energy
Department:
Energy
REPUBLIC OF SOUTH AFRICA

PROJECT FINAL REPORT

MARKET ASSESSMENT OF RESIDENTIAL AND SMALL COMMERCIAL AIR CONDITIONERS IN SOUTH AFRICA

ANALYSIS & RECOMMENDATIONS

Final Report

Impacting poverty through Energy

BERKELEY LAB
Lawrence Berkeley National Laboratory

EIGHTY20

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Abbreviations

°C – Temperature units in Celsius

AC – Air conditioners

AMPS – All Media and Products Study

APF – Annual Performance Factor

CFCs – Chlorofluorocarbons

Consultants – Refers to the contracted consulting company Integrated Energy Solutions (Pty) Ltd and the their partners Eighty20

COP – Coefficient of Performance (or heating efficiency)

CSPF – Cooling Seasonal Performance Factor

DoE – South African Department of Energy

EER – Energy Efficiency Ratio (or cooling efficiency)

EN - European Standards

EU – European Union

GEF – Global Environmental Facility

GWh – GigaWatt hour

GWP – Global Warming Potential

HSPF – Heating Season Performance Factor

ISO – International Standards Organisation

kW – kiloWatt

kWh – kiloWatt hours

LCC – Life Cycle Cost calculation

LOA – Letter of Authority

MEPS - Minimum efficiency performance standards

NRCS – National Regulator for Compulsory Specifications

ODSs – Ozone-depleting substances

RFP – Request for Proposal

S&L – Standards & Labelling programme

SABS – South African Bureau of Standards

SANS - South African National Standards

SCOP – Seasonal Coefficient of Performance

SEER – Seasonal Energy Efficiency Ratio

UNDP – United Nations Development Programme

US – United States of America

1 Introduction

Report purpose and objective

This report forms part of a UNDP contracted project entitled "*A Market Assessment of Residential and Small Commercial Air Conditioners in South Africa*". The first project output covered detailed research on the dynamics within the air conditioner (AC) market and was separately reported. This second and final report covers the detailed analysis subsequently completed and provides recommendations to advance current regulation activities and energy efficiency levels in South Africa.

General project background

Given the significant use of electricity in South African households (17% of energy generated GWh and 35% of evening peak demand MW). The Department of Energy (DoE) policy has targeted the adoption of energy efficient appliances to reduce both electrical demand (MW) and electrical usage (GWh) with associated amelioration of the country's carbon footprint. To this end the Department of Energy (DoE) in collaboration with the Department of Trade and Industry and donor partners GEF, UNDP have introduced appliance minimum efficiency performance standards (MEPS) and an associated appliance labelling scheme covering 12 appliances. This programme was launched in May 2016.

The programme objective is to remove inefficient appliances from the South African market and encourage adoption of efficient technologies. The setting of minimum standards and the associated educational labelling is being augmented by market interventions to accelerate the take up of more efficient electrical appliances.

Air conditioning equipment suppliers implemented new standards for two years and as a result a market assessment of residential and small commercial air conditioners in South Africa is needed. This assessment provides an insight into how much the industry has progressed and will be the basis upon which the initial air conditioners MEPS and labelling activities can be assessed, refined and augmented to further increase their positive impact.

Original project objective

Overall the project can be summarised from the Request for Proposal as:

> *Air conditioners (ACs) are among the most energy intensive products available in the market and are typically used in residential homes, commercial buildings such as offices and shopping malls as well as manufacturing premises in industrial buildings. Understanding AC's market penetration, characteristics and energy usage is therefore necessary in determining the appropriateness of measures /interventions for market transformation.* ***The purpose of this study is to uncover the current market trends of ACs in South Africa and identify the main market barriers that limit the penetration of more efficient ACs as well as suitable measures/interventions****. The study will compare the results of the study with international best practices and recommend regulatory and non-regulatory measures/interventions to advance market transformation of ACs sold in South Africa.*

Project work plan and activities

To achieve the project objectives the following series of activities were planned and agreed:

Market information

Gathering intelligence on the current air conditioning supply industry, through both desk research and direct consultations;

- Quantitative research – an industry "snap shot" producing representative numerical values.
- Qualitative research – obtaining the trends behind the facts.
- *Usage information*, on how end users operate the appliance.
- *Regulatory understanding.*
- Preparation of an *Interim Report* for circulation to the Project Manager and Project Management Team.

Analysis and recommendation development

- A review of international trends and success stories to obtain lessons for South Africa.

Findings review and industry workshop

- Presentation of the material to the DoE, the industry and other stakeholders.

Stages and timeframes

The original agreed time lines for the project are shown below:

		July				August				September				October				November			
#	Activity description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Project inception * Client workshop * Inception report				* A																
2	Market information * Desk research and set up * Interviews * Analysis and write up																				
3	Usage information * Eskom and others * 5 x 5 telephone interviews * Write up findings																				
4	Regulatory * Obtain copies & analyse																				
5	Interim Report & review meeting										* B										
6	International trends * Engage Berkeley * Review material and write up																				
7	Development of findings and recommendations																				
8	Draft Final Report & review meeting																	* C			
9	Final report and workshop * Report preparation & finalisation * Stakeholder workshop																			* D	

Notes
A. Submission of a brief inception report
B. Submission of Interim report
C. Submission of draft Final Report
D. Submission of the Final report
* Review meetings

Figure 1. Original agreed Project Time line

Due to a range of reasons the timeline was delayed. The overall project was completed by 30 March 2019. Reasons included the lack of databases, the need to constantly verify data plus need to expand the quantitative research.

Report limitations/sources, intent and layout

Information sources with scope limitations

Information utilised in the work was drawn from a range of sources including:

1. NRCS LOA database, however a major limitation of the quantitative research was the fragmented and incompleteness of the NRCS database.
2. The South African Revenue Service Trade Database. In this database units with a power rating of up to 8.8kW were included.
3. 25 store/supplier audits focused on which AC's models are currently being supplied.
4. Qualitative interviews for market arrangements, profile of purchase decision-makers and their general reaction to the MEPS & Labelling programme.
5. Inputs by the Lawrence Berkeley National Laboratories, through Stephane de la Rue du Can, were used to ensure international trends and knowledge were incorporated. Further Greg Rosenquist provided valuable insights and information on the set up of a local test laboratory. Their inputs to this report and references are fully acknowledged.
6. Plus numerous interviews in person and telephonically with knowledgeable persons across the industry and international specialists. These include Theo Covary (UNDP), Lancerlot Riyano (NRCS) and Marco Ferdinandi / Richard Vermaak (AC industry); their inputs are acknowledged with thanks.
7. Key document utilised as a starting point with the study entitled "Review of South Africa's appliance energy classes and identification of the next set of electrical equipment for inclusion in the national standards and labelling project" completed by Urban Econ Development Economists in 2018.
8. Other sources:
    - Review of online shopping platforms
    - Review of supplier websites, product manuals and industry calls for the verification of information.
    - AMPS data from the Eighty20 Data Portal (2010-2016)
    - BigEE reports
    - FRIDGE report (2012) -i.e. initial S&L study

The report focuses on the supply and purchase of new appliances, the focus of the efficient appliance programme. Ownership and usage behaviour of previously purchased (second-hand) AC units is not included in the study.

Overall there is complete confidence that the quantitative research reached at least 80% of the market, based on the NRCS LOA database, augmented by the store audits, covering retailers, Supplier-Installers and e-commerce. During the qualitative interviews the main stakeholders were interviewed.

Report layout

In line with the study purpose this final report comes with a complete picture or "snapshot" of the current market trends of ACs in South Africa from the perspective of energy efficiency minimum standards and labelling. It includes a commentary of barriers and issues limiting the penetration of more efficient ACs. Next international best practices are provided, with lessons for the South African context. Lastly a set of recommended regulatory and non-regulatory measures/interventions to advance market transformation of ACs sold in South Africa are set out under the banners of regulation, compliance and market take up enhancement.

2 Answering the question, where are we?

A considerable portion of the project was the collection of quantitative, qualitative and other information related to the importation, sale and use of air conditioners in South Africa under the current MEPS and energy efficiency labelling environment. This section is a summary and paints a clear picture of the *current reality*. [Note; the full research phase write up is contained in a separate project document entitled "Market assessment of residential and small commercial air conditioners in South Africa - Project research phase report".]

The *current reality* or "*snap shot*" can be viewed through four lenses; the regulatory framework, the programme enactment/enforcement, the market dynamics and the supply industry perspectives. For each *view* pertinent information is provided plus a commentary on what is working well or where there are problems.

2.1 Regulatory framework

Regulatory legal framework overview

Applicable minimum efficiency standards, regulations and measurement

Energy efficiency standards – SANS 941, includes:

- Clause 4.2.1 that all air conditioner combinations shall comply with requirements for energy consumption in SANS 54511. In addition, they must display an energy efficiency label reflecting the measured values; a minimum energy efficiency rating of Class B.
- Minimum standards (and therefore MEPS) requirements for South Africa are based on the measured Energy Efficiency Ratio (EER or cooling efficiency) and the measured Coefficient of Performance (COP or heating efficiency) at rated capacity rather than a seasonal rating.

Regulation – VC 9008

- The regulation is a declaration by the Minister of Trade & Industry that has made compliance with SANS 941 applicable, following two delays, from the 28 Nov 2016 (printed in Govt Gazette No. 38232)
- This declaration falls under the NATIONAL REGULATOR FOR COMPULSORY SPECIFICATIONS ACT (Act 5 of 2008).
- The MEPS level stipulated in VC9008 applies to the entire window, portable and wall mounted split units which have a cooling capacity of 7.1kW (24 000btu/h), or lower.

Air conditioner performance measurement standard - SANS 54511-3:2016/EN 14511-3:2013. A few points are highlighted:

- The measurement standard embraces air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling, with Part 3 specifying the official test methodology. Clause 4.2.1 states; air conditioners and heat pumps for space heating and cooling shall comply with the requirements of SANS 54511-3, and shall carry an energy efficiency label designed in accordance with the national annex on energy labels in SANS 54511-3.
- In origin this national standard is a straight adoption of EN 14511-3:2013, but with the addition of a national annex on the energy efficiency of air conditioners. The technical information required for the calculation of energy classes was obtained from the European Directive.
- The test conditions applicable to South Africa are cited in SANS 54511-2, which mirrors EN 14511-2. Table 3 of SANS 54511-2 specifies the indoor and outdoor conditions for

heating mode tests. Table 4 of SANS 54511-2 specifies the indoor and outdoor conditions for cooling mode tests. For split systems and window types, these test conditions are the same as ISO conditions for air-to-air source heat pumps and air conditioners as follows:

  - Cooling condition T1: indoor 27°C dry bulb / 19°C wet bulb, outdoor 35°C dry bulb / 24°C wet bulb
  - Heating condition H1: indoor 20°C dry bulb / 15°C (max) wet bulb, outdoor 7°C dry bulb / 6°C wet bulb.

- Similarly for double duct systems (nominally portable), the test conditions are:
  - Cooling condition: indoor / outdoor 35°C dry bulb / 24°C wet bulb
  - Heating condition: indoor / outdoor 20°C dry bulb / 12°C (max) wet bulb.
- Plus for single duct systems (nominally portable), the test conditions are:
  - Cooling condition: indoor and outdoor 35°C dry bulb and 24°C wet bulb
  - Heating condition: not specified, but an indoor and outdoor 20°C dry bulb and 12°C (max) wet bulb is specified in Commission Regulation (EU) No 206/2012.
- The efficiency COP/EER level ranges for Split, Portable and Window type units specified are shown below, with the current acceptable levels highlighted:

Efficiency level	Split type	Portable type	Window type
EER/COP > 3.6	A++	A	A
3.6 ≥ EER/COP > 3.4	A+	A	A
3.4 ≥ EER/COP > 3.2	A	A	A
3.2 ≥ EER/COP > 3.0	B	A	A
3.0 ≥ EER/COP > 2.8	C	A	B
2.8 ≥ EER/COP > 2.6	D	A	C
2.6 ≥ EER/COP > 2.4	E	B	D
2.4 ≥ EER/COP > 2.2	E	C	E
2.2 ≥ EER/COP > 2.0	E	D	F
2.0 ≥ EER/COP > 1.8	E	E	G
1.8 ≥ EER/COP > 1.6	E	F	G
1.6 ≥ EER/COP	E	G	G

Figure 2 Current efficiency COP/EER level ranges

Appliance Labelling

SANS 54511-2 lists the information to be provided on the energy efficiency label and includes:

- Manufacturer and model number
- Efficiency rating A, B etc.,
- Annual energy consumption in kWh, based on 500 hours.
- Cooling output in kW
- EER
- Heating output in kW
- COP
- Plus an optional noise level.

A further addendum to SANS 54511-2 is a document entitled “A Guide to Energy Efficiency Labelling”. The document is made available via the programme support website https://www.savingenergy.org.za/about/

The document specifies the label requirements including the print guidelines from font size/type to colours. The size specifications for air conditioner label are a width of 110 mm and a length of 200 mm

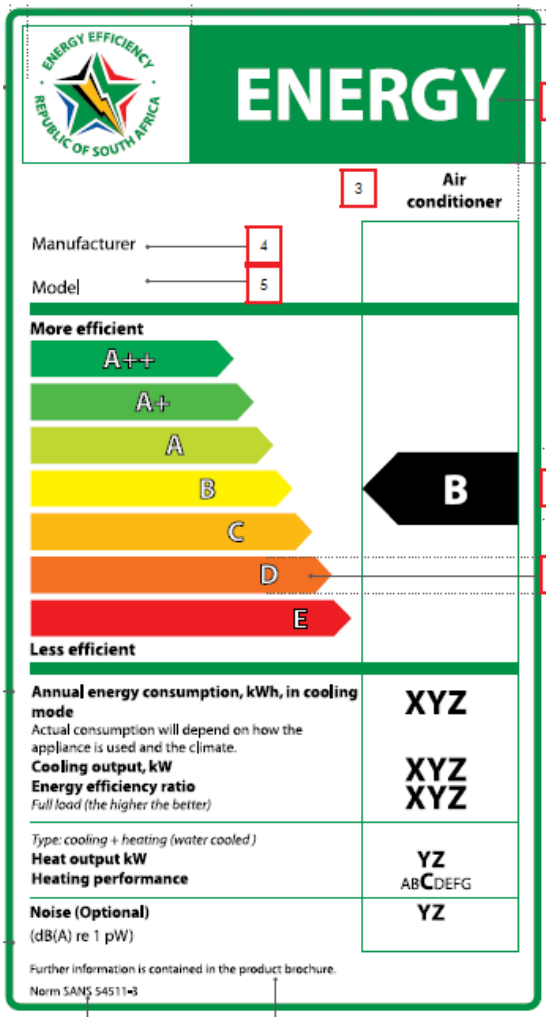


Figure 3. AC Energy efficiency label specification

Regulation commentary

1. Overall the regulatory framework is consistent, complementary and encompasses all that is needed to lift the minimum efficiency level to Class B and ensure labels are placed on the appliance.
2. The testing regime is consistent with a global standard having been drawn from EN14511.[1] However, the South African standard SANS 54511-3:2016 references and is based on the European standards EN 14511-3:2013. Subsequently the EN standard has been revised and published again on 1 March 2018. SANS technical committees will need to evaluate if the revision has any significant changes that need to be incorporated into SANS 54511-3.
3. Single set points for summer cooling and winter heating are noted for further comparison to international trends.
4. Over the past 2.5 years the industry would have shifted and taken on board the Class B levels of efficiency to the point where for most this is fully accepted and incorporated. It noted that the original programme intent was to begin at a moderate level and then progress to a Class A for example if justified.

