Title
South Africa National Cooling Plan

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GOVERNMENT OF SOUTH AFRICA

SOUTH AFRICA

NATIONAL COOLING PLAN (NCP)

Department of Mineral Resources and Energy (DMRE)
Department of Forestry, Fisheries and the Environment (DFFE)

2023

KIGALI COOLING EFFICIENCY PROGRAM

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Acknowledgements

The development of the South Africa National Cooling Plan (NCP) has been a multi-stakeholder effort, with inputs from government departments, state agencies, industry, associations, individual subject experts and academia.

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Individual contributions and inputs:

- Climate Legal
- South African National Energy Development Institute
- UN Environment – Sustainable Energy for All
- UNEP's United for Efficiency (U4E)

Acronyms

AC	Air Conditioning
Btu	British Thermal Unit
CFC	Chlorofluorocarbons
COP	Coefficient of Performance
CAGR	Compound Annual Growth Rate
DEL	Department of Employment and Labour
DFFE	Department of Forestry, Fisheries and Environment (previously Department of Environmental Affairs)
DoH	Department of Health
DIRCO	Department of International Relations and Cooperation
DMRE	Department of Mineral Resources and Energy (previously Department of Energy)
DSI	Department of Science and Innovation
DTIC	Department of Trade Industry and Competition
EE	Energy Efficiency
EEDSM	Energy Efficiency Demand Side Management
EER	Energy Efficiency Ratio
EPC	Energy Performance Contract
EU	European Union
FBE	Free Basic Electricity
GBCSA	Green Building Council of South Africa
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse gas emissions
GW	Gigawatts
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HPMP	HCFC Phase-Out Plan
HVAC	Heating, ventilation, and air conditioning
IDM	Integrated Demand Management
INEP	Integrated National Electrification Programme
IRP	Integrated Resource Plan
IPP	Independent Power Producer
ITAC	International Trade Administration Commission
kWh	Kilowatt hour
LSM	Living Standard Measure
LoA	Letter of Authority
MB	Methyl Bromide

MEPS	Minimum Energy Performance Standards
MV&E	Monitoring, Verification and Enforcement
$MtCO_2$	Million tonnes of CO_2
NCP	National Cooling Plan
NDA	National Designated Authorities
NDP	National Development Plan
NDC	Nationally Determined Contribution
NEEAP	National Energy Efficiency Action Plan
NEES	National Energy Efficiency Strategy
NERSA	National Energy Regulator of South Africa
NOU	National Ozone Unit
NRCS	National Regulator for Compulsory Specifications
NZEB	Net Zero Energy Buildings
ODP	Ozone Depleting Potential
ODS	Ozone Depleting Substances
PA	Paris Agreement
RAC	Refrigeration and Air conditioning
REEEP	Renewable Energy and Energy Efficiency Partnership
RRR	Recovery, Recycling, and Reclamation
SABS	South African Bureau of Standards
SACREEE	Southern African Council for Renewable Energy and Energy Efficiency
SADC	Southern African Development Community
SANAS	South African National Accreditation System
SANEDI	South African National Energy Development Institute
SANS	South African National Standards
SAPOA	South African Property Owners Association
SARACCA	South African Refrigeration and Air Conditioning Contractors Association
SARS	South African Revenue Services
SEER	Seasonal Energy Efficiency Ratio
SEforAll	Sustainable Energy for All
S&L	Standard and Labelling
tCO_2e	tonnes (t) of carbon dioxide (CO_2) equivalent
TWh	Terawatt-hours
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
W	Watts
WEEE	Waste Electrical and Electronic Equipment

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1. Executive Summary

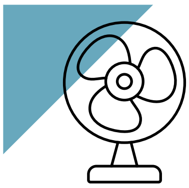
Introduction

South Africa is committed to preserving the environment and addressing climate change related issues based on science and equity. In 2019, South Africa ratified the Kigali Amendment to the Montreal Protocol to reduce the consumption and production of hydrofluorocarbons (HFCs) to simultaneously protect the ozone layer and contribute to mitigating climate change. In 2015, South Africa also signed the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement to fight against climate change and committed to achieve a "peak, plateau and decline" greenhouse gas (GHG) trajectory at a level between 398 and 614 MtCO_2e/year by 2030[1]. In 2021 revised target ranges of 398-510 Mt CO_2-eq for 2025, and 398-440 Mt CO_2-eq for 2030 were issued, as well as aspiring to reach a net zero carbon economy by 2050.

Addressing the environmental impacts of cooling products converges the objectives of these two treaties. Cooling products are the main source of HFC use and they consume a significant amount of electricity produced from emission intensive coal fired power plants. South Africa's efforts to mitigate global warming can therefore be amplified if the energy efficiency (EE) of cooling products is improved at the same time a refrigerant transition from HFC is considered. Synergistic actions with respect to sustainable cooling access across sectors will have a higher impact than actions taken in isolation.

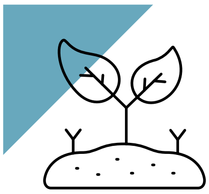
Improved EE of cooling products also contributes to achieving the UN sustainable development goals that have been adopted by South Africa. UN organisation Sustainable Energy for All (SEforAll) estimates that access to cooling is a sustainable development factor associated with three main themes: human comfort and safety, food and agriculture, and health services, as illustrated in ES Figure 1. Additionally, EE cooling saves consumers and businesses money on their utility bills, and reduces electricity waste and capacity additions, therefore contributing to economic development priorities.

ES Figure 1: Opportunities to address access to cooling needs in South Africa



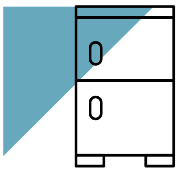
HUMAN COMFORT AND SAFETY

- Address cooling needs of **10.84 million people at highest risk** while closing rural and urban energy access gaps
- Prevent **productivity and job losses** associated with a lack of access to cooling
- Enhance **energy efficiency and passive cooling** measures in buildings and urban environments to reduce the need for cooling and the energy it consumes



FOOD AND AGRICULTURE

- Provide small-scale agriculture and fisheries producers with **enhanced access to cold chain and cold storage** by addressing data gaps and market and technology barriers
- Support **agricultural workers** with workplace cooling resources to prevent loss of productivity
- Address **undernourishment** in rural communities with community cooling resources



HEALTH SERVICES

- Vaccines and medical products need intact cold chains **to maintain effectiveness**

