. There is one linear fluorescent lamp (LFL) lamp in 20 most efficient lamps, a 36Wtube, costing R38. Overall these data suggest consumers do not weight the energy-efficiency of a lamp very highly in their purchase decisions as the most efficient lamps available do not contribute significantly to total sales. This may be because of a lack of readily available information on the relative energy-efficiency of a lamp and the impact on overall lifecycle costs.

Table 16: Lamps with highest efficacy in lm/W vs. contribution to sales in the first half of 2018

	ITEM	Wattage	Lifetime	Lumens	Type	Efficacy (lm/W)	Efficacy grade	AvPrice June 2018	% of total unit sales in June 2018
1	PHILIPS LED SPOT GU10 3.5W 3 1 S	3.5	15000	545	LED	156	2	20	0.0
2	EUROLUX R50 PLAS LED 2.4W G909 1S	2.4	15000	350	LED	146	2	20	0.2
3	PHILLIPS GLOBE 60W ES 1 S	6.5	20000	800	LED	123	2	28	0.0
4	LUMAGLO 4W LED CANDLE GLOBE CW BC 1S	4	15000	470	LED	118	2	28	0.3
5	LUMAGLO DICHROIC LED GLOBE 4W MR16 1S	4	25000	440	LED	110	2	21	0.1
6	ENERGY SAVER 8W BC OSRAM WW 1S	8	15000	806	LED	101	2	28	0.4
7	ENERGY SAVER 8W ES OSRAM WW 1 S	8	15000	806	LED	101	2	29	0.2
8	OSRAM ENERGY SAVER 8W BC WW 1S	8	15000	806	LED	101	2	20	0.1
9	GLOBE LED 9W BC CW LUMAGLO ECONO 1S	9	10000	900	LED	100	2	28	0.0
10	GLOBE LED 9W ES CW LUMAGLO ECONO 1S	9	10000	900	LED	100	2	21	0.0
11	EUROLUX GLOBE 5W LED BC CW G844 1S	5	15000	500	LED	100	2	20	0.0
12	EUROLUX GLOBE 5W LED ES CW G843 1S	5	15000	500	LED	100	2	29	-
13	LUMAGLO GLOBE CLA LED 5W CW 1S	5	15000	480	LED	96	2	28	0.1
14	LUMAGLO GLOBE CLA LED 5W WW 1S	5	15000	480	LED	96	2	28	0.2
15	LUMAGLO GLOBE CLA LED 5W ES CW 1S	5	15000	480	LED	96	2	28	0.0
16	OPPLE ENERGY SAVER BULB 20W B22 0 1S	20	20000	1800	LED	90	1	21	1.2
17	EUROLUX 36W 1.2M FLOURESCENT 1 S	36	15000	3200	LFL	89	2	38	0.1
18	PHILIPS PH 50W 240V GU10 DIC GLOBES 5 S	4.6	15000	395	LED	86	2	28	0.1
19	EUROLUX ENERGY SAVER GU 10 6 S	6	25000	510	LED	85	1	27	4.9
20	LUMAGLO DICHROIC LED GLOBE 4W GU10 1S	4	6000	340	LED	85	1	28	2.3

4.5 Market analysis – key findings

The trade data provide detail on the type and value of electric lamps imported into South Africa for general use, defined as use in residential, commercial and industrial applications. Given that there is no significant local manufacturer of electric lamps in South Africa, net annual imports provide a good proxy for total sales in the market. The key findings of the trade data analysis presented in this chapter may be summarised as follows:

- The total value of electric lamps imported into South Africa in 2018 was $94 million while the total value of re-exports (mostly into African nations) was $17 million (Figure 1).
- The bulk of South Africa's lamps come from China, who imported USD 67 million, constituting approximately 71% of the total value of imports, followed by Germany (US$8 million, which represents 8.5% of the total value of imports) and Poland (USD 3%, which represents around 3% of the total value of imports).
- Total imports of lamps for general use have consistently increased since 2014. As at 2018, the total market is valued at US$67 million.
- The value of LEDs imported for general use has increased exponentially since 2016, largely displacing the value of sales of CFL and Halogen lamps. The value of sales of CFL and Halogen lamps have contracted year-on-year since 2017.

The Nielsen data facilitate between insights into the residential market for lighting, though the data are only representative of one supply channel in the residential market, namely, retailers who supply approximately 23% of electric lamps in the domestic market. The major findings of the residential market analysis are summarized as follows:

- The value of LED sales overtook those of halogens in May 2018, but CFLs - or what South Africans consider to be ‘energy saving lamps’ - are still the most popular.
- There has been a sharp growth in unit sales of LED lamps since January 2018, which has been at the expense of growth in halogens. Incandescent and CFLs have both been contracting on a year-on-year basis since the end of 2017.
- LED lamps have become less expensive relative to other technologies over the past 3 years which has undoubtedly assisted in driving more rapid uptake.
- Consumers continue to make poor choices. They purchase lamps largely based on upfront cost (low price) and inadvertently choose energy inefficient lamps, some of which have the highest lifecycle cost.
- MEPS effectively removes halogen and CFL lamps from the market, while placing quality and performance requirements on the LED lamps that will remain in the market. There are no incandescent or halogens among sales of the 177 branded products analysed that would meet the minimum criteria for luminous efficacy, even the less stringent criteria in imposed in 2020. Only a very small proportion of CFL models (3 out of a total of 84) sold in the first half of 2018 met the adjusted criteria for 2020 and none of these three are self-ballasted CFLs so they don’t fall within the scope of the regulation. There are self-ballasted CFLs that could meet the more lenient minimum luminous efficacy level of 64 lm/W that would be applied from 2002 but none among the 84 products that were sold in the first half of 2018.
- Only 16% of the total electric lamps units that were sold in retailers in the first half of 2018 would meet the minimum criteria for energy-efficiency that will be effective in 2020 if MEPS is introduced, and these are almost exclusively LEDs. Only 2% of the total volumes electric lamps sold in the first half of 2018 would have met the even stricter criteria that will be imposed under MEPS from 2023.

5. Stakeholder Consultation

5.1 Introduction

The recommendations provided in this report incorporate insights from a thorough process of stakeholder engagement. The NRCS initiated the formal stakeholder engagement process for the introduction of the proposed technology-neutral MEPS for lighting by holding the first meeting with key Stakeholders on the 28th of October 2018. This meeting was then followed by a working group meeting convened by NRCS in December 2018, where the initial proposed draft regulation and risk assessment were discussed.

In February 2019, Nova Economics initiated a supplementary stakeholder consultation process with a view to obtaining insights and data to specifically inform the economic cost-benefit analysis of the proposed regulation for household lighting. This process involved setting up and conducting a series of face-to-face and telephonic interviews with representatives of all the key stakeholder groups identified. Roughly 35 individuals representing 20 organisations were interviewed, either face-to-face or telephonically.

The five key stakeholder groups identified were:

- **Public sector:** Key partners in the national quality system including the National Regulator for Compulsory Standards (NRCS), The South African Bureau of Standards (SABS) and the National Metrology Institute of South Africa (NMISA). The Department of Energy which is the government department responsible for development of energy policy.
- **Core Technical Group** - The core technical group was responsible for giving input into the technical specification of the proposed MEPS for household lighting and included representatives of NMISA, Eskom, the Illumination Engineering Society of South Africa (IESSA) and BEKA Schréder - Africa's leading manufacturers of luminaires.
- **Large Suppliers** – This group included the largest suppliers of lighting products for the residential sector in South Africa. These were identified as Philips (Signify), LEDVANCE (Osram), Eurolux, Radiant, Voltex, Aurora and Ellies. Radiant was subsequently acquired by Eurolux and Vit appears Voltex only retails products on behalf of other suppliers to residential market.
- **Local Manufacturers** – This group were identified as local manufacturers of lighting products. The intention was to approach these firms to gain insight into the potential impacts of the new regulations on local manufacturers of LED or other lamps. Further research however suggested the proposed MEPS is not relevant to this group as they are only involved in the manufacture of niche luminaires for the commercial and industrial markets which is covered by other regulation.
- **Other –** The remaining group included all other stakeholders ranging from non-profits and donors concerned with the promotion of energy-efficiency (UNDP and CLASP), industry associations (IESSA and SAFEHouse), a private laboratory (TACS Laboratories) concerned with testing and enforcement, and Massmart a major retailer of lamps concerned with enforcement and consumer awareness.

A summary of the key stakeholders that were identified and approached for interviews is provided in Table 17. A detailed list of the all the interviews scheduled and conducted is provided in Appendix A.

Table 17: Summary of key stakeholders identified and approached for interviews

	Stakeholder Group	Organisations
	Public Sector – Key public sector stakeholders include the Department of energy (DoE) who is responsible for energy policy and key partners in the national quality system (NMISA, the NRCS and SABS) who are responsible for developing, administering, maintaining and enforcing quality and performance standards and regulation. The SABS is responsible for voluntary standards and for testing compliance.	• NRCS – Regulator • SABS – Bureau of standards • DOE – Dept. of Energy • NMISA – Metrology institute of Sa
	Core Technical Group - The core technical group was responsible for giving input into the technical specification of the proposed MEPS for household lighting. They were engaged to give insight into some of the technical issues.	• Eskom • IESSA • NMISA • Beka
	Large Suppliers - Key industry stakeholders identified included a list of the largest suppliers of lighting products. They were engaged to give insight into the market for lighting in South Africa and the potential impact of proposed MEPS on the lighting industry and consumers of lighting products. They also gave feedback on issues such as the enforcement of existing regulation.	• Signify (Philips) • Ellies • Radiant • Ledvance • (OSRAM) • Eurolux • Aurora
	Local Manufacturers – the firms listed were identified by large suppliers and non-profits as local manufacturers of residential lighting products. The intention was to approach these firms to gain insight into the potential impacts of the new regulations on local manufacturers of LED or other lamps. Further research suggested the proposed MEPS is not relevant to this group as they are primarily involved in the manufacture of niche luminaires for the commercial and industrial markets. A 100% non-response rate for this group also suggests that little or most likely, no - local manufacturing of lamps is taking place.	• Pioled • G Light (Pty) Ltd • LED Concepts • eLighting • EconLED industries • LEDwise • Afrison
	Other (Non-profits, Retailers, Industry Associations, Foreign government) – The fifth group of stakeholders identified included industry-associations (IESSA and SAFEHouse), non-profit organizations concerned with the promotion of energy efficiency (CLASP), retailers of lighting (Massmart), a privately-owned testing laboratory (TACS Laboratories) and the lighting energy efficiency division of the Australian Department of Energy. These stakeholders were approached for their views on the likely efficacy of the proposed technology-neutral MEPS, for input regarding issues such as effective enforcement and consumer awareness and for good practice. The TACS laboratory was approached for input on issues around testing, compliance and effective enforcement as well as exiting testing capacity.	• CLASP • IESSA • SAFEHouse • TACS Laboratories • Lighting Energy Efficiency Division of the Australian Department of the Environment and Energy • Massmart • UNDP

5.2 Approach to stakeholder consultation

Once the five key stakeholder groups, and the associated organisations were identified, a request for interview was sent to each via email. The initial request for interviews were sent by Nova Economics in early January 2019, accompanied by an official letter from the Department of Energy (see Appendix A).

We obtained a 100% response rate from all groups approach except for potential local manufacturers, where only two of the seven companies contacted agreed to an interview. A detailed list of the all the interviews scheduled and conducted is provided in Appendix A.

We began each interview by taking the stakeholder through an introductory presentation. The presentation was used to facilitate a discussion around the proposed problem statement, an overview of the regulation, the objectives of the regulation, the market for residential lighting based on an initial analysis of trade data, the approach to the cost-benefit analysis, a discussion of the potential costs and benefits of the proposed regulation. We also asked representatives of industry (both large lighting suppliers and lighting industry associations) to complete a short questionnaire which was used to consolidate their feedback around the following four main themes:

- Sentiment towards the proposed regulation
- Trends across the residential lamp market
- Considerations around impacts on suppliers
- Support for harmonisation of MEPS with international standards.

A copy of the questionnaire we asked suppliers and industry representatives complete is provided in Table 18.The other stakeholder groups that were interviewed (such as the technical group, public sector and laboratories) were not asked to complete the questionnaire as many of the questions are only relevant to large suppliers and representatives of industry. The views of these other groups have however been captured in areas where they felt they were able to comment.

Table 18: Copy of questionnaire selected stakeholders were asked to complete

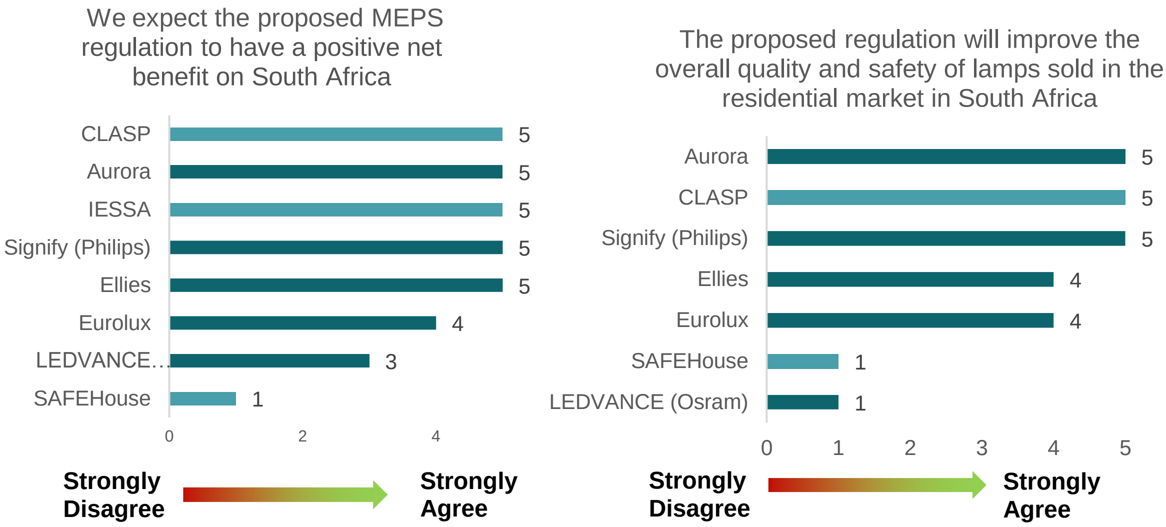
Area	Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Regulation sentiment	1. We expect the proposed MEPS regulation to have a positive net benefit on South Africa					
	2. The objectives of the regulation can be efficiently delivered through the proposed MEPS legislation and few changes are required					
	3. The regulatory bodies are appropriately equipped to introduce and enforce the proposed MEPS legislation					
	4. The proposed MEPS legislation will improve the overall quality and safety of lamps sold in the residential market in South Africa					
The residential lamp market	5. South African consumers are willing to pay more for better quality lamps (when considering lifetime and energy savings)					
	6. There has been a significant decline in sales of CFLs in South Africa since 2016 due to growing adoption of LED lamp technology					
	7. There are many non-traditional lighting suppliers importing products into South Africa					
	8. Large retailers are the dominant channel for domestic residential lamp sales					
	9. There are no manufacturers of lamps for the residential market in SA					
Impacts to suppliers	10. The proposed regulator will not create significant additional compliance costs for suppliers					
	11. Suppliers will be able to pass the costs of compliance onto consumers					
	12. The compliance process will be easily accommodated into our business-as- usual					
Harmonisation with international regulation	13. The harmonisation of local MEPS regulation with international standards (i.e. EU Regulations) is desirable for South Africa					

In addition to the above-mentioned stakeholders' consultation, the NRCS arranged three stakeholder engagement on the 14th of May 2019, 9th of July 2019 and 25th of July 2019. In these meeting there were extensive discussions on the proposed draft regulation, the risk assessment and impact assessment. International lighting expert from CLASP, the NRCS, and Nova made presentations in these meeting with regards to the topics related to the development of the regulation.

5.3 Overall sentiment of stakeholders towards regulation

Overall, stakeholder sentiment towards the proposed MEPS regulation for lighting was positive. Six of the eight stakeholders who completed the questionnaire, expect the proposed regulation to have a positive net benefit on the South African economy (Figure 20). These include international NPO Clasp, lighting industry association IESSA and large suppliers Aurora, Signify, Ellies and Eurolux. These six stakeholders also believe the regulation will improve the overall quality and safety of lamps sold.to the residential market in South Africa.

Figure 20: Overall sentiment towards proposed regulation



Most of the large suppliers of lighting products interviewed noted that regulation would be beneficial as the lack of regulation of LED lamps at present, has led to an influx of inferior quality products. This is posing health and safety risks to consumers and allowing inferior quality products to flood the residential lighting market.

LEDVANCE[76] was more sceptical than the other large suppliers about the potential impact of the regulation because they felt, given the current track record, that it was very unlikely that it would be adequately enforced by the NRCS and SARS (Customs & Excise). LEDVANCE supports the proposed MEPS regulation in principal but noted that it was very unlikely that South Africa would realise any of the suggested benefits, including improvements in safety and quality unless there was a significant improvement in enforcement.

SAFEhouse[77], whose members[78] include one or two large suppliers, a number of smaller suppliers, manufacturers and retailers of lighting and other electrical products, strongly disagreed with the notion that the introduction of MEPS will have a positive net benefit on the lighting market and SA consumers. They felt that the pre-certification by third-party which requires suppliers to apply for letter of authority (LOA) is cumbersome, expensive and disadvantages smaller importers and suppliers who would not be able to bear the increased cost of compliance.

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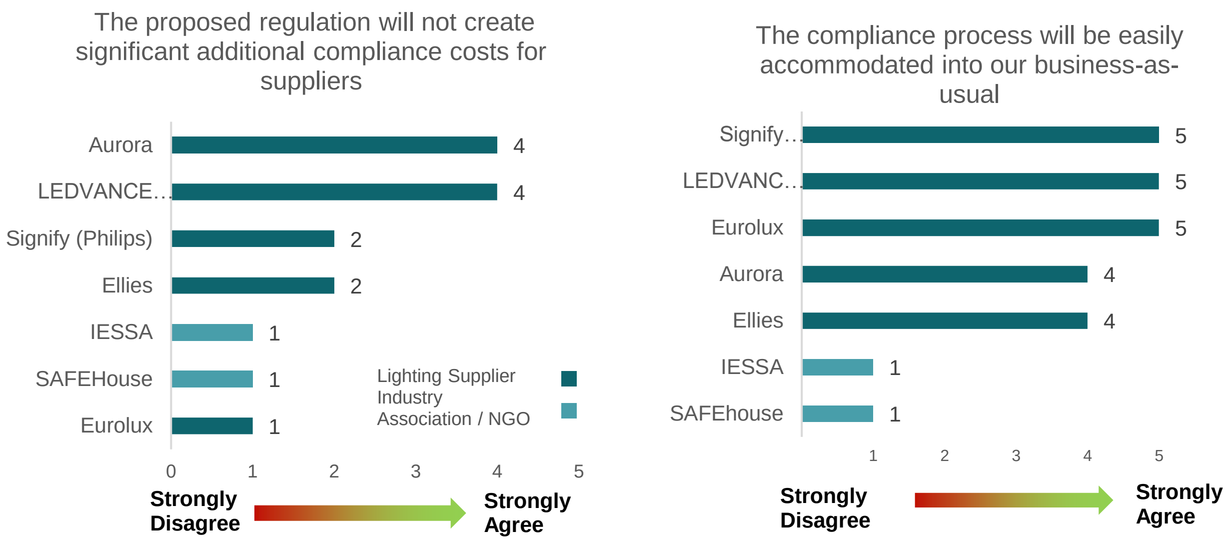
[76] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[77] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.
[78] Their members include Eurolux, Voltex, Nordland Lighting, Spazio, Lighting Warehouse, Electrical Warehouse and Build-it… see http://safehousesa.co.za/safehouse-members/

5.4 Comments on the compliance process (pre-certification with LOAs)

Five of the seven stakeholders who responded to questions on compliance disagreed or strongly disagreed with the statement that the regulation *will not* create significant costs for suppliers, implying that they do believe the costs will be material (Figure 21). Most of the suppliers however noted that the compliance process (pre-certification which requires application for a letter of authority (LOA)) will be easily accommodated into their business-as-usual (BAU). IESSA[79] did not agree that the compliance process would be easily accommodated into BAU as they noted that they would not consider the compliance existing process around VC9012 for electrical luminaries to be acceptable. SAFEhouse expressed several concerns about the existing LOA process which are documented in the remainder of this section.

Figure 21: Stakeholder feedback on cost of compliance and the process



The key issues raised by stakeholders with respect to the compliance process are summarised in the following list:

5.4.1.1 The regulator is taking too long to process and issue LOAs and doesn't have adequate resources.

Several large suppliers including Eurolux, LEDVANCE and Aurora noted that the NRCS is taking too long to issue LOAs. Previously the NRCS issued LOA's within a 30-day period, but this LOA issuance period has steadily increased over time. The procedural cap allows for LOAs to be processed within a maximum of 120 days80, but only 74% of applications were processed within this time frame according to a NRCS 2018 Newsletter81.