[1] Urban Econ Development Economists, Review 2018.

5. Under the current measurement standard SANS 54511-3:2016, whilst the measurement accounts for standby power, the usage is not included in the calculation of the COP/EER. Hence standby usage is not being included in Class determination.
6. Further the regulation states that the annual usage is based on 500 hours of operation. This will need to be further investigated for suitability/correctness, plus the possible inclusion of standby power usage. The number of 500 hours seems arbitrary, and was set before the shift to predominantly reverse cycle units offering winter and summer usage and does not take that application into account.
7. In SANS 54511-3:2016 the Class tables are provided for three types; Split, Portable and Window. However, the split type is listed as “Table AA.3 — Mid-wall/high-wall mounted split type air conditioners”. Given this wording the industry does not believe ceiling mounted “cassette” type split units are covered by the regulation. Only mid and high wall split units are covered. Hence cassette units are being imported and mounted on walls through the loophole. The Customs and Excise Tariff book does prescribe units “of a kind designed to be fixed to a window, wall or ceiling or floor, self-contained or split -system” under code 8415.10.
8. An applicability anomaly exists between the Regulation VC9008 that limits the application to AC units with a cooling capacity of 7.1kW (24 000btu/h) or lower, whereas the Customs and Excise Tariff book includes all units up to cooling capacity of 8.8kW (30,000 BTU/hr).
9. Lastly a few points need to be highlighted on the current Energy Label that will need to be addressed going forward:
    - The annual energy consumption is published in kWh but no mention is made of the 500 hours of annual use as a reference for usage.
    - Cooling information is shown in larger lettering than heating.
    - No combined annual consumption is shown for heating and cooling.

2.2 Programme enactment and enforcement

Enactment and enforcement

Standards and labelling enactment

The Standards and Labelling Programme has been developed and introduced by the Department of Energy with the support of the UNDP and GEF.

The Government entity carrying the mandate for ensuring all AC units supplied in South Africa meet any compulsory specifications is the National Regulator of Compulsory Specifications (NRCS). They are based in the SABS building in Pretoria and governed under the NATIONAL REGULATOR FOR COMPULSORY SPECIFICATIONS ACT (Act 5 of 2008). Energy efficiency standards are only one of a number of specifications that apply. The entity falls under the Ministry of Trade and Industry.

The newly set efficiency Standards & Labelling requirements following extensive development work were proactively introduced by holding interactive work sessions with the AC Industry to obtain agreement and providing road shows detailing what the regulatory framework would require.

Industry then commenced becoming compliant to the new standards. The process to import compliant AC units includes:

1. Obtain a test report from a laboratory which is ILAC accredited (International Laboratory Accreditation Cooperation) and/or be a member of the IEC System of Conformity Assessment Schemes for Electro-technical Equipment and Components (IECEE) CB Scheme. Currently the self-declaration from the manufacturer is not accepted by the NRCS. Additional points:
    - In the case where an importer or manufacturer wants to change or incorporate a brand name/trademark or model number to an existing test report they need to make the changes through an accredited laboratory by requesting a declaration report to incorporate the changes and make reference to the original test report.
    - For new applications, the test report must not be older than three years.
    - For renewal application the test report must not be older than five years. Conformity of Production indicating that product design has not changed may be required for renewal-application.
2. Registration as the entity importing AC units, or via a South African agent if foreign. Plus registration on the electronic portal.
3. Completion of a LOA application form and uploading of the document including the valid test report.
4. NRCS then verifies the submission for correctness, that the test report laboratory is suitably registered, that all criteria are met, the Class is B or better and the Label is correct.
5. Lastly the importer is notified and the make/model is added to the NRCS LOA database and a 3 year certificate LOA is issued.

Once the LOA has been issued AC Industry is free to import the units. Customs clearing of the consignment includes the following steps:

1. Declaration of the invoice to SARS via an Electronic data interface system. SARS captures the invoice, allocates/verifies the tariff code and requests excise payment.
2. Following payment SARS issues a release form that will in the case of AC units include a “Detain for Other Government Agency” restriction.

3. At this point NRCS will need to check the LOA and stamp the Release document before delivery can take place. Alternatively a NRCS inspector may schedule a check of the goods before opening of the container.

Standards and labelling enforcement

Enforcement of the standard is achieved by NRCS through the following actions:

1. Operating the LOA system and ensuring only AC Units that meet the standard are issued with a LOA.
2. Approve the clearance of the consignment through rubber stamping the release paperwork following an in-office check of the LOA.
3. Alternatively scheduling an inspector to visit the importer and inspect the goods/LOA when the container is opened.
4. Random stoppages of containers at the port of entry to check the goods are compliant.
5. Either through pre-determined store inspections or following tip offs, NRCS inspectors will check AC units being supplied in the market. Model and Make are compared to the LOA database to ensure they are registered and the label is suitably applied. Further verification will take the form of removing an actual AC Unit for laboratory testing to verify the imported goods are in accordance with the test report.

Sanctions by the NRCS include:

- Stoppage of the container at the port of entry and notification that a suitable LOA is required, with the goods being held at the importers cost in the bonded store.
- If goods are found in warehouses or shop floors that don't comply with LOA requirements, NRCS inspectors will issue a directive to restrain the sales of the goods. The inspector has a prerogative to decide where the goods will be stored whilst under the directive.
- Next Section 34 of the NRCS Act is invoked and the importer will be engaged on what corrective action can be taken.
- Failure to cooperate public notifications can be made and further action taken in association with other government agencies such as SARS and National Consumer Commission to impose sanctions from multiple Acts.

Survey and NRCS information gathered

NRCS activity

As an indicator of NRCS activity the following graph indicates the number of LOAs accepted onto the database per month over the last 2 years[2]:

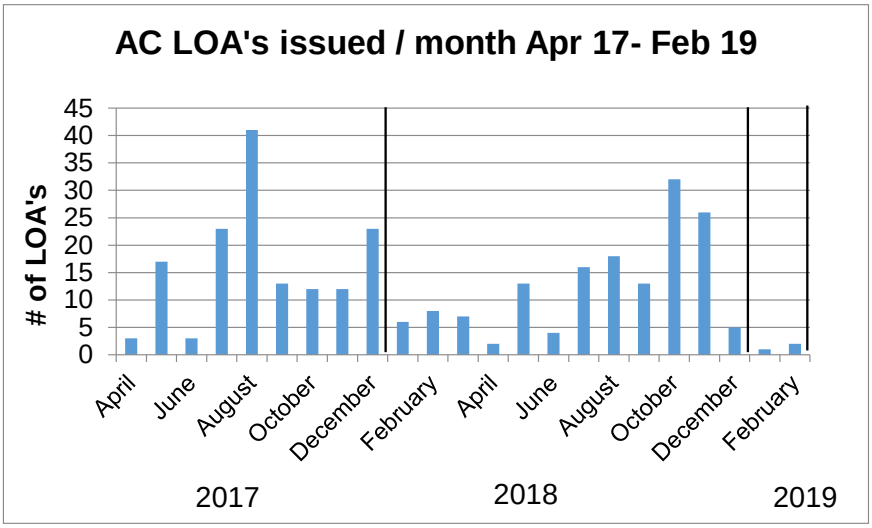


Figure 4. AC LOA's issued over the past two years

The volume varies between 1 and 41, with year on year number decreasing from 168 to 137 LOA's accepted per year.

LOA database anomaly

During store audits 199 models were identified, and within those models, there were 50 models that were not represented within the LOA database. This would indicate a fair percentage (25%) of the AC units found for sale were not authorised and may be on the market without the necessary approval from the regulator. This might constitute non-compliance.

NRCS constrained sanction

Feedback from the NRCS indicates that in the past year, the only recorded sanctions by NRCS inspectors relate to stoppages at the ports of entry where no LOA were available at the time of inspection. These interventions forced the importers to comply and produce correct LOA's. However, no sanctions are recorded where inspectors have found AC units for sale or in stock despite the number of un-authorised units identified during the store audit.

Additional enactment and enforcement observations

1. Whilst some shipments are still stopped, an increasing percentage of the air conditioners seen at the ports of entry do have LOA's and the correct energy efficiency labels. This will be linked to the increasing number of AC unit LOA's on the database.
2. Compliance sanctions by the NRCS have been limited to only SARS release compliance stoppages at ports of entry in the past year. Compliance checks on AC stocks in warehouses and retail shops by NRCS inspectors have been minimal given that no units have been confiscated or other non-compliance actions taken, yet despite clear evidence of LOA non-compliance (25%).
3. An on-going NRCS challenge is checking the displaying of labels in the retail space as last baseline inspection on the energy efficiency labels was conducted in mid-2017, when the compliance of air conditioners was found to be very low. The initial plan was to conduct ten store audits; five of these would be among consumer retailers and the

[2] NRCS Data base downloaded

remaining five would be among supplier-installers. However, after the fieldwork exercise begun, it was observed that the initial 10 outlets were not sufficient to capture more of the market, as each store did not have a large selection of models. As a result, additional locations needed to be audited. In the end, 25 stores were audited.

4. Actual testing of any AC units to ensure manufacture is conforming to Test Certificate levels since the introduction of the new energy efficiency standards in November 2016 has not been possible. This is directly related to no authorised test laboratory in South Africa and the complexities and budget constraints related to shipping selected AC units to international laboratories.
5. NRCS and others have undertaken activities to reduce the complexities and timelines to obtain a LOA. This is evident through the electronic submission systems and the new support website https://www.savingenergy.org.za/
6. A key comment is all aspects of the current regulatory framework being implemented by the NRCS are built on an independent third party testing and "policing" for compliance. This keeps the pressure on NRCS to "catch" non-compliance rather than industry "prove/demonstrate" compliance.
7. Currently the primary NRCS sanctions for noncompliance are; to hold back the release goods at port of entry or the issue of NRCS directives to stop the sales of goods. There are currently no financial "penalties" for noncompliance.
8. Risks related to non-compliance that are evident in the importation process include:
    - Deliberate incorrect declaration on invoices related to the type of equipment to avoid duties and in this case efficiency standard compliance.
    - "Rubber stamping" or simple system generated sign offs of detainment orders by NRCS, without NRCS inspectors actually verifying products when the containers are opened. It should be noted that due to cost implications containers are only allowed to wait at warehouse for around 2 hours. Thus importers will simply go ahead and unpack without inspectors on site.
    - Random stoppages of goods coming in at ports of entry are few and the likelihood of picking up delinquent goods is small.

2.3 Sales, import volumes and market dynamics

AC type characteristics

AC type description

- *Window air conditioning units*, contain all the components of an air conditioner, namely the compressor, condenser, expansion valve, evaporator and cooling coil, all enclosed in a single box. This unit is then fitted through a slot made in the wall of a room, or more commonly through a window or portion of a window.

- *Split air conditioner unit* comprises of two parts: the outdoor unit and the indoor unit. The outdoor part, houses the main components like the compressor, condenser and expansion valve. The indoor unit comprises the evaporator or cooling coil and the cooling fan. For installation only a hole though the wall is need for piping and cables. In addition, these units have aesthetic appeal and do not take up as much space.

- *Cassette units*; are similar to the wall-mounted split system units, the difference being, the indoor unit is installed flush with the ceiling. Note, this distinction is made due to a South African market/regulation anomaly that will be dealt with later in the report.

- *Portable/freestanding air conditioning unit;* is designed to add additional cooling or for temporary cooling in a location where there is no existing air conditioning. Importantly, unless the unit is connected to a hose that rejects air outside, the overall effectiveness is lost.