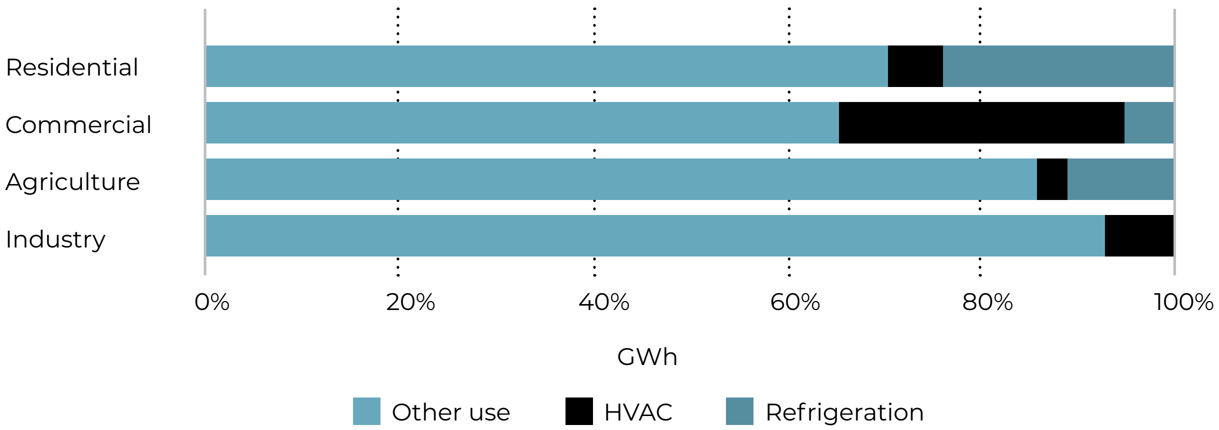
1 *South Africa's Nationally Determined Contribution (NDC). 2015.*
2 *South Africa's Low Emmission Development Strategy 2050 (February 2020) Department of Fisheries Forestry and Environment*

These converging interests brought together the Department of Forestry, Fisheries and Environment (DFFE) and the Department of Mineral Resources and Energy (DMRE) to develop a National Cooling Plan (NCP). The plan looks at actions needed to reinforce the government commitment to EE for cooling over the next decade. It provides recommendations on programme development that will foster EE and environmentally compliant cooling access throughout all sectors and applications while ensuring that cooling access continues to meet essential development goals.

Energy Sector Overview

In South Africa, electricity is primarily produced from coal (81% in 2021).[3] If the 2019 Integrated Resource Plan (IRP) is implemented, the share of coal-producing electricity will be reduced to 59% of power produced in 2030, and renewables will represent 33%. This large remaining share of coal in the energy mix puts emphasis on the importance of efficiency in reducing greenhouse gas (GHG) emissions from electricity consumption. Cooling-electricity consumption accounted for as much as 32 000 gigawatt-hours per year (GWh/year) in 2017, representing 31% of electricity consumed by all buildings and 16% of total final electricity consumption (ES Figure 2). This corresponds to emissions of 30.5 million tonnes of CO_2 equivalent (tCO_2e) in 2017.

ES Figure 2: Share of electricity consumption from cooling equipment in 2017 (by sector)



ES Figure 2: Share of cooling electricity consumption in 2017 per sector

Ownership of Air Conditioners (ACs) in households is still very low (6%), but sales are growing rapidly. SEforALL estimates that 10.84 million people in South Africa are lacking access to cooling (including refrigeration). Projected temperature increases due to climate change will exacerbate the impact of cooling needs. By mid-century, temperature increases of between 3.0 °C–3.5 °C are projected in the interior of the country where the largest city, Johannesburg, is located. Considering the IRP's projection of the average growth of electricity consumption to 2030 and continued growth of Refrigeration and Air Conditioning (RAC) penetration, notably in the residential sector, electricity used for cooling is expected to grow to 20% of total final electricity consumption, representing 44.4 $MtCO_2$ in 2030.

Policy and Programmes Roadmap

Over the last seven years, South Africa has implemented a strong foundation for EE investment in cooling. Opportunities exist to scale up South Africa's efforts to transform its market towards more efficient cooling products and cooler buildings by continuing to strengthen and expand the existing enabling policy environment. The NCP provides synergistic actions to improve cooling efficiency and amplify the impact of transitioning to low Global Warming Potential (GWP) refrigerant used in cooling equipment.

As summarised in ES Table 1, the NCP proposes to expand the Standard and Labelling (S&L) programme to continue to eliminate the least-efficient products from markets and sets the floor for EE. It also motivates for improved and increased enforcement of the programme regulations and the revision of the energy labels to better communicate the products' efficiency to buyers. The NCP also considers the implementation of innovative financing mechanisms to accelerate the uptake of highest performing products that are super-

3 Council for Scientific and Industrial Research (CSIR) Statistics of utility scale power generation in South Africa 2021 https://researchspace.csir.co.za/dspace/bitstream/handle/10204/12067/Statistics%20of%20utility-scale%20power%20generation%20in%20South%20Africa_Jul_2021.pdf?sequence=1&isAllowed=y

efficient and that contribute to sustainable cooling. Noting the cooling demand in buildings, the NCP considers the implementation of the building code acceleration, its revision to include cool roofs and to set national and regional targets for reaching a higher penetration of net-zero energy building (NZEB) construction in the near term. Finally, the NCP deems it essential to adopt a circular approach to reduce unnecessary waste and significantly increase the percentage of appliance recycling.