[79] Alex Cremer and Henk Rotman (IESSA), in interview with the authors, February 2019.
[80] Electrotechnical Letter of Authority administrative procedure, ET/SCF018 Issue 11 Revised 08 Jan 2018
[81] NRCS Annual Reports: 2015/16 and 2016/17; The 2017/18 Annual Report has not been published on the NRCS website.

Aurora[82] and Eurolux[83] noted that a lamp can take up to 9 months to test and then it is taking up to six months for the NRCS to process and issue an LOA. This means a significant delay in getting new products and technologies to market.

SAFEhouse (2019) felt that given the increasingly wide variety of electrotechnical products being produced internationally, the number of LOA applications would only increase and that the NRCS would not be able to cope with the increasing administrative burden. IESSA[84] noted that the regulator by its own admission simply does not have the resources process LOAs in an acceptable timeframe, let alone to undertake adequate market surveillance and enforcement of MEPS.

With adequate resources it should be possible to streamline this pre-certification process-Australia issues registration certificates within two weeks, while in China a successful application means that a system generated certificate is issued immediately.

5.4.1.2 The LOA process is being abused by some suppliers, test reports obtained cannot be trusted and there are insufficient checks and balances.

SAFEhouse (2019), presented some evidence that the LOA process was being abused by some suppliers – they produced an LOA that had been issued for a particular produce but that in fact contained a list of many distinct products for which separate test reports and LOAs should have been issued. They also noted that it was also easy to import a non-compliant product under a LOA issued for a different compliant product because Customs & Excise are not sufficiently trained or vigilant about checking for these irregularities.

TACS Laboratories[85] noted that while the NRCS required full safety and performance test reports from an independently accredited test laboratory, they often simply accepted the reports at face-value. They noted that some of the test reports from international laboratories are obviously fraudulent because they have been issued so quickly that it wouldn't have been impossible to conduct the required tests (such as those for lifetime) in the reported turnaround time.

5.4.1.3 The costs of testing and indirect cost of compliance with LOA process are high.

While few suppliers expressed concern about the direct cost of LOA applications (about R2 000 per LOA) Eurolux[86] noted that they currently have LOAs for about 500 different halogen and CFL lamps and that the direct cost of re-obtaining accreditation for these products would be significant due to the cost of obtaining tests from an accredited laboratory (estimated at R45 000 per test). It is unlikely however, in the author's view that the costs would be that significant, as our market analysis shows that very few of the existing halogen or CFL lamps will met the minimum efficacy requirements stipulated under MEPS. Eurolux also noted that there was a significant indirect cost (time and human resources to apply for new LOAs). They felt that the regulator should give them automatic accreditation for lamps that have already been awarded LOAs, but it is not clear how many of the existing products will met MEPS minimum requirements.

SAFEhouse[87] felt that the pre-certification by third-party which requires suppliers to apply for letter of authority (LOA) is unnecessarily cumbersome, expensive and disadvantaged smaller importers and suppliers of LED lamps would not be able to bear the increased cost of compliance that came with introducing technology-neutral MEPS.

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[82] Alan de Kocks (Aurora), in interview with the authors, May 2019.
[83] Patrick Stuckie and Eben Kruger (Eurolux), in interview with the authors, February 2019.
[84] Alex Cremer and Henk Rotman (IESSA), in interview with the authors, February 2019.
[85] Frederick Nkosi and Joel Ndaba (TACS Laboratories), in interview with the authors, February 2019.
[86] Patrick Stuckie and Eben Kruger (Eurolux), in interview with the authors, February 2019.
[87] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.

LEDVANCE[88] noted that one of the main costs to suppliers was testing and accreditation, particularly that it was very expensive to have the same lamp with minor improvements re-tested. They noted that the regulators in Europe made some allowances for this – a lamp model with same basic specifications but improvements on one or two technical parameters would not require re-testing and accreditation.

Signify[89] anticipate additional costs for reprinting and new package design in the inception of the new MEPS regulation.

5.4.1.4 Most of the suppliers are in favour of retaining pre-certification to administer and enforce compulsory specifications but one group favours self-declaration.

Eurolux were in favour of keeping a process of pre-certification (LOAs) but suggested that suppliers be allowed to produce test reports that complied with either the International Electrotechnical Commission's (IEC) Standards format or the European Norms (EN) standard (as opposed to just the IEC standard). Eurolux[90], Aurora[91], LEDVANCE and Signify all noted that given very limited market surveillance and enforcement activities, South Africa was not in a position to introduce self-declaration as an alternative to pre-certification and felt this would only give rise to an increase in imports of inferior and non-compliant lighting products.

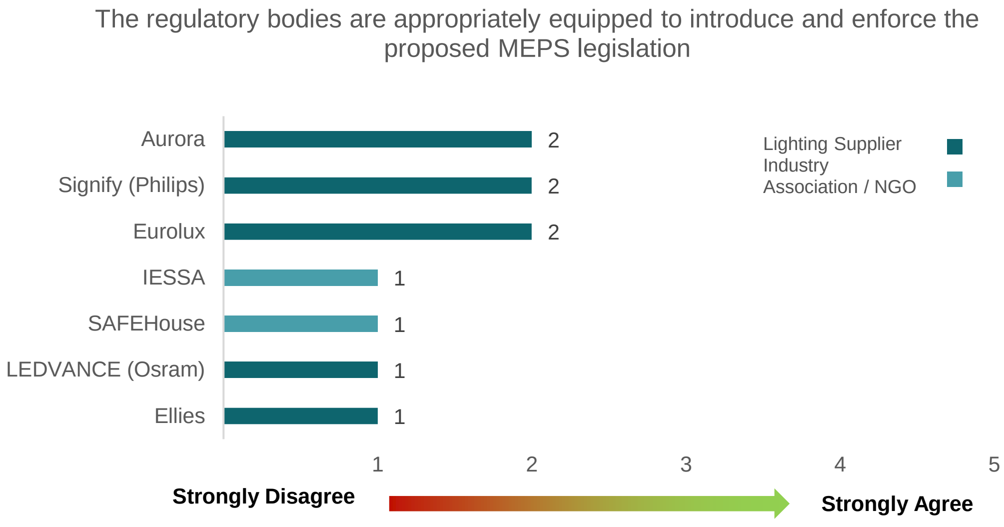
SAFEhouse[92], however felt that MEPS requiring pre-certification via a third party as current compulsory standards for CFLs and incandescent requires, represents a barrier to smaller suppliers, favours larger suppliers and will reduce competition in the lighting market. SAFEHouse noted that while they are not against regulation, they favour self-declaration. Under a process of self-declaration, the regulator requires that suppliers provide a declaration of conformity that a product meets the requirements of the applicable regulation/compulsory specification.

5.5 Comments on enforcement - market surveillance, check testing and investigations.

While overall stakeholder sentiment towards the proposed MEPS regulation for lighting was positive, major concerns were raised by most of the stakeholders interviewed with regards to the NRCS's capacity to enforce compulsory standards. All seven stakeholders who responded to our questionnaire disagreed or strongly disagreed with the statement that regulatory bodies would be appropriately equipped to enforce and introduce the proposed MEPS regulation (Figure 22). Large suppliers and industry associations were deeply sceptical about the capacity and ability of the NRCS and its partners (such as SARS Customs & Excise) to enforce the existing compulsory standards and/or the proposed MEPS for lighting and the lack of enforcement of current regulation was consistently raised by stakeholders as their single largest area of risk to the successful implementation of proposed MEPS for lighting.

[88] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[89] Maciej Debowski and Nelisiwe Nkosi (Signify), in interview with the authors, March 2019.
[90] Patrick Stuckie and Eben Kruger (Eurolux), in interview with the authors, February 2019.
[91] Alan de Kocks (Aurora), in interview with the authors, May 2019.
[92] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.

Figure 22: Regulatory bodies are appropriately equipped to introduce and enforce MEPS



5.5.1.1 The NRCS, SARS and their partners are not adequately equipped to introduce and enforce the proposed MEPS regulation.

LEDVANCE[93] were very sceptical about the potential impact of the regulation because they felt, given the current poor track-record, that it was very unlikely that it would be adequately enforced by the NRCS and SARS (Customs & Excise). LEDVANCE supports the proposed MEPS regulation in principle but noted that it was very unlikely that South Africa would realise the suggested benefits unless there was a significant improvement in enforcement.

Once of the main issues identified by LEDVANCE[94] was that SARS Customs & Excise were not currently able to prevent the import of products that are illegal under current VCs for incandescent and CFL lamps. There noted that there was plenty of anecdotal evidence – in informal retailers or "China Malls" it is possible to find incandescent lamps retailing for as little as R3.50 a lamp which is less than the environmental levy on legal electric filament lamps of R7.50/lamp. They had also experienced the incompetence of SARS customs officials first-hand when they inadvertently imported a container of incandescent lamps incorrectly labelled as LED lamps and despite the fact that the container was inspected twice – both at the port of Durban and at the Swaziland border they discovered it was a container full of lamps that have been banned in South Africa and had to destroy the product at their own cost.

5.5.1.2 The NRCS undertakes very limited market surveillance.

Stakeholders suggested that the NRCS currently focuses most of its time and resources on the pre-certification process and pays limited attention to monitoring, verification and enforcement activities. Several stakeholders including LEDVANCE[95] and SAFEhouse[96] noted that there was very little evidence that the NRCS was actively undertaking market surveillance.

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[93] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[94] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[95] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[96] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.

TACs Laboratories[97] and the SABS[98] revealed that they had not received any requests from the NRCS to test lighting products against the existing VCs in the last year and TACS had never been contracted by the NRCS to test any lamps.

5.5.1.3 The NRCS is not assessing or investigating claims of non-compliance.

As part of its enforcement activities, the regulator must assess each reported instance of alleged or suspected non-compliance and where appropriate investigate. SAFEhouse noted that to date none of their reported instances of non-compliance have been assessed by the NRCS, and this has created a lack of trust in the regulators ability to perform their mandate under the ac. LEDVANCE[99] mentioned that they had reported three retailers which they discovered were selling non-compliant products (based on their own testing) to the NRCS but they none of the cases were investigated and that no feedback was provided.

5.5.1.4 The borders are porous - customs & excise are failing to detect imports of illegal lighting products.

Several stakeholders complained that Customs & Excise is failing to detect imports of illegal and non-compliant lighting products at the borders. Ellies[100] noted that Customs officials at the ports appeared to be inadequately trained or equipped to detect imports of illegal or non-compliant lighting products. He noted that it was likely due to a combination of a lack of specialised knowledge, a lack of capacity and possibly also bribery and/or corruption. The NRCS acknowledged that communication between the regulator and customs officials at the ports could be improved.

The NRCS has insufficient human resource-capacity - The NRCS[101] admitted to experiencing difficulties in enforcing regulation in the lamp market because of a lack of adequate human resource capacity. The NRCS[102] mentioned that they are deeply-resource constrained that the lack of enough inspectors was the main bottleneck. Inspectors are qualified engineers who command an annual salary of around R850K. The NRCS currently employs 30 inspectors in the electro-technical division but has no dedicated inspectors for lighting.

5.5.1.5 The Act doesn’t allow for the NRCS to impose penalties on non-compliant suppliers.

The NRCS[103] reported that they Act doesn’t currently allow for penalties (fines) to be levied on non-compliant suppliers. They believe that if penalties were incorporated as part of the enforcement process this would send a signal to regular offenders (importers of non-compliant products).

5.5.1.6 Industry does not currently bear the cost of disposing of used lamps and there are limited funds for crushing of confiscated lamps.

The NRCS[104] reported that there are currently no disposal levies in place for LEDs and that the very limited budget for lamp crushing had been problematic to date. The funds for disposal/crushing programmes currently come from the general fiscus when the cost should really be imposed on offenders (via penalties) or collected from the industry via levies.

One concern raised by the NRCS[105] was that when goods were confiscated at the Port, SARS stores them at the state warehouse, but they should be handed over to the regulator to

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[97] Frederick Nkosi and Joel Ndaba (TACS Laboratories), in interview with the authors, February 2019.
[98] Theo Fourie and Sihle Qwabe (SABS), in interview with the authors, February 2019.
[99] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[100] Shaun Nel (Ellies), in interview with the authors, February 2019.
[101] Lancerlot Riyano, Langa Jele and Stephina Teffo (NRCS), in interview with the authors, February 2019.
[102] Lancerlot Riyano, Langa Jele and Stephina Teffo (NRCS), in interview with the authors, February 2019.
[103] Patsy Andrews (NRCS), in interview with the authors, March 2019.
[104] Patsy Andrews (NRCS), in interview with the authors, March 2019.
[105] Patsy Andrews (NRCS), in interview with the authors, March 2019.

destroy. However, since there is a limited budget available to pay for crushing/disposal they are often stored for an unnecessarily long period.

5.5.1.7 Insufficient capacity in South Africa to test LED lamps performance against the specifications.

Our discussion with the NRCS and SABS revealed that no products had yet been sent for testing against the existing lamp VCs.

The SABS[106] does not currently have the testing equipment to be able to facilitate the necessary checks for the new MEPS for LEDs, and they require a supply agreement with the NRCS for consistent volumes to justify the investment in equipment for the new VC. Currently SABS are preparing a business case for support from the UNDP to be able to acquire some of the needed technologies for tests that will be required under the new MEPS. This will make it possible for them to do the full range of testing for LEDs in order to comply with new standard (including blue light hazard) in South Africa.

TACS Laboratories[107] reported that they currently have a lot of the equipment needed for testing products against the new technology-neutral MEPS and have plans to acquire more on their own account. TACS Laboratories mentioned that they have never been contracted by the NRCS to test any lighting products. They suggested the NRCS enter into a retainer with them for constant market surveillance and testing as this would enable them to offer testing at a greatly reduced cost.

The NRCS[108] noted that currently TACS have the best equipment of any laboratory and the regulator should consider making use of their testing facilities which include:

(a) Testing machines at TACS Laboratories include:

(b) Lamps aging stations

(c) Integrating Sphere

(d) Type C Photogoniometer

(e) Photobiological Hazard Tester

(f) Electrical safety tester

(g) Mechanical tester

(h) Lamp gauges (Still looking for some)

(i) Test probes.

Both the SABS[109] and TACS Laboratories[110] were questioning whether volumes from regulator will be sufficient (especially considering they hardly ever received samples under other regulation to test) to justify further investment in testing equipment as suppliers mostly tests lamps abroad with product manufacturers based there.

NMISA noted that they had equipment to test LED lamps and that that they were applying to become an accredited testing laboratory and noted that the public sector partners should work together to avoid duplication of investment in testing equipment. SABS notes that the

[106] Theo Fourie and Sihle Qwabe (SABS), in interview with the authors, February 2019.
[107] Frederick Nkosi and Joel Ndaba (TACS Laboratories), in interview with the authors, February 2019.
[108] Patsy Andrews (NRCS), in interview with the authors, March 2019.
[109] Theo Fourie and Sihle Qwabe (SABS), in interview with the authors, February 2019.
[110] Frederick Nkosi and Joel Ndaba (TACS Laboratories), in interview with the authors, February 2019.

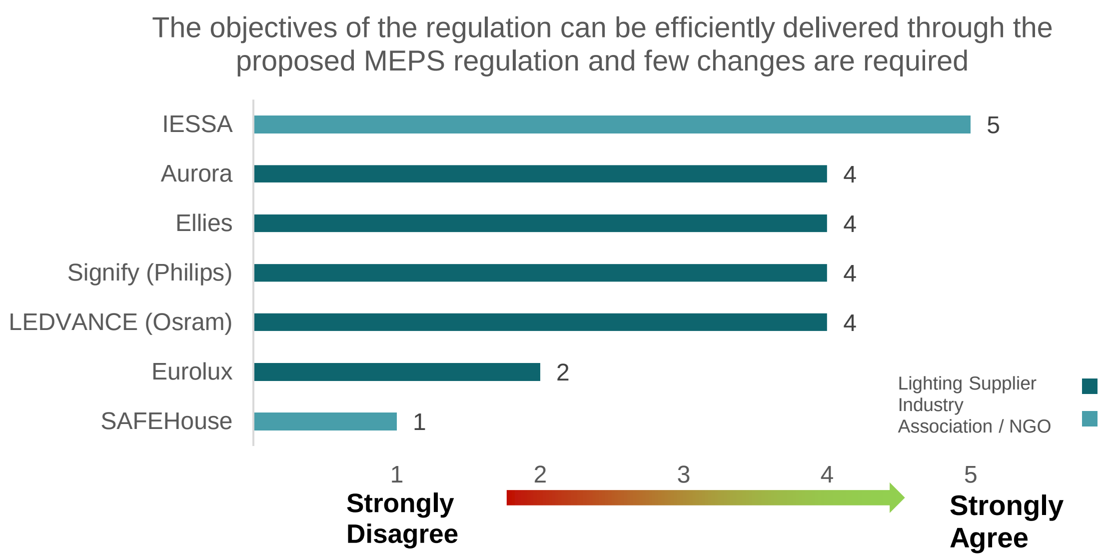
accreditation of the NMISA equipment would not have a significant impact on their need to invest in new equipment as the equipment available at NMISA is quite limited.

Eskom[111] also noted that they were planned to have their laboratory facilities for the testing of electric lamps accredited although they could not confirm the timelines.

5.6 Comments on the specification of proposed technology-neutral MEPS

Most stakeholders (five out of seven interviewed) reported that they had no issues with the technical specifications of MEPS. Most noted that they would submit any specific comments they had on the technical specifications to the NRCS and UNDP via the formal process they are running to obtain comment on the draft specifications.

Figure 23: Sentiment towards MEPS Technical Specifications



- LEDVANCE[112] had no problem with the technical specification of MEPS and estimated that South Africa could improve energy-efficiency by 38% in the residential lighting market if it was possible to enforce the new regulation.
- Ellies[113] mentioned that a few changes were required with the proposed MEPS and mentioned that the standards covering LEDs should go ahead as soon as possible, because at present there wasn't any specification for products to conform to.
- Eurolux[114] mentioned that many changes were required, and they would make a submission on draft regulations. One key issue they did however raise, was that this new MEPS would override existing VCs for CFLs, and halogen lamps and they were concerned that they would have to re-apply for LOAs for these products under technology-neutral MEPS at significant cost.
- SAFEhouse[115] noted that they would be making a submission on changes that were required.

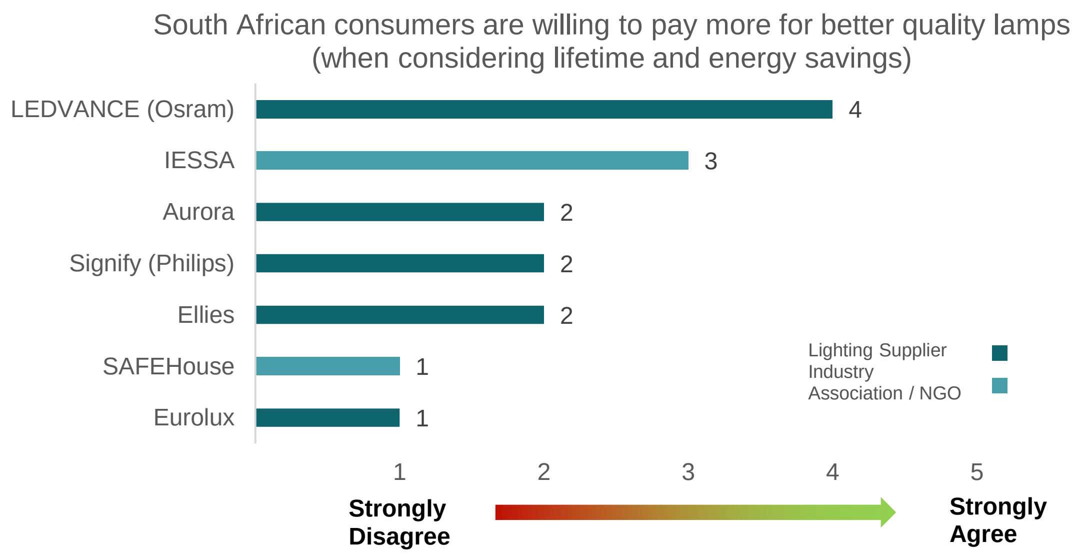
[111] Andre Blignaut (Eskom), in interview with the authors, February 2019.
[112] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[113] Shaun Nel (Ellies), in interview with the authors, February 2019.
[114] Patrick Stuckie and Eben Kruger (Eurolux), in interview with the authors, February 2019.
[115] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.

- TACS Laboratories[116] reported that they would need to look more closely at the technical specification to ensure that they had all of the necessary testing equipment for testing compliance against the new compulsory standards, but they noted having a lot of the required LED and lamp product testing machinery already.
- While Signify[117] had few technical issues with MEPS, they felt the regulator would not be able to enforce it.