Market total size

From the SARS database [3]the volume of AC units imported between 2011 and 2018 can be viewed in the following table and graph:

Year (Oct - Sep)	Units ('000)	Value (R' Million)
10/11*	183	R257
11/12	272	R460
12/13	324	R554
13/14	331	R610
14/15	285	R616
15/16	350	R805
16/17	281	R572
17/18	**363**	**R742**

Figure 5. Table showing annual AC imports for 10 years

** The SARS Trade Database only contains data from 201101, therefore only 201101 - 201109 data represented during the 10/11 period*

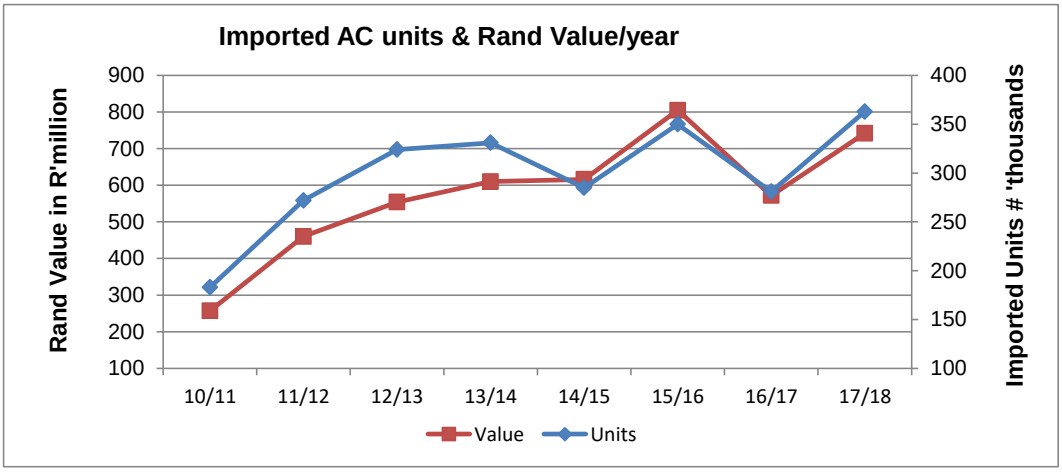


Figure 6. Graphical view of AC imports over 10 years

Points of note on the source and accuracy of the numbers (appendix A includes further information):

- These numbers are a summation of the applicable tariff code; 8415.10 sub category 8415.10.10. In 2017/18 the code 8415.10 represented 82% of the units, containing the description “Of a kind used for buildings, compressor operated, having a rated cooling capacity not exceeding 8.8 kW”.
- After consultation with the NRCS it was agreed that tariff code 8415.10.90 be excluded as it was defined as “parts” and the statistical measure is kilograms not units.
- Checks by NRCS of the way SARS capture data would be recommended and alignment ensured.
- A clear dip can be seen in 2016/17 that stemmed from the introduction of the new MEPS/Labelling requirements standards and associated paperwork delays.

[3] South African Revenue Service – Customs based trade database

Average annual sales

From the data the average annual sales were found to be 322,000 AC units based on either 2 or 5 years. These averages indicate limited growth in sales. However, given the higher levels of 363,000 units during the last year 2017/18, a market value of 350,000 units/year has been accepted as the basis for the report future recommendations.

Market characteristics

Key characteristics of the units being sold in South African from the detailed store and supplier survey (by number not volume) are:

- A full database of air conditioners (large commercial, small commercial and residential) was found on the NRCS website. This database historically contained some 793 air conditioners, but only 238 were identified as being small commercial or residential models. Within these 238 models 149 were found in the stores during the audit, leaving 50 models existing in field but not represented in the NRCS database. With this discrepancy noted, the NRCS was contacted and provided the feedback that the outstanding 50 models were most likely non-compliant.
- All imported AC units are new and no second hand units are imported into South Africa.
- Breakdown of *AC types* found in the market during the audit and verified during qualitative interviews indicated:

Type	Volume Sales	Value Sales
Split	91%	±85%
Window	4%	±5%
Free Standing (Portable)	5%	±10%

Figure 7. Table of AC types found in the market during the store audit

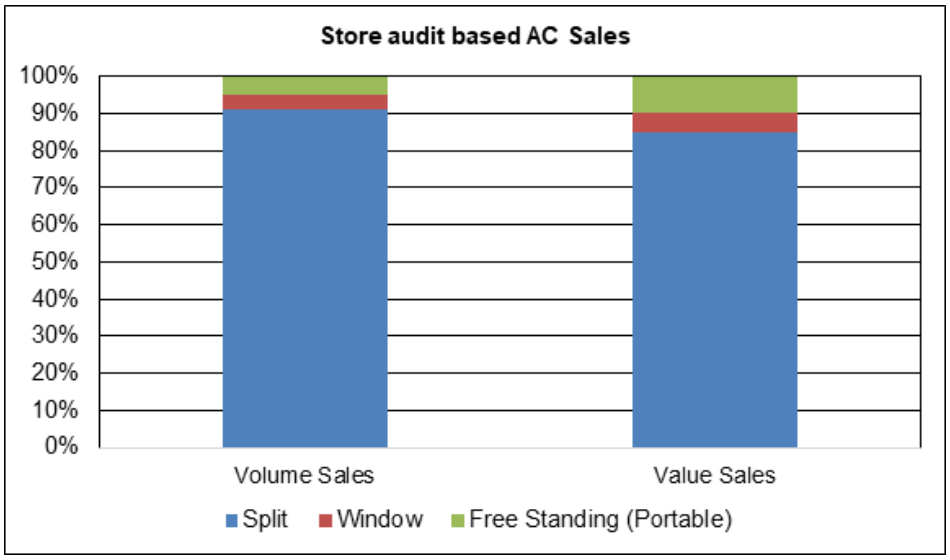


Figure 8. Graphical depiction of AC types found in the market during the store audit

- Origin of manufacture is clearly dominated by China (90%), followed by South Korea (6%) the Hong Kong & Thailand (1% each).
- Brand share is fairly spread; Alliance air (19%), Samsung (12%), Carrier (9%), Gold air and LG (6%). Remaining 49% are other brands including in-house bands that have a local retailers name and not the original manufactures brand.
- Type shows split/wall mounted as the most popular by far (79%), then portable (9%) cassette (7%) and window (5%). If split and cassette are combined given the closeness of the type the dominance would be 86%.

- Technology utilised showed a split of 62% inverter controlled compressors versus 38% non-inverter.
- Refrigerant utilised; only 2.5% of the 199 units being supplied still utilised R22, with all the others R410A.
- Average efficiencies of the 199 units observed was cooling EER = 3.233 (lowest = 2.81 highest = 3.73) and heating COP 3.504 (lowest = 2.81 highest = 3.64). Note, the database was 65.5% completed for EE and 34.0% for COP, due to lack of information n in the NRCS database. These points

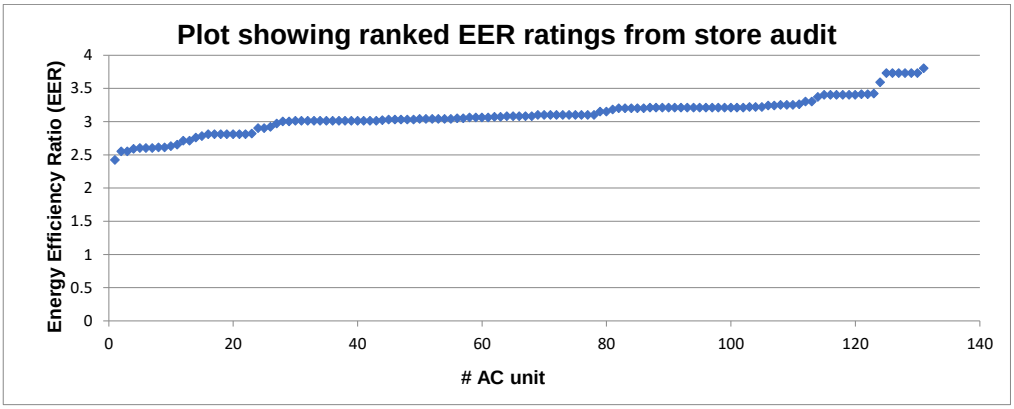


Figure 9. Range of EER ratings from the store audit

- Similarly the average price of the units was R9,842 and the highest being R26,999 and lowest being R5,285. The correlation between price and EER was found to be low as shown in the following graph:

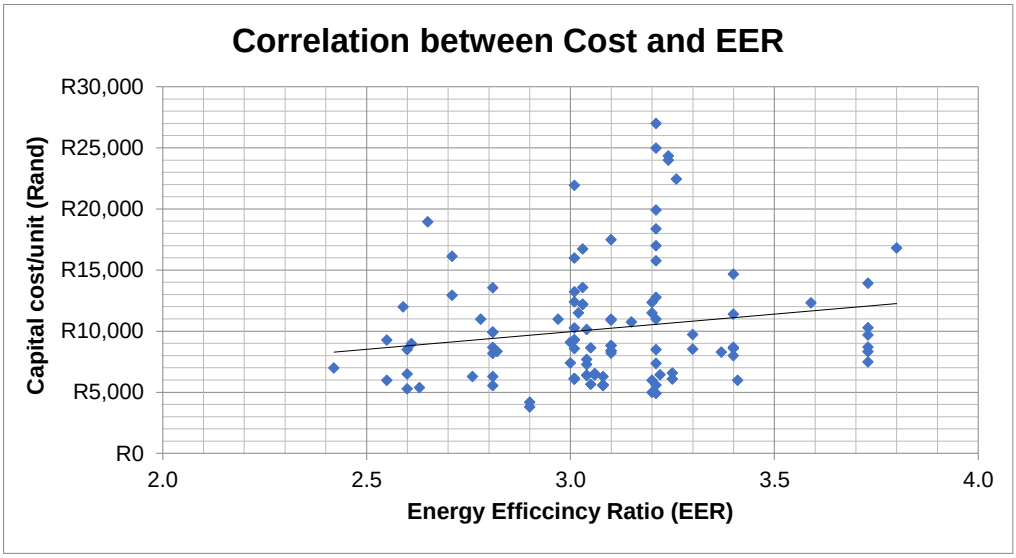


Figure 10. Correlation between AC costs and EER ratings

- Lastly the range of units on offer by cooling capacity, with clear peaks at 9,000 12,000 18,000 and 24,000BTU.

Cooling Size in BTU	Cooling Size in kW	% Volume Share
9000	2.65	21.5%
10 000	2.93	1.0%
12 000	3.52	26.0%
14 000	4.10	1.0%
18 000	5.28	23.5%
18 600	5.45	0.5%
22 000	6.45	0.5%
24 000	7.03	21.5%
30 000	8.79	1.5%
36 000	10.55	2.5%
48 000	14.07	0.5%

Figure 11. Table showing the share of unit capacities in the market

AC purchases and ownership

Two fundamentally different markets or purchases of AC's are evident in South Africa, when viewed against the 2017/18 base and would be from industry feedback:

1. *Residential users* – From industry qualitative interviews, households account for less than 40% of AC sales or below 157,000 units a year. When compared to the AMPS database this number appears to be high as the rate of increase in AC use (not ownership) from 2010 to 2017 was in the region of 40,000 per year. Annual purchases of less than 106,000 have been accepted for on-going analysis (27%).
2. *Commercial users* – Similarly, from AC industry qualitative interviews business accounts for more than 60% of AC sales or over 267,000 units a year. For on-going analysis annual purchases of more than 288,000 has been accepted (73%).

Ownership – Commercial

AC units are used across all commercial business sectors, from hotel rooms, to offices, from board rooms to industry staff rooms. In all cases the investment is primarily made with the purpose of improving the working conditions by maintaining a reasonable air temperature. In a small percentage of the cases the air conditioners would be installed to provide a controlled environment for equipment and processers e.g. small computer/server rooms, laboratories needing fixed temperatures and mobile offices.

Appreciation of how AC's are purchased by the business sector is critical and includes:

1. Empowered individuals or buyers in an organisation will simply call new or known (repeat) air conditioning suppliers for a quote or quotes. Sizing of the units will mostly be left to the supplier.
2. Landlords and owners of rented commercial properties will purchase AC's from new or known suppliers. Given their knowledge of similar installations the AC specification will be in house.
3. Third party specification of requirements by the likes of a consulting engineer, architect and project manager. This would be the case when large numbers are needed for property developments and may include open or closed (limited) tenders.

Ownership – Individual residential

During the quantitative research phase, a basic residential consumer profile was developed to understand current household dynamics of households that own an air conditioner. These profiles were further developed with the dipstick qualitative interviews.

Households with Air Conditioners tend to be older, with 67% of adults in these households being older than 35 years. Air Conditioner ownership remains a luxury, only available to the more affluent households in the country, with >35% of households earning above R40,000/month owning at least one AC.

Confirmed by the Urban-Econ study that states *"The bulk of the air-conditioners are operated by LSM 9 and 10 groups, having a share of 29% and 56%, respectively.' 'Additionally, the data suggests that the two LSM groups proved to have purchased more units over the past few years (AMPS, 2010-2016). LSM 9 and 10 operated about 56 200 and 55 900 more units in 2016 when compared to the usage in 2011, respectively."*

From a communication perspective highest household language usage with an AC were English speaking (40%) and Afrikaans speaking (35%). Plus a high usage of smart phone usage correlated with AC ownership.

Geographically, Gauteng has the highest prevalence of AC ownership followed by KZN.

Lastly in terms of ownership the white population group which only accounts for 9% of the South African population yet 53% of those have access to an air conditioner within their household. While the black population accounts for most of the country's population with 79%, they only account for 32% of people with access to an air conditioner in their household.

The decision maker involved in the purchase of AC units for residential use is further complicated as follows:

1. Private home owner decision – generally a home owner will approach a supplier, often a retailer for the purchase of a unit. Sales persons will be highly influential in the specification of the unit purchased.
2. Rented property owner own decision – owners whilst developing or upgrading properties will include the installation of AC units. Both new and known suppliers will be asked to quote in line with existing experience on unit sizes/specifications.
3. Third party decision – during large scale or high priced house developments engineers, architects, project managers and others will be responsible for specifying what is needed, obtaining quotes etc.

These points support the notion that AC units are best served by MEPS when compared to awareness / efficiency labelling.

AC electrical usage

On the energy efficiency labels the annual electrical usage is based on 500 hours of operation, with a caveat that it may vary dependent on application and usage. This level was set in 2013 before a shift to the sale of reversible AC units. Identification of new levels was a project requirement.

Existing usage data sets were difficult to obtain, short of an extensive survey of users, which falls beyond the scope of the project. Within Eskom and the South African academia a similar dearth of information exists. The Urban Econ study[4] alludes to a consumption of 60kWh/week based on "bigEE, 2015" Policy Guidelines. Based on the average electrical draw of 1.474kW for the AC units surveyed, this would equate to a very high average weekly usage of 40 hours per week or nearly 6 hours per weekday across the year.

[4] Urban Econ Development Economists, Review 2018.

Further, the 60kWh/week (3,120kWh/year) or 2,080/year operational hours listed above have no correlation to the 500 hours of annual operation the basis for calculating annual electrical usage for the efficiency labels.

There is clearly a usage anomaly within the estimation of AC electrical usage savings that will need to be addressed later in the report. Another important aspect is that two significant usage variants are simply not taken into account in any global figure of usage:

1. Straight cooling AC units will use only half of the electricity that a reversible heat pump will incur through the addition of winter heating usage.
2. Commercial applications have a different usage pattern to residential households given the different needs.