ES Table 1 – National Cooling Plan Proposed Actions

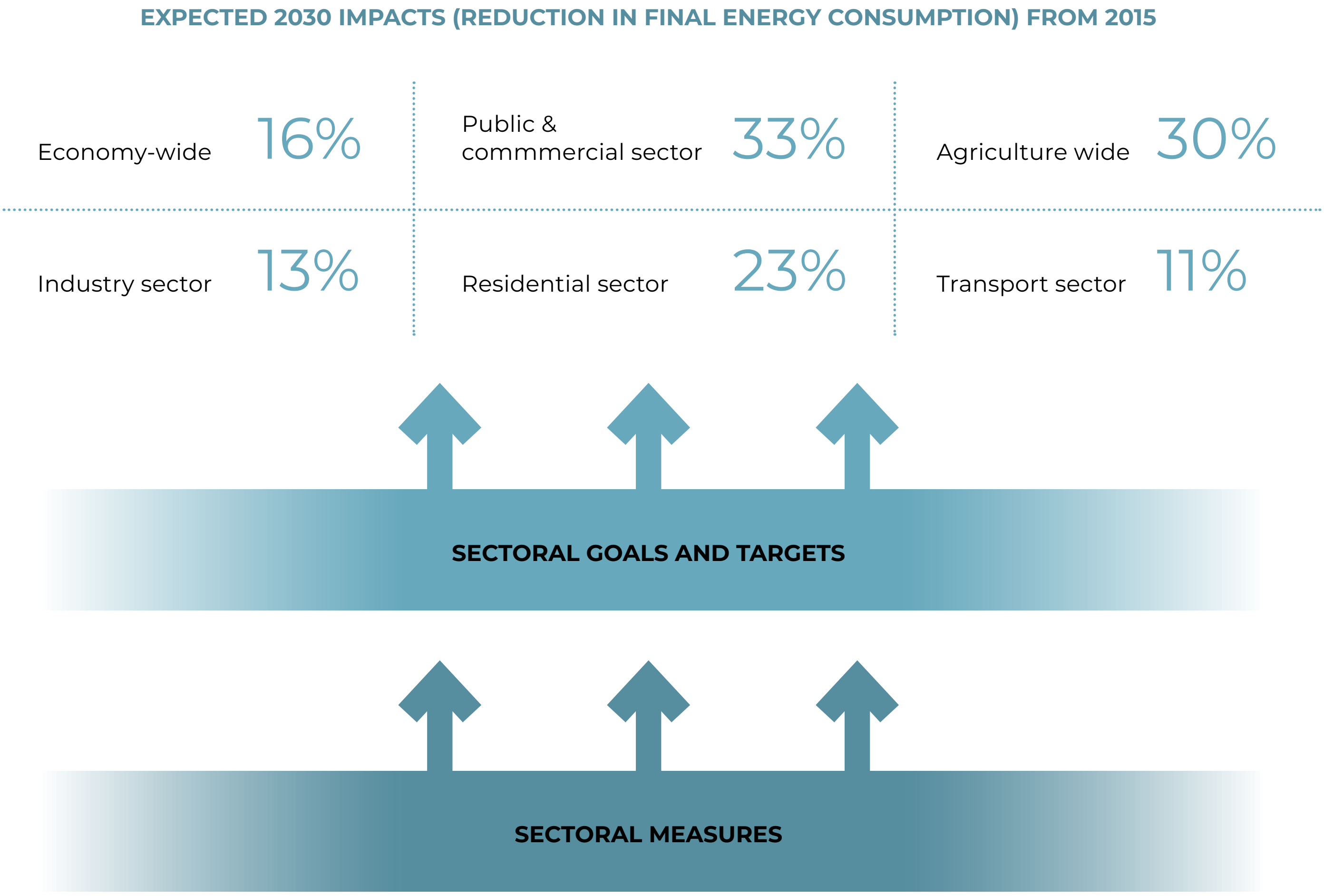
		CURRENT SITUATION		PROPOSED ACTIONS
Standard and Labelling Programme	**EFFICIENT COOLING EQUIPMENT**			
	ACs	> 7.1 kW	No MEPS	Adopt Minimum Energy Performance Standards; (MEPS) for larger ACs
		< 7.1 kW	Current B 2023 A	Adopt U4E model regulations, which are aligned with the new 2022 China MEPS, to reduce risk of dumping and increase size to 8.0 kW
	Refrigerators MEPS	2023 A 2026 A+		Consider commercial refrigeration Rescale energy classes
	MVE	Registration database Testing for refrigeration		Develop a Monitoring, Verification, and Enforcement (MV&E) plan to check and increase compliance with the regulations
	Labels	Comparative label		Update the label to reflect rescaling and include refrigerant gas-indicator icon: i.e., good, average, or poor
Buildings Code	**COOL BUILDINGS**			
	Building Codes Implementation	Lack of application of national Building Code		Develop capacity building and tools to assist building sector stakeholders and code officials to fast track the implementation of the current building code
	Cool Roofs	Cool roof projects are being deployed		Scale up cool roof adoption by including a cool roof requirement in the Building Code and standardising product categories
	NZEB	Low uptake		National and local government need to set short-term targets for the building sector to integrate passive designs and achieve NZEB construction
Financing	**ACCELERATION OF EFFICIENT COOLING THROUGH FINANCING**			
	Financing	No major cooling financing program		Map out efficient cooling financing needs and market gaps, and design new financing programmes to accelerate uptake of sustainable cooling access
Circular Economy	**CIRCULAR ECONOMY**			
	Waste Management	No recycling facilities available		Implement DFFE industry waste-management plan (currently still being developed) for electronic equipment to provide recycling facilities supported by regulations

Note: MEPs = Minimum Energy Performance Standards; NZEB = net zero emission building

Conclusion

South Africa has one the most emissions-intensive electricity production systems in the world, which presents significant potential for large emissions reductions through EE. We estimate that if the NCP is implemented, the country could save 13.3 $MtCO_2$ by 2030. This is a substantial contribution that could be made for the South Africa Nationally Determined Contribution (NDC) which is at the heart of the Paris Agreement (PA) to fight climate change and limit global warming to below 2 °C, with 1.5 °C as a target. Cooling EE improvements also contribute to better usage of resources and allow households and business to reduce their energy bills. Indeed, the 'first fuel' is being prioritised in the DMRE's post-2015 National Energy Efficiency Strategy (NEES), which covers the period up to 2030 and seeks to 'embrace the concept of energy efficiency as South Africa's "First Fuel" in driving balanced, socially inclusive and environmentally sustainable economic growth, boosting job creation and leading technological innovation across the region'.

ES Figure 3: NEES (post-2015) Targets



Source: DMRE (2021)

The NEES targets are ambitious and if they are to be achieved, cooling efficiency will be one of the primary contributors due to its cross-cutting nature. Pairing EE with transitioning ODS (refrigerants) to meet national objectives and international climate change commitments has multiple national benefits, which this Plan seeks to contribute towards achieving.

2. Introduction

Section 24 of the South African Constitution recognises that everyone has the right to an environment that is not harmful to human health and well-being. The Constitution commits the country to protecting the environment while recognising the need for economic and social development through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development.

The South African National Development Plan (NDP),[4] which has targets to be achieved by the year 2030, aims to ensure a decent standard of living is attained for all South Africans through the elimination of poverty and reduced inequality. Development goals for a decent standard of living are described across the following core elements: nutrition; housing, water, electricity and sanitation; safe and reliable public transport; quality education and skills development; safety and security; quality health care; employment; recreation and leisure; clean environment; and adequate nutrition. Furthermore, Chapter 5 of the NDP is titled Environmental Sustainability: An Equitable Transition to a Low-Carbon Economy, and it focuses on how such an economy can be achieved through protecting and enhancing our environmental assets and natural resources. Moreover, cooling access, ozone protection and EE are key pillars of the UN sustainable development goals, which South Africa has endorsed.

Acknowledging our part in the global ecosystem and ensuring our planet can continue to sustain human life, South Africa has expanded its commitments to several international treaties intended to preserve the environment and human health. Included in these are the obligations of the Montreal Protocol on ODS[5] — the first UN treaty to achieve universal ratification, demonstrating the world's commitment to ozone protection. Indeed, by 2009, 98%[6] of the consumption of the chemicals[7] controlled by the Protocol had been phased out. However, HFCs have become the commonly used alternatives to ODS, and while not ODS themselves, they are greenhouse gasses (GHGs), which can have high or very high Global Warming Potential (GWP). The Kigali Amendment to the Montreal Protocol, which South Africa ratified on 1 August 2019, is the next global commitment to protect the ozone layer; it will be done at the same time as the country tackles climate change. The Amendment, an international agreement to reduce the consumption and production of HFCs, commenced in 2019. South Africa, classified as an Article 5 developing country, starts its phase-down in 2024, when the official freeze and phase-down begins culminating in HFCs being reduced by 80% by 2045 as shown in the schedule in Table 1.

Table 1: Article-5 countries HFC phase-down schedule

Step	Deadline	Reduction of Deadline (%)
1	2029	10
2	2035	30
3	2040	50
4	2045	80

Another chief international treaty signed by the South African government is the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement to fight against climate change. South Africa submitted its climate pledge, or NDC, for the Paris Agreement on 25 September 2015. Under the NDC, South Africa is committed to progress its contribution to the global effort to mitigate climate change in line with the principle of common but differentiated responsibilities and respective capabilities. South Africa's mitigation component of its NDC moves from a 'deviation-from-business-as-usual' form of commitment and takes the form of a peak, plateau and decline GHG emissions trajectory range. South Africa's emissions by 2025 and 2030 was set between a range of between 398 and 614 $MtCO_2$–eq, as defined in national policy. This is the benchmark against which the efficacy of mitigation actions will be measured. In 2021, a draft NDC originally proposed to reach 398 - 440 $MtCO_2e$ by 2030.