5.7 Comments on consumer preferences and price-sensitivity

One of the reoccurring themes raised during the stakeholder consultation process was South African specific consumer preferences and price sensitivity within the South African market. Suppliers noted that the majority of South Africans are lower-income consumers who are highly price sensitive when purchasing lamps and other smaller household products. Most suppliers mentioned that there the implications were twofold - firstly consumers need regulation to protect them from cheap inferior and potentially dangerous products, and secondly, the regulation shouldn't be so restrictive that all lamps in the market who comply become unaffordable for local consumers.

Figure 24: Consumer Preferences and Price Sensitivity



5.7.1.1 Consumers will be willing to pay more upfront for quality lamps if they are made aware of potential benefits and cost savings.

Both CLASP[118] and LEDVANCE[119] reported that South African consumers would be willing to pay more, if they understood the long-term benefits that good quality LED lamps would afford them, citing lack of education and knowledge, as well as a flooded market, as reasons for selections of inferior products.

Ellies[120] mentioned that within reason consumers could be motivated to buy better quality lamps, however it was the responsibility of government and regulation and enforcement to clean up the current state of low-quality lamps which have flooded the South African market.

[116] Frederick Nkosi and Joel Ndaba (TACS Laboratories), in interview with the authors, February 2019.
[117] Maciej Debowski and Nelisiwe Nkosi (Signify), in interview with the authors, March 2019.
[118] Michael Scholand (CLASP), in interview with the authors, March 2019.
[119] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[120] Shaun Nel (Ellies), in interview with the authors, February 2019.

In the absence of regulations Ellies[121] anticipate that low quality bulbs will continue to be the purchase choice of most South African consumers.

5.7.1.2 The residential consumer of electric lamps in South Africa is price-sensitive although it is middle to high-income households that are responsible for the majority of sales volumes.

Eurolux[122] noted that while consumers are price sensitive, middle-to-high income households are responsible for the majority of the volumes seen where 100 halogen/LED downlighters will be present in one large home, versus one lamp in a lower income or informal home.

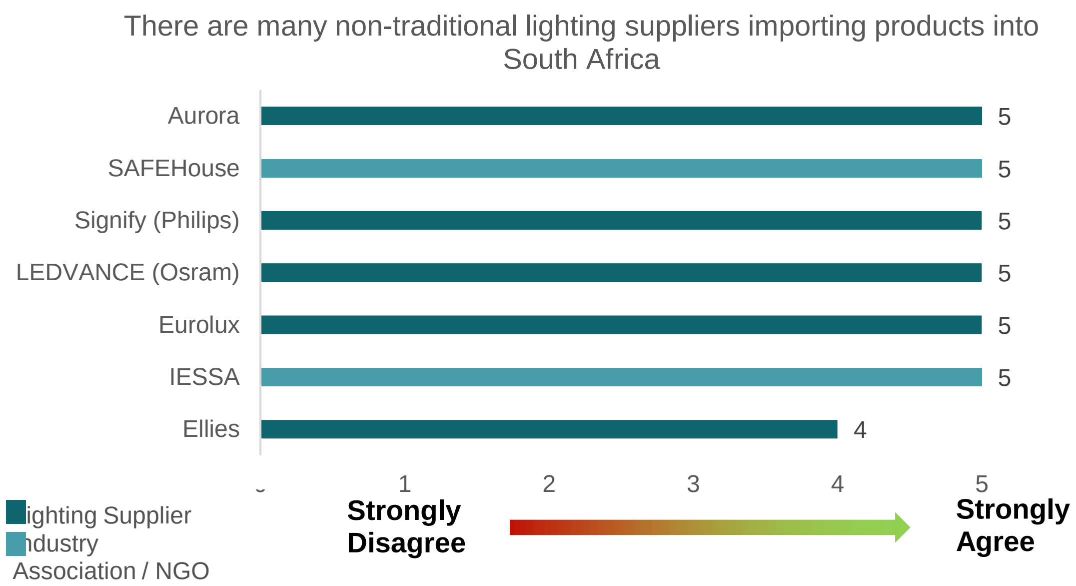
SAFEhouse[123] advocated that the local South African consumer cannot afford expensive lamps, and that current lamps retailing for over R20 per lamp are out of the affordability bracket of most consumers. SAFEhouse suggested that suppliers will not be able to pass the costs of compliance on to consumers due to the price sensitivity of local South African consumers. Signify[124] also reported that in their experience South Africa was a very price-driven and price-sensitive market.

5.8 Comments on the extent and nature of suppliers and local manufacturers

5.8.1 Comments on the extent and nature of lamp suppliers

Most stakeholders agree that a lack a regulation has led to a drastic increase in non-traditional suppliers and importers of LED lamps into the South African market. These include local retailers, building and electric contractors and wholesalers, independent retailers and opportunistic one-off importers. By contrast, the NRCS noted (Lancerlot, 2019), that at mid-2017 there were only about 13 to 20 suppliers that were registered to supply halogen and CFL lamps that currently fall under compulsory specifications.

Figure 25: There are many non-traditional suppliers of lighting products in South Africa



[121] Shaun Nel (Ellies), in interview with the authors, February 2019.
[122] Patrick Stuckie and Eben Kruger (Eurolux), in interview with the authors, February 2019.
[123] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.
[124] Maciej Debowski and Nelisiwe Nkosi (Signify), in interview with the authors, March 2019.

It was agreed, as above, that the South African market is currently flooded with a wide variety and quality of electric lamps due to the growth in non-traditional suppliers

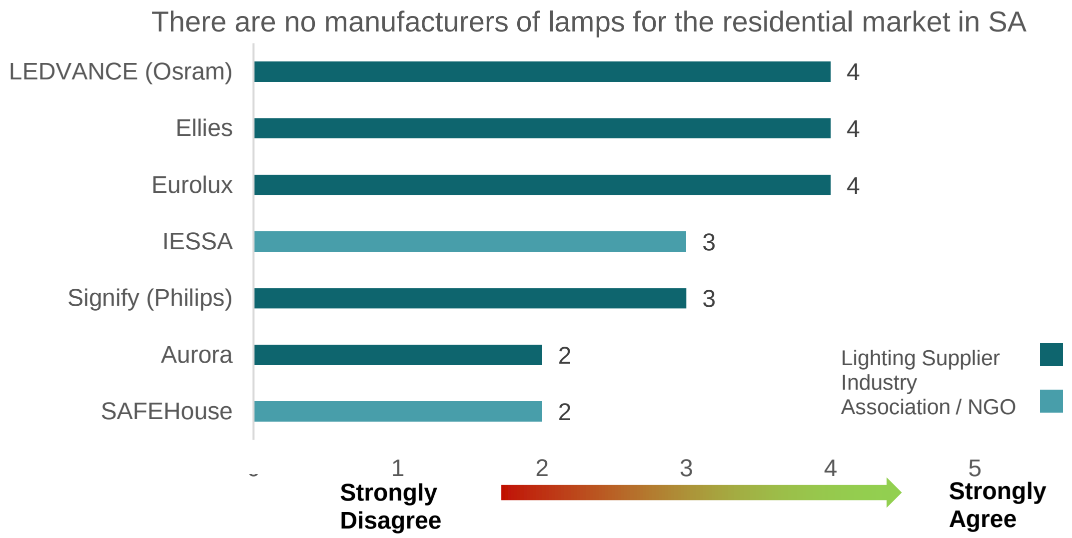
- LEDVANCE[125] estimates that there are currently over one-thousand LED importers bringing LED lamps into South Africa, compared with only eight established lamp importers, less than ten years ago, this signals a significant shift in the market enabled by a lack of regulation and levies on LEDs in the industry. LEDVANCE[126] continued that having so many importers also raises concerns around quality of lamps imported.
- TACS Laboratories[127] concurred that in the absence of regulation they had noted a large increase in non-traditional suppliers.
- Ellies[128] mentioned that there were many non-traditional LED importers due to the absence of regulation. They concurred that some regulation would be a vast improvement to the current void and that the market needed a specification with which to conform, and that this would at least remove inferior products from main retail outlets.
- LEDVANCE[129] noted that regulation would definitely reduce the number of suppliers, however they still anticipate that some illegal imports will still be likely. Retailers are currently importing LEDs directly and stocking under own label. Some of these are products from traditional suppliers that are just branded ‘own label’ but some are inferior-quality lamps and the market urgently needs regulation.

5.8.2 Comments on the extent and nature of local manufacturers of lamps

Reports about the extent of local manufacturing of LED or other electric lamps were mixed. Most stakeholders noted that there are a few small-volume manufacturers of lighting products in South Africa. But as discussed in Section 4.3.3, further research revealed that most of these firms were mostly engaged in manufacturing LED fittings or luminaires.

Figure 26: Extent of local manufacturing of electric lamps

[125] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[126] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[127] Frederick Nkosi and Joel Ndaba (TACS Laboratories), in interview with the authors, February 2019.
[128] Shaun Nel (Ellies), in interview with the authors, February 2019.
[129] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.



- IESSA[130] noted there are a few 'lighting companies' that claim they manufacture these products locally, however, they only do the assembly as all components are imported and not manufactured locally, as claimed.
- LEDVANCE[131] mentioned that there were a few small-volume manufacturers of LED lamps, tubes and luminaires in South Africa although they probably were engaged mainly in assembly of LED lamps and luminaires from imported components. They identified PioLED in Pietermaritzburg as a local assembler/manufacturer (PioLED however, did not respond to a request for interview).
- Ellies[132] were not aware of any local manufacturers, and mentioned it was unlikely that there were any, due to a lack of incentives for local manufacturing. They noted that it did not make financial sense to manufacture locally because of enormous economies of scale in production in China. He noted they designed their lamps locally but outsourced manufacturing to factories in China.
- The Aurora[133] representative said he felt there were some local companies manufacturing lamps and mentioned GLight.
- SAFEhouse[134] identified a number of smaller firms as local manufacturers: - Afrison, LedWise, EconlEED, VISIONWARE, and Electroweb. We researched the activities of these firms based on their websites and contacted them for interviews but of these only EconLED responded. However as discussed in Section 4.3.3 most of these firms are engaged in the assembly of luminaires for the commercial and industrial market and do not produce lamps. A representative of EconLED[135] noted that they do manufacture high quality LED lamps in small quantities for niche applications - mainly industrial and commercial warehousing - on a project-by-project basis. They confirmed there are no local manufacturers of electric lamps for the residential

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[130] Alex Cremer and Henk Rotman (IESSA), in interview with the authors, February 2019.
[131] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[132] Shaun Nel (Ellies), in interview with the authors, February 2019.
[133] Alan de Kocks (Aurora), in interview with the authors, May 2019.
[134] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.
[135] Barry Tree (EconLED), in interview with the authors, March 2019.

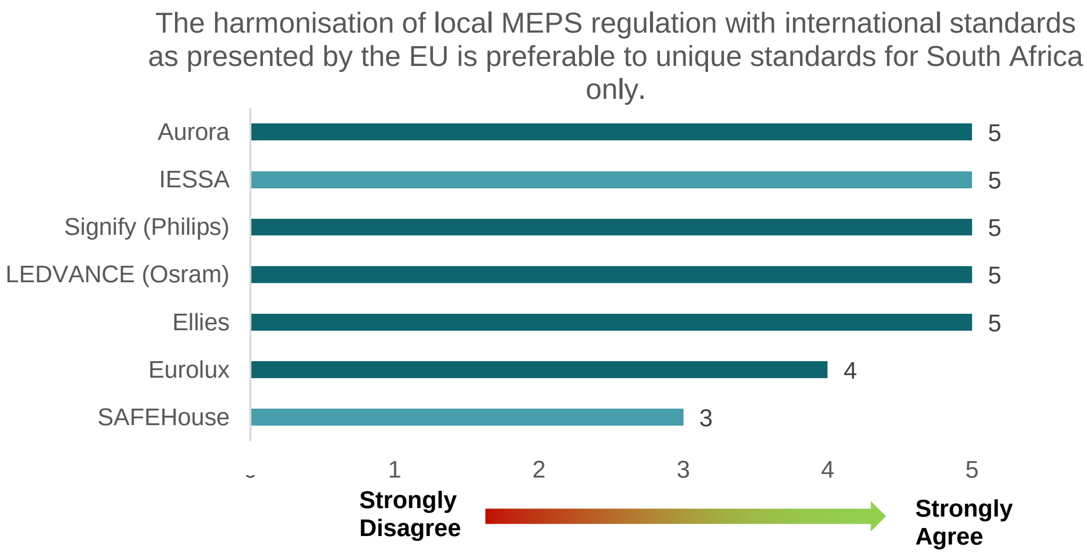
market, noting that it was highly doubtful that local manufacturers would be able to compete with cheaper imports in a segment that is also not very discerning in terms of quality.

5.9 Harmonisation to International Standards

All stakeholders agreed that it made sense to harmonise the technical standards and specifications in the South African MEPS with international regulations. At this stage the European Union is the only region that is also introducing a technology-neutral MEPS for household lighting and this makes it a natural benchmark for South Africa.

However, some stakeholders held the view that the local market is very different from the EU in areas such as the price-sensitivity of consumers, the availability of grey or illegal imports and inconsistent electricity supply. This went both ways in comparison with the EU specifications, suggesting some of the technical specifications should be relaxed to make room for affordability, while others should be more stringent to account for erratic electricity or power interruptions – specifically in the area of requiring surge protection.

Figure 27: Harmonisation to International Standards



Massmart[136] made a specific point of noting that consumers are much more price sensitive and less environmentally savvy in South Africa. And noted one concern with harmonisation – that the South African market had vast differences to that of Europe – and that MEPS shouldn't be so strict so as to exclude relatively affordable lamps which may not be of the highest quality and longevity but will adequately serve the average South African consumer.

Eurolux[137] were concerned that not all of the technical specifications could be accounted for in the translation from EU MEPS to South African standards due to some measurement differences

Signify[138] were in support of international harmonisation, especially considering their advanced foot print in international markets, however they did stress that voltage fluctuations should be considered

[136] Alex Haw (Massmart), in interview with the authors, March 2019.
[137] Patrick Stuckie and Eben Kruger (Eurolux), in interview with the authors, February 2019.
[138] Maciej Debowski and Nelisiwe Nkosi (Signify), in interview with the authors, March 2019.

for the South African market (and rest of Africa), as power supply issues that are present in this market are not a consideration for the EU, and thus the international MEPS may lack some requirements

CLASP[139] felt very strongly that MEPS should be harmonised internationally, especially because South Africa was leading the SADC region on lamp and electricity efficient appliance regulation, and that harmonisation made long term sense and had various benefits. CLASP[140] provided the following additional comments:

> "Country governments reviewing this study and these recommendations should consider harmonising their policies and actions with those of neighbouring states. Harmonising policy measures would mean adopting the same requirements, test standards and/or other requirement as another country (or countries) in a region. Through harmonisation, consumers benefit from lower prices and better product choice because the supplier's administrative trade barriers are reduced and testing, and compliance certification reporting costs are lower. The compliance costs are spread across a larger number of products, enabling consumers in those markets to enjoy better prices and choice of goods associated with the other (generally larger) economies with which they are harmonised.
>
> Harmonisation of test standards enables multiple national markets to be accessible for the cost of only one test. Testing standards underpin all lamp MEPS and energy labelling programmes because they are the means by which a product's performance is measured and compared. Harmonisation of test procedures facilitates trade; comparison of performance levels; technology transfer; and encourages replication of best practices. The most widely used test methods today for measuring the performance of lamps are those of the International Electrotechnical Commission (IEC) and the Commission Internationale de l'Eclairage (CIE). To ensure that they have an opportunity to participate in the development of these test methods, countries are encouraged to join the IEC."

5.10 Comments on draft problem statement

Stakeholders interviewed were also asked to comment on the draft problem statement (the main rationale for introducing MEPS), their comments are summarised in the following sections.

5.10.1 Current regulation is lagging technological advancements

Generally, stakeholders agreed that the regulation for electric lamps had lagged technological advancements and that there was an urgent need to have regulation covering LEDs to prevent import of inferior products.

5.10.2 Consumers make poor choices due to imperfect information

Suppliers and retailers noted that consumers continued to make poor choices when purchasing lamps due to lack of awareness about the benefits of newer technologies and the relative lifecycle cost of lamps.

- Massmart[141] reiterated that the South African market is highly price-sensitive and consumers with low levels of disposable income are unwilling to pay higher prices for lamps upfront with

[139] Michael Scholand (CLASP), in interview with the authors, March 2019.
[140] Michael Scholand (CLASP), in interview with the authors, March 2019.
[141] Alex Haw (Massmart), in interview with the authors, March 2019.

the promise that they will realise electricity cost and replacement cost savings in the long-term. They reported that in partnership with Ellies and other energy efficient brands, a green product aisle campaign had been very successful in supporting customers to understand the benefits and availability of new and more efficient technologies.

- LEDVANCE[142] noted that South African consumers are not well educated about the extent of improvements of technologies like LED's and are not aware of the available benefits of newer technologies, they have developed a poster comparing the lifecycle costs of different lamp technologies within their product range to help inform consumers of relative advantages of new technologies that may be more expensive upfront.

5.10.3 Barriers to uptake of LED technology

Stakeholders disagreed with some of the statements made in this section of the draft statement, particularly the notion that the relatively high upfront price/cost of LEDs was a barrier to adoption. They noted that LEDs were no longer more costly than CFL and halogen lamps and noted that consumers were becoming more willing to adopt LEDs.

- LEDVANCE[143] disputed that notion that LED lamps cost more upfront that halogens and CFL. They noted that you could probably land an LED lamp for R7/lamp with surge-protection which is less than the R7.50/ lamp environmental levy on electric filament lamps – tungsten halogen and incandescent.
- Eurolux[144] disputed the notion that good quality LED lamps cost more upfront than halogen and CFL lamps. They noted that LEDs are not necessarily more expensive as prices of the lamps have been falling and there is an R8/lamp environmental levy on halogen lamps. They noted that it's possible to import LED lamps from China that might actually be less expensive than CFL and halogen lamps (upfront cost) but that are still of a reasonably good quality
- Mention was also made of consumer's historical preferences for CFL lamps associated with energy saving after Eskom's lamp programme, and it was also noted that some corrective efforts may need to be applied here in order to update consumer preferences[145].
- CLASP[146] raised risks of "technology spoiling" due to inferior quality LED products in the South African market. Due to the absence of regulation, LEDs on the market currently are not all created equal, and consumers may unknowingly purchase an inferior quality LED and after a negative experience wish to return to using halogen or CFLs.

[142] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[143] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[144] Patrick Stuckie and Eben Kruger (Eurolux), in interview with the authors, February 2019.
[145] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[146] Michael Scholand (CLASP), in interview with the authors, March 2019.

5.10.4 Health risks associated with the extended use of LED light sources

Most stakeholders noted that there were some health risks associated with the use of inferior LED products. SAFEhouse, did not agree and maintains that there are no significant health or safety risks associated with electric lamps of any variety. In addition to the potential health risks mentioned in the problem statement first draft, stakeholders raised the following points:

- SAFEhouse[147] strongly disagreed with the proposed health effects as part of the problem statement, maintaining that there is no evidence that lighting products are associated with health risks. Jonker noted that if there were risks lamps wouldn't be present in all offices, everywhere. The authors note that SCHEER[148] concluded that there is no evidence of direct adverse health effects from LEDs in normal use (lighting and displays) by the general healthy population but has noted some risks for more vulnerable groups with extended use.
- Theo Fourie from SABS[149] mentioned that there is potential radio frequency interference and that the electromagnetic compatibility of LED lighting and the associated control gear (i.e. the driver) are to comply with the Telecommunications (Control of Interference) Regulations (Cap 106B) and the CISPR 15 standard. The LED lighting and control gear should also comply with the relevant electromagnetic compatibility standards. CISPR-15[150]
- CLASP[151] referenced the SCHEER official opinion on LED health effects, as commissioned by the EU which states: "It has been shown that normal use of LEDs or screens illuminated by LEDs during the evening can perturb the circadian system, as do other types of artificial lights. Light sources with a higher component of short-wavelength light, such as some LEDs, have increased impact on the circadian system, perhaps influencing sleep quality. During the workshop industry presented the latest research on the topic, a position paper from the International Commission of Illumination (CIE)[152]. The NRCS and CLASP had further discussions with the CIE resulting in all references to blue light being removed from the technical specification.

5.10.5 Potential additions to problem statement

It was suggested that lack of adequate enforcement of current regulation be added to the problem statement. While we agree that this is an important issue it does not add to the rationale for introducing MEPS but is rather a separate issue that needs attention (according to the NRCS and LEDVANCE[153]). Some stakeholders have said that the dti should take a more active role in addressing industry concerns and NRCS performance.

It was also noted that if South Africa fails to adopt compulsory specifications for both energy, performance and safety standards that are in line with the international norms it risks becoming or continuing to be a dumping ground for inferior and unsafe products that can no longer find a market elsewhere.