These two points make the inclusion of AC units in the MEPS and labelling programme far more complex than an appliance such as an oven which is used only in the residential households.

2.4 AC Supply Industry Perspectives

Industry structure

The major entities within the South African AC supply structure are:

A. *Air Conditioner Manufacturers* – all external to South Africa which leads to 100% importation

B. Categories of importer who bring AC units into South Africa with a % share*:*

- *A local Distributor* - refers to a local company nominated by the manufacturer to sell their products within a certain location or consumer segment.
- A *Distribution Agency* - refers to a company that distributes household electronics across various categories as a subsidiary of a global company e.g. Samsung.
- *Local importers* retailer/installers – refers to a retailer who selects, orders and imports their own limited product lines, often seasonally – e.g. Makro, or Builders Warehouse. The units are often branded by the importer. Larger installation companies may at times import their own product lines.

C. Wholesalers – across the country there are wholesalers that stock a number of brands/product lines in a geographic locality. They in turn supply the local installation trade.

D. Retail and other sales level channels:

1. *Retailers* who sell units to the end consumer account for less than 27% of total sales. This includes both shops and the emerging trend of online sales. In both cases the retailers will refer customers to installers for non-freestanding portable units.
2. *Non-retail (direct) sales* account for over 73% of AC sales. Sub sectors include:
    - Air conditioner installers who sell AC units as part of their service.
    - Large project tender or negotiated preferred supplier deals for larger projects e.g. new office blocks, building refurbishments.

Please note that a number of supply combinations can be configured amongst these entities and will change on an on-going basis. The listing of entities though is dependent on the correct definition of the different players.

LOA registration trends – breadth of the Industry

A further understanding of the industry can be obtained from registration of new LOA's over the past 2 years. These are shown graphically below[5]:

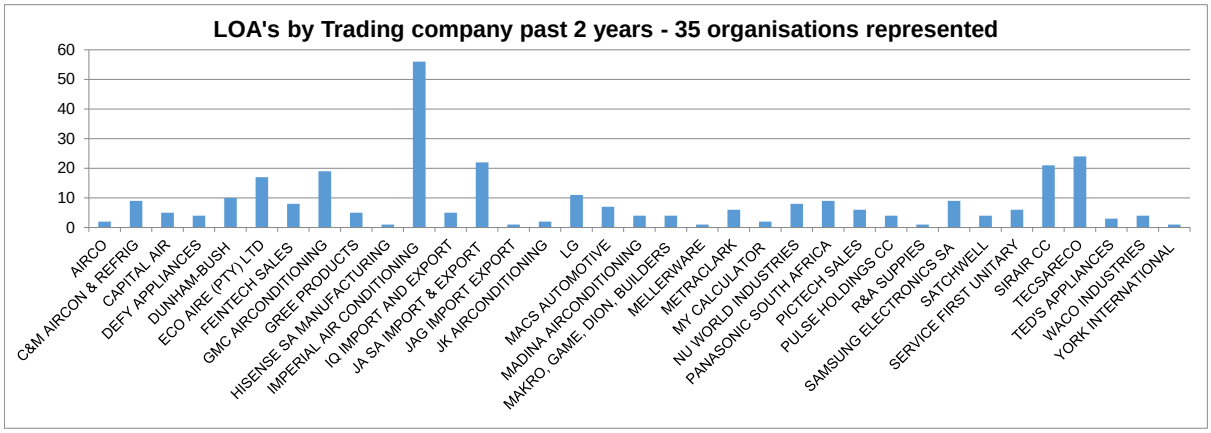


Figure 12. Graphically - LOA registrations by organisation for past two years

A significant number of organisations (35) have obtained new LOA's in the past two years. The dominant players registering LOA's are; Imperial Air Conditioning, Tecsareco, JA SA Import & Export, Sirair and GMC Air conditioning.

Similarly the LOA database provided the brand names for past 2 years[6]:

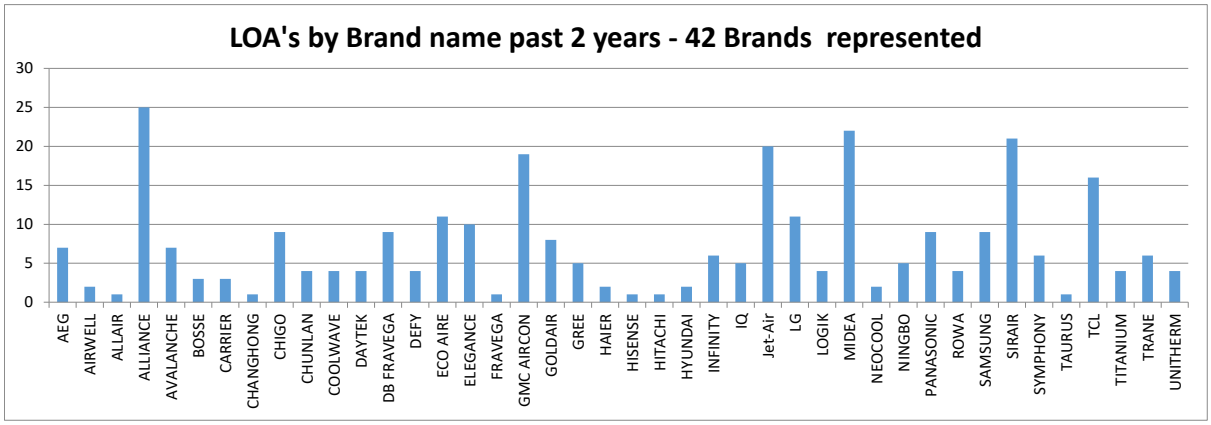


Figure 13. Graphically - LOA registrations by brand for past two years

Again, the issuing of LOA's shows a large number (42) of brands is active in the market. Dominance of registrations have been; Alliance, MIDEA, SIRAIR, Jet-Air and GMC.

This information clearly shows that the AC market is broad.

Online retailers are not conforming to the need for an efficiency label to be shown during a sales interaction. Currently an initiative is underway with Massmart, starting with Makro, to show a label.

AC Supply industry perspectives on the programme

The AC supply industries are a major stakeholder in the programme, being directly impacted by the MEPS and LOA regulated requirements. Over the past few years they have had to adjust the list of products supplied, submit and obtain LOA approvals and dealt with NRCS approvals on importation. The industry observations and feedback is important:

[5] Listing of LOA by importer supplied by NRCS as a database extract.

[6] Listing of LOA by brand supplied by NRCS as a database extract.

Current industry related comments:

1. Confusion exists amongst the industry players as to the overall objects and intent of the Standards and Labelling programme. This would be related to a lack of on-going communication and vision reinforcement plus the turnover of staff and loss of historical knowledge.
2. Overall there was no push back or concern about achievement of the current B standard.
3. Complaints as to the length of time and the effort that it takes from selection of a new AC model and completion of the registration process and issuing of the Letter of Authority (LOA) to allow Customs and Excise clearance. Timing was compounded by the need to wait for LOA to be issued before the shipping process can begin. Despite a request for proof of these delays and time frames the AC industry did not respond.
4. Perhaps the strongest feedback related to the need for third party accreditation is that manufacturers already have high-level internal laboratories that test the products and provide information on the efficiency levels. These test results are used as the basis for registration in the largest European/USA markets in the form of self-declaration. Hence, when South African importers request third party test reports manufacturers are reluctant to incur these external laboratory costs for the relatively small South African sales volume.
5. The high cost of third party test reports and complexities in obtaining LOA's is limiting the range of AC units that are being brought into South Africa by some importers. Often older designs and longer standing LOA's and test reports are being utilised to meet the current local regulatory framework. A consequence is the South African market is not being offered the latest and most efficient units, which is counterproductive to the programme intent.

Any Standards and Labelling Programme changes and enhancements need to embrace these AC industry entities and suitably balance their various interests to be successful.

3 International best practices

This current South African air conditioner efficiency reality needs to be compared and set against international trends. To assist, Stephane de la Rue du Can of the Lawrence Berkeley National Lavatories, was approached and provided sections 3.1 to 3.3[7].

3.1 Regulation compliance methods and principles

A. Test Methods

The market share of variable-speed AC units (or inverter) in South Africa has increased significantly over the last few years to reach 62% today. Similar trends are observable in other countries. For example, the market share of variable-speed RACs in China, the world's largest AC market, increased from 8% in 2007 to 65% in 2016. China adopted seasonal metrics in 2013 when the share of inverter ACs was less than 30%.

The introduction of variable-speed compressors in most markets has led to the adoption of new metrics to measure more accurately the performance of ACs. Variable-speed compressors enable an AC unit to respond to changes in cooling requirements due to change in temperatures and reduces energy consumption, especially in countries with high variation in daily temperatures.

Seasonal energy efficiency ratio (SEER) metrics have been introduced to take into account a country's temperature conditions for variable speed load requirements. SEER metrics provide a more accurate measure of the energy performance of the AC as energy consumption is measured during full-load and part-load operations at different temperature points. SEER is calculated by combining full and part load operating performances. Moving to SEER metrics requires that at a minimum one more measurement, in part-load conditions, be taken to compare with EER metric.

The international bureau of standards developed ISO 16358 in 2013 to rate the performance of fixed-speed and variable speed ACs under a common metric. Cooling Season Performance Factor (CSPF) and Heating Season Performance Factor (HSPF) consist in a weighted average based on a country specific temperature bin. The advantage of adopting ISO 16358 is that it uses the same test points as ISO 5151 which was originally used to measure fixed speed ACs.

Internationally, many countries now use SEER rating metrics that are based on ISO 16358 with region-specific climatic conditions and in some case, adjustments to the weighting average methods. Japan uses the Annual performance factor (APF) which combines cooling and heating performance in one indicator and takes the actual operating time into account

[7] Abhyankar Nikit, Nihar Shah, Won Young Park and Amol Phadke, 2017 » Accelerating Energy Efficiency Improvements in Room Air Conditioners in India: Potential, Costs-Benefits, and Policies" http://eta-publications.lbl.gov/sites/default/files/lbnl-1005798.pdf

de la Rue du Can Stephane, Greg Leventis, and Nihar Shah. 2015. 'Lessons Learned From Incentive Programs For Efficient Air Conditioners: A Review" http://eta-publications.lbl.gov/sites/default/files/lbnl-191145.pdf

Eurovent, 2019. https://eurovent.eu/?q=articles/review-study-ecodesign-and-energy-labelling-air-conditioners-gen-78700

Khanna, Nina, Nan Zhou, David Fridley, and Michael A McNeil. Prospective Evaluation of the Energy and CO2 Emissions Impact of China's 2010 – 2013 Efficiency Standards for Products. 2016. LBNL-1005921. http://eta-publications.lbl.gov/sites/default/files/lbnl_1005921.pdf

Park Won Young, Nihar Shah, and Brian Gerke, 2017. "Assessment of commercially available energy-efficient room air conditioners including models with low global warming potential (GWP) refrigerants". LBNL-2001047. https://eta.lbl.gov/sites/default/files/publications/assessment_of_racs_lbnl-_2001047.pdf

Shah, N., Waide, P., Phadke, A. (2013). Cooling the Planet: Opportunities for Deployment of Superefficient Room Air Conditioners. Energy Technologies Area. Lawrence Berkeley National Laboratory. LBNL-1003671.

Shah, N., Abhyankar, N., Park, W.Y., Phadke, A. (2016). Cost-Benefit of Improving the Efficiency of Room Air Conditioners (Inverter and Fixed Speed) in India. Lawrence Berkeley National Laboratory. LBNL-1005787.

during one year. The table below provides a summary of experience in large economies using SEER Metrics[8].

Country	Year of Adoption	Name
China	2013	• SEER for cooling-only products • Annual performance factor (APF) for reversible-type products
EU	2013	• SEER for cooling-only products • Seasonal coefficient of performance (SCOP) for heating performance
India	2015	• Indian SEER (ISEER)
US	2015	• both SEER and HSPF for heat pumps • both SEER and EER (for the Southwest region)
Japan	2006	• Annual performance factor (APF) for reversible-type products

Figure 14. Table showing SEER Metrics for 5 countries

B. Compliance Approach

Compliance is vital to ensure MEPS delivers the anticipated savings.

A compliance, certification, and enforcement plan is necessary to ensure that products meet MEPS and to verify manufacturers' energy efficiency performance claims. This plan is essential to the success of S&L programs.

A compliance, certification, and enforcement plan entails the following:

- Certification scheme: testing certification that test products performance prior to entering a country's market.
    - 3 options: self-declaration, third party accredited laboratories or national laboratory.
- Market surveillance: program which checks whether products in the market place conform with the claim registered
- Product performance database: electronic repository of products' information, often publically available
- Enforcement framework: legal framework defining the procedures, responsibilities and penalties in cases of noncompliance

The next table provides a summary of experience in a few major economies.

	Certification (pre-retail)	**Market surveillance (at retail)**	**Product information databases**	**Enforcement framework**
US	Third-party certification preferred but self-certification in manufacturer testing laboratories admitted after checked by DOE	DOE conducts verification testing on any product at its discretion Concurrent manufacturers can report infractions to DOE	Test reports submitted online via DOE's Certification Compliance Management System	$110/product/day Cases reported publicly here: https://energy.gov/gc/enforcement-cases

[8] LBNL https://escholarship.org/uc/item/01h8g7zb

EU	Self-certification and Third-party certification	EU member countries market surveillance authorities are in charge of check-testing	Non-compliant products must be reported to E.U. databases of compliant products vary between EU member countries	Criminal sanctions with maximum fine of £5,000 ($6,500)
Japan	None	inspections of product catalogues and retail store	Annual questionnaires to manufacturers on units shipped and EE of units	Up to ¥1,000,000 ($9,500) fine and "name and shame" approach used for those in non-compliance
China	Self-reported manufacturer certification	Random selection from manufacturers and/or retailers.	China Energy Label Centre maintains database of products and testing laboratories	MEPS violations: fine 1 to 5 times illegal gains made from sales. Label violations: RMB 30,000 – 100,000 ($15,000).