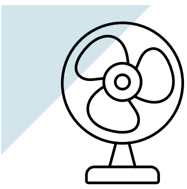
4 National Development Plan 2030: Our Future – Make it Work. Developed by the National Planning Commission, The Presidency.
5 Signed in 1987, it entered into force on 1 January 1989. The Protocol is designed to stop the production and import of numerous ODS and reduce their concentration in the atmosphere to help protect Earth's ozone layer.
6 'Key Achievements of the Montreal Protocol to Date'. https://ozone.unep.org/sites/default/files/MP_Key_Achievements-E_0.pdf
7 Chlorofluorocarbons, halons, carbon tetrachloride, and other fully hydrogenated ODS.

But based on proposals from the Presidential Climate Commission (PCC), the DFFE released an updated draft of its first NDC targets demonstrating stronger ambition, as well as aspiring to reach a net zero carbon economy by 2050 through South Africa's Low Emission Development Strategy (SA LEDS). The revised target ranges are 398-510 Mt CO_2-eq for 2025, and 398-440 Mt CO_2-eq for 2030.

South Africa is the world's 14th-largest emitter of GHGs. Carbon dioxide (CO_2) emissions are principally due to a heavy reliance on coal. Electricity consumption in South Africa comes with a hefty environmental cost to the society. For every kilowatt-hour (kWh) produced, 1 kilogramme (kg) of CO_2 is emitted, 1.4 litres of water are used, and 0.37 grams of particulate emissions are released into the atmosphere. These environmental implications result from the large share of electricity produced from coal (81% in 2021 - see Figure 2). While planned new capacity will ramp up 23 gigawatts (GW) of renewable energy, the 2019 IRP for the country still projects the share of electricity produced by coal in 2030 to be 59%. Thus, environmental concerns are not confined solely to the GWP of refrigerants but extend to the electricity consumption of equipment used for cooling and heating, which are particularly energy intensive. Refrigerators are to be found in almost every household in South Africa, with a sizable percentage of middle- and high-income homes having two or more. AC penetration, albeit from a low base, is growing rapidly as families and businesses use them for both cooling and heating. Moreover, many households lack access to cooling during hot summer months.

Improved EE of cooling products also contributes to achieving the UN sustainable development goals that have been adopted by South Africa. Figure 1 was developed by SEforALL to show the benefits of increasing access to sustainable cooling.

Figure 1: Opportunities to address access to cooling needs in South Africa



HUMAN COMFORT AND SAFETY

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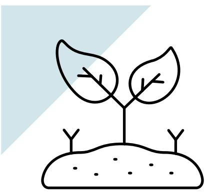

FOOD AND AGRICULTURE

- Provide small-scale agriculture and fisheries producers with **enhanced access to cold chain and cold storage** by addressing data gaps and market and technology barriers
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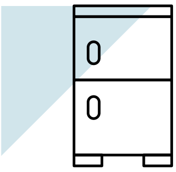
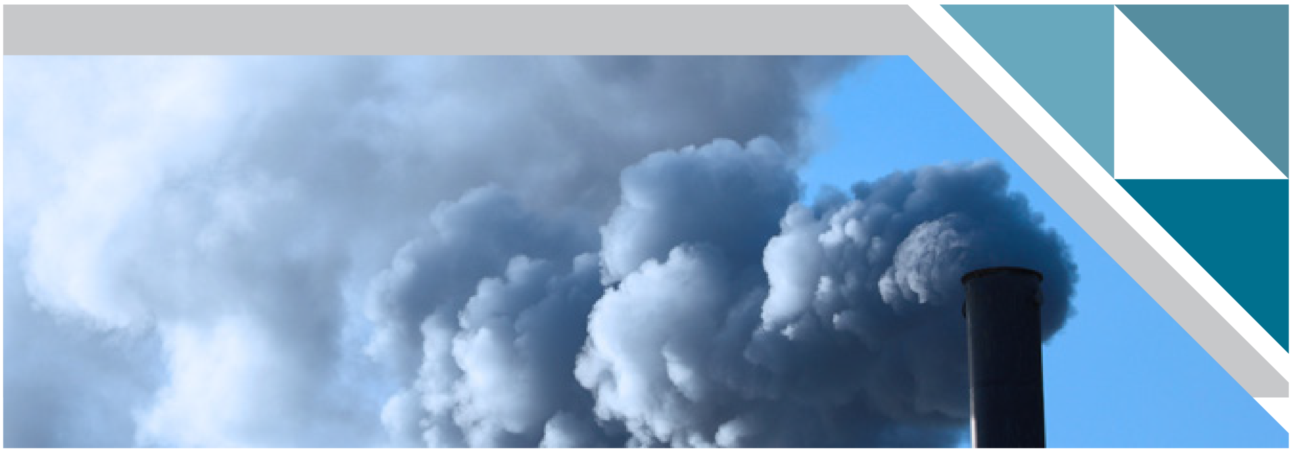


HEALTH SERVICES

- Vaccines and medical products need intact cold chains **to maintain effectiveness**

Improving cooling access contributes to better labour productivity and the wellbeing of populations.[8] Refrigeration and air conditioning also play a critical role in reducing food degradation, extending its shelf life and that of medicinal products. RAC is used across multiple sectors and industries,[9] in industrial, commercial and residential applications[10] and extensively in food transportation. Ensuring thermal comfort for all and access to cooling across the populace contributes to achieving a decent standard of living for all South Africans through the reduction of poverty and inequality.

8 SEforAll, 2020. 'Chilling Prospects: Tracking Sustainable Cooling for All 2020'. https://www.seforall.org/chilling-prospects-2020
9 Including automotive, mining, food distribution, leisure, and hospitality.
10 Domestic refrigeration, commercial refrigeration, industrial-process cooling, transport refrigeration, stationary air conditioning, and mobile air conditioning.



Reducing the environmental impact of cooling products converges with the objectives of reduced GHG emissions, improved resource efficiency, and of realising sustainable development goals. Improved EE also contributes directly to save consumers and businesses money on their utility bills, reduce electricity waste, enable greater comfort and productivity for building occupants, advance national economic development priorities, and mitigate pollution and the impact of GHG emissions on the planet.

It is estimated that while the global HFC phase-down will contribute to avoid global warming by 0.5 °C by 2100, improving the EE of appliances could nearly double these climate benefits.[11] [12] This is particularly relevant to South Africa due to its high carbon electricity generation. Therefore, South Africa's combined efforts to phase down HFC and improve EE of cooling products will contribute significantly to the national efforts to combat climate change, whilst improving cooling access. Most important, synergistic actions with respect to cooling across sectors will have a higher impact than actions taken in isolation.

These converging interests bring together the DFFE[13] and DMRE[14] in developing this NCP for South Africa's cooling sector/industry.

The NCP plan provides an outlook on how cooling demand is likely to evolve in South Africa and identifies strategies and actions needed to lower the environmental impact while ensuring that cooling access continues to meet essential development goals. The country's commitment to EE is rooted in the Energy White Paper of 1998[15] and reinforced in the NEES, which created the mandatory residential appliance S&L Programme and building code that cover the RAC sector.