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[147] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.
[148] SCHEER, 2018
[149] Theo Fourie and Sihle Qwabe (SABS), in interview with the authors, February 2019.
[150] http://shuttlelighting.com/emi/Residential lamp market
[151] Michael Scholand (CLASP), in interview with the authors, March 2019.
[152] Position Statement on the Blue Light Hazard (April 23, 2019) http://www.cie.co.at/publications/position-statement-blue-light-hazard-april-23-2019
[153] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.

5.11 Recommendations from Stakeholder Consultation

5.11.1 Recommendations on how to improve monitoring verification and enforcement activities

In this section the author's (Nova Economics) provide recommendations on how to improve the MVE function at the NRCS and its key partners (including SARS Customs & Excise) draw on insights about best practice obtained during an interview with David Boughey[154] from the Australian GEMS Regulator, which is based in the Commonwealth Department of the Environment and Energy. Other recommendations come from interviews with local stakeholders.

1) **Streamline the pre-certification process where possible -** develop a product registration database to automate registration.

2) **Design and implement a more efficient and effective compliance function based on international best practice and focus on basic market intelligence.**

   At the Australian GEMS regulator, the compliance team is responsible for ensuring compliance with minimum energy and performance standards (MEPS) for electric lighting, while a separate body ensures compliance with electrical safety. Boughey[155] noted that the three main categories of activity that are carried out by the compliance team and GEMS inspectors are market surveillance, check testing and investigations.

   Most of the time of the compliance team is dedicated to market surveillance as testing and investigations are more expensive. Basic market surveillance includes checking whether products being imported and sold in the Australian market are indeed registered in the GEMS database. If a product is not registered it cannot be sold, it is not necessary to test an unregistered product, it will simply be removed from stores. Other basic checks include whether the product meets labelling requirements.

   Boughey[156] noted that basic market surveillance includes the following activities:

3) **Checking product compliance online** (over the internet). Inspectors will check whether products listed on store websites and online catalogues are register in the database and meet basic labelling requirements. This is one of the most cost-effective ways of conducting market surveillance.

4) **Physical site visits of retail stores and other important channels**. The compliance team do however still dedicate a fair amount of their time to doing site visits to stores and channels such as the electrical product wholesalers that supply building contractors.

5) **Compile market intelligence** – the compliance team compile market intelligence to inform market surveillance activities. For example, through research they discovered that building contractors primarily buy their products from electrical wholesalers who in turn import unregistered products.

6) **Investigate if it is possible to automate aspects of market surveillance using technology**

   Once the product registration database has been automated it will open up opportunities to develop a range of smartphone-based applications for use by consumers and the regulator. It should be possible to automate the process of verifying whether lamps are registered on the LOA database using technology. For example, we believe it would be possible to build a simple smartphone

[154] David Boughey (Australian Department of the Environment and Energy), in interview with the authors, March 2019.
[155] David Boughey (Australian Department of the Environment and Energy), in interview with the authors, March 2019
[156] David Boughey (Australian Department of the Environment and Energy), in interview with the authors, March 2019

application or website to scan a product barcode in-store and immediately verify whether it has a valid LOA.

7) **Improve the human resource capacity in the compliance function at the NRCS and adopt a more cost-effective model for resourcing it**

The NRCS[157] noted inspectors are responsible for monitor and enforcing compliance under the Act. Inspectors in South Africa are highly technically qualified engineers and command a relatively high annual salary of ~R850K. As a result, the NRCS only employs about 30 inspectors in the electro-technical division and none are dedicated to lighting.

The NRCS suggested they would need another five inspectors dedicated to lighting to adequately enforce MEPS. However, in Australia, the GEMS inspectors are public servants with varied backgrounds, often with experience in enforcement but they are seldom qualified engineers or technical specialists in the electrical field. This means it is possible to resource the compliance function adequately but more cost-effectively. The GEMS regulator makes use of technical specialists on a consulting basis when their specific expertise is required. TACS Laboratories[158] expressed the view that it was not necessary for the NRCS to employ highly qualified engineers to perform basic market surveillance activities, technical specialists were only really required to interpret test reports and conduct investigations.

Set a clear strategy for compliance and monitoring, with specific goals and targets and report transparently and timeously on the results

During our discussions with the NRCS it became apparent that they do not yet have a detailed annual plan that outlines specific goals and targets for lighting market surveillance and enforcement. The Australian GEMS regulator publishes an annual compliance monitoring programme[159] and reports on the results of check-testing and market surveillance activities as the reports become available at www.energyrating.gov.au[160].

There is strong interest from some stakeholders in having transparent reporting on all market surveillance and compliance activities undertaken by the NRCS – the imports stopped, detained, and inspected[161].

8) **Educate Customs Officials and build better relationships with key partners in quality system.** Boughey[162] noted that the GEMS regulator had provided the Australian Customs & Excise department with funding to educate officials and raise awareness about compliance of lighting product with compulsory standards.

9) **Conduct training and awareness workshops for customs officials and inspectors on lighting products and the implications of new regulation**. Create better channels of communication/relationships between the regulator and customs authority and other partners in the quality system to work more closely together and raise collective levels of awareness around the roles.

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[157] Lancerlot Riyano, Langa Jele and Stephina Teffo (NRCS), in interview with the authors, February 2019.
[158] Frederick Nkosi and Joel Ndaba (TACS Laboratories), in interview with the authors, February 2019.
[159] http://www.energyrating.gov.au/sites/new.energyrating/files/documents/2018-19%20GEMS%20Compliance%20Monitoring%20Program.pdf
[160] David Boughey (Australian Department of the Environment and Energy), in interview with the authors, March 2019.
[161] Barry O'Leary and Konnie Jonker (SAFEhouse), in interview with the authors, February 2019.
[162] David Boughey (Australian Department of the Environment and Energy), in interview with the authors, March 2019.

10) **Consider amending the NRCS Act** to allow for fines and penalties to be levied to aid enforcement. We understand from the DoE[163] that the process to amend the Act including the strengthening of penalties and the consideration for the NRCS to impose financial penalties is already underway.

11) Consider whether it is feasible to introduce self-declaration for certain categories of products where the risks associated with non-compliance are relatively low.

12) Invest in local laboratories to enable the testing of LED lamps against the compulsory specifications and make better use of existing test facilities. The UNDP has noted that it will be sourcing funding for the SABS to be able to acquire some of the laboratory equipment that is required to test LED lamps to the new MEPS. This will make it possible for them to do the full range of testing for LEDs in order to comply with new standard (including blue light hazard) in South Africa. Both NMISA and Eskom will be seeking accreditation for the laboratory equipment they have to test electric lamps, while they do not have the equipment to perform the full range of tests required by MEPS this will also boost local testing capabilities.

    The NRCS[164] noted that currently TACS have the best equipment of any laboratory and the regulator should consider making use of their private testing facilities.

5.11.2 Recommendations from stakeholders on complementary policies and programmes

Stakeholders interviewed also offered the following suggestions for complementary processes and programmes.

1) **Consumer Education –** LEDVANCE[165] noted that the most important complementary policies were consumer education, they have produced a consumer awareness infographic that allows consumers to assess and compare the full lifecycle cost of using different lighting technologies and have distributed the poster to several Builder's Warehouse stores. Massmart[166] reported that in partnership with Ellies and other energy efficient brands, a green product aisle campaign had had very successful in supporting customers to understand the benefits and availability of new technologies.

    Consumer awareness campaigns could include traditional and social media campaigns to educate consumers about lifecycle costs of different lamp technologies and the potential electricity costs associated with switching. A consumer awareness brochure has been designed by the UNDP standards and labelling programme together with a mark of endorsement from the DoE (see Appendix A).

    Consumer education may also include in-store promotions and campaigns such as discounts offered for switching to more energy efficient products and posters to explain the relative lifecycle costs of different lamp products.

    The authors raised the idea of accessing funding from sources such as the Department of Human Settlements Upgrading programme to replace inferior quality and inefficient lighting in informal settlements with better quality LED lamps. LEDVANCE[167] supported the idea of a government sponsored programme to grant-fund LED lamps (perhaps not high-end but of a reasonably good quality) for indigent (poor) communities as this would drive up awareness and also potentially

[163] Maphuti Legodi (DoE), in interview with the authors, February 2019.
[164] Patsy Andrews (NRCS), in interview with the authors, March 2019.
[165] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.
[166] Alex Haw (Massmart), in interview with the authors, March 2019.
[167] Nelo Neves, Dalette Britz and Nicollete Grobler (LEDVANCE), in interview with the authors, February 2019.

reduce the risk of shack fires occurring. LEDVANCE however did not support the idea of another nationwide mass-roll out programme such as those that Eskom undertook in 2010 as they said the procurement processes had been flawed and resulted in companies with inferior quality lamps being awarded contracts.

2) **Make energy efficiency labelling mandatory and** investigate whether it is possible to publish the relative lifecycle cost, for an assumed number of hours of use, on the box or price tag – it is understood that when MEPS is introduced, energy efficiency labelling for electric lamps (which is voluntary, will become mandatory).a sample of the existing energy efficiency label is provided in Appendix A. The existing label doesn't carry any information about cost in Rands and of using that product for a given period as consumers will not be aware of the magnitude of potential savings even after checking the energy efficiency rating. It would be useful in the author's (Nova Economics) view if the price tag or packaging could include an estimate of the relative lifecycle cost in say Rands per 7000 hours of use, using a standard set of assumptions about the input costs for a given period (e.g. electricity price). The main value would be in the relative cost so it would not be necessary to update the assumptions too often.

3) **Requirements for lamps installed in new property developments –** Eurolux[168] suggested that regulation to ensure that only quality and energy-efficient lighting products were installed in new developments be introduced. It is not clear in the author's view whether this could be implemented via existing green building standards and to what extent these standards overlap with MEPS.

[168] Patrick Stuckie and Eben Kruger (Eurolux), in interview with the authors, February 2019.

6. Economic modelling

6.1 Introduction

In order to quantify the potential socio-economic impacts of introducing technology-neutral regulation that will set MEPS for household lighting, we have used a widely accepted framework known as a cost benefit analysis (CBA). CBA provides a comprehensive assessment of the potential impact to society of introducing new regulation and a way to quantify the net impact in monetary terms.

CBA is also the framework specifically recommended by UNEP[169] for the assessment of the economic impact of regulation via MEPS for lighting in its guidance note for policymakers. The Australian and New Zealand Governments[170] completed a study in 2018 on the impact of introducing new regulation for LED lamps (and older technologies) that was also based on CBA. The study is recent and was very similar in scope and intent to this project. As such we have been able to draw quite extensively on their assumptions and approach in conducting the appraisal of the potential impact of MEPS for lighting in South Africa.

6.2 Policy options under consideration

CBA is a comparative approach and therefore the impacts of the proposed regulation must be defined in terms of 'policy option' scenarios which are then compared to a baseline or 'business-as-usual (BAU)' scenario. The following two policy scenarios have been modelled:

- **Business as Usual (BAU) -** There is no further regulation of the household lighting market. The existing compulsory specifications for CFLs, halogen and incandescent lights remain in place -
- **MEPS -** technology-neutral MEPS for general service lamps is introduced as per the technical specifications currently laid out in the draft regulation. We assume in this scenario that the NRCS and its partners (such as SARS) can carry out strong enforcement having significantly expanded and improved on current market surveillance activities.

In deciding which policy options should be modelled, several different options for the introduction of MEPS were put forward by stakeholders and were considered. These included:

- It was proposed by the DoE and UNDP that we consider modelling a MEPS scenario without the current concessions on minimum efficacy requirements (lm/W) that make it possible to import some energy efficient CFL lamps in the first 3 years post-regulation - in other words a scenario where imports of CFL are banned. The rationale for this is that CFLs contain mercury in small quantities which is harmful to the environment if used lamps are not correctly disposed of and it would be easier to enforce a ban at the borders. This practice is in line with the Minamata Convention to which South Africa is a signatory and deposited its instrument of ratification on 29 April 2019.
- We determined however that very few models of self-ballasted CFL (none of the ~80 that are currently being sold by general retailers) would meet even the more lenient requirements and

[169] UNEP. 2015. "Developing Minimum Energy Performance Standards for Lighting Products Guidance Note for Policymakers." www.unep.org/energy.
[170] Department of Energy and Environment, Commonwealth of Australia (2018) Decision Regulation Impact Statement Lighting.

as such there would be little difference between the scenario banning CFLs and the central MEPS scenario. In practice however, it may make more sense as a policy just to ban CFLs rather than restrict import via minimum energy-efficiency requirements alone, because the intention to effectively ban them will be clearer to suppliers and the consumer and it will be easier to enforce.

- It was proposed by suppliers that we model scenarios demonstrating the impact of low compliance. We decided it was better to model this as part of the sensitivity tests done on the analysis.
- It was proposed by one supplier that we consider a policy alternative where suppliers would still be able to import CFL and halogen lamps for which they had obtained LOAs under the existing VCs. This in effect delays the introduction of MEPS by 3 years and we have presented some results for this scenario in the sensitivity test section.

6.2.1 Business-as-usual scenario

The business-as-usual (BAU) scenario assumes no change to the existing regulations for household lighting (or general service lamps) in South Africa.

The natural trend towards increasing adoption of LED technology is expected to gradually continue as the relative price of LED lamps continues to fall. Consumers however would still be exposed to wide variation in product quality and performance, which will continue to constrain uptake by some consumers and suppliers will continue to import a higher proportion of inferior quality LEDs.

Information failures will remain, meaning consumers will have difficulty in making informed decisions to select more efficient, cost-effective alternative products. Consumers and businesses would continue to pay more for extra replacements and unnecessary electricity usage, losing out on potential electricity cost savings. Additionally, the safety of lighting is a concern, as consumers may be exposed to potential health (including flicker and mercury-containing lamps), fire and electrical hazards that may be associated with the use of inferior products. Finally, there are significant environmental costs associated with the use of inefficient lighting – the unnecessary electricity used is associated with greenhouse gas (GHG) emissions and CFLs contain mercury in small quantities which may have negative environmental impacts if the lamps are not correctly disposed of.

6.2.2 MEPS scenario

Introduce technology-neutral MEPS on GSL lamps at least cost to industry to remove inefficient and poor-quality electric lamps from the South Africa market including CFLs, halogens and inferior quality LEDs. Legislation requires consumers to purchase higher LED quality lamps, albeit at a slightly higher upfront cost initially, but we have assumed the real cost of LED lamps continues to fall over the period.

This option includes wherever possible the matching of test standards and levels with the IEC and CIE regulation (which the EU harmonises with) for technology-neutral MEPS on lighting and international electrical safety standards.

The application for registration on the NRCS product registration database will be automated to allow for faster processing, and a family of lamp models can be registered under one LOA.

The assumed timing allows stakeholders approximately 12 months to manage their stock levels before they are required to comply with the new regulation. More stringent (tier 2) lamp efficacy requirements come into force 3 years after the regulation is effective.

We have assumed in the central scenario that measures to increase market surveillance and generally to improve the enforcement of compulsory standards are introduced so that overall the enforcement of MEPS for general lighting is adequate to ensure compliance.

6.3 Cost Benefit Analysis

Cost Benefit Analysis (CBA) seeks to provide a comprehensive assessment of the net benefit of a project or programme to society that can be valued in monetary terms. CBA typically distinguishes between costs and benefits that accrue to various stakeholders of a particular programme or project and is frequently employed to establish the broader economic (rather than financial) viability of proposed investment programmes (infrastructure, research etc.).

While the calculation is, at face-value, quite simple, it can be a complex exercise as it is necessary to consider:

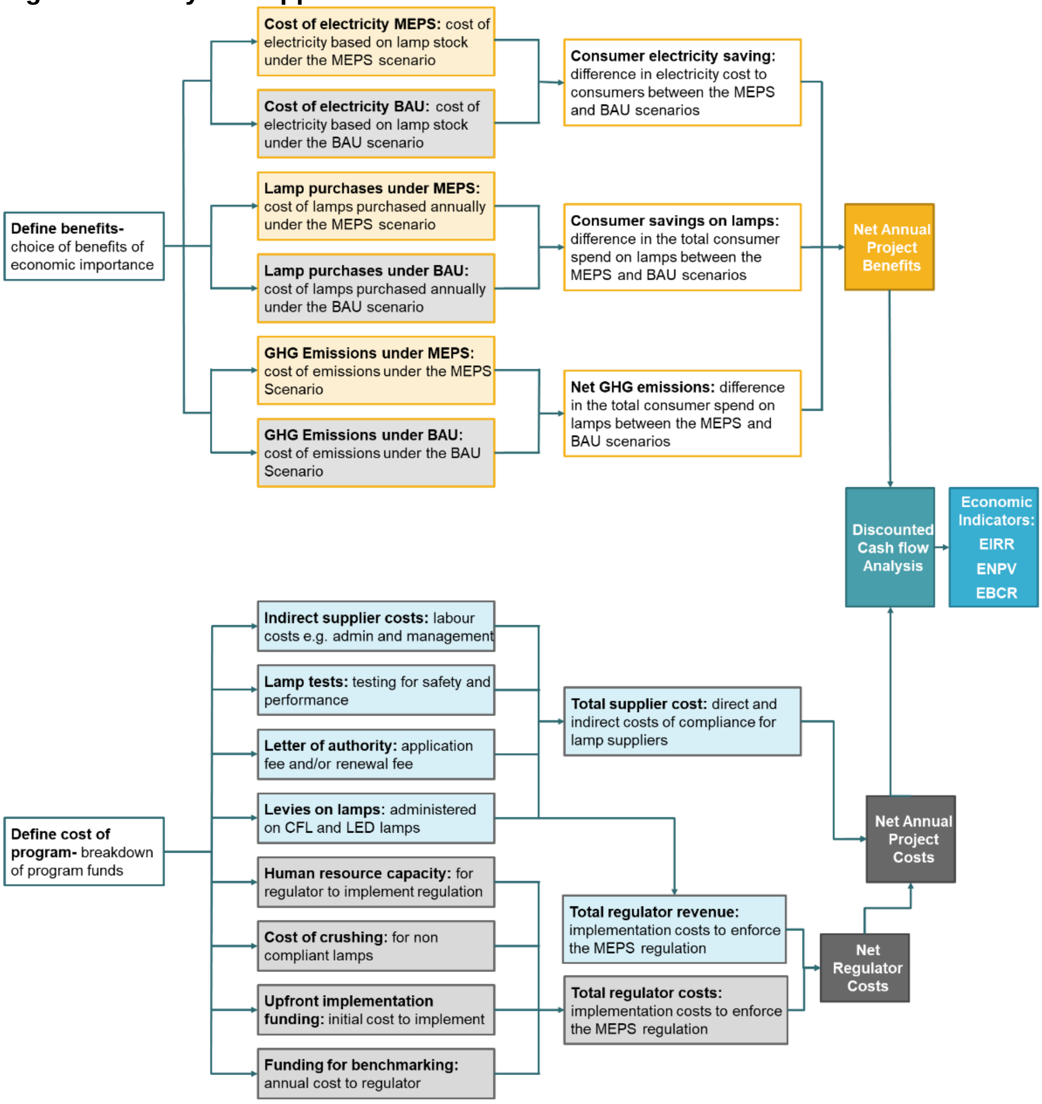
- The scope of the appraisal in terms of whether the impact assessment will be forward- or backward-looking; and the period over which the range of impacts will be realised into the future (in other words, how far beyond the last year of funding the programme benefits should be modelled bearing in mind that benefits in the outer years are usually much more uncertain and will often be heavily discounted).
- How to practically measure and monetise benefits including the monetary valuation of reduced electricity consumption, lower consumer spending on lamps and reduced GHG emissions.
- How to calculate impacts on lamp suppliers and manufacturers (of which there are none in SA) in terms of the cost of complying to the legislation
- The mechanics of the process including CBA inputs, project life, discount rate, aggregation of benefits and costs, unit of account.

The approach used here begins by defining the benefits of economic importance that will arise from the programme. Several methods are then used to quantify these economic benefits depending on information supplied and the available data. The programme costs are then identified and incorporated. Additionally, the supplier costs are estimated based on various inputs of cost of compliance. Both the benefits and the costs are then discounted back at the appropriate rate in a Discounted Cash Flow (DCF) analysis. Finally, various economic indicators are calculated based on the DCF.

6.4 Analytical approach to CBA of MEPS for household lighting

The analytical approach to the quantifying the potential economic impact of introducing technology-neutral regulation that will set MEPS for household lighting is summarised in Figure 28

Figure 28 Analytical Approach to the CBA



6.4.1 Defining the 'counterfactual' scenario

CBA is a comparative analysis so at the outset we define the reference or counterfactual scenario. In this case the counterfactual is a 'Business as usual' scenario, so all costs and benefits are assessed relative to a scenario in which the MEPS regulation is not introduced.

6.4.2 Defining benefits of the programme

We began the CBA process by defining the benefits that are expected to arise from introducing technology-neutral regulation that will set MEPS for general lighting. While the analysis should ideally include all impacts of the programme, it is more practical to exclude impacts that are likely to be insignificant to the overall result. Therefore, the benefits have been grouped into three categories for estimation (Figure 28). We identified the areas of significant benefit as:

1. Saving on electricity from using more efficient lamps
2. Reduced spend on purchasing lamps due to longer lamp lifetimes
3. Lower GHG emissions from the lower energy consumption.