Figure 15. Table summarising current compliance approaches in 4 countries

3.2 Levels of minimum efficiency, plus EER/COP values

Historical developments

China	MEPS were first introduced for fixed-speed ACs in 1989 and revised in 2004 and 2010. MEPS for variable-speed units were introduced as a separate category in 2008 and revised in 2013 (Khanna et al., 2016). China has developed revised version of fix and variable speed MEPS that will be published in 2019.
EU	The current Eco-design regulation for ACs with ≤ 12 kW of cooling capacity applies since January 2013 and requires different levels of efficiency according to the type of refrigerant GWP used. The European Commission has launched a review study of the regulation on Eco-design and Labeling requirements which results will become available in 2019. (Eurovent, 2019)
India	India Bureau of Energy Efficiency (BEE) launched a voluntary S&L program in May 2006. In 2012, mandatory labeling and MEPS were introduced for fixed-speed ACs. In June 2015, BEE adopted voluntary label for variable speed ACs. (Abhyankar et al., 2017).There are now mandatory for both fixed and variable.[9]
US	The USA has an extensive MEPS program for air conditioners and heat pumps, which includes the following product types: residential RACs (window/wall), package terminal ACs (wall units with an air change function included), central ACs and heat pumps, small commercial package ACs and heat pumps, and large commercial package ACs and heat pumps. The 2015 revision has adopted regional MEPS (North, Southeast, and Southwest) for split central ACs.
Japan	In Japan, MEPS setting follow the "top runner" approach where the most efficient product on the market during the standard-setting process becomes the Top Runner target that will become the standard.

Figure 16. Table summarising the history of MEPS development in 5 countries

MEPS Value

MEPS set the floor of efficiency in a country's AC market. Shah et al (2013) finds that the average energy efficiency of mini-split ACs which form the majority of global residential air

[9] http://www.beestarlabel.com/Content/Files/AC_Notification.pdf

conditioners in every country except the United States, varies from an average Energy Efficiency Ratio (EER) of 4.1 in Japan to an average of 2.69 in the UAE.

The next table show the MEPS in large economies (CC – Cooling capacity[10]):

Country	Product Scope	MEPS Date	Efficiency Metric	Efficiency Requirement
China[11]	AC fixed-speed	2010	EER	CC < 4.5kW: **3.2** 4.5kW<CC<7.1kW: **3.1** 7.1<CC<14.0kW: **3.0**
	AC variable speed	2013	SEER	CC < 4.5kW: **4.3** 4.5kW<CC<7.1k: **3.9** 7.1<CC<14.0kW: **3.5**
	AC variable speed	2013	APF	CC < 4.5kW: **3.5** 4.5kW<CC<7.1kW: **3.3** 7.1<CC<14.0kW : **3.1**
EU	Cooling Only	2013	SEER for cooling SCOP for heating	CC< 6 kW GWP > 150: SEER 4.60, SCOP 3.80 GWP < 150: SEER 4.14, SCOP 3.42 6kW<CC<12 kW GWP > 150: SEER 4.30, SCOP 3.80 GWP < 150: SEER 3.87, SCOP 3.42
India	Room AC variable-speed	2018	ISEER	3.1 W/W (effective 2018)
	Unitary AC	2018	ISEER	2.5 W/W
US	Split AC		SEER	North 13[12] Southeast 14 Southwest 14
			EER	Southwest only CC< 13.2kW: 3.57
Japan			APF	4.1[13]

Figure 17. Table summarising the MEPS levels in 5 countries

The United for All Initiative (U4E) is developing model regulations for ACs based on ISO 16358 seasonal metrics. U4E has recently announced that the model MEPS will be aligned with the new 2022 China MEPS. Since South Africa imports more than 80% of AC from China, there will be benefits for SA to adopt these in the longer term. In otherwords. in 2022 or 2023 to take advantage of the economies of scale that would be achieved by harmonizing with larger market such as China and to avoid dumping of inefficient equipment.

[10] Park Won Young, Nihar Shah, and Brian Gerke, 2017. "Assessment of commercially available energy-efficient room air conditioners including models with low global warming potential (GWP) refrigerants". LBNL-2001047. https://eta.lbl.gov/sites/default/files/publications/assessment_of_racs_lbnl-_2001047.pdf

[11] As mentioned previously, China has developed revised version of fix and variable speed MEPS that will be published in 2019. Draft regulation shows the use of APF as the only measurement unit for all ACs by 2022 and a target MEPS of 4 for AC with CC< 4.5kW, 3.5 for 4.5kW<CC<7.1kW and 3.3 for 7.1<CC<14.0kW.

[12] This is based on Btu/Wh. 1 W = 3.412142 BTU/hr

[13] Japan's top runner requirements vary by size (cooling capacity)

3.3 Technical trends used to improve efficiency

Refrigerants

Refrigerants used in ACs contributed to ozone-layer depletion when they are released into the atmosphere. The Montreal Protocol, signed in 1987, regulates these ozone-depleting substances (ODSs) and established a schedule to gradually phase out production and consumption of ODSs and transition to non-ozone-depleting refrigerants.

Chlorofluorocarbons (CFCs) were the 1st generation refrigerants and were largely replaced by HCFCs (e.g., R-22), which has a much lower ODS potential but have high Global Warming Potential (GWP). HCFCs have been gradually replaced by HFCs (e.g., R-410A and R-134a), the 3rd generation of refrigerants. Today, R-410A, is the most widely used refrigerant in high-efficiency RACs. However, these refrigerants still have a high GWP and the Montreal protocol is helping countries to move to the 4th generation of refrigerants, which include low-GWP HFCs (e.g., R-32), hydrofluoroolefins (HFOs) or HFO blends (e.g., R-452B, R-1234yf), and natural refrigerants such as HCs (e.g., R-290).

In some cases alternative refrigerants are flammable or mildly flammable, lower efficiency, or higher cost. HFC R32, hydrofluoro-olefins such as R1234yf, and blends of these (with each other and with hydrocarbon refrigerants) are among the leading alternatives being considered. These substances have GWPs ranging from 675 for R32 to 3 for R1234yf and 0 for hydrocarbons (Table below).

The EU considers the GWPs of the refrigerant used in its MEPS, as shown previously[14].

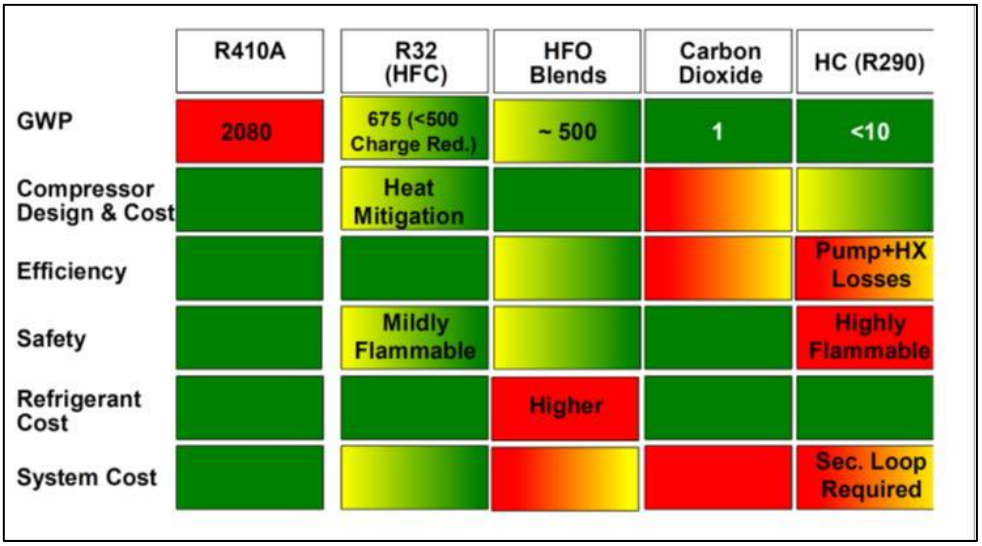


Figure 18. Overview of refrigerants and their characteristics

As a party to the Protocol and its amendments, South Africa is committed to following the agreed phase out as follows[15]:

- Freeze consumption in 2013 at the baseline consumption (2009-2010);
- Reduce 10% by 2015;
- Reduce 35% by 2020;
- Reduce 67.5% by 2025;
- Allow 2.5% annual consumption during 2030-2040

South Africa can adopt low-GWP refrigerants in that time frame or target to meet its commitment sooner.

[14] Source: Pham and Rajendran, 2012

[15] https://www.environment.gov.za/sites/default/files/docs/sa_hpmp_newsletter.pdf

Emerging energy efficient technologies

In addition to advancing low-GWP refrigerants, various options to improve air conditioner efficiency exist, including increasing heat exchanger size and efficiency, variable speed and efficient compressors, efficient fans, and thermostatic and electronic expansion devices.

Shah et al (2013) estimates the incremental cost of improving the efficiency of room ACs based on the cost of improving the efficiency of its key components. The study finds that the cost effective efficiency improvements range from 20% to 30% reduction in energy consumption based on a consumer perspective. The following table is issued from this analysis. According to their research, if all the efficiency improvement options shown in the table are employed, then 60-72% of energy could be saved compared to a base case model.

International review of Efficiency Improvement Options and Corresponding Energy Savings (Shah et al. 2013), is shown below:

Option	Description	% improvement from base case	
		Min	Max
Efficient Heat Exchanger	high efficiency microchannel heat exchangers, larger sized heat exchangers	9.1%	28.6%
Efficient Compressors	two-stage rotary compressors, high efficiency scroll compressors with DC motors	6.5%	18.7%
Inverter/Variable Speed	AC, AC/DC or DC inverter driven compressors	20%	24.8%
Expansion Valve	Thermostatic and electronic expansion valves	5%	8.8%
Crankcase Heating	Reduced crankcase heating power and duration	9.8%	10.7%
Standby load	Reduced standby loads	2.2%	2.2%
Total/cumulative[7]		60 %	72%

Figure 19. Table of AC efficiency improvement options

Recycling

Recycling old units and properly disposing of their refrigerant gases reduces impacts on the ozone layer and climate-change.

ACs contain refrigerants that deplete ozone and have high GWP. Recycling old units and properly disposing of these gases allow reduced impacts on the ozone layer and could also reduce climate change impacts if replaced with low-GWP refrigerant using ACs. However, this recycling comes at a significant cost, estimated at US$30 per unit in the Mexican PNSEE program (de la Rue du Can, et al. 2015). Possibility of receiving carbon credits for disposing of these gases offers governments a potential avenue to recover recycling costs.

Other trends

Countries are now being encouraged to prepare National Cooling Plans[16]. Such plans are cross cutting as the targeted refrigeration cycle is used in a range of appliances; refrigerators, freezers, air-conditioners, water heat pumps, tumble dryers etc. Overall the objective is a combined approach to lowering greenhouse gas impacts of refrigeration usage. Again this varies from shifting to less environmentally effecting refrigerants to improvements in the cycle efficiencies. In Sept 2018, the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, released a draft of the National Cooling Action Plan[17] to provide a 20-year outlook on how cooling demand in India will evolve and grow, and outline

[16] https://www.k-cep.org/wp-content/uploads/2019/01/Principles-for-National-Cooling-Plans.pdf

[17] http://www.indiaenvironmentportal.org.in/files/file/DRAFT-India%20Cooling%20Action%20Plan.pdf

strategies and actions that promote sustainable and smart cooling practices to mitigate adverse impacts.

3.4 International lessons learned for South Africa

Key international lessons for South Africa that will support regulatory and non-regulatory measures/interventions to advance market transformation of ACs sold in South Africa include:

1. A shift from third party certification to “self-certification” by manufacturer laboratories is firmly established. Manufacturer laboratories need certification andregistration plus enforcement is ensured through market surveillance and random verification testing on any product at regulator discretion. To support the self-certification option significant penalties including criminal sanctions need to be in place.
2. A comparison of the South African MEPS to international trends are shown below:

   Current minimum South African EER/COP levels:

   Split between 3.2 - 3.0 (91%) Target area

   Portable 2.6 - 2.4 (4%)

   Window 3.0 - 2.8 (5%)

   Other countries (difficult to directly compare due to mixed metric), but include:

   China minimums; EER 3.2 fixed speed, SEER 4.3 inverter or APF 3.5

   EU lowest SCOP 3.42

   Japan APF minimum 4.1

   Clearly South African is beginning to lag international MEPS practices with associated impacts such as dumping of old designs and reduced MEPS programme benefits.
3. Metric for measurement of efficiency has been broadened to include EER/COP for fixed speed units and Seasonal Energy Efficiency Ratio (SEER) for variable speed units. Plus the SEER metrics take into account a country’s temperature conditions for variable speed load requirements
4. Countries are placing greater emphasis on the introduction of 4^{th} generation refrigerants to replace the high GWP dominant R-410A which is widely used. National cooling plans that are being adopted, that cover air conditioning hope to achieve a shift away from these gasses.
5. A refrigerant recycling programme is needed for AC units to ensure the gasses from scrapped units are effectively handled thereby reducing their impact on the ozone layer and climate-change.

4 Identification of improvement measures/interventions

The current reality or "*snap shot*" provided a view of the AC market in South Africa through four lenses; the regulatory framework, the programme enactment and enforcement, the market dynamics; and, the supply industry. Throughout, comments and points have been made on barriers or dynamics related to achieving higher levels of AC appliance efficiency.

These South African regulatory orchestrated market and industry dynamics, together with the international lessons, have been used to identify measures and interventions for further advancing market transformation of ACs stocked and sold.