The NCP looks at actions needed to reinforce the government commitment to EE for cooling and provides recommendations on programme development that will foster EE and environmentally compliant cooling throughout all sectors and applications. The plan considers opportunities to develop existing initiatives already addressing cooling efficiency into an expanded scope to capture the full environmental and energy savings potential. Consideration is also given to the life-cycle impact of significant market uptake, including regulation, financing, market monitoring, local industry creation, and recycling.

2.1 Approach

With the foresight of market and technology developments, the NCP recognises the urgent timing in developing a well-structured direction for the South African cooling sector. The plan is based on understanding the gap between the current market status and trajectory and the measures required to address sustainable cooling and thermal comfort for all. This understanding informs a roadmap of action needed over the next 10 to 15 years, with details of the various components unpacked in this plan. Stakeholder engagements serve as critical inputs to formulating a thorough understanding of the sector and developments and as validation for the analysis and recommendations.

11 Zaelke, D., Borgford-Parnell, N., Andersen, S.O., Campbell, K., Sun, X., Clare, D., Phillips, C., Herschmann, S., Ling, Y.P., Milgroom, A., and Sherman, N.J. 2017. 'Primer on HFCs'. http://www.igsd.org/wp-content/uploads/2017/11/HFC-Primer-19May20171.pdf

12 Dreyfus, G., Borgford-Parnell, N., Christensen, J., Fahey, D.W., Motherway, B., Peters, T., Picolotti, R., Shah, N., and Xu, Y. 2020. 'Assessment of Climate and Development Benefits of Efficient and Climate-Friendly Cooling'. Molina, M., and Zaelke, D., Steering Committee Co-Chairs. http://www.igsd.org/wp-content/uploads/2020/03/Assessment-Final-FINAL-20207.pdf

13 The DFFE mandate is focused on environmental management and protection.

14 DMRE carries, among others, a mandate to ensure sustainable and affordable energy supply to support socioeconomic developmental needs. The 1998 Energy White Paper specifically describes appropriate appliance/fuel combinations; the availability of efficient and safe appliances and fuels; and the effect of pricing and financing on affordability.

15 Department of Minerals and Energy. 1998. White Paper on the Energy Policy of the Republic of South Africa. http://www.energy.gov.za/files/policies/whitepaper_energypolicy_1998.pdf

2.2 Structure

The Plan first considers the South African electricity sector and the challenges and opportunities associated with adding cooling-energy requirements to the system. It also gives consideration to the cooling sector, technology, and market developments, and the likely impact for South Africa as it relates to specific technology areas. Within this context, it makes short-, medium-, and long-term recommendations across different sectors while providing linkages with various government programmes.

Relevant funding and financing mechanisms are then considered as enablers to facilitate the adoption and implementation of recommended measures. In addition to financial support, implementation will rely on market oversight and enforcement. The plan therefore identifies appropriate market-monitoring and -verification protocols that, in turn, will ensure availability of data for planning, decision-making and investment.

The plan concludes with opportunities for collaboration and leveraging of synergies and shared resources, globally, regionally, and between private- and public-sector role players.

3. Energy Sector Overview

3.1 Electricity Supply and Consumption

In 2021, electricity in South Africa is primarily produced from coal (83%, see Figure 2), with the contribution from renewables being about 6%. However, the share of renewables is expected to grow rapidly and to contribute 34% of annual power production by 2030.[16] The 2019 IRP anticipates that several coal plants will be decommissioned by 2030. Coal-will therefore decrease to 43% of total capacity installed and represent 59% of the power produced in 2030 (Figure 3). This large remaining share of coal in the energy mix emphasises the importance of efficiency to reduce GHG emissions from electricity consumption.

Figure 2: Total electricity generated by source, 2016 (Source: CSIR)[17]

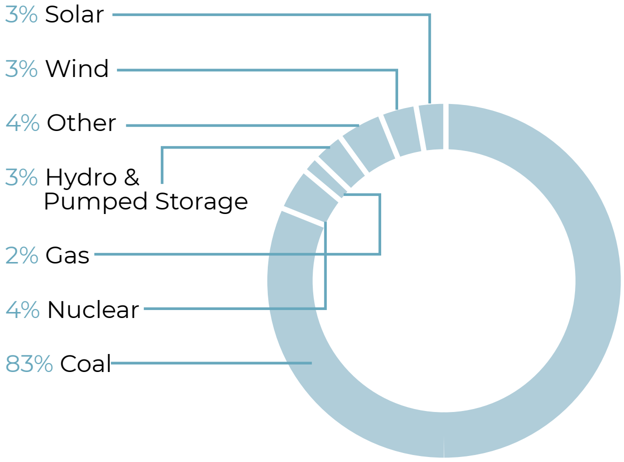
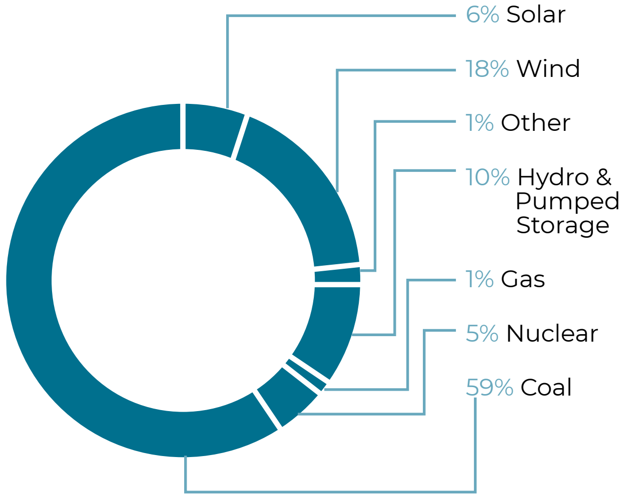


Figure 3: Projected electricity generated by source, 2030 (Source: IRP, 2019)



South Africa's annual electricity consumption has plateaued at about 230 TWh/year for the last five years (Table 2).

Table 2: Volume of electricity distributed in South Africa (GWh)[18]

Year	2015	2016	2017	2018	2019	2020
Electricity (GWh)	230,857	228,546	229,669	231,805	227,336	53,895*

** First quarter only, and data for the latest month is preliminary.*

The anticipated 3% average annual growth in electricity use, as projected in the promulgated 2010 IRP, did not materialise. For the period from 2010 to 2018, the actual net electricity sent out[19] declined at an average compound rate of -0.6%. This is ascribed to a number of factors, including lower economic growth, improved EE, steep tariff increases, fuel switching for various end uses, and relocation of energy intensive industries to other countries. Suppressed demand resulting from supply constraints and load shedding has also potentially contributed to this trend.