6.4.3 Defining costs of the programme

Once the benefits had been defined, we assessed the expenditure required to introduce and enforce MEPS regulation. The costs of introducing MEPS are incurred by suppliers, who must comply to the new legislation, and the regulator who is tasked with enforcing it. The supplier costs include indirect costs, such as the management and administration required for compliance, as well as direct costs, such as LOA fees, lamp levies and costs of testing for performance and safety. The regulator incurs costs including the additional human resource capacity required for monitoring, verification and enforcement, the cost of crushing for non-compliant lamps and funding for benchmarking. An upfront implementation cost will also be incurred as the regulator sets up the necessary infrastructure to enforce the legislation. The costs the regulator incurs however are partly offset by the revenue it obtains from the LOA fees and lamp levies that suppliers pay (as illustrated in Figure 28). The net costs incurred by the regulator are its total costs less the total revenues from LOA fees and lamp levies.

6.4.4 Discounted cash flow analysis

Having identified the costs and benefits associated with each project alternative, we modelled the future stream of costs and benefits as an annual series of real cash flows, which were then discounted back to present values at the appropriate social discount rate.

6.4.5 Produce the key summary economic indicators

We used the cash flows from the CBA scenario to produce two key economic indicators:

- **The economic net present value (ENPV)** which is the sum of the discounted present value of the economic costs and benefits over the appraisal timeframe. An ENPV greater than zero represents a positive economic return. The ENPV represents the national net financial benefit of the program, providing the rationale for government fund these programs as net financial savings for the country can be used for more productive purposes
- **The benefit cost ratio (BCR)** which is the ratio of the present value of net economic benefits to the present value of economic investment costs. A BCR greater than one implies that the net economic benefits outweigh the net economic costs, thus representing a positive economic return.

These indicators provide a summary of the overall assessment of the economic value of the implementation of the MEPS legislation.

6.5 Discussion of the intended outcomes of the proposed regulation

A summary of the direct costs and the expected benefits of the MEPS regulation are presented in Table 19. As mentioned previously, the mandate of the NRCS is to maintain mandatory specifications in the interest of promoting public health and safety, environmental protection and to ensure fair trade.

- The primary objective of the proposed regulations is to improve the health, safety and economic welfare of all South African citizens, which can only be achieved through carefully considered and effective standards.

- Lighting is probably one of, if not the, most essential and basic energy services of every household; its usage is universal. Thus, meaningful energy savings, which is now possible due to recent technology advances, would have a significant impact on all South African households and would also lead to reduced overall electricity demand, especially during peak periods. With positive implications for the country's stated climate change goals of reducing its greenhouse gas emissions and usage of fossil fuels.

- The regulation is also expected to improve economic welfare as consumers who switch to more efficient and better-quality lighting products are expected to realise significant electricity cost savings.

Table 19 Summary of the direct costs and benefits associated with the MEPS Regulation

Estimated Costs	Expected benefits
Consumers • Consumers may, but not necessarily, have to pay more upfront to purchase higher quality lamps. CFLs can be more expensive than LEDs. • Potentially incurring additional costs to upgrade existing lighting systems to be compatible with LED lamps	Consumers • Electricity savings in the first year and replacement cost savings. • Health benefits – reduction in the harmful health and discomfort effects that are associated with use of inferior quality lighting products.
Government • Costs for implementing and enforcing the regulation (LOAs, enforcement, and crushing)	Government • Health cost savings – reduction in public health costs associated with health hazards, such as the mercury present in CFL lamps • A regulated market which reduces illegal imports and inferior products • Reducing peak demand. This is especially useful during periods of constrained supply (Eskom etc)
Suppliers • Suppliers will incur direct costs of complying with the regulations, costs of testing and obtaining LOAs etc. • Suppliers may also incur some indirect costs such as hiring additional human resources to manage compliance.	Environmental • Benefits to society, from reduced emissions and reduction in harmful pollutants into the atmosphere • Meeting the country's obligations on Minamata, GHG and NEES targets

6.6 Summary of key CBA parameters

A summary of the key parameters used in the CBA is provided in Table 20, each parameter is discussed in the relevant sections that follow.

Table 20 Summary of key CBA Parameters

Parameter	Value
Prices (Real vs nominal)	Real prices, 2019 market values
Unit of account	All values expressed South African Rand at market prices
Discount rate/STPR	2.3%
Key project dates	
Start date (Legislation takes effect)	01 January 2021
Quantification of costs and benefits	2020 onwards
Appraisal period	15 years (2021 to 2035)

6.6.1 Prices and unit of account

The appraisal is undertaken in real prices (inflation-adjusted) and all values are expressed in 2019 prices. Real prices rather than constant prices have been used (where possible the forecasted increase in real prices such as electricity tariffs has been included). The analysis is undertaken in market prices and expressed in South African Rands.

6.6.2 Social discount rate

The discount rate applied in cost benefit analysis can have two different applications – in one interpretation it reflects the social rate of time preference (i.e. the rate at which households are willing to trade a unit of present consumption for future consumption) or the rate that induces consumers in the borrowing country to save rather than consume) [171]. When applied to capital costs it should reflect the “opportunity cost” of capital (in real or inflation adjusted terms) or the likely return of funds in their best alternative use.

We estimate the Social Time Preference Rate (STPR) or social discount rate for South Africa in 2018 to be 2.3%. The reason for the lower estimates is that growth in GDP per capita, one of the key inputs to STPR has slowed in recent years. A detailed discussion of the choice of the estimation of the STPR can be found in Appendix B.

6.6.3 Appraisal Period

The appraisal period for the CBA is 15 years starting in 2020 and ending in 2035. This allows for a year for the regulation to take effect (in 2020), with it being enforced by the start of 2021

6.7 Estimation of cost of regulation

As discussed previously, there are two parties that bear the costs of introducing, complying with and enforcing MEP regulation – the first group are suppliers, who incur costs related to compliance with the regulation and the second is the regulator who incurs costs related to implementation and administration and enforcement. In this section we discussed the approach and assumptions used in the estimation of the cost of regulation. In South Africa the regulator is primarily funded by the LoA application fee and levies. The system was designed in this way to reduce the burden on the state, so effectively it is the consumer who pays the regulator’s costs as manufacturers pass these costs on. This strengthens the consumers argument for an effective regulator because they have paid for this service in advance

6.7.1 Supplier cost assumptions

Assumption about the number of suppliers

The starting point for calculating the cost to suppliers of implementing MEPS is the number of suppliers that will be affected by the legislation. Suppliers interviewed during the course of the project suggested that there are currently a large number of non-traditional suppliers importing unregulated LED lamps into the SA market with some suggesting that there may be as many as 1 000 (LEDVANCE, 2019). The NRCS (Riyano, 2019) however, confirmed that in mid-2017 as few as 13 to 20 firms had registered as suppliers of halogen and CFL lamps under the existing compulsory specifications. We have assumed, that this number will increase to 40 with the introduction of MEPS, and then by implication we assume

[171] Mackie, P., Nellthorp, J. and Laird, J., 2005. A Framework for the Economic Evaluation of Transport Projects. Transport Note No. TRN-5. Transport Notes–Economic Evaluation Notes, The World Bank, Washington, DC.

that many of the current firms importing small quantities of LED lamps will not have the capacity to comply with the MEPS regulation and will leave the market.

Assumption about the number of lamps to be registered with the NRCS

Next, we estimated the number of lamps that fall under MEPS. There were 400 different LED lamps that were identified in the Nielsen retail store dataset (before we truncated the sample at 85% of volumes sold). We have assumed that as LEDs replace CFL and halogen lamps, the number of models imported into South Africa will increase so have assumed a total of 750 types of lamp will be registered under MEPS with the NRCS.

Assumptions about the indirect cost of compliance

Compliance with the MEPS regulation will result in indirect costs for suppliers. Firstly, there will be administration required for compliance with the legislation. We estimate that one additional administrator would be required per supplier, with an annual salary of R140 000. Secondly, the process would require a manager to dedicate a portion of their capacity to compliance. We estimate that 25% of senior manager time would be required for overseeing compliance processes, with an annual salary estimated at R1 million.

Table 21 List of key assumptions and inputs for calculation of supplier costs

Parameter	Value	Source and notes
Key assumptions for indirect costs		
Number of suppliers	40	Internal estimate
Cost of employing an administrator per supplier	R240 000	Internal estimate
Cost of senior manager's time per supplier	R200 000	Internal estimate (25% of senior manager time at R800k per annum)
Key assumptions for direct costs		
Number of lamps	750	Estimate based on Nielsen data
LOA fees per application	R2 500	Cost per LOA provided by the NRCS
CFL lamp levies	R2.30	Cost per 10 lamps, provided by the NRCS
LED lamp levies	R2.30	Cost per 10 lamps, provided by the NRCS
Proportion of lamp models imported for which there is no existing test report	5%	Feedback provided from the NRCS stakeholder workshop held in May 2019
Performance testing per test	R30 000	Estimate based on quotes from laboratories
Safety testing per test	R20 000	Estimate based on quotes from laboratories

Assumptions about the direct cost of compliance

There are some direct costs associated with the implementation of MEPS (**Table 21**). Firstly, suppliers will need to apply for a letter of authority (LOA) for each lamp, and the application fee for these in 2019 prices is estimated by the NRCS at ~R2500 per lamp. There are currently levies on CFL lamps and these will also now apply to LED lamps. The NRCS proposed that this levy be set at **R2.30 per 10**

lamps imported in 2019 prices.[172] To calculate the total cost of levies to suppliers per year, the levy is multiplied by the lamps sales estimated in the model.

Suppliers may also incur costs related to obtaining a test report from an IEC accredited laboratory for compliance with the compulsory specifications. Suppliers will however only have to pay for test reports in cases where the manufacturer has not already obtained a test report demonstrating compliance with international standards similar to those established under MEPS in South Africa. We assume that suppliers will only need to pay for new test reports for 5% of total lamps imported since most lamps produced will already be exported to other countries that require precertification and test reports from an accredited laboratory. Based on quotations obtained from testing facilities, the cost of testing is assumed to be between R30 000 and R20 000 per lamp for performance testing and for safety testing respectively (Table 22).

6.7.2 Total supplier cost estimation

Based on the central set of assumptions, the total present value of costs to suppliers, as a group, is approximately R327 million. This is comprised of:

Indirect costs

- **Administration:** the annual cost of administration is estimated at R9.6 million which results in a net present value of R127 million over the 15-year period (between 2021 and 2035).
- **Management:** the annual cost of management is estimated at R8 million, resulting in a net present value of R106 million over the 15-year period (between 2021 and 2035).

Direct costs

- **LOA fees:** the annual cost of LOA fees for suppliers is estimated at R625 000, with a net present value of R8 million over the 15-year period (between 2021 and 2035).
- **CFL lamp levies**: the annual cost of CFL levies is dependent on the number of CFL lamps sold. The net present value of CFL levies is R3.6 million over the 15-year period (2021-2035).
- **LED lamp levies**: the annual cost of LED levies is dependent on the number of LED lamps sold. The net present value of LED levies is R74 million over the 15-year period (2021-2035).
- **Testing for performance and safety:** the annual cost, across all suppliers, of testing for performance is R375 000 and for safety is R250 000. This results in a net present value of R5 million for performance and R3 million for safety testing over the 15-year period (2021-2035).

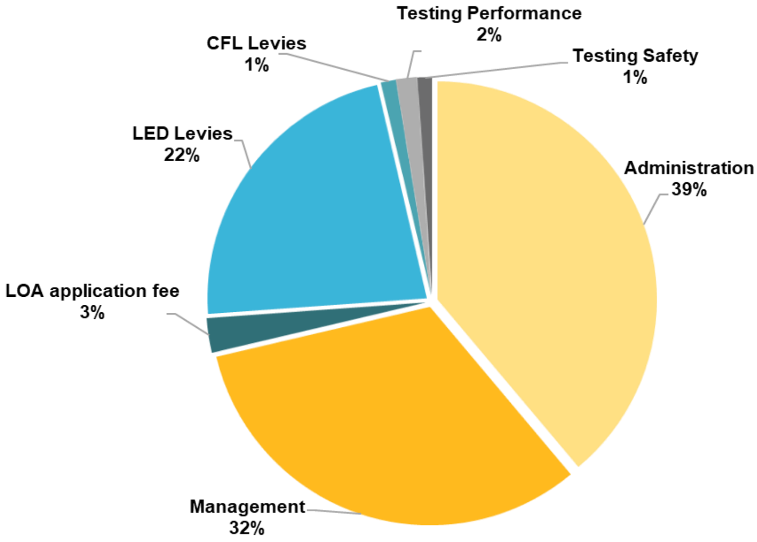
Table 22 Indicative costs for testing to safety standards for LEDs

Laboratory	Sample size	ıotation	ınd conversion (approximate)
LUX-TSI Limited, UK	10	2,220 (VAT incl.)	ı0,000
LUX-TSI Limited, UK (bulk quote for multiple models)	10 per model	1,080 (VAT incl.)	20,000
Intertek, UK	10	1,910 (unknown)	34,500
TACS Laboratories, South Africa	20		25,000

Source: Research by Alakriti

[172] It is expected that this levy will increase. At the time the estimates provided were 2.30. We have subsequently been notified by the NRCS that it will increase in 2020/ 2021

Figure 29 Composition of supplier costs as a result of complying with MEPS regulation



6.7.3 Regulator cost estimates

The NRCS will require a larger budget to be able to implement, administer and adequately enforce the proposed MEPS regulation. Part of this cost is offset by the revenue that will be collected from LOA fees and levies on lamps. This has been incorporated into the model by allocating these costs from the suppliers as revenue to the NRCS, which results in revenue of approximately R8 million in LOA fees and R77 million in lamp levies.

In terms of human resource costs, the NRCS currently employs qualified engineers as inspectors. The NRCS estimates that they would need to employ at least two additional inspectors to cover LED lighting and at least another one inspector to process LOAs but would prefer closer to a total of five new inspectors to carry out the administration and enforcement of MEPS. The inspectors are recruited as candidate inspectors and trained over a period of 2 years. We have assumed total additional human resource costs at R5 million per year.

In terms of additional costs related to enforcement, the NRCS expects to impound and destroy up to 500 000 lamps per year. At R2/lamp the annual additional cost for crushing will be R1 000 000 per annum – this is covered in part by the levies on lamps but in future it is hoped the contravener of the regulation will pay. There will also be upfront costs associated with implementation and benchmarking. These include international training (R400 000), Awareness and education workshops at SARS (R200 000), costs associated with training candidate inspectors (R1 200 000 per inspector in the first year). The total upfront cost of implementation and benchmarking has been estimated at ~R5 million.

6.8 Estimation of project benefits

This section gives an overview of the assumptions made and appraisal methods used in the estimation of the benefits. The key data inputs and assumptions used in the estimation of the project benefits are summarised in Table 26. These parameters are used as the basis for the three areas of benefits discussed below.

6.8.1 Electricity cost savings

With the introduction of MEPS residential consumers of electric lamps are expected to realise significant electricity cost savings. This is as a result of consumers switching to energy-efficient lighting (away from CFLs and halogen lamps to LEDs) more rapidly with the introduction of MEPS than they would have in the baseline or BAU scenario and being forced to purchase higher quality LEDs as inferior quality LEDs are removed from the market. A key part of this estimation is the electricity tariff, as these vary from metro to metro in South Africa. This is shown in Table 23 below.

Table 23 Electricity tariffs 2018/19 block of >600kWh/ month

Major Metropolitan Area	Incl Vat
Cape Town	R2.56
eThekwini	R1.74
Ekurhuleni	R4.17
Johannesburg	R1.86
Tshwane	R2.24
Average	**R2.51**

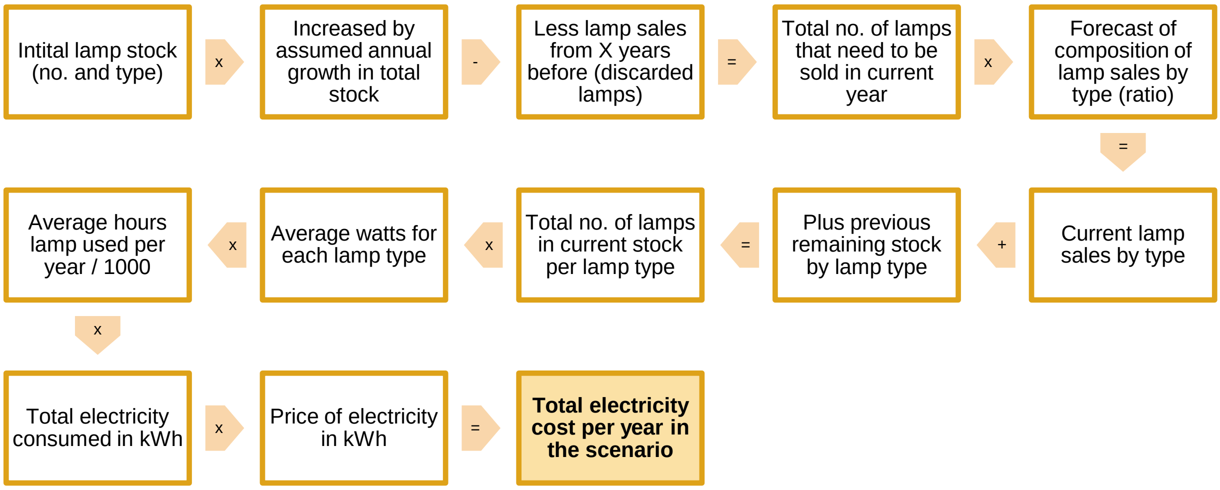
To examine the extent of electricity cost savings we estimated the electricity consumed under a MEPS scenario and then subtracted electricity consumed under the “business-as -usual scenario”.

The process of estimating electricity consumption in each scenario is illustrated in Figure 30. This was done by:

1. Estimating the initial size and composition of the lamp stock,
2. Multiplying initial lamp stock by assumed annual stock growth
3. Subtracting from the stock the historical sales of lamps that have exceeded their useful life
4. Equals the total number of lamps that need to be sold in current year
5. The total number is then multiplied by the forecast composition of lamp sales (based on historical trend in composition of lamp stock for BAU and adjusted to reflect impact of minimum energy-efficiency requirements on composition of sales for MEPS)
6. Equals the total current year’s lamp sales by type of lamp
7. This is added to the previous remaining stock by lamp type to arrive at the total no. of lamp in the current stock by type
8. These are then multiplied by the average wattage of each lamp and an assumption about the average number of hours each lamp in the stock is used per year divided by 1000 to give total kWh of electricity consumed in that year.
9. This is then multiplied by an assumption about the average cost of electricity in R/kWh to give the total cost of electricity consumed in that scenario in that year.

The net electricity cost saving is then the difference between total electricity cost in the BAU and the MEPS scenarios.

Figure 30 Process to forecast the total annual electricity consumption and cost per scenario



6.8.1.1 Initial size and composition of the lamp stock in South Africa

The starting point for the estimation of electricity cost savings was to estimate the size and composition of the total stock of lamps in South Africa.

The size of the total initial lamp stock of 176 million was estimated based on data from Statistics South Africa's General Household Survey, 2017, which provides information on the number of households in South Africa and the number of rooms per household. The methodology and data sources employed in estimating the size of the stock is described in detail in Section 4.3.1. The 176 million equates to sales of ~60 million lamps per year if the replacement cycle is 3 years, which is close to estimated imports of general use lamps of 78 million per year.

The initial composition of stock (proportion of lamps of each technology) was based on the three years of historical retail sales data from Nielsen. This is likely to be a fairly accurate reflection as any halogen, incandescent and CFL lamps sold before this data would likely have been replaced and there were very limited sales of LED lamps before mid-2015.

Table 24 Lamp sale composition via general retailers (actual) and other channels (estimates)

Market share	Nielsen POS data (average 3 years)	Supplier estimates (2019)
(%)	General retailers	Hardware, wholesales, independent
	25%	75%
	(e.g. PnP, Shoprite, Game, Clicks etc.)	(e.g. Makro, Agrimart, Builders, Boxer)
LED	14%	32%
CFL	52%	45%
Halogen	33%	17%
Incandescent	1%	5%
Speciality	0.6%	1%

Source: Own analysis, based on Nielsen trade desk data and supplier survey

Since only about 25% of lamps sold to households are sold via the general retailers that the Nielsen data represents, the composition of the total stock was adjusted to reflect feedback from a few of the large suppliers that LEDs and incandescent lamps account for a slightly higher proportion of total sales via the other residential market channels (e.g. bulk hardware, electrical contractors and independents)(Table 24). Data on the assumed size and composition of the initial stock of lamps in South Africa is presented in Table 25.