A natural grouping of the measures would be:

1. Regulation advancement.
2. Compliance strengthening.
3. Market response enhancement.

The following diagram sets out twelve possible measures and interventions:

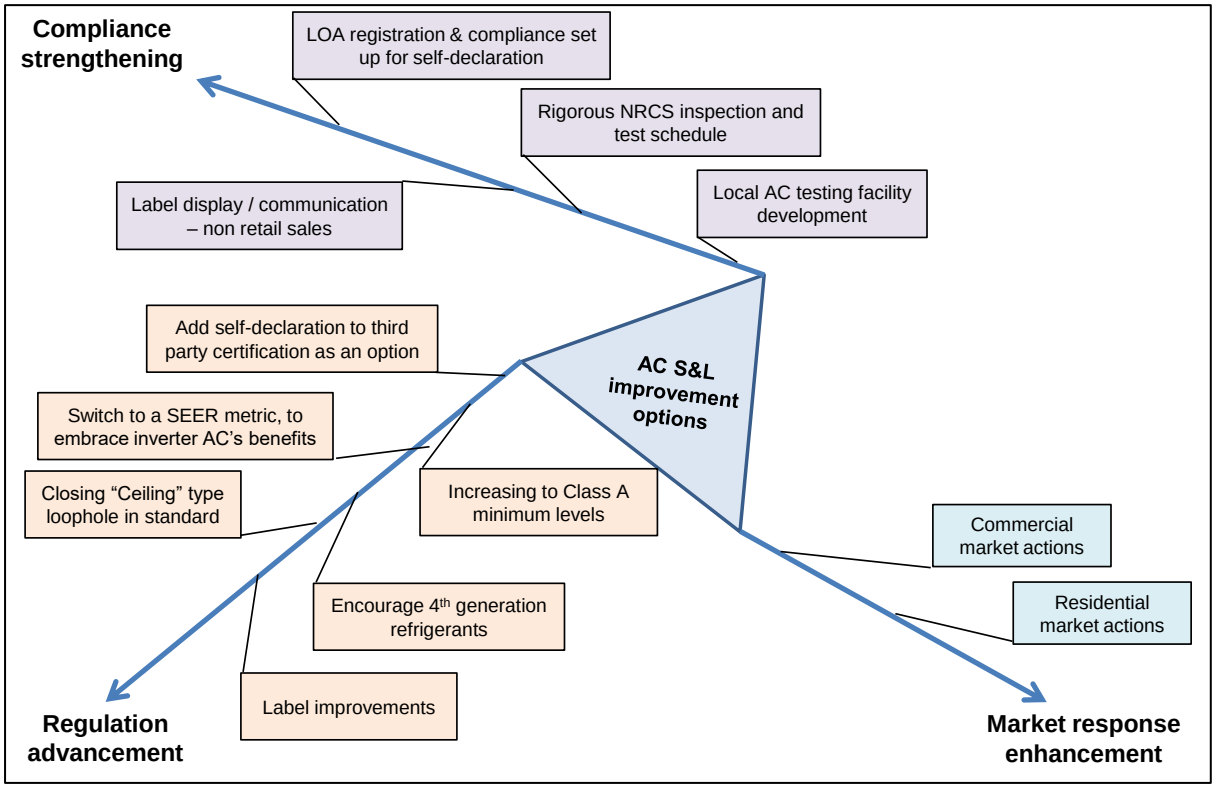


Figure 20. Diagram of twelve recommended improvement measures

Each option will be expounded, covering; description, motivation & facts, activities required and resources needed, complexity & timing; and, benefits to different stakeholders.

5 Regulation advancement

Advancing the current legislative and regulatory framework to further increase average efficiency of AC sold in South Africa.

5.1 Add self-declaration to third party certification as an option

Option description, motivation and facts

Internationally (US, EU, China, India etc.) there is a strong emphasis on self-certification and declaration of energy efficiency levels as part of the AC unit registration process. By persisting with independent third party laboratory test certificates South Africa faces a widening gap in appliance regulatory approach.

Clear implications of this mismatch of approach are as follows:

- Increasing difficulty by local importers to actually obtain third party test certificates from international manufactures, since they are loath to spend the money and deal with the complexities given South Africa is only 0.45 out 100million unit sales a year. These manufacturers are focused on meeting requirements in the large European, North American and other major markets.
- Clear negative feelings by the local AC supply industry towards the S&L programme, including self-declaration will foster far better relations.
- As a consequence the models available in South Africa are often not the latest and most efficient as it becomes easier to obtain third party certificates for older units, a counterproductive reaction by the industry – avoidance of the latest AC units

Furthermore simply producing a third party certificate and registration leads to a “them versus us” and “policing/distrusting” mind set by NRCS and an imbalance in compliance responsibility. Should South Africa move to accepting self-certification/declaration, with a suitable framework of testing and penalties it will shift the burden of compliance more to the Industry than NRCS. (The important issue of local testing will be addressed later.)

Commercially this barrier to entry for some importers and suppliers is hampering competition and self-declaration will level playing fields between all manufacturers by offering the choice of both approaches

Activities required and resources needed

A fundamental prerequisite to adding a self-declaration option to the registration process is the availability of a local independent testing laboratory (dealt with later).

With a laboratory available (see next section: 6.1) the following activities must be completed:

1. Revision of the current NRCS procedures to include self-declaration as an option. Recommend that a higher charge is levied for the option to support the testing regime. NRCS activity.
2. Setting and publishing of penalties and sanctions for proven non-compliance, these may be financial, or removal of privileges. The current NRCS move towards weighting the risk of suppliers can be integrated with these sanctions.
3. Communication with the AC industry when ready for launch

Complexity & timing

Highly complex option

2-3 years

Benefits

- Higher levels of compliance
- The savings from a 1% EER/COP increase equates to 5.33 GWh/year on one year's AC sales – plus will compound over 5 and more years
- Will encourage and open the way for latest most efficient models in SA market
- Move weight of responsibility more towards industry
- Shifts NRCS from having a compliance "police – them versus us" dynamic to shared "industry be ready to prove – else penalties" dynamic.
- Likely to improve government relations with the industry

5.2 Switch to a SEER metric, to embrace inverter AC's benefits

Option description, motivation and facts

Currently the Measurement Standard SANS 54511-3:2016 only allows for a single set point testing (EER/COP) for heating and cooling, plus differentiates levels between air conditioner installations arrangements (split/portable/window) levels.

Such single set point testing does not adequately reflect the efficiency benefits of variable speed/inverter driven AC units. Thus all countries listed in the research have included seasonal energy efficiency ratio (SEER) and equivalent seasonal coefficient of performance (SCOP) for heating as the metric for variable speed units.

By South Africa adopting a similar approach, combination of single point EER/COP for fixed speed and multipoint SEER/SCOP for variable speed, the correct signal would be given to the market.

Whilst under review there is a further option to move to a single figure annual performance factor (APF) combining both heating and cooling ratings as one. This is recommended as the prevalence of reverse cycle units is now so high at 98.5%.

Overall this advancement of the regulation will encourage the sale of high efficient inverter units, by naturally lowering attractiveness of non-inverter units.

Actions required and resources

SANS committees would need to be requested to initiate work on setting these metrics and associated levels based on ISO 16358 with South Africa specific climatic conditions. Plus an annual performance factor (APF) for reversible-type products

Through the committee SANS 54511-3:2016 can update the new metrics on all future LOA tests from a fixed date.

Update NRCS LOA registration guidelines/process accordingly, including the checks and methodology for determining the class from a test report.

Complexity & timing

Medium complex option

1-2 years

Benefits

- More efficient units for sale as inverter driven units will be encouraged.
- Increase in average efficiency levels of AC units sold in South Africa.
- Positive response from AC industry as they would prefer a SEER/APF metric.
- Greater alignment between South African S&L compliance approach and global trends.

5.3 Increasing to Class A minimum levels

Option description, motivation and facts

As far back as 2014 the CLASP study[18] found the MEPS levels in key countries was broadly comparable with current South African levels. Naturally over the past 5 years there has been significant upward shift in the efficiency required in key countries with significant markets.

Current minimum EER/COP levels:

Split between 3.2 - 3.0 (91%) Target area

Portable 2.6 - 2.4 (4%)

Window 3.0 - 2.8 (5%)

Other countries (difficult to directly compare due to mixed metric), but include:

China minimums; EER 3.2 fixed speed, SEER 4.3 inverter or APF 3.5

EU lowest SEET 3.42

Japan EER minimum 4.1

South African levels are consistently lower and indicate a lag behind global trends. It should be noted that as the sales volume of the higher classed units naturally increases with time the price per unit will decrease. This negates the previous arguments that higher efficiency units will be too costly for the local market.

By lagging behind on the minimum levels globally, coupled with South Africa market dynamic of strong price based buying decisions, will be an encouragement for old technology dumping as manufacturers try and keep selling these “cash cows”.

Industry has accepted and readily come to terms with the current Class B over the past 2.5 years, the time is right for a further advancement of the standard.

Actions required and resources

Couple the increase to Class A, with the shift to SEER and initiation of a move to inclusion of a self-declaration option. This will ensure the AC industry both benefits from and supports the regulation advancements – a balanced “value offer”.

Initiate a SANS 54511-3:2016 update through the working committee at the same time as the metrics are changed.

Gazette the increase when all systems ready by Minister Trade & industry.

Update NRCS LOA registration guidelines/process accordingly.

[18] Urban Econ Development Economists, Review 2018.

Complexity & timing

Medium complex option

1-2 years

Benefits

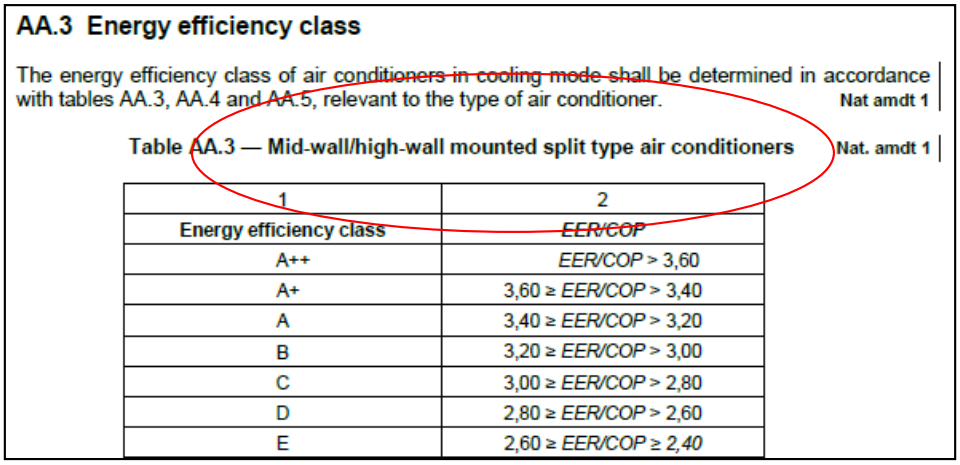
- Greater alignment of the South African S&L programme and global trends.
- Higher average efficiency of AC units on sale in South Africa.
- Saving from 10% EER/COP increase is 53.3GWh/year on one year's AC sales – compounds over 5 years

5.4 Closing "Ceiling" type loophole in standard

Option description, motivation and facts

The anomaly in the SANS 54511-3:2016 standard needs to be rectified thereby closing the current loophole for potential avoidance of compliance by 'ceiling" mounted split units.

The following extraction shows the incomplete wording:



AA.3 Energy efficiency class

The energy efficiency class of air conditioners in cooling mode shall be determined in accordance with tables AA.3, AA.4 and AA.5, relevant to the type of air conditioner. Nat amdt 1

Table AA.3 — Mid-wall/high-wall mounted split type air conditioners Nat. amdt 1

1	2
Energy efficiency class	~~EER/COP~~
A++	*EER/COP* > 3,60
A+	3,60 ≥ *EER/COP* > 3,40
A	3,40 ≥ *EER/COP* > 3,20
B	3,20 ≥ *EER/COP* > 3,00
C	3,00 ≥ *EER/COP* > 2,80
D	2,80 ≥ *EER/COP* > 2,60
E	2,60 ≥ *EER/COP* ≥ *2,40*

Figure 21. Extraction of the AC testing standard definition loophole

Actions required and resources

While SANS 54511-3:2016 is updated for metric and class A, the wording needs to change to:

Table AA.3 All split type air conditioners, including of kind designed to be fixed to a window, wall or ceiling or floor, self-contained or split -system".

Thereby, aligning the description with the Customs and Excise Tariff book, for category 8415.10.

Complexity & timing

Low complexity option

1 year

Benefits

- Higher levels of compliance to current minimum standards.

5.5 Encourage 4th generation refrigerants

Option description, motivation and facts

Global Warming Potential (GWP) is the rating system for refrigerants. While the Montreal Protocol has eliminated most generation 1 & 2, South Africa still utilises 3rd generation R410A (97%).

Actual legislation requiring the use of 4th generation refrigerants will not be possible currently in South Africa. Greater levels of such legislation are needed in the dominant market countries to bring about the scale of use and associated lowering of costs.

However, South Africa needs to at least start encouraging a shift to 4th generation refrigerants (HFC R32, hydrofluoro-olefins e.g. R1234yf). This can be achieved by educating and encouraging public to purchase air conditioners with 4th generation refrigerants.

Recommend that this is achieved through adding a variable on the label:

Green for 4th generation

Yellow for 3rd generation

Red for older

Further as South Africa starts looking into the establishment of an overall cooling plan, covering all appliances utilising refrigeration cycles, air conditioners will naturally be included.

Actions required and resources

Inclusion and alignment of air conditioners in a South African National Cooling Plan, as it is developed. Matters that would be included are:

1. Agreement on what 4th generation will be acceptable, plus the specification of which are generation 3, 2, 1 for rating purposes.
2. Reduce imports of R22 and similar gasses used to repair old units, thereby ensuring they will need to be replaced.
3. Rules and guidelines on recycling/scrapping of AC units and the handling of old gasses in an environmentally friendly way.

Initiate an AC label change to reflect refrigerant type and global warming impact, for example:

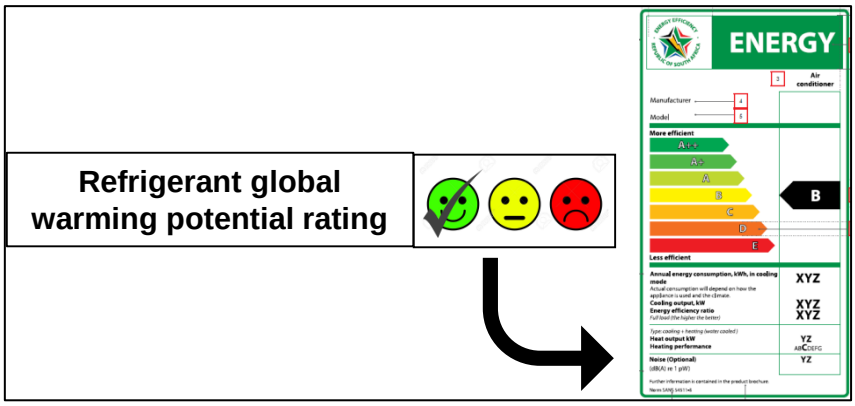


Figure 22. Proposed label addition to reflect refrigerating global warming impact

Then, add the communication material on the website, brochures etc.