16 Integrated Resource Plan (DMRE) . 2019. here

17 Council for Scientific and Industrial Research (CSIR) Statistics of utility scale power generation in South Africa 2021 https://researchspace.csir.co.za/dspace/bitstream/handle/10204/12067/Statistics%20of%20utility-scale%20power%20generation%20in%20South%20Africa_Jul_2021.pdf?sequence=1&isAllowed=y

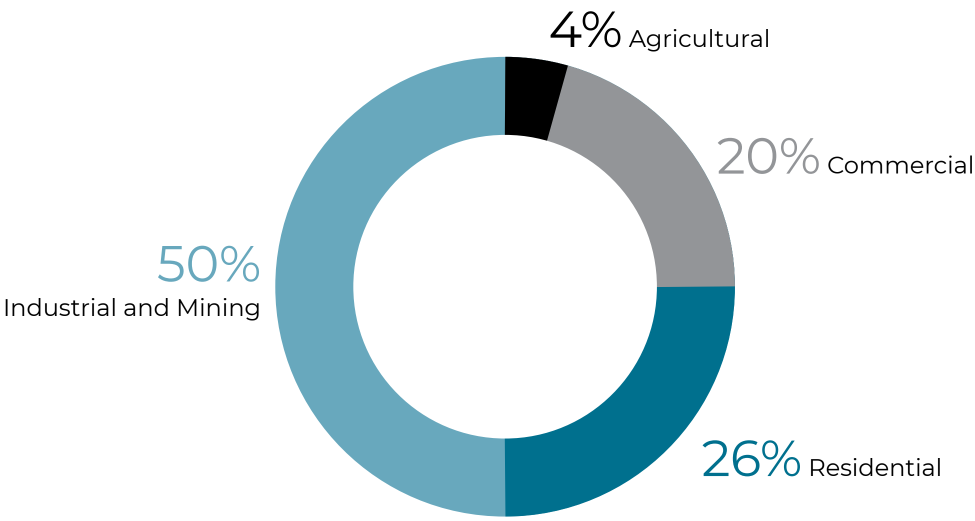
18 Stats SA. March 2020. 'Electricity Generated and Available for Distribution'. Statistical Release P4141. Released: 20 April 2020.

19 A standard term used in South Africa. 'Electricity sent out' is after internal power station use, i.e., what is sent from the power stations and not what is produced. It is before any losses and any exports, but does not include imports, therefore it does not represent true national consumption.

The 2019 IRP electricity demand forecast modelled three scenarios, describing high-, low-, and median-growth trajectories. IRP-modelled consumption growth sees South Africa consuming between 280 and 315 TWh/year in 2030, representing average annual growth rates of 1.9% and 3.0%.

The exact share of power consumed per economic sector is shaped by a variety of fluctuations and influences each year, but the typical order of magnitude per sector is shown in Figure 4. The industrial and mining sectors remain the largest consumers of electricity in South Africa, collectively accounting for more than 50% of the power use in the country.[20] The combined share of annual consumption by the commercial, residential, and agriculture sectors is also about 50%.

Figure 4: Relative electricity consumption per economic sector, 2019 (Source: Eskom)



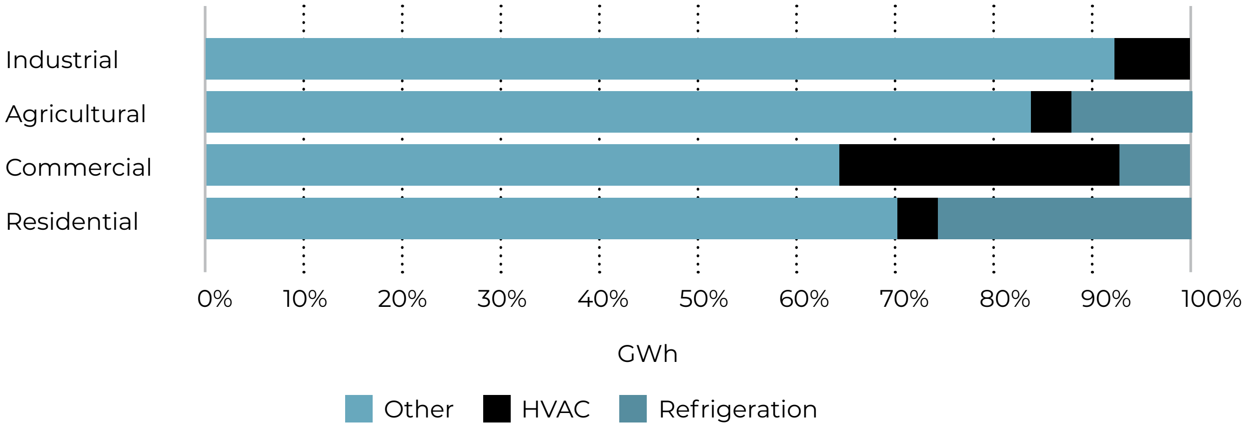
In the commercial sector, Eskom's estimates suggest that Heating, Ventilation, and Air Conditioning (HVAC) systems are the largest single end-use contributor to energy demand, accounting for 26%[21] (Figure 5). Eskom also notes that HVAC's contribution to energy demand is poised to increase. The utility gives the example of Australia, which has similar temperature and climate ranges to those in South Africa, where the breakdowns of energy usage often quote figures for HVAC systems as high as 50%. Depending on the type of businesses, the age of the buildings, and the efficiency of the equipment, HVAC systems already account for more than 50% of electricity use for some hotels, retail malls, and high-rise office buildings.[22]

In the residential sector, refrigeration is a significant contributor to household electricity consumption, accounting for 24% in 2015,[23] while AC makes up only 6% of total residential consumption, as the penetration of equipment is still low and mostly restricted to higher-income households. SEforALL estimates that 10.84 million people in South Africa are lacking access to cooling.[24] The share of electricity used for ACs is projected to increase to 14% in 2040 as households progressively get more access to cooling.[25]

In the industrial and mining sector, HVAC represents 7%[26] of the total consumption. Finally, within the agricultural sector, refrigeration contributes an average of 11% to consumption, and HVAC accounts for 4%, according to a recent report from the South African National Energy Development Institute (SANEDI) and the Renewable Energy and Energy Efficiency Partnership (REEEP).[27] A tally across these sectors suggests annual electricity used for cooling accounted for 32 TWh/year in 2017, representing 16% of the total final electricity consumption (Figure 5) and corresponding to emissions of 30.5 million tCO_2e.