Table 25 Assumptions about the composition and size of the initial lamp stock

Type	% In. stock	Initial Stock
LED	16%	28.8 million
Medium Quality	13%	22.6 million
High Quality	3%	6.2 million
CFL	54%	95.6 million
Halogen	25%	43.4 million
Incandescent	5%	8.1 million
Total Lamp Stock		175.9 million

6.8.1.2 Estimating total number of lamps to be sold in a given year

In order to estimate the total number of lamps that need to be sold in the current year in order to maintain overall stock of lamps (block 4 in Figure 30) we had to make an assumption about the average annual growth in lamp stock in South Africa. We assume the stock grows gradually by 0.8% per year, aligned with the growth in residential building plans passed and the growth in real disposable income.

We then estimate the total number of lamps that need to be sold in the current year by subtracting the number of lamps that need to be replaced that year from the total stock. The number of lamps that need to be replaced are estimated as total sales per category (e.g. LED, CFL) from X years before, where X is the lamp lifetime that varies by technology. Halogen lamps, for example are assumed to last for 2 years on average while LEDs are assumed to last for 8 years; (Table 26)

Table 26: Lamp assumptions for project benefits

Type	Avg. Watts	Avg. Price	Lifetime	Hours
LED				
Medium Quality	8.16	R30	8 years	
High Quality	5.90	R32	8 years	
CFL	13.45	R31	5 years	
Halogen	54.18	R24	2 years	
Incandescent	60.60	R46	1 year	
Average hours lamp used per year (2.2 per day)				802

6.8.1.3 Forecast of composition of lamp stock by type

The composition of annual lamp stock by type (e.g. LED, CFL etc.) in the BAU vs. the MEPS scenario is one of the key drivers the electricity cost savings. As discussed previously, we assume that the lamp stock grows at a rate of 0.8% per annum. We then subtract the lamps that are estimated to have failed in that year and add the sales from that year to estimate the lamps stock in that year

The composition of lamp stock in the BAU scenario is shown in Figure 31, and demonstrates a case where the lamp composition gradually changes over time, with the proportion of CFL and Halogen lamps decreasing and the two types of LED increasing . The forecast composition of stock for the MEPS scenario, as illustrated in Figure 32 is the same as the BAU until 2021 when MEPS comes into force and stops the sale of CFL and halogen lamps, which then slowly fade out of the lamp stock. Lower quality LEDs are no longer sold from 2023 and the quantity of stock decreases over time.

Figure 31: Lamp stock composition per year (2019-2034) in BAU scenario

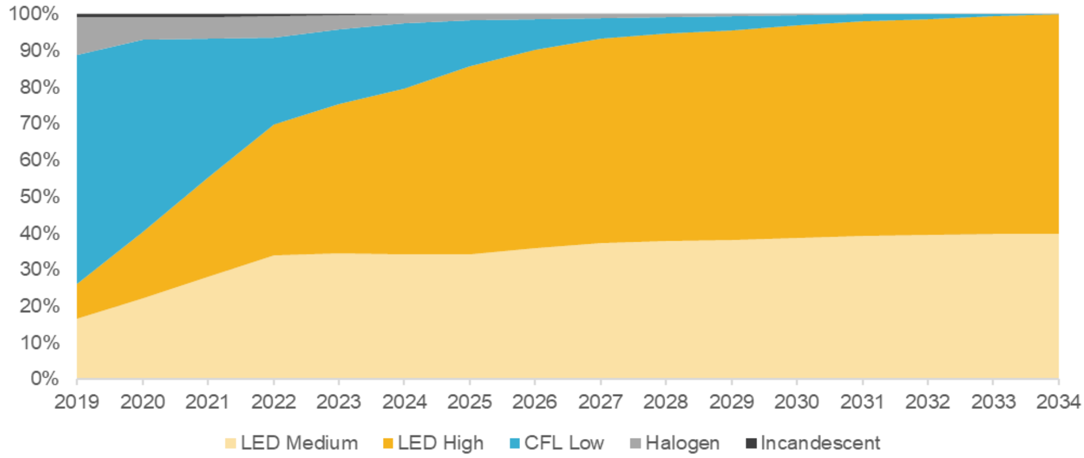
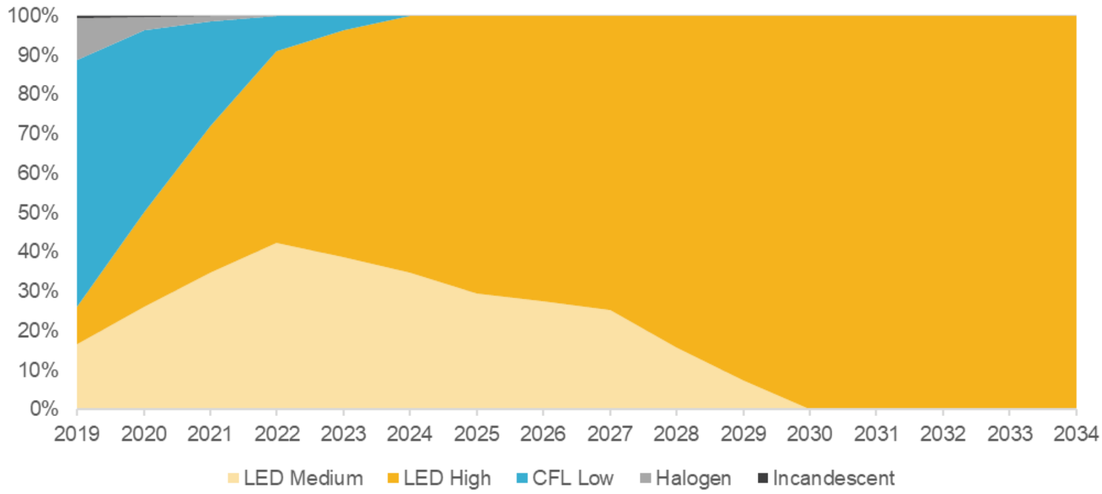


Figure 32: Lamp stock composition per year (2019-2034) in MEPS scenario



6.8.1.4 Forecast of composition of lamp sales by type

One of the key set of assumptions that drive the electricity cost savings is the forecast of the composition of annual lamp sales by type (e.g. LED, CFL etc.) in the BAU vs. the MEPS scenario.

Assumptions about the composition of lamp sales in the BAU scenario are based on extrapolating the existing historical trends and see the share of CFLs for example reducing from 55% of sales in 2018 to just 9% of sales by 2026 (**Figure 33)**. The forecast composition of sales for the MEPS scenario is the same as the BAU until 2021 when MEPS comes into force and eliminates CFLs and halogen lamps from the market. Lower quality LEDs are also eliminated from 2023 (as illustrated in Figure 34).

The difference in the forecasts of the composition of sales drives the energy cost savings. To estimate the current stock, we add estimated annual sales of lamp by type to the previous years' remaining stock by type. We then multiply this by assumed average wattage by type and our assumption about the average hours a lamp is used per day (see Table 26) and divide by 1 000 to arrive at an estimate of total electricity consumed and saved in kWh.

We then multiplied this by the average prices of electricity which was estimated as an average of municipal tariffs for residential consumers in the inclining tariff block (where relevant of >600kWh per month consumption with exception of Ekurhuleni where tariffs for the block for >600kWh and >700kWh are averaged as tariff is so much higher than other municipalities) across major metropolitan areas. We also assumed a real annual average price increase of 4% y/y for 10 years effective from 2020 (Table 23).

Figure 33: BAU: Forecast composition of sales by lamp type (2017 to 2035)

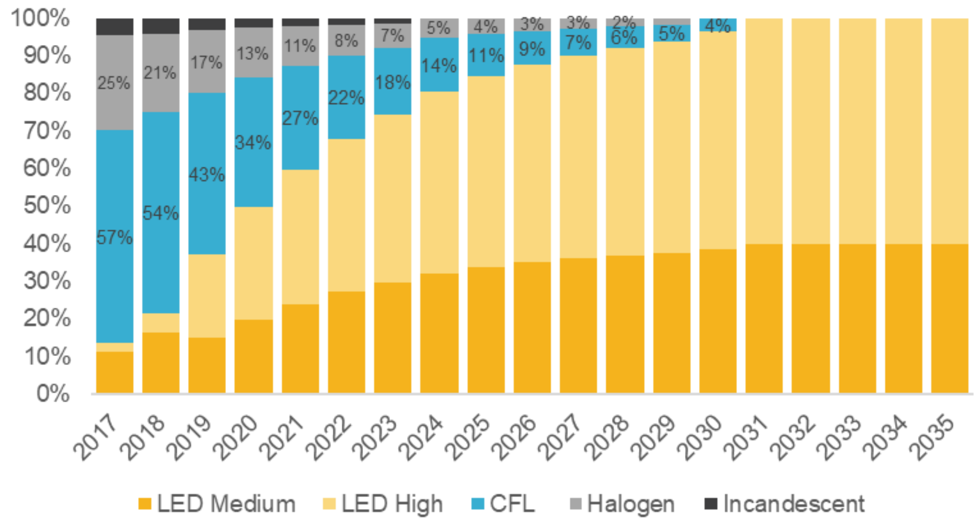
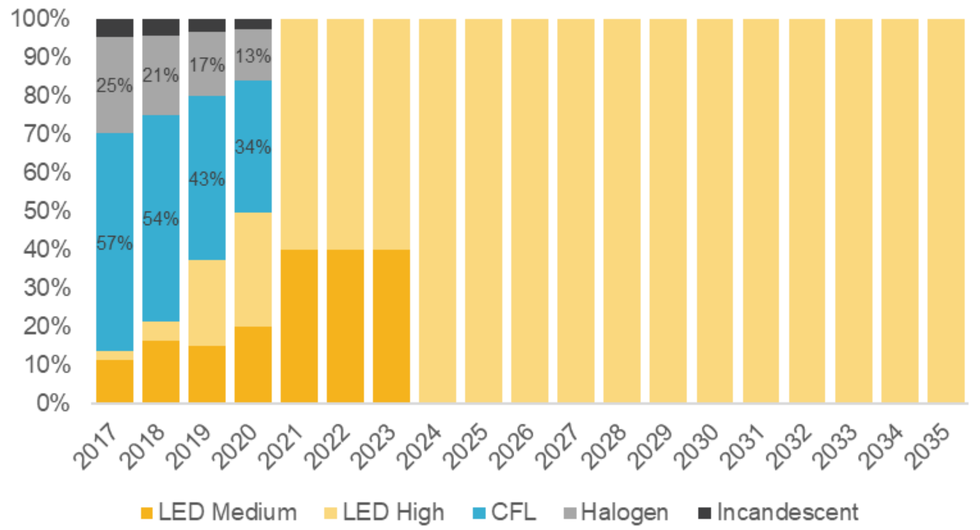


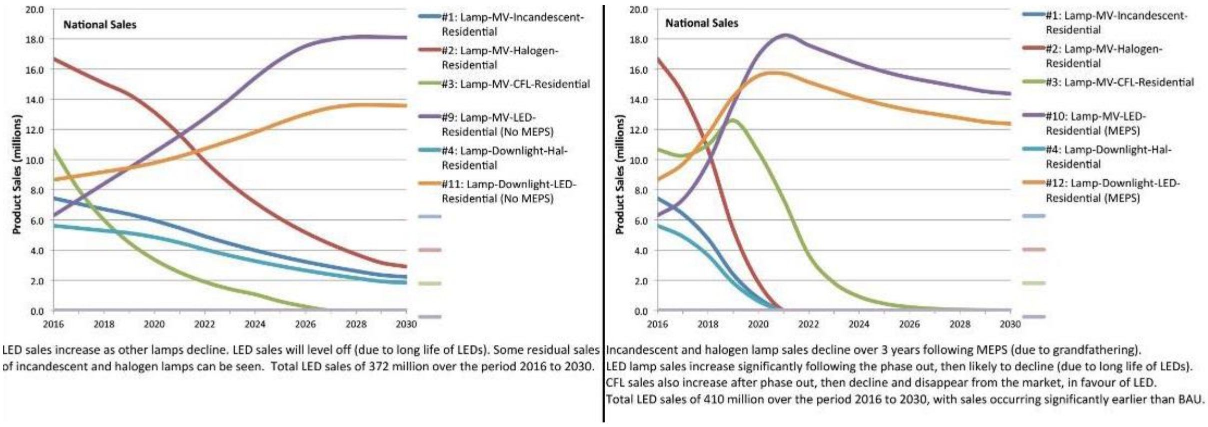
Figure 34: MEPS: Forecast composition of sales by lamp type (2017 to 2035)



6.8.1.5 Comparison of lamp forecasts to Australian forecasts

The sales forecasts for the implementation of MEPS in South Africa are based on extrapolation of the trends historical retails sales in South Africa. The assumptions about the trend in composition of sales (between lamp technologies) is also informed by the Australian MEPS model. The figure below is from the Australian MEPS report and shows the BAU sales (left) compared to the MEPS sales (right).

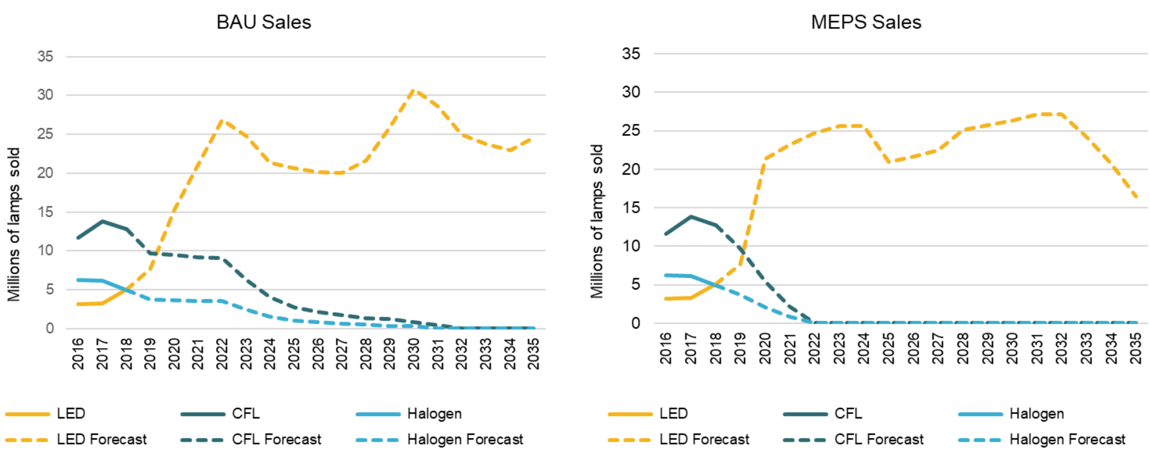
Figure 35 Australian lamp sales forecasts for BAU (left) and MEPS (right)



The figures below are the sales volumes used in the CBA for South African MEPS, with the BAU scenario on the left and the MEPS scenario on the right. The forecasting has been done on the basis of lamps needing to be sold to maintain lamp stock, including factoring in a reasonable growth rate for this lamp stock. The result is a seasonality in the LED sales in both scenarios as a result of the need to replace halogen and CFL lamps.

In the figures below, the historical trend of sales is indicated by the solid lines while the forecasts are indicated by the dotted lines. The forecasts are calculated by first determining the total number of lamps that will be purchased in that year. Then, the lamp sales for halogen and CFL lamps are determined as the proportion of lamps purchased in the previous year multiplied by a reduction factor of 20%. Therefore, if sales of halogen lamps are 10% of the total in one year, they will be 8% of the total in the following year. This is in line with the trend in the composition of sales in the Australian BAU scenarios.

Figure 36 South African lamp sales forecasts for BAU (left) and MEPS (right)



6.8.2 Reduced spend on lamps replacement

LED lamps have a longer lifetime than other lamp technologies. Therefore, the introduction of MEPS regulation is expected to result in a lower replacement costs for the consumer over time, as lamps need to be replaced less often.

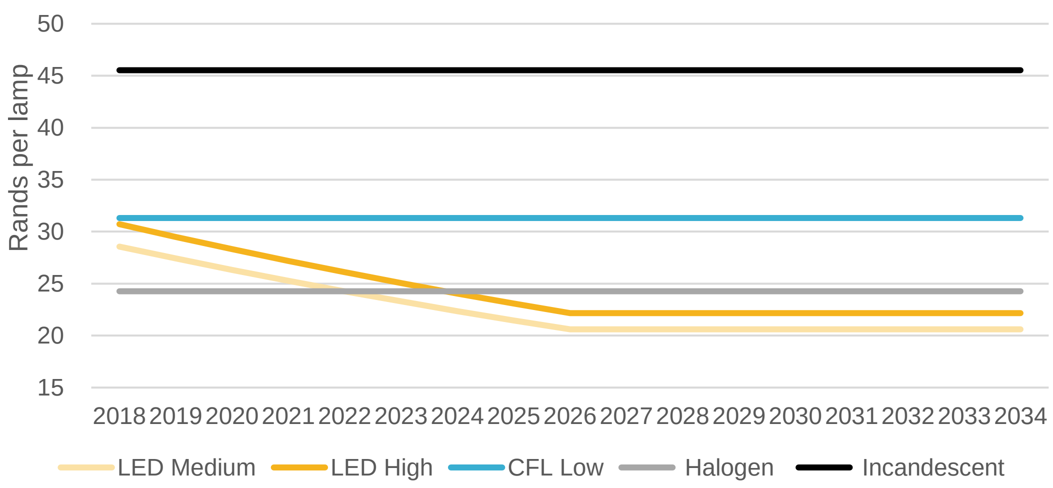
To examine the impact of this, we estimated the sales under a MEPS scenario and a "business as usual scenario". This was done by estimating the number of lamps that are required by consumers based the lamps that failed in that year, plus the growth in lamp stock. This produces the estimated sales for the year. The sales are then allocated per category of technology based on the historic sales and whether legislation is introduced to impact this allocation. Finally, this is multiplied by the estimated price of lamps to give the total lamp sales for each category.

The net benefit is calculated as the different between the BAU lamp sales and the MEPS lamp sales

6.8.2.1 Lamp price forecast assumptions

The initial lamp price estimates are based on Nielsen data and these prices are assumed to remain constant in real terms (inflation-adjusted), except for LEDs, the price of which is assumed to decrease in real terms by 4% year-on-year until 2026 – this assumption is in line with the LED price trajectory assumed in the Australian study on the impact of MEPS[173]. The average watts are also based on the Nielsen data, as a weighted average of the watts in the different lamps in the data.

Figure 37: Forecast decrease in real lamp prices over appraisal period



6.8.3 GHG emissions reduction

If effective, the regulation is expected to result in a reduction in energy consumption and associated greenhouse gas emissions which will support South Africa in achieving its stated climate change goals.

The calculation of the GHG emissions is based on the electricity consumption in each scenario. We assume CO_2e per MWh of 1.01 tons based on the Eskom Integrated Report of 2016 and a carbon price of R120/ton of CO_2e based on the rate at which a carbon tax will be introduced in South Africa from

[173] Department of Energy and Environment, Commonwealth of Australia (2018) Decision Regulation Impact Statement Lighting.

2020. This is multiplied by a carbon tax value to attain an estimated cost of GHG emissions per scenario. The net benefit is calculated as the different between the BAU GHG cost and the MEPS GHG cost.

6.9 CBA results - central scenario

The key results for the economic evaluation of the introduction of MEPS in South Africa based on the assumption for our central scenario are summarised in Table 27.

Table 27: Summary CBA results, STPR of 2.3%

Summary of Impact Measures	Central Scenario
Total Benefits (PV)	**R 12 130 115 225**
Total Supplier (PV)	**-R327 189 547**
Total Regulator Costs (PV)	**-R115 619 493**
Economic Net Present Value (ENPV)	**R 11 687 306 185**
Benefit Cost Ration	**27.4**

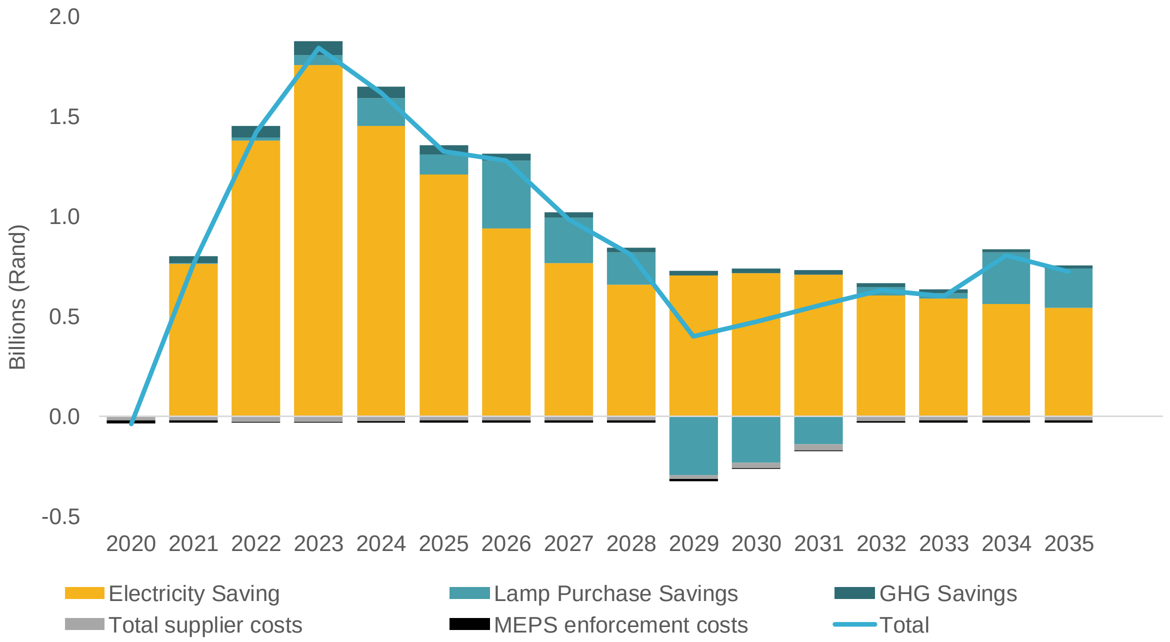
The results show that introducing MEPS for general lighting is expected to yield significant, positive net economic benefits for the South African economy. The total present value of the economic benefits is calculated to be just over R12.1 billion over fifteen years. The present value of the costs incurred by suppliers is estimated at R327 million while the present value of costs that will be incurred by the regulator are estimated at R116 million. This results in an estimated Economic Net Present Value (ENPV) of R11.7 billion over the 15-year period of measurement.