Complexity & timing

Low complexity option

1 year

Benefits

- Gradual shift to lower GWP refrigerants
- Informed public on GWP matters.

5.6 Label improvements

Option description, motivation and facts

The current label format has a number of usage and layout issues that will be reducing the communication benefit to prospective buyers, including:

- Hours of operation set an arbitrary 500 hours per year - incorrect.
- No hours of operation or usage (kWh) for heating mode.
- No distinction on usage between residential versus commercial users.
- Smaller sized lettering for heating mode, yet 99 % are now reverse cycle capable units.

Assumptions used as a basis for more reflective operational hours:

Commercial users	Assumtions
Annual weeks	52.1
Seasonal weeks	13.0
Summer load factor	60.0%
Spring load factor	30.0%
Winter load factor	55.0%
Autumn load factor	20.0%
Office hours/week	40
Process hours/week	168
Office / process ratio	90.0%
	hours/year
Cooling operating hours	619
Heating operating hours	516
Total hours	**1,136**

Residential users	Assumtions
Annual weeks	52.1
Seasonal weeks	13.0
Summer load factor	60.0%
Spring load factor	30.0%
Winter load factor	55.0%
Autumn load factor	20.0%
Active hours/week	35
	hours/year
Cooling operating hours	411
Heating operating hours	342
Total hours	**753**

Market average hours	#
Residential market %	27%
Commercial market %	73%
Cooling operating hours	564
Heating operating hours	470
Total operating hours	**1,034**

Figure 23. Tables showing the assumptions and recommended AC usage factors

Recommended layout and data for the potential buyers:

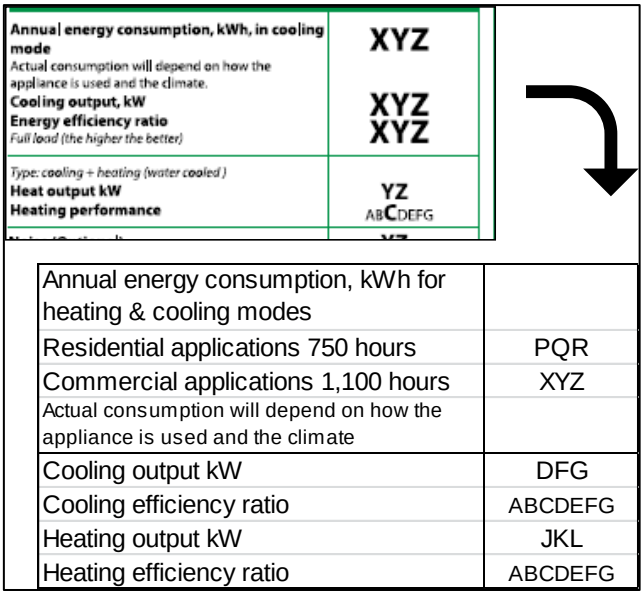
Annual energy consumption, kWh for heating & cooling modes	
Residential applications 750 hours	PQR
Commercial applications 1,100 hours	XYZ
Actual consumption will depend on how the appliance is used and the climate	
Cooling output kW	DFG
Cooling efficiency ratio	ABCDEFG
Heating output kW	JKL
Heating efficiency ratio	ABCDEFG

Figure 24. Table showing new label usage information

Actions required and resources

Consensus will need to be reached between stakeholders that the recommended operational hours for residential and commercial markets are fair.

Next an AC label change will need to be initiated, replacing the current layout/values as follows:



Annual energy consumption, kWh for heating & cooling modes	
Residential applications 750 hours	PQR
Commercial applications 1,100 hours	XYZ
Actual consumption will depend on how the appliance is used and the climate	
Cooling output kW	DFG
Cooling efficiency ratio	ABCDEFG
Heating output kW	JKL
Heating efficiency ratio	ABCDEFG

Figure 25. Picture showing the label usage replacement

Add to the communication material on the website, brochures etc.

Complexity & timing

Low complexity option

1 year

Benefits

- Increased buyer understanding of the annual usage and place equal worth on the cooling and heating functions.
- Both residential and commercial users are supported.

6 Compliance strengthening

6.1 Local AC testing facility development

Option description, motivation and facts

NRCS have the legal responsibility to ensure adherence to the current standards. This work has two components; evaluation and issuing Letters of Authority to allow for the importation and sale of conforming air conditioners and secondly enforcement of compliance.

Compliance activities by the NRCS have to include the drawing of AC units from the market and then having them independently tested. This applies to the third party accreditation approach, where “golden” samples” could have been tested and the actual units imported don’t function at the same level. Even incorrect labelling of a unit could allow for low performing units to be imported under a higher indicating label.

Most definitely should self-declaration be included in the programme, it is imperative that such independent targeted tests are performed. Thus central to the self-declaration shift and in support of all compliance activities a local accredited test laboratory is a necessity.

Factors that are impeding local test laboratory development include; lack of funding, no workable business model and resistance of industry to financially contribute, underutilisation of the asset; and, the need for the unit to be at sea level.

To initiate development of an accredited local test laboratory the following business parameters are recommended[19]:

1. *AC unit size limitation*. Current MEPS and labelling programme is targeted at AC units below 30,000BTU or 8.8kW. International test laboratories can handle units up to 120,000BTU/hour or 35kW. Yet, in the South African market over 73% of the units currently being sold are 18,000BTU/Hr or 5.3kW and below. Laboratory costs increase with the cooling capacity; hence it is *recommended that the laboratory cooling capacity is limited to 30,000BTU or 8.8kW*. For larger single AC units reliance on third party accreditation only would need to be accepted as a trade-off against the low sales volume.
2. *Laboratory type. Balanced Ambient Calorimeter Test Chamber* suitable for room air conditioners (split, window, or free standing) is recommended. Note, centralised air conditioner units required different Test Chamber type; again the market would be small making such a laboratory not worth the cost.
3. *Scale and multiple uses*. To cater for the South African market a single test unit would be acceptable, able test around 50-80 AC units a year. If a secondary use of the chambers is possible such as academic research or teaching there will be a higher utilisation of the asset.
4. *Accreditation.* Required during set up and then every 2/3 years thereafter. Accreditation requires that all testing equipment be calibrated annually and extensive paperwork be kept on site demonstrating the processes used for performing testing. This is detailed in ISO 17025. Represents a laboratory cost overhead.
5. *Testing time.* A single test point test (e.g. non inverter cooling only) 4-8 hours, with up to 4 days for multiple set point SEER test on a reverse cycle inverter unit.
6. *Staffing.* Key to the operation of a laboratory will be trained and experienced technicians. Berkeley lab indicates testing rarely goes smoothly requiring problem

[19] Information in this analysis has been drawn from Berkeley Laboratories feedback to written questions.

solving and well trained and experienced technicians. Thus the most important consideration for operating and maintaining a test chamber.

7. *Laboratory capital cost.* A single AC unit test lab for systems up to 30,000BTU/hr or 8.8kW would cost in the region of R6-7million[20] (USD 430,000 – 510,000) installed.
8. *Laboratory operating costs.* Any institution hosting the laboratory will incur service related costs; secure and protected floor area, water connection, electrical provision and data etc. Plus labour cost per test would be the region of R10,250 (USD 710) or for 80 units a year R820,000 (USD 56,800).

Recommended and model approach for South Africa:

- House the laboratory at a local academic institution having suitably qualified technical staff to operate the unit.
- Lower the laboratory overheads by exchanging the *services costs* (floor space, water, electricity etc.) for the benefit of laboratory use for research and teaching when not used for conformance testing.
- Guarantee the use of the institution staff through an annual maintenance payment of R500,000 (USD 35,000) fee. This will effectively "maintain" the unit and have it available for up to 80 tests.
- Motivate for a capital grant from GEF or other funders to a value of R8-9 million ($600-700,000) to facilitate the conformance to minimum standards within the Southern African market. This will cover manufacture, construction (R6-7 million) and allocate R500,000/year for 5 years to cover an institution "maintenance/availability fee". The motivation to GEF for the funds, despite a smaller market of 350,000 units/year less than 500,000, should be based on the following reasons:
    - The cost is only ~40% of the $1.5million normally allocated by GEF for a laboratory, given the smaller market size of 350,000 pa compared to their 500,000 pa.
    - The laboratory service will be available to all neighbouring countries and the SADC region. This represents a substantive and economically developing geographical area.
    - Most importantly, South Africa has already implemented the MEPS and labelling programme, this is simply to improve and underscore the good work.
- Further payment by NRCS for the 80 tests costing will be R4,000/test or R320,000pa.
- Through open tender local academic institutions[21] would bid for the opportunity to host the laboratory. Having met minimum staff and hosting conditions, adjudication would be on the lowest annual operating cost. Expected that the annual cost to cover staff provision will be less than R820,000, as the service related hosting costs will be exchanged for rights to academic use.

Actions required and resources

1. Submission of a detailed motivation to GEF and others funders, for the establishment of a Southern African accredited test laboratory based on a market of >350,000 units per year plus SADC. A single test laboratory limited in size to 30,000BTU/hr or 8.8kW with an expected cost of up to R9million including an annual availability/maintenance fee.

[20] Budget quote obtained from ETC TESTING & SIMULATION SYSTEMS, USA.

[21] Email interactions Stellenbosch University indicated that Mechanical Engineering Faculties at universities or universities of technology would be strong candidates for such a role.

2. A closed bidding process be offered to Engineering faculties at South African universities, with the winner contracted by SANEDI to host the test chamber and perform the tests, exchanging reaching/teaching rights for hosting costs. Such a tender needs to include a clear specification of the capabilities and facilities that need to be met. Particularly the institution will need to show they have the skills/staff to specifically operate a Balanced Ambient Calorimeter (BAC) test chamber or show how these skills will be obtained.
3. Agreement by industry to pay an increased registration fee on each self-declaration LOA's, by R4,000 to contribute towards the costs of the testing.
4. A NRCS budget allocation for up to 80 compliance tests a year of R320,000.
5. International tender for the supply of the test unit, possible suppliers of a test unit being:
    - Climatic Testing Systems, Inc. (CTS)

      http://climatictesting.com/balanced-ambient-calorimeter/
    - Environmental Tectonics Corporation (‘”ETC”) TESTING & SIMULATION SYSTEMS

      http://www.testingandsimulation.com/psychrometric-and-balanced-ambient-test-rooms/
    - Gz-lans Experimental Technology Co., Ltd

      http://www.gzlans.com/main_e.asp
    - Vipac engineering solutions

      http://www.vipac.com.au/wp-content/uploads/2017/06/Flyer_Appliances_Enthalpy-Test-Chambers.pdf

Complexity & timing

Highly complex option

Over 3-4 years

Benefits

- Higher levels of compliance
- Increase in average levels performance
- Happier industry – government relations

6.2 Rigorous NRCS inspection and test schedule

Option description, motivation and facts

Only limited compliance activities are currently completed by NRCS, which is leading to non-compliant AC units being sold in South Africa. This was fully confirmed by the 50 models for sale without LOA's identified during the survey.

A rigorous inspection and testing framework is recommended that must be enacted by the Regulator.

Strengthen importation & stock checks:

- SARS import initiated NRCS inspection increase
    - Clear target set for checks when import container opened e.g. 10 per month
- Warehouse checks initiated,
    - Each importer (36 at least) to have two warehouse inspections per year, amounts to = 2x36/12 = 6 inspections per month
    - Verification that all models on site have LOA's and labels affixed to product

Retail/quotation checks:

- Website bi-monthly – model LOA & verify label link
- Retail store inspections – 3 per month, different retailers / cities
- Small /large installer/supplier verification inspections
- Inspections on current LOA's and label displayed / provide in any written quotes - cover 50 sales outlets a year 4/month

Sanction levels enforced:

Recommended, that the existing sanction options (8 options) from a letter to conform through to actual prosecution are applied in full. Greatest action would be:

- Removal of product from the market
- When labs available target units for tests

Actions required and resources

Sufficient staff time needs to be allocated in the form of inspectors to complete this work. Estimated that it will be between 1 and 1.5 man-years to complete the level of inspections.

Detailed planning for inspections, staff availability, target information provided, dates, etc. is needed. A formal framework is needed whereby these plans and the activity reports shared with the Department of Energy for agreement and reassurance on the activities.

Communication with the AC industry in general on what is happening, what action has been taken will all help to build in the S&L objectives.

Complexity & timing

Low complexity option

1 year

Benefits

- Higher levels of compliance
- Higher average levels of efficiency.

6.3 LOA registration & compliance set up for self-declaration

Option description, motivation and facts

In preparation for self-declaration, the NRCS will need to adjust and rework the LOA registration process.

In this case manufacturer laboratory registration is needed and a decision is needed as to whether third party accreditation of the manufacturer's laboratory is needed.

Clear random test sampling directive is needed whereby a target percentage of units are drawn from the importers for independent testing.

Handling of the test report on compliance to manufacturer's submission will need different guidelines/process whereby self-declaration privileges will be withdrawn if non-compliance is found.

Actions required and resources

- Any process and paperwork changes to LOA registration
- Preparations for the new registration method
- Through a revision to SANS 941 suitable penalties/sanction need to be published and assumed by NRCS.

Complexity & timing

Highly complex option

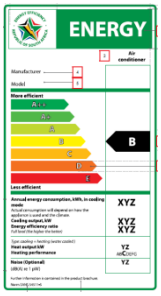
3-4 years

Benefits

- Higher levels of compliance
- Increase in average levels performance

6.4 Label display / communication – non-store sales

Option description, motivation and facts



Given the historical focus on a display label applicable to in-store promotion, the need to broaden this to all purchases was identified. These include online sales and most importantly all the commercial market sales completed through tenders and written quotes. All organisations selling AC units through tender, quotes or other non-retail outlet methods need to comply with the requirement of a label display.