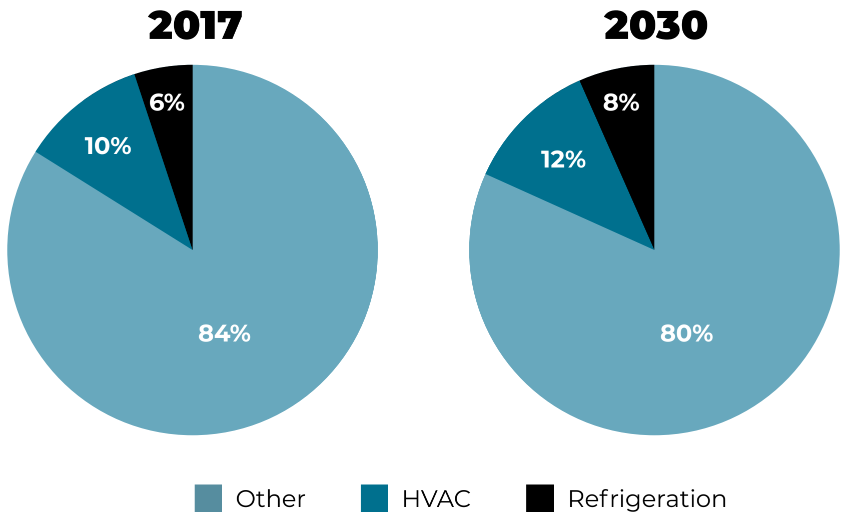
20 DMRE. 2019. The South African Energy Sector Report. Produced by the Directorate: Energy Data Collection, Management and Analysis.
21 Eskom. August 2014. 'Energy Efficiency Opportunities in South Africa: Commercial Sector Eskom Integrated Demand Management'. Presentation. http://www.eskom.co.za/sites/idm/Documents/airconditionernote.pdf
22 Eskom Integrated Demand Management. 2015. 'Heating, Ventilation and Air Conditioning (HVAC) Systems: Energy-Efficient Usage and Technologies"; Eskom Integrated Demand Management. January 2016. 'Electricity Smart HVAC Systems: Reducing Energy Costs in the Hospitality Sector'.
23 Idem.
24 SEforALL. June 2020. 'Cooling for All in South Africa – Opportunity to Deliver Access to Cooling through the National Cooling Action Plan'. SEforALL Recommendations. Presentation.
25 Lawrence Berkeley National Laboratory (LBNL). 2020. South Africa's Appliance Energy Efficiency Standards and Labelling Program Impact Assessment. https://eta-publications.lbl.gov/sites/default/files/south_africa_appliance_energy_efficiency_sl_impacts._final_february_2020_1.pdf.
26 Eskom. 2019. Integrated Demand Management Market End-Use Knowledge.
27 SANEDI and REEEP. 2016. 'Sustainable Energy Consumption and Production (SECP) in Agriculture and Integrated Waste Management: Research and Training'. https://www.reeep.org/switch-africa-green-sustainable-energy-consumption-and-production-secp-agriculture-and-integrated.

Figure 5: Share of cooling-electricity consumption in 2017 per sector



Considering the average electricity consumption to 2030, as projected by the IRP, and with relative growth forecasts for RAC, this share is expected to grow to 20% in 2030 (Figure 6). If only the building sector's electricity consumption is considered, the share of electricity consumption for cooling in 2017 is 31% and 2030's projection is 35%. These shares could be accentuated with global warming in future years. The Climate Change Adaptation and Mitigation Plan by the DFFE (2015)[28] projects that by 2050, the coastal regions of South Africa are expected to experience an average increase in temperatures of 1.5 °C–2.5 °C, while the interior regions are expected to experience an average increase in temperatures of 3.0 °C–3.5 °C. By the end of the century, an accelerating increase in temperatures is projected at 3.0 °C–5.0 °C along the coast and up to 6.0 °C and more in the interior. Since Gauteng Province is located in the interior of the country, an increase in consumption for cooling there could be significant.

Figure 6: Share of cooling-electricity use



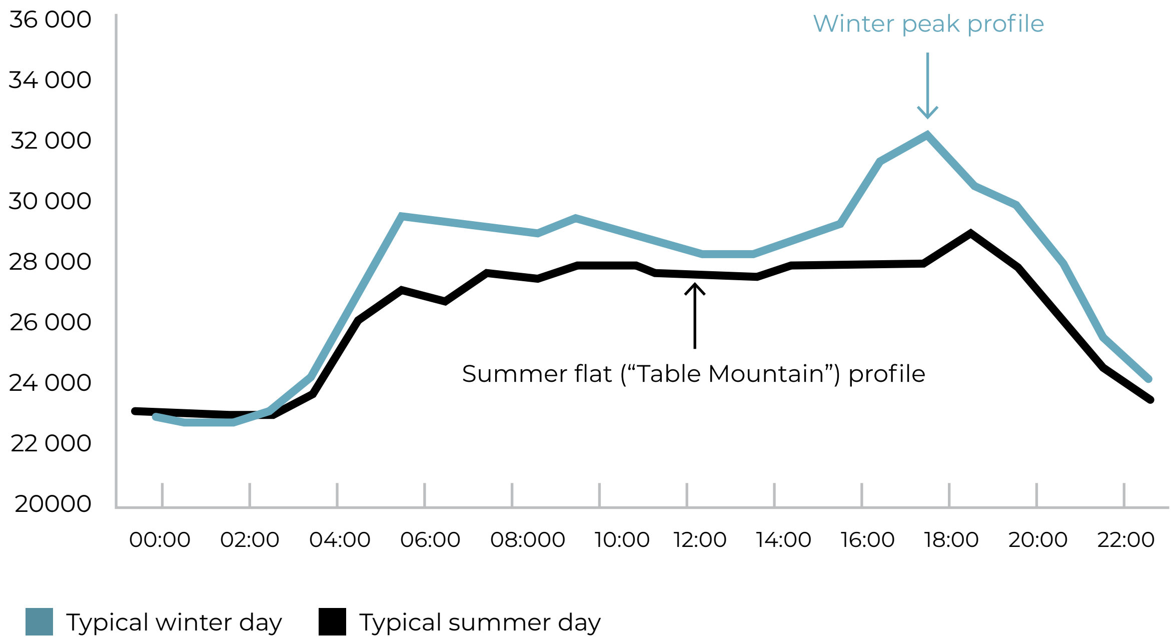
28 Department of Agriculture, Forestry and Fisheries. May 2015. Draft Climate Change Adaptation and Mitigation Plan for the South African Agricultural and Forestry Sectors. https://static.pmg.org.za/150603climatechangeadaptation.pdf

3.2 Peak Demand

South Africa has a well-established electricity sector with a comprehensive power network that serves 88% of South African citizens.[29] Eskom, as a national power utility, is the dominant role player in the supply sector. It is vertically integrated, responsible for approximately 90% of the generation, all power transmission, and approximately 60% of the power distribution in the country. The balance of generation is sourced by Eskom from neighbouring countries and independent power producers (IPPs) that mostly produce electricity from renewable resources. Distribution is shared with municipalities who purchase from Eskom and redistribute electricity to businesses and households within their area of jurisdiction. Nationally, electricity infrastructure is aging, with low grid intelligence and limited communication capability.

The national daily winter demand profile (Figure 7) shows pronounced morning and evening peaks, reflecting the daily activities of 60 million citizens. It is estimated that the residential sector contributes 24% to peak demand. Electricity demand during the day remains high, consistent with the power needs of most business functions. In summer, the daytime profile has a flatter shape. It is likely that as market penetration of AC grows, the summer day demand will see a consistent increase during peak hours.