The benefit-cost ratio is 27.4, which means that the present value of the project benefits is more than 27 times the present value of the costs of introducing and enforcing the regulation.

A summary of the composition of the economic benefits on an annual basis is presented in Figure 38. The annual electricity savings are shown in yellow, the lamp purchase savings in teal, the GHG savings in dark teal. The supplier costs are shown in grey and the regulator costs are shown in black. The blue line shows the net cost benefit for each year of the model.

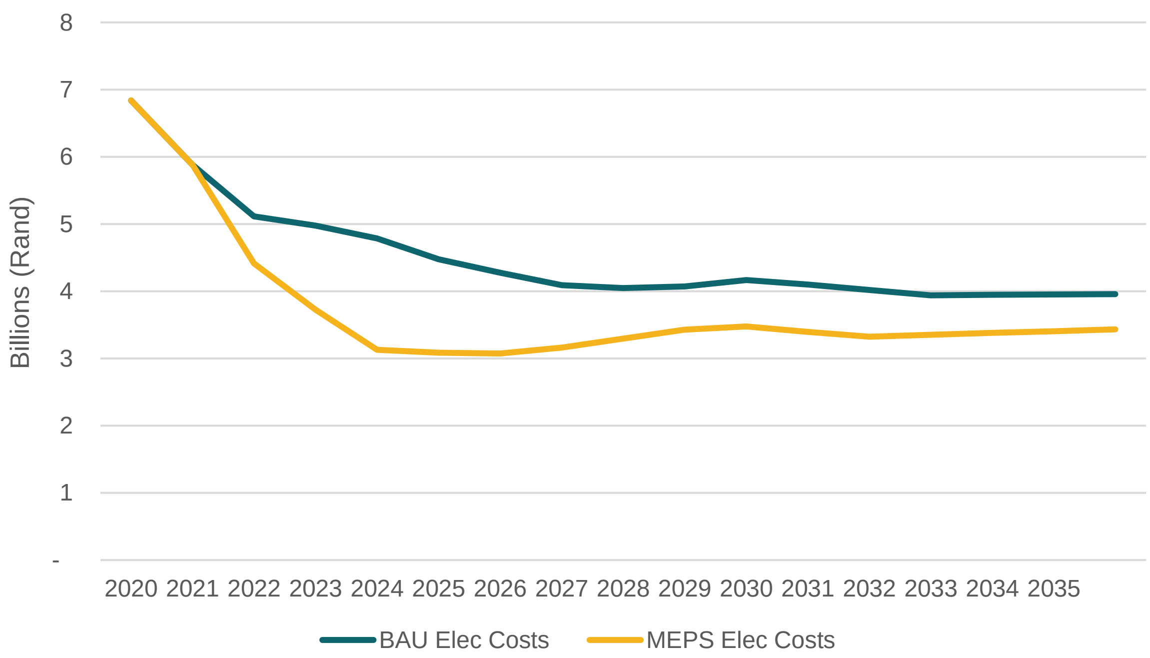
Initially, the net impact is negative, as some costs related to implementation of MEPS and training of human resources are incurred before the regulation takes effect. From 2021, the regulation becomes effective and electricity cost savings are by far the predominant benefit realised. The electricity cost savings realised peak in 2023 when the more stringent requirements for efficacy in lm/W takes effect. The negative lamp purchase savings that take place between 2029 and 2031 are attributable to a sharp increase in lamp replacement costs. The sharp increase in LED lamps purchased when MEPS comes into force 2021, results in negative lamp purchase savings when they all suddenly need to be replaced eight years later. The proposed regulations enacted in 2021 will result in 192 kt of CO_2 emissions reduction per year in 2030 and a total estimated CO_2 4 105 kt over the period of measurement, contributing toward South Africa's international engagement in fighting Climate Change through its National Determined Contribution. At a carbon price of R120 per tonne, the net present value is R410 million, with an annual net benefit of R22 million a year by 2030.

Figure 38: Composition of CBA net benefits between 2019 and 2035



The final year of quantification is 2035, at which point there is an estimated benefit of R721 million per year. The significant benefits in the earlier years are the result of the electricity costs associated with assumed rapid switching from CFL and halogen lamps to LED technology. This begins to plateau as the BAU scenario eventually catches up to the MEPS scenario, but in 2035 consumers are still assumed to buy a higher proportion of quality LEDs under MEPS than under the BAU.

Figure 39: Total electricity costs under MEPS and BAU over the appraisal



6.10 Sensitivity of results to changes in key parameters

The results of the CBA present a positive economic case for implementation of MEPS. However, the results of the economic evaluation are potentially sensitive to the assumptions made for a few important parameters. The key parameters, in our view, include the discount rate, the level of compliance and whether the implementation of the regulation is delayed. The sensitivity of the results of the economic evaluation to the key assumptions made during the analysis is tested on the following three scenarios. The results are presented in Table 28.

- **Scenario 1: Low compliance with only 33% of the market complying**
- **Scenario 2: Use of a 6.0% discount/STPR rate as opposed to 2.3%.**
- **Scenario 3: Delay MEPS by three years**

Table 28: Results of sensitivity tests (R millions)

Summary of Impact Measures	Central Scenario	Low compliance (33%)	Discount rate (6%)	Delay by 3 years
Total Benefits (PV)	**R 12 130**	**R 3 979**	**R 9 111**	**R2 347**
Total Supplier (PV)	**R 327**	**R 486**	**R 250**	**R 329**
Total Regulator Costs (PV)	**R 115**	**R 11**	**R 86**	**R113**
Economic Net Present Value (ENPV)	**R 11 687**	**R 3 503**	**R 8 776**	**R1 905**
Benefit Cost Ratio (BCR)	**27.4**	**8.4**	**27.2**	**5.3**

6.10.1 Scenario 1: Low compliance with only 33% compliance

The lack of adequate market surveillance and enforcement of compulsory specifications in South Africa was consistently raised by stakeholders during the consultation process as one of the major risks to the implementation of technology-neutral MEPS for lighting. Stakeholders noted that without a significant improvement in enforcement of compulsory standards by the NRCS and its partners (e.g. SARS) many of the expected benefits associated with MEPS, including the expected electricity cost savings for consumers, would not materialise.

We therefore modelled a scenario with very low enforcement, where only 33% of the market complies with the regulation. This is not meant to be a realistic scenario; it is meant to illustrate the impact of an extreme scenario where the majority of suppliers do not comply. In reality, we would expect that most major formal retailers will comply with MEPS. In the low enforcement scenario, the total net benefit associated with MEPS is reduced to R3.5 billion from R11.7 billion under the central assumptions and the BCR falls from 27.4 to 8.4. This demonstrates that inadequate enforcement would greatly reduce the expected benefit associated with MEPS and that given the relatively low costs associated with improving enforcement (as compared to the expected benefit that can be delivered to consumers), every effort should be made to see that adequate market surveillance and investigation of non-compliance is undertaken by the NRCS and its partners.

6.10.2 Scenario 2: Higher discount rate

In this scenario, we tested the impact of using a higher discount rate. The central scenario uses the STPR calculated in Annexure I of 2.3%. In this scenario, we use an alternative discount rate which is closer to the opportunity cost of capital of 6.0% which is our estimate of the real cost of capital invested in South Africa between 2010 and 2013 (Table 28). In the higher discount rate scenario, the total net benefit associated with MEPS is reduced to R9.1 billion from R11.6 billion under the central assumptions but because both the costs and benefits are discounted at a higher rate the BCR decreases from 27.4 to 27.2.

The use of a higher discount rate scenario does significantly reduce the net present value of the expected net benefit associated with MEPS, but the benefit-cost ratio and consequently the economic case for introducing MEPS, remains very high at 27.2. The reason this is similar to the previous benefit-cost ratio is that the timing of the cash flows is similar between the costs and the benefits. The ratio would be significantly different if, for example, the costs were incurred upfront and the benefits accrued in subsequent years.

6.10.3 Scenario 3: Delay MEPS by three years

As noted in the problem statement regulation of electric lamps in South Africa has lagged technological developments by a number of years, reducing the opportunity for regulation to promote a more rapid switch to energy-efficient lighting as consumers gradually make the transition to new technologies in the absence of regulation.

It was proposed by one supplier that we consider a policy alternative where they are able to import CFL and halogen lamps for which they had obtained LOAs under the existing VCs. This in effect delays the introduction of MEPS by three years and we report on the results of this scenario in this section.

In the delay MEPS scenario, the total net benefit associated with MEPS is reduced to R1.9 billion from R11.7 billion under the central assumptions and the BCR actually decreases from 27.4 to 5.3. Since the net economic benefits are greatly reduced when MEPS is delayed, there is a strong case for implementing MEPS as soon as possible to maximise the economic benefit associated with implementing the regulation as the market will gradually make a transition in the absence of MEPS and a significant opportunity to realise electricity cost savings in the near term will be lost. This scenario also demonstrates why it is important for the regulation to keep up with technological developments.

6.10.4 Additional sensitivity considerations

There are two other key assumptions that were considered in the process of conducting sensitivity analysis on the CBA model. The first is the phase out of CFL lamps in the business-as-usual scenario and the second is the growth rate of the national lamp stock, which has been set at 0.8%. Both of these assumptions have been set at a very conservative level, and it was therefore important to examine the impact on the model if the assumptions were set less conservatively.

The estimated phase out of CFL lamps under BAU is based on the Australian MEPS CBA report and the historical sales trends in the Nielsen data. However, the phase out of CFL under BAU in South Africa may not be as rapid, given that the market and consumers differ significantly from those in Australia. Therefore, we modified the market share of CFL under BAU to test whether this would have a significant impact on the model, which resulted in CFLs comprising of 15% of the market in 2025 as opposed to 11% in the original model. This resulted in the BCR moving from 27.4 to 30.2. Indeed. 15% remains conservative given the barriers identified in the study and there remains a reasonably high likelihood that CFLs will persist in the market for in greater numbers and for longer than what has been modelled.

The second factor to be tested was the growth rate of the lamp stock, which was changed from a conservative 0.8% per annum to 2.5% per annum. This was in line with the recommendation from stakeholders, as they noted that the DoE has forecast the lamp stock to be 239 million in 2030. The original growth rate resulted in a lamp stock in 2030 of 193 million lamps, while the higher growth rate resulted in the lamp stock increasing to 237 million lamps, which is more in line with the DoE estimate. This meant that the BCR changed from 27.4 in the central scenario to 32.0 in the higher growth scenario. Again, this increase underlines the overall conclusion of a strong positive case for the introduction of MEPS.

6.11 Conclusions

The results of the CBA present a strong positive case for the introduction of technology-neutral MEPS for general service lighting in South Africa. Taking all results of the CBA into account (central assumptions and sensitivity testing scenarios) an economically viable outcome is very likely.

Under the central assumptions, the net economic benefit of the project is expected to amount to R11.7 billion over the 15-year period and the benefit-cost ratio is 27.4, which means that the present value of the project benefits is more than 27 times the present value of the costs of introducing and enforcing the regulation.

The present value of the costs incurred by suppliers under the central scenario is estimated at R327 million while the present value of costs that will be incurred by the regulator are estimated at R116 million. This results in an estimated Economic Net Present Value (ENPV) of R11.7 billion over the 15-year period of measurement.

The sensitivity tests on the analysis show that the economic case for implementation of MEPS remain robust under a range of alternative assumptions, including higher discount rates, lower enforcement and delaying implementation by three years.

The results of the low enforcement scenario also reinforce the view of stakeholders that the lack of adequate market surveillance and enforcement of compulsory specifications in South Africa is one of the major risks to the implementation of technology-neutral MEPS for lighting. In the case of low enforcement (33%) the total net benefit associated with MEPS is reduced to R3.5 billion from R11.7 billion under the central assumptions and the BCR falls from 27.4 to 8.4. This demonstrates that inadequate enforcement would greatly reduce the expected benefit associated with MEPS and that given the relatively low costs associated with improving enforcement (as compared to the expected benefit that can be delivered to consumers), every effort should be made to see that adequate market surveillance and investigation of non-compliance is undertaken by the NRCS and its partners.

A higher discount rate has limited impact on the economic case for regulation as the future stream of costs and benefits are quite evenly distributed over time and the scenario had not impact on the BCR relative to central assumptions.

The sensitivity analysis shows that a delay in the implementation of MEPS is one of the most significant risks to the economic case for introducing the regulation as it would greatly reduce the expected net benefit.

The modelling of a three-year delay under Scenario 3 demonstrates that by delaying implementation by just three years, the total net benefit associated with MEPS is reduced to R1.9 billion from R11.7 billion under the central assumptions and the BCR actually decreases from 27.4 to 5.3. As a result, much of the expected benefit associated with the introduction of MEPS, including the potential electricity cost savings would be lost. There is a strong case for implementing MEPS as soon as possible to maximise the potential economic benefit associated with more rapid switching to energy-efficient lighting. This scenario also demonstrates why it is important for the regulation to keep up with technological developments.

Considering all the scenarios discussed above, we concluded that there is strong and positive economic case for the introduction of technology-neutral regulations to set MEPS for general household lighting in South Africa. The economic case for implementation of MEPS remained positive and robust under a range of alternative assumptions. The key risks to the economic case for the introduction of MEPS are a potential delay in implementation of the regulation and very low levels of enforcement (33%) of the compulsory specifications. Modelled in isolation, the impact of each of these scenarios was that they reduced the expected net economic benefit by more than two-thirds relative to the central scenario.

7. References

7.1 Interviews

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Debowski, M. and Nkosi, N. 2019. Signify MEPS Interview. Interview with Talisa Du Bois. 12 March 2019, Skype, South Africa.

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Qwabe, S. and Fourie, T. 2019. SABS MEPS Interview. Interview with Kay Walsh, Rowan Spazzoli, and Talisa Du Bois. 27 February 2019, SABS Head Office, Pretoria, South Africa.

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7.2 Research documents

SCHEER (Scientific Committee on Health, Environmental and Emerging Risks). 2018. *Opinion on Potential risks to human health of Light Emitting Diodes (LEDs)*. Accessed online, March 2019. Available at:

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Appendix A

I. Letter from the Department of Energy sent with email invites

DE 10

energy
Department:
Energy
REPUBLIC OF SOUTH AFRICA

Private Bag X96; PRETORIA; 0001; Matimba House; 192 C/o Visagie & Paul Kruger Street; PRETORIA; 0001
Enquiries: Xolile Mabusela Tel: 012 406 7697 Email: Xolile.mabusela@energy.gov.za

29 January 2019

Introduction to Nova Economics and Request for Support for Lighting Study

Dear Sir/Madam,

The Department of Energy (DoE) together with the National Regulator for Compulsory Standards (NRCS) are proposing to introduce technology neutral technical regulation that will prescribe minimum energy and performance standards (MEPS) for general residential electrical lighting products.

Your organisation has been identified as a representative of one of the key stakeholder groups and we would greatly appreciate if you would lend your support and expertise to the process by making yourselves available for an interview with the appointed consultants – Nova Economics (Pty) Ltd.

The NCRS and DoE wish to understand the potential socio-economic impact that the proposed regulation may have on consumers and industry the regulation is expected to result in energy savings, to reduce peak electricity demand and yield environmental benefits. However, the proposed regulations also have costs and implications for business which must also be understood and assessed.

To this end, the DoE and NCRS, with support from the United Nations Development Programme (UNDP), have commissioned Nova Economics to deliver a cost-benefit analysis of the impact of Introducing Technology Neutral Regulations that set MEPS for General Illumination Purposes. Nova Economics is a specialist economic and strategy consultancy.

While the NCRS will be carrying out a formal stakeholder engagement process on the impact of the proposed regulation, the interviews that Nova Economics will be conducting are a parallel and complementary process to obtain data and insights that are specifically required to deliver the cost-benefit analysis.

If you have more questions regarding this study, please do not hesitate to contact Theo Covary on theo.covary@undp.org, or Maphuti.Legodi@energy.gov.za

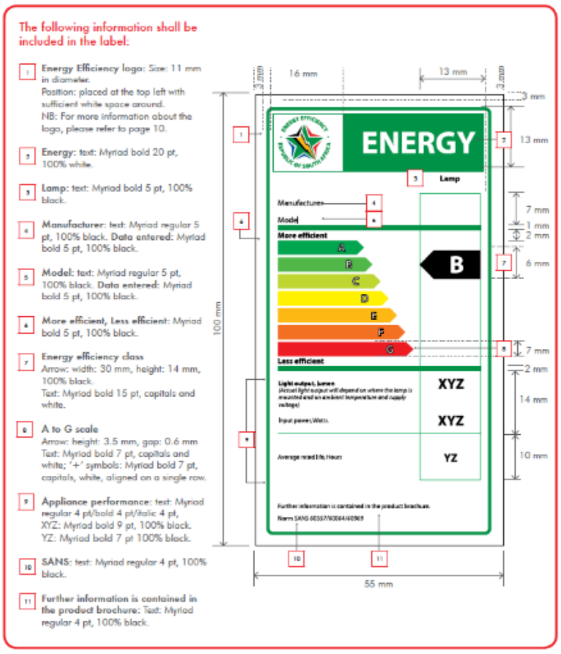
Yours sincerely,

Mr Xolile Mabusela
Director: Energy Efficiency Initiatives
Date: 29/01/2019

II. List of stakeholder interviews

Stakeholder Groups & Organisation		Interview Date	Representatives
Public Sector	NRCS	26 February 2019 4 March 2019	Lancerlot Riyano Langa Jele Stephina Teffo Patsy Andrews
	SABS	27 February 2019	Theo Fourie Sihle Qwabe
	DoE	13 February 2019	Maphuti Legodi Xolile Mabusela
	Eskom	26 February 2019	Andre Blignaut
Core Technical Group	NMISA	26 February 2019	Natasha Nel-Sakharova
	Beka	26 February 2019	Daniel Kasper
	Eskom	26 February 2019	Andre Blignaut
	IESSA	26 February 2019	Alex Cremer Henk Rotman
Largest Suppliers	Aurora Lighting	10 May 2019	Alan de Kocks
	Ellies	12 February 2019	Shaun Nel
	Signify (Philips)	12 March 2019	Maciej Debowski Nelisiwe Nkosi Shaun Tate Eric Hall
	Ledvance (OSRAM)	12 February 2019	Dalette Britz Nelo Neves Nicollete Grobler
	Eurolux	14 February 2019	Gerhard van Staden Patrick Stuckie Eben Kruger
	Radiant	Declined due to merger	Jabu Khumalo
Local Manufacturing	LED Concepts	Visited in April 2018 for related project.	Eric Levi
	eLighting	15 July 2019	Craig Smith
	Ledwise	No response	TBD
	Afrison	No response	TBD
	EconLED	5 March 2019	Barry Tree
	Pioled	No response	TBD
Other	UNDP	13 February 2019	Marcia Lephera Theo Covary
	GEMS Regulator, Australia		David Boughey
	TACS Labs	27 February 2019	Joel Ndaba Frederick Nkosi
	CLASP	5 March 2019	Michael Scholand
	IESSA	26 February 2019	Henk Rotman
	SAFEHouse	26 February 2019	Barry O'Leary and Konnie Jonker
	Massmart	5 March 2019	Alex Haw

III. Existing energy-efficiency label for electric lamps



IV. Consumer awareness brochure – electric lamp choices and energy department mark of endorsement

Appendix B

Technical note on the estimation of the social time preference rate for South Africa

I. Introduction

A public investment programme typically incurs costs and generates benefits at different points of time. The purpose of discounting, is to express all costs and benefits in present value terms, making project alternatives with costs and benefits occurring in different periods more comparable. There are two arguments for why the stream of future costs and benefits should be discounted in order to make them comparable:

The first is that it has been widely observed that consumers have a positive time preference – they would rather receive a unit of goods or service now than in the future. The literature on this subject[174] suggests that the reasons for this include:

- The greater risk and uncertainty attached to the realisation of future benefits
- Consumers expect to be consuming more in future and as such expect their marginal utility from consuming to decline in future.
- Consumers are impatient or myopic and therefore place a higher value on present consumption.