For online sales, it is recommended that a label icon is needed either on or adjacent to the picture of the unit on offer. The icon in turn needs to link to an 'on screen' readable picture of the label. Plus when adding the item to the sales "basket" an option needs to be added highlighting the label and "have you compared energy efficiency with others".

For commercial sales via written quotes and tenders, all organisations selling AC units through tender, quotes or other non-retail outlet methods for each model offered on a quote needs a label copy attached to the document (hard print or electronic copies of the label – in addition to the label on the physical units). Further it is recommended that the reader needs to be alerted to the matter of efficiency class, savings etc. via the following standard paragraph:

> "Before making your purchase decision, we recommend that you familiarise yourself with the energy efficiency Class and ratings of each model on offer. Attached are copies of the relevant labels."

Actions required and resources

Editing/adding to the label guidelines the above information and requirements. This will make the display of labels enforceable by the regulator.

To assist with implementation, the preparation of an electronic "briefing pack" on the new guidelines and application be sent to all registered importers for circulation to their on- sellers.

NRCS will then need to broaden their compliance checks to include:

1. A survey of all "on-line" sites selling AC units to verify label visibility on a regular basis.
2. Undertake ad hoc checks of on-sellers, to ensure the labels are being included in documentation.

Copies are sent with guidelines to all installers and others supplied.

Complexity & timing

Low complexity option

1 year

Benefits

- Increased buyer understanding of efficient appliances & more informed decision making.

7 Market response enhancement

7.1 Commercial market actions

Option description, motivation and facts

Buying higher efficiency units often will have lower Life Cycle Cost (LCC). Whilst the AC industry indicates that price alone is the determinant of sales choice, a strong effort is needed to position LCC as the method used by commercial buyers of AC units. Calculations need to include:

- Initial capital cost
- Installation cost
- Electrical usage cost over say 5 or 8 years, allowing for an annual electricity price increase of at least 5%.
- Volume of electricity usage is a function of the hours of operation as per label guidelines or adjusted if usage known and the kW usage.
- On large tenders even Net Present Value calculations can be completed.

An example is shown adjacent:

Samsung 9,000Btu comparison			
Model	EER	Cost	LCC
AQ09TSBN	3.22	R 6,449	R 18,953
AR03MQRBWKNFA	3.73	R 7,499	R 17,742
LF = 11.7%		R1.7/kWh	8 years

Figure 26. Table indicating LCC based sales benefits

Yet the S&L website and promotional activities have failed to:

- Provide information for commercial AC market buyers being only residential focused.
- Does not encourage or show the calculation parameters to evaluate different AC units on a LCC basis.
- Specifier's (architects, developers) have not been directly alerted to the energy efficient of AC units, the S&L programme & benefits of buying up.
- Emphasize operational energy cost savings to landlords and property management companies and tenants.

Actions required and resources

Update the website material with a link to Commercial market focused information on LCC and other efficiency related matters.

Development of a training video and brochure for specifier's such as; architects, developers, project managers etc. These can be distributed through professional Institutes such as architects, engineers associations who should be briefed and involved.

Training pack for Importers to circulate to all installers who quote to ensure they advize and sell on LCC basis if possible.

Complexity & timing

Low complexity option but high cost

1 year

Benefits

- Increase in average efficiency levels purchased by commercial market

7.2 Residential market actions

Option description, motivation and facts

At the point of AC purchase, buyers are making high ticket item decisions (R' thousands) and therefore need to make the best optimal decision. Central to the decision is an understanding and application of the guidelines and information that has been made available by the programme.

This includes; the label itself, the brochure, and now a quick access to the LOA database information and a savings calculator. Even a Quick Response Code link being prepared for use on a smart phone has been provided.

In the end the focus needs to be on increasing usage of the material and guidelines. Here the store sales staffs are the key. Sales staff move on quickly and focus only on price and their sales margins.

Repeated briefing, training and reinforcement are central to ensuring that they inform and educate the buyer during the sales interaction.

To this end good quality and beneficial sales staff training package is needed. Specifically for use by all retailers such as an electronic video can be prepared and distributed through the importers to all final sales organisations of their AC units.

Actions required and resources

Preparation of a sales person training pack, electronic brochure & video.

Get importers to circulate to retail groups for training of staff

Request on line sellers to add links to the S&L website pages/brochures

Complexity & timing

Low complexity option perhaps but high cost and time consuming

1 year

Benefits

- Increase in average efficiency levels purchased by residential market

8 Conclusions and recommendations to take forward

General conclusions

The AC industry *confirmed* the "snap shot" of the current AC market reality. They are an industry that is attempting to meet the Class B efficiency requirements, yet enforcement weaknesses are leading to *up to at least 25% non-compliance*.

Whilst the current regulation is *complete and integrated* the application has missed the fact that *>70% of sales are to the commercial market*, as opposed to the current S&L focus on the residential market.

From the international lessons, the current South African regulatory/standards regime is *falling behind* where AC's are headed in the major European, North American and Chinese markets. Minimum class of energy efficiency plus the metrics used all need to be updated and aligned otherwise South Africa will become a *dumping ground for old inefficient units.*

Compliance issues include both the inspection of volume correctness and importantly South Africa has no test laboratory where individual units can be randomly tested to confirm test report levels.

Recommend options to take forward

#	AC S&L improvement options	Complexity	Time years	Benefits
	Regulation advancement			
R1	Add self-declaration to third party certification as an option	High	2-3	Higher levels of conformance Move weight of responsibility more towards industry
R2	Switch to a SEER metric, to embrace inverter AC's benefits	Medium	1-2	More efficient units for sale as inverter driven uns will be encouraged Increase in average levels performance
R3	Increasing MEPS to Class A minimum level	Medium	1-2	More efficient units on sale Saving from 10% EER/COP increase is 53.3 GWh/year on one years AC sales – compounds over 5 years
R4	Closing "Ceiling" type loophole in standard	Low	<1	Higher levels of conformance to current minimum standards
R5	Encourage 4th generation refrigerants	Low	1	Gradual shift to lower GWP refrigerants
R6	Label improvements	Low	1	Increased buyer understanding of the annual usage and place equal worth on the cooling and heating functions
	Conformance strengthening			
C1	Local AC testing facility development	High	2-3	Higher levels of conformance Increase in average levels performance
C2	Rigorous NRCS inspection, test schedule & sanction	Low	1	Higher levels of conformance
C3	LOA registration & conformance set up for self-declaration	Hlgh	2-3	Higher levels of conformance Increase in average levels performance
C4	Label display / communication – non retail sales	Low	1	Increased buyer understanding of efficient appliances & more informed decision making
	Market response enhancement			
M1	Commercial market actions	Low	1	Increase in average efficiency levels purchased by commercial market
M2	Residential market actions	Low	1	Increase in average efficiency levels purchased by residential market

Figure 27. Table of Recommend options

Enhanced S&L saving possibilities

Based on the annual sales of 350,000 AC units for every 1% increase in efficiency rating, the annual electricity savings would be 5.33GWh/year or 5.17 tons of CO_2 equivalents. These numbers would compound over the years and each years need to be added.

An increase to Class A alone (Option R3 on the previous page) would account for a 10% increase, hence an overall increase of at least 15% would be expected or 79.97GWh/year or 77.57 'thousand tons of CO_2 equivalent/year from these interventions.

Engagement and commitments

Then the overall industry view and snapshot, plus the 12 recommendations were presented to the NRCS and DoE on the 25 March 2019 during a 2 hour workshop. The options were discussed and it was agreed to take these forward to the AC industry. Appendix B. has more detailed notes.

Lastly, on the 27 March a workshop was held that included representations of the DoE, NRCS and the AC industry. At the workshop the overall industry view and snapshot, plus the 12 recommendations where again presented. Following a breakout session feedback was given by the three organisations. The overriding conclusion being; the "snap shot" is a good representation of the current industry dynamics and all 12 recommendations can certainly be taken forward for implementation. A number of caveats where raised; concerns with inverter reliability and the size of the AC market. These where incorporated into the report. Appendix B. has more detailed notes.

The DoE has committed to work with the AC industry to reach consensus on the extent and timing of their introduction.

Appendix A. SARS AC unit information checks and discussion

The following process was undertaken to determine imports of Air Conditioners in to South Africa that fell within the scope of this project.

Source:

The SARS Trade Database was leveraged to determine official import volumes and values.

https://tools.sars.gov.za/tradestatsportal/data_download.aspx

Issue:

The official number of an average of 395 000 Units per year was deemed too high by the industry stakeholders, and a review was requested.

Possible Hypotheses

1. The number of from the SARS Trade Database includes units imported for the purpose of regional exports. ***False:*** *Units imported for the purpose of regional export are not released to the importer; instead they are kept in a bonded warehouse and later released to the exporter for export.*
2. Business people from neighbouring countries enter the country to purchase air conditioners from local retailers or importers and then export these themselves to their respective countries. ***False:*** *Industry stakeholders reported that this is a limited practice.*
3. SARS Customs & Excise are capturing indoor and outdoor units incorrectly and as a result are double-counting the number of units. ***Possible:*** *According to the NRCS who provided a Commercial Invoice as evidence this may be possible, however it is not clear to what extent.*

Stakeholders contacted to verify import volumes

1. NRCS – Response as captured under hypothesis 3
2. SARS – Captured as per statistical requirements
3. An Importer (Name withheld to ensure confidentiality) – A formal request was sent to understand their current import volume in relation to their estimated market size, however no response was received even after a follow request was issued.

Agreements and conclusions

- These numbers are a summation of the applicable tariff code; 8415.10 sub category 8415.10.10. In 2017/18 the code 8415.10 represented 82% of the units, containing the description “Of a kind used for buildings, compressor operated, having a rated cooling capacity not exceeding 8.8 kW”.
- After consultation with the NRCS it was agreed that tariff code 8415.10.90 be removed as it was defined as parts and the statistical measure is kilograms not units. The NRCS do not regulate the parts separately, only as integral to the assembly. This tariff code is included in their inspections to close all loop holes, e.g. where there could be false declaration to evade the regulator. It also adds to market intelligence gathering whereby they would pick up any new entrants or players who may be importing parts, for follow ups. At the port of entry if it is indeed parts, the consignment is released.
- During 2017/18 for example tariff code 8415.10.90 represents a transactional value of R358 million or around half of the value of code 8415.10.10. It is clearly a significant importation of AC related equipment. As AC the industry indicated price per unit on code 8415.10.10 is low, an explanation could be for split units the internal portion may

be listed as a part and would increase the overall customs cleared cost per unit. Importantly the number of AC units imported would remain the code 8415.10.10 value.

- Checks by NRCS of the way SARS capture data would be recommended and alignment ensured.
- Furthermore tariff code 8415.10.50 was also removed from the total units imported as it represents less than 5% of all imports and therefore had minimal impact on the total number of AC imports.
- In the absence of any other official data that captures the actual unit volumes we are inclined to utilise the SARS Trade Database as a data source. While making adjustments for the residential vs commercial volume splits.

Appendix B. Minutes of workshops

Workshop with Department of Energy & Regulatory Authority - 25 March 2019

A meeting with the above stakeholders was held to present research findings, analysis and recommendations for further action.

The purpose of the workshop was an opportunity for the consultants to share the results of the project analysis and findings with the DoE and NRCS before presentation to the Industry.

The following individuals, representing the below organisations were present:

	Name	Organisation	Contact #
1	Daniel Ntlhane	NRCS	082 454 1084
2	Tumelo Mashiane		073 307 8010
3	'Xolile Mabusela	DOE	
4	Theo Covary	DOE/UNDP	084 224 3000

The following key points were communicated:

- Overall the overview of the AC industry and trends was accepted.
- Current international trends was welcomed and agreed.
- Lastly it was agreed that the set of 12 recommendations be proposed to all stakeholders.

Workshop with Industry Stakeholders, Department of Energy & Regulatory Authority – 27 March 2019

A meeting with the above stakeholders was held to present research findings, analysis and recommendations for further action.

The purpose of the workshop was:

a. For the consultants to share the results of the quantitative and qualitative market research

b. For the industry and other stakeholders to communicate issues with the current system as it relates to energy efficiency standards and labelling.

c. For the industry and the regulatory authority to formulate responses to the 12 recommendations proposed by the consultants.

d. For the industry to share any further comments on the programme.

The following individuals, representing the below organisations were present

	Name	Organisation	Contact #
1	Daniel Ntlhane	NRCS	082 454 1084
2	Patsy Andrews		061 986 9283
3	Lancerlot Riyano		012 482 8873
4	Dellen Roberts		012 482 8841
5	Michael Mangena		076 118 9646
6	Tumelo Mashiane		073 307 8010
7	Marco Ferdinardi	SAASA	083 700 1171
8	Grant Spires	GMC	083 445 2063
9	Greg Ball	Airco/SAASA	082 456 0821

10	Antonie Engelbrecht	Dunham-Bush	082 465 7194
11	Rodney Schlemmer	Metra-clark	011 620 0300
12	Selwyn Niebuhr	Tecsareco	076 412 0839
13	Theo Covary	DOE/UNDP	084 224 3000

The following key points were communicated:

NRCS

- *Self-declaration*
    - The issue of Self-declaration is an option, but with the right conditions. There is an opportunity to tailor these conditions to be specific to the South African market. i.e. Importers who have been identified as low risk may receive the option
    - Not all elements of regulation can be left to self-declaration i.e. Safety
- *Changes in energy efficiency standards*
    - The NRCS is not responsible for changes pertaining to standards and therefore regardless of such changes will always uphold what the requirements at the type are.

Industry

- *Self-declaration*
    - The industry welcomes self-declaration as the best approach, however they had concerns regarding a funding model that could be sustainable i.e. custom duties
- *Changes in energy efficiency standards*
    - The industry indicated that the rate of change was too quick and communicated that the introduction of new legislation was the shrinking of current market.
    - Moving to an A rating would impact importers of fixed speed (inverter) models. As these were currently the better products for the market dynamics.
        - South Africa's current power grid is too volatile to effectively run inverter models
        - The humid weather in KwaZulu Natal was corrosive to the internal components of inverter models i.e. salt spray on PCP boards
        - South African buildings were not sophisticated enough for newer technology i.e. South African homes did not have double-glazed windows.