The social time preference rate (STPR) is therefore the rate at which households are willing to trade a unit of present consumption for future consumption or the rate that induces consumers in the project country to save rather than consume[175]. There are various methods suggested for estimating the STPR.

The second argument which takes the perspective of an investor is that the discount rate in CBA is required to reflect the opportunity cost of capital:

> *"The opportunity cost of capital is estimated by looking at prevailing return on investment in South Africa and adjusting this for inflation. The national treasury estimates that the average inflation-adjusted (real) rate of return on investment in South Africa between 2001 and 2013 was 8.5% and from 2010 to 2013 it was 6%."*[176]

Multi-lateral development institutions such as the World Bank and Asian Development Bank recommend that a country-specific STPR is estimated and used as a discount rate (in preference to market-related opportunity cost of capital).

The formula most commonly used to estimate the STPR is Ramsey's formula which is defined as:

$r = \rho + \mu . g$

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[174] Zhuang, J., 2007. Theory and practice in the choice of social discount rate for cost-benefit analysis: a survey.

[175] Mackie, P., Nellthorp, J. and Laird, J., 2005. A Framework for the Economic Evaluation of Transport Projects. Transport Note No. TRN-5. *Transport Notes–Economic Evaluation Notes, The World Bank, Washington, DC*.

[176] Department of Energy., 2016. Draft Integrated Energy Plan for South Africa.

Where:

- r is the STPR
- ρ is the pure time preference rate – the rate at which individuals have been observed to discount future consumption over present consumption assuming no growth/change in per capita consumption
- µ is the marginal elasticity of consumption – the rate at which a consumer's marginal utility from consumption declines as total consumption grows
- g is the expected growth in per capita consumption.

II. Estimation of the STPR for South Africa

In a 2013 Cost-Benefit Analysis[177], Du Preez *et al.* estimate the STPR for South Africa to be 2.9%. This was based on the following assumptions:

- µ is the marginal elasticity of consumption was set at a value of 0.5
- ρ is the pure time preference rate was set equal to the average death rate in South Africa of 1.91 from 2006 to 2010.
- g is the expected growth in per capita consumption was estimated using average annual growth GDP per capita from 2006 to 2010 which was 2%.

We estimate that the STPR for South Africa in 2016 is 2.3% based on the following assumptions:

- We assumed the rate of pure time preference ρ is 1.5%. Evans and Sezer[178] suggest that it should be 1% in Europe and 1.5% in emerging and developing market to reflect higher risk of a catastrophic event occurring.
- Following HM Treasury guidelines[179] we assumed that the elasticity of marginal utility of consumption µ is 1, meaning than an incremental increase in consumption for a generation that has twice the consumption of the current generation, will reduce the utility by half.
- We have assumed average real per capita GDP growth of 0.8%. According to data from the World Bank growth in real GDP per Capita averaged 0.8% over the period 2007 to 2016. In the period 1997 to 2006 real GDP per capita expanded at an annual average rate of 2%.

[177] Du Preez, M., Beukes, J. and van Dyk, E., 2013. A cost-benefit analysis of concentrator photovoltaic technology use in South Africa: A case study. *Journal of Energy in Southern Africa*, *24*(4), pp.02-11.

[178] Sezer, H. and Evans, D., 2004. Social discount rates for six major countries. Applied economics letters, (9), pp.557-560.

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Table 29: Estimates of the STPR for South Africa, using data from previous 10 years

		r (%)	g (%)	q	STPR (%)
South Africa	2007	1.5	2	1	3.5
	2016	1.5	0.8	1	2.3

III. Long-term discount rates

Discounting at even a modest rate, such as 2.3%, reduces the value of costs (or benefits) several hundred years hence to almost zero. While discounting at a single rate over time has been common practice in CBA since it was first introduced, the practice has come under scrutiny in recent years with many studies including Oxera[180] and the Stern Review[181] suggesting that high discount rates disenfranchise future generations from consideration in today's decisions.

The UK Treasury suggests that where the appraisal of a proposal depends materially upon the discounting of effects in the very long term, a lower discount rate for the longer term (beyond 30 years) should be used. The main rationale for declining long-term discount rates results from uncertainty about the future. The HM Treasury guidelines[182] suggest discount rate of 3.5% used in the United Kingdom for example should fall by about 0.5 percentage points beyond 30 years.

This approach is based on the Stern Review, is largely applied to environmental projects where there are intergenerational (equity) considerations. One of the main criticisms of this method is that it mixes efficiency and equity considerations. For South Africa a social discount rate of 1.4% is used in the Stern Review.

IV. Recommendations on the discount rate for MEPS legislation

We recommend using a social discount rate of 2.3% as the central discount rate and running sensitivity tests on a discount rate of 3.5% (2007 discount rate in higher growth period) and 6% (real opportunity cost of capital invested from 2010 to 2013).

[180] Oxera, A., 2002. Social Time Preference Rate for Use in Long-term Discounting.

[181] Treasury, H.M.S., 2006. Stern review on the economics of climate change. London: HM Treasury, 30.

[182] H M Treasury. 2011. The green book: Appraisal and evaluation in Central Government. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf

Appendix C

Product testing: summary of findings

A sample of ten LED lamps from nine different suppliers were purchased from retail outlets and tested to obtain an indication of (i) the quality of lamps currently in the market and (ii) consistency of products with the information provided on packaging. The test sample was chosen to include some of the best sellers in the market and also a variety of LED lamp brands and includes the lamps listed in Table 31.

Table 30: LED lamps purchased for testing

Brand	Lamp type	Wattage	Lumens	No. of units tested	Price range[183]	
Osram	A60	8.5W	806	3	High end	>R30
Philips	A60	5W	500	3	Mid-range	R20 to R30
Ellies	A60	5.5W	450	3	High end	>R30
Simple Choice	A60	6W	480	3	Budget option	<R20
Eurolux	A60	6W	500	3	Budget option	<R20
PicknPay	A60	7W	600	4	Mid-range	R20 to R30
Light Worx	A60	5W	475	4	High end	>R30
Lumaglo	A60	5.5W	450	3	Mid-range	R20 to R30
Lumaglo	A60	5.5W	450	3	Mid-range	R20 to R30
Luceco	PAR 16, GU10	3.5W	250	3	Mid-range	R20 to R30

Testing was done by Eskom's Swan Edison Illumination Laboratory[184] located at its Research and Innovation Centre in Rosherville, Johannesburg. The laboratory is one of only a few in South Africa that can test all the colour parameters of lamps and equipped with all the instruments required for the testing, and research and development (R&D) of lighting.

Product testing assessed actual performance of the lamps against the product information provided on the packaging. While the sample sizes were not adequate for formal market surveillance testing, every model had at least three models purchased and tested, thus they are indicative of typical market performance.

Time and testing limitations did not allow for all parameters such as life expectancy, flicker and electromagnetic compatibility (EMC) or interference (EMI) to be included within the available timeframe.

I. Consistency between performance and product information

[183] Budget option priced below R20 per lamp; Mid-range priced between R20 and R30 per lamp; High end priced above R30 per lamp

[184] The Eskom laboratory is in the process of finalising accreditation through SANAS

In general, the LED lamps tested met their stated performance parameters. A few exceptions are highlighted in the discussion below. More complete test results on all models are available in Table 31.

Light levels (lumens). Lumens indicate the light output or brightness a consumer can expect from the specific product. Historically, levels of light output were associated with the wattage of an incandescent lamp (ICL), as each wattage represented a corresponding level of brightness. New (more efficient) technologies therefore often use an equivalence claim (for instance “equivalent to a 60W” ICL) to help consumers understand the lighting level they can expect. With these new technologies in the market, communication opportunities now exist to raise consumer awareness regarding lumens as the correct measure of brightness, shifting away from ICL equivalency statements.

Two of the ten models tested overstated their light output, both doing so by at least 15%. This is especially significant considering that these are initial lumen values and they will decrease over the life of the lamp. Two lamps claimed an equivalence to a 60W ICL, but only one met the required equivalent light output.

Power rating and power consumed. The power rating (W) of a lamp indicates the amount of electricity it will use to operate, which is the energy (kWh) it will consume when burning over a period of time. When efficacy is not clearly itemised (refer below), the provision of the correct wattage is a critical consideration in selecting more efficient lighting products.

Among the test sample, all products either accurately estimated their power use or use less than claimed.

Efficacy. A lamp that provides more light (lumens) relative to its power use (W) will have a higher efficacy (lm/W) and thus will provide more cost-efficient lighting to the consumer.

Only three lamps stated their efficacy (lm/W). Two of these met the claimed efficacy value, and the one that did not comply also stated equivalency to a 60W ICL, which it did not meet.

Colour temperature. Colour temperature is indicative of the quality of white light to expect. A lower Kelvin value (e.g. 2,700K) indicates a warmer or more ‘yellow’ white light that resembles incandescent light, while higher Kelvin values (e.g. 6,500K) indicate a cooler, bluish white light. Colour temperature is an important consideration for ambiance, as it creates the ‘feeling’ in a room.

Colour temperature of all lamps fell within a 5% variation from the stated value, with 80% of the lamps with less than 2.5% variation. One of the budget lamps showed significant variation between the three units tested, with the variation visually detectable and results ranging between -4.38% and +4.25% of the stated Kelvin value.

Colour rendering. The colour rendering index (Ra) is an old metric that indicates how the light spectrum of the lamp under test compares to the spectrum of a reference ICL. It provides an indication of how well certain colours will appear under the lamp’s light. CRI Ra is the regulated metric, and it refers to a set of 8 colours. Ra is the indicator most typically used for LED lighting.

All the lamps met or exceeded the stated colour rendering claims.

Power factor. Five lamps stated a power factor on the packaging. Of these, one product did not meet the claimed power factor, overstating it by more than 20%.

II. Comparison with proposed regulatory requirements in VC 90XX

According to the draft regulation (VC 90XX), compliance testing requires a sample size of 10 units. Models tested in this market assessment consisted of either three or four units, thus the results are indicative but not conclusive.

Efficacy (Lumens/Watt). An average was calculated for the available units, the average value rounded and then compared to the Tier 1 and Tier 2 requirements of the draft regulation (i.e. 80 and 95 lm/W, respectively). All but one of the lamp models already met the Tier 1 requirement. The one lamp that did not, might have passed had a larger sample been tested as it failed by a very small margin. The test results showed that two of the models already met the Tier 2 requirement, including one of the mid-range priced products. This suggests that the proposed legislation could aim for slightly more ambitious efficacy requirements, with minimal impact to the industry but significant benefits to the country. The draft regulation has been amended accordingly, reducing the time period between Tier 1 and Tier 2 from three years to two.

Colour Rendering Index (Ra). All the lamps tested met the minimum CRI Ra specification of 80.

MacAdam ellipse calculations. These calculations test colour consistency against the regulatory requirement that the variation of chromaticity coordinates fall within a five-step MacAdam ellipse or less. As anticipated from the colour variations observed during the colour temperature measurements (refer above), one lamp failed on colour consistency with the test sample not all sitting within one Five-Step MacAdam Ellipse.

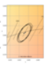
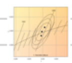
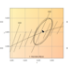
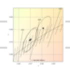
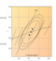
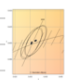
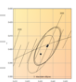
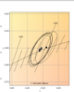
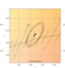
Fundamental Power Factor. The draft VC does not propose to regulate on Power Factor, but Displacement Factor (also called Fundamental Power Factor). All lamps in the sample met the minimum fundamental power factor requirement for their measured wattage.

From this sample of lamps purchased and tested, it would appear that the lamps being imported into South Africa and sold by the major formal sector retailers are of a reasonable quality and that packaging is generally consistent with the product. Three of the ten lamps tested however did not meet efficacy or energy-efficiency (lm/W) implied by the specifications on the packaging, two of the three were not as bright (in lm) as the packaging suggested and the third was less energy efficient than specifications implied because the power factor was much lower than reported. It would also appear that price is not necessarily a direct indicator of quality since measured performance did not correlate directly with price across the small sample.

Table 31: Comprehensive test results

Number	Manufacturer	Lamp Description	Flux (lm)				Power (W)				Efficacy (lm/W) of 2019 models				
			Stated	Measured	Sample Avg	Variation	Stated	Measured	Sample Avg	Variation	Stated	Measured	Sample Avg	Tier 1 (2021)	Tier 2 (2023)
DP1	Osram	8.5W ww LED lamp B22	806	800			8.5	8.4			95	95.2			
DP2	Osram	8.5W ww LED lamp B22	806	807			8.5	8.5			95	95.0			
DP3	Osram	8.5W ww LED lamp B22	806	800	802	-0.5%	8.5	8.3	8.4	-1.2%	95	96.4	95.53	80, pass	95, pass
DP4	Philips	5W ww LED Lamp E27	500	522			5	5.3			100	98.6			
DP5	Philips	5W ww LED Lamp B22	500	498			5	5.1			100	97.6			
DP6	Philips	5W ww LED Lamp B22	500	494	505	0.9%	5	5	5.1	2.7%	100	98.8	98.31	80, pass	95, pass
DP7	Ellies	5.5W ww A60 LED Lamp B22	450	474			5.5	5.1			82	92.9			
DP8	Ellies	5.5W ww A60 LED Lamp B22	450	463			5.5	5.2			82	89.0			
DP9	Ellies	5.5W ww A60 LED Lamp B22	450	450	462	2.8%	5.5	5	5.1	-7.3%	82	90.1	90.68	80, pass	95, fail
DP10	Simple Choice	6W cw A60 LED Lamp E27	480	507			6	6.3			–	80.5			
DP11	Simple Choice	6W cw A60 LED Lamp E27	480	516			6	6.3			–	81.9			
DP12	Simple Choice	6W cw A60 LED Lamp E27	480	476	499	4.0%	6	6.2	6.3	4.4%	–	76.7	79.68	80, pass	95, fail
DP13	Eurolux	6W ww LED Lamp B22	500	535			6	5.9			–	90.7			
DP14	Eurolux	6W ww LED Lamp B22	500	533			6	5.8			–	91.9			
DP15	Eurolux	6W ww LED Lamp B22	500	543	537	7.4%	6	5.9	5.9	-2.2%	–	92.0	91.54	80, pass	95, fail
DP16	PnP	7W ww LED Lamp B22	600	488			7	6			–	81.4			
DP17	PnP	7W ww LED Lamp B22	600	486			7	6.1			–	79.7			
DP18	PnP	7W ww LED Lamp B22	600	488			7	6.1			–	80.1			
DP19	PnP	7W ww LED Lamp B22	600	487	487	-18.8%	7	6.2	6.1	-12.9%	–	78.5	79.90	80, pass	95, fail
DP20	Light Worx	5W ww LED Lamp B22	475	403			5	4.8			–	84.0			
DP21	Light Worx	5W ww LED Lamp B22	475	393			5	4.7			–	83.5			
DP22	Light Worx	5W ww LED Lamp B22	475	399			5	4.7			–	84.9			
DP23	Light Worx	5W ww LED Lamp B22	475	404	400	-15.8%	5	4.8	4.8	-5.0%	–	84.2	84.15	80, pass	95, fail
DP24	Lumaglo	5.5W ww A55 LED Lamp B22	450	451			5.5	5.7			–	79.2			
DP25	Lumaglo	5.5W ww A55 LED Lamp B22	450	449			5.5	5.6			–	80.2			
DP26	Lumaglo	5.5W ww A55 LED Lamp B22	450	448			5.5	5.8			–	77.2			
DP27	Lumaglo	5.5W ww A55 LED Lamp B22	450	438			5.5	5.4			–	81.0			
DP28	Lumaglo	5.5W ww A55 LED Lamp B22	450	446			5.5	5.7			–	78.3			
DP29	Lumaglo	5W ww A55 LED Lamp B22	450	459	448	-0.4%	5	5.7	5.7	2.7%	–	80.5	79.39	80, fail	95, fail
DP30	Luceco	3.5W ww LED Lamp GU10	250	294			3.5	3.7			–	79.4			
DP31	Luceco	3.5W ww LED Lamp GU10	250	285			3.5	3.7			–	77.1			
DP32	Luceco	3.5W ww LED Lamp GU10	250	299	293	17.1%	3.5	3.7	3.7	5.7%	–	80.8	79.10	68, pass	81, fail

Table 32: Comprehensive test results (continued)

Number	Manufacturer	Correlated Colour Temperature (CCT)				Colour Consistency				Power Factor		Displacement Factor (Fundamental Power Factor)			CRI Ra			
		Stated	Measured	Sample Avg	Variation	x	y	MacAdam (5 steps)		Stated	Measured	Calc. DF	Minimum DF	Pass/Fail	Stated	Measured	Sample Avg	Variation
DP1	Osram	2700	2695			0.4597	0.4096			–	0.559				–	81.7		
DP2	Osram	2700	2707			0.4579	0.408			–	0.559				–	81.8		
DP3	Osram	2700	2711	2704	0.2%	0.4577	0.4081	Pass		–	0.556	0.848	0.5	Pass	–	81.9	82	Pass
DP4	Philips	3000	3026			0.4334	0.3999			–	0.543				70	83.3		
DP5	Philips	3000	3052			0.4340	0.4043			–	0.545				70	83.1		
DP6	Philips	3000	3032	3037	1.2%	0.4373	0.4088	Pass		–	0.544	0.939	0.5	Pass	70	82.7	83	Pass
DP7	Ellies	3000	2959			0.4400	0.4053			0.5 ± 10%	0.518				> 80	82.1		
DP8	Ellies	3000	2975			0.4395	0.4062			0.5 ± 10%	0.519				> 80	81.8		
DP9	Ellies	3000	2952	2962	-1.3%	0.4405	0.4055	Pass		0.5 ± 10%	0.516	0.626	0.5	Pass	> 80	82.0	82	Pass
DP10	Simple Choice	4000	4143			0.3756	0.3781			≥ 0.5	0.558				–	82.4		
DP11	Simple Choice	4000	3825			0.3915	0.3915			≥ 0.5	0.559				–	82.7		
DP12	Simple Choice	4000	4170	4046	1.2%	0.3744	0.3770	Fail		≥ 0.5	0.555	0.938	0.5	Pass	–	82.5	83	Pass
DP13	Eurolux	3000	2923			0.4438	0.4085			≥ 0.5	0.54				≥ 80	82.0		
DP14	Eurolux	3000	2926			0.4423	0.4059			≥ 0.5	0.533				≥ 80	82.1		
DP15	Eurolux	3000	2930	2926	-2.5%	0.4406	0.4029	Pass		≥ 0.5	0.536	0.927	0.5	Pass	≥ 80	82.0	82	Pass
DP16	PnP	3000	2963			0.4408	0.4074			> 0.6	0.464				> 80	82.0		
DP17	PnP	3000	3017			0.4361	0.4044			> 0.6	0.464				> 80	82.5		
DP18	PnP	3000	3020			0.4365	0.4056			> 0.6	0.463				> 80	82.1		
DP19	PnP	3000	2971	2993	-0.2%	0.4401	0.4070	Pass		> 0.6	0.467	0.945	0.5	Pass	> 80	82.1	82	Pass
DP20	Light Worx	3000	3012			0.4353	0.4022			–	0.451				–	81.6		
DP21	Light Worx	3000	3005			0.4361	0.4029			–	0.453				–	81.3		
DP22	Light Worx	3000	3006			0.4357	0.4023			–	0.45				–	81.3		
DP23	Light Worx	3000	3050	3018	0.6%	0.4305	0.3966	Pass		–	0.453	0.517	0.4	Pass	–	82.0	82	Pass
DP24	Lumaglo	3000	3059			0.4335	0.4041			–	0.504				–	80.9		
DP25	Lumaglo	3000	3066			0.4335	0.4050			–	0.499				–	81.1		
DP26	Lumaglo	3000	3083			0.4319	0.4036			–	0.502				–	81.0		
DP27	Lumaglo	3000	3075			0.4318	0.4024			–	0.498				–	81.1		
DP28	Lumaglo	3000	3062			0.4384	0.4055			–	0.501	0.944	0.5	Pass	–	81.3		
DP29	Lumaglo	3000	2987	3055	1.8%	0.4334	0.4042	Pass		–	0.503	0.944	0.5	Pass	–	80.8	81	Pass
DP30	Luceco	2700	2800			0.4556	0.4157			> 0.4	0.43				> 80	82.9		
DP31	Luceco	2700	2795			0.4561	0.4160			> 0.4	0.43				> 80	82.7		
DP32	Luceco	2700	2799	2798	3.6%	0.4546	0.4136	Pass		> 0.4	0.436	0.476	0.4	Pass	> 80	83.2	83	Pass