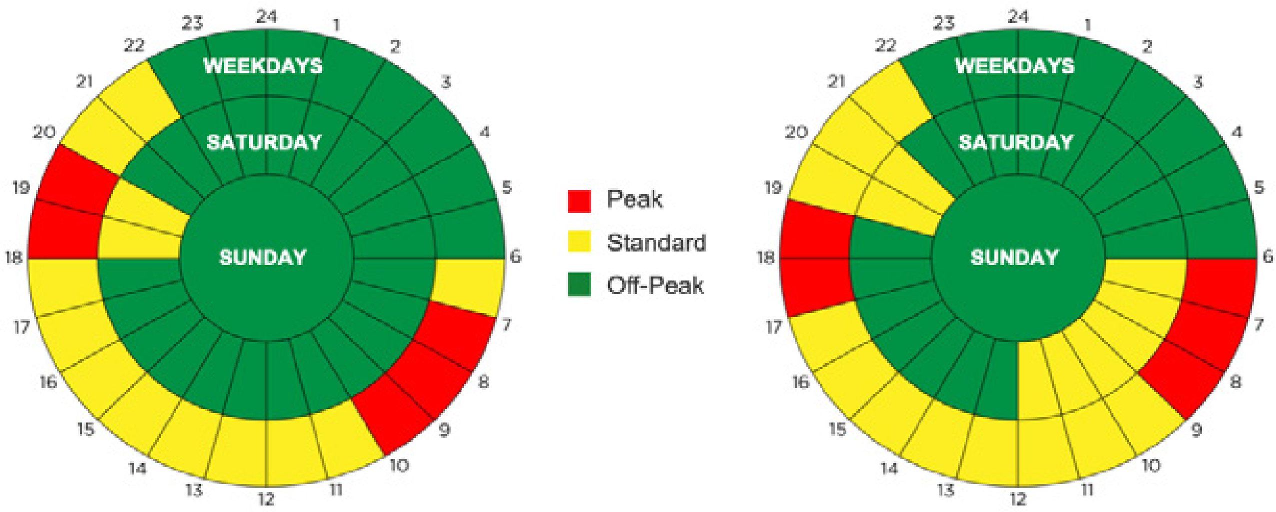
Figure 7: National daily demand profile[30] (Source: Eskom)



Time of use tariffs (Figure 8), tailored for the various economic sectors, are designed to reflect the added cost of generating electricity during peak hours. Time of use tariff signals are passed on to large consumers in the industrial and commercial sectors as well as municipalities. In reselling, municipalities define their own electricity rates and tariff structures, but all tariffs are subject to approval by the National Energy Regulator of South Africa (NERSA),[31] who regulates the industry within the existing policy and regulatory framework. Accordingly, tariffs aim to support national objectives of social, economic, and environmental sustainability. Currently, time of use tariffs are not applied to the residential sector.

29 South African Government. Integrated National Electrification Programme (INEP) Data. https://www.gov.za/about-government/government-programmes/inep
30 Eskom. 2014. Integrated Report. http://integratedreport.eskom.co.za/par-keeping.php
31 NERSA, established in terms of the National Energy Regulator Act of 2004, is mandated to regulate South Africa’s electricity, piped gas, and petroleum industries and to collect levies from people holding title to gas and petroleum. In terms of electricity, NERSA’s functions include issuing licences, setting and approving tariffs and charges, and mediating disputes.

Figure 8: Eskom's defined time of use periods[32]



Low Demand Season High **Demand Seasooon**

Table 3 demonstrates the large variances in the tariffs (2019 prices) between the different periods in the two seasons.

Table 3: Seasonal electricity tariffs

	Low-Demand Season	High-Demand Season
Off-Peak	×	1.15×
Standard	1.5×	2.13×
Peak	2.2×	7×

For the sectors where a time of use tariff applies, tariff signals as a stand-alone measure have not proven to be adequate to influence energy consumption patterns. Complementary policy instruments, such as tax incentives, building standards, and minimum-energy performance standards, remain necessary to encourage improved energy management practices.

While the morning and evening peaks are generally ascribed to activities in the residential sector, which are not subject to time of use tariffs, there is no incentive to move energy use out of these peak-demand periods. A different approach was pursued here. In the early 2000s, the government introduced Free Basic Electricity (FBE). Under this scheme, low-income households receive 50 kWh per month free — an amount deemed sufficient to provide basic electricity services to a poor household. All other household customers are charged according to an inclining block tariff whose objective is to shift rising electricity prices to more affluent households (shown in Table 4).

32 Time of use periods relevant for WEPS, Megaflex, Megaflex Gen, Miniflex, Ruraflex and Ruraflex Gen: low- and high-demand seasons. Eskom tariff charges booklet 2020/21

Table 4: Electricity tariffs (2019) from South Africa's biggest municipality

Block	Tariff
Block 1 (0–500 kWh)	Starting tariff
Block 2 (501–1,000 kWh)	Starting tariff + 14%
Block 3 (1,001–2,000 kWh)	Block 2 tariff + 8%
Block 4 (2,001–3,000 kWh)	Block 3 tariff + 5%
Block 5 (> 3,000 kWh)	Block 4 tariff + 5%
All houses must pay a monthly service and capacity charge R580 (~USD 35)	

This approach necessitates alternative interventions to manage peak demand for the sector. At present, the adoption rate for advanced metering infrastructure in the country has been slow, limiting the immediate application of dynamic tariff signals, load management options, and aggregated end-use digitalisation. The transition to more intelligent, interconnected grid capability is expected to accelerate with the growing adoption of smart meters, energy storage systems, smart thermostats, smart appliances, and building controls. Digitalisation advances in HVAC and refrigeration increasingly allow for monitoring and control for the benefit of local operations and maintenance or – once grid intelligence allows – to nationally manage power reliability, energy efficiency, and sustainability goals. Consequently, the NCP takes cognisance of the anticipated developments in power distribution networks and technology advances, ensuring South Africa can take advantage of these opportunities.

Across all sectors, energy efficiency and load management have the potential to effectively support management of peak demand and reduction of energy and carbon intensity.

3.3 National Energy Policy

Three key policy documents lay the groundwork for EE in South Africa. The Energy White Paper of 1998 provides the basis for improving EE in the country. It recognises the importance of appropriate appliance–fuel combinations; a household's ability to acquire these fuels and appliances; the availability of efficient and safe appliances and fuels; and the effect of pricing and financing on affordability. It points to energy consumers' decisions as key to achieving macro-level environmental goals. It also identifies the use of EE electrical appliances as a primary tool to improve the availability of affordable energy use and to lead the improvement in the standard of living for all the country's citizens.

The National Energy Act,[33] promulgated in 2008, sets out to ensure that diverse energy resources are available in sustainable quantities and at affordable prices to the South African economy in support of economic growth and poverty alleviation, while taking into account environmental management requirements, international commitments and obligations, and interactions amongst economic sectors. Section 19(1), gives authority to the Minister to:

- Set minimum levels of EE in each sector of the economy;
- Define steps and procedures necessary for the application of EE technologies and procedures;
- Prescribe labelling for EE purposes of household appliances, devices and motor vehicles;
- Prohibit the manufacture, importation, or sale of electrical and electronic products and fuel-burning appliances for reasons of poor EE;
- Specify standards and specifications for energy carriers; and
- Set EE standards for specific technologies, processes, appliances, devices, motor vehicles, and buildings.

The NEES, published in 2005, derives its mandate from the 1998 Energy White Paper and responds to the provisions of the Energy Act. The vision of the strategy is to contribute to affordable energy for all, and to minimise the effects of energy usage on health and the environment. The initial NEES set a target for the reduction of energy intensity of 12% overall with specified sectoral energy intensity improvements by 2015. The accompanying National Energy Efficiency Action Plan (NEEAP) described actions per sector towards

33 Act No. 34 of 2008, Section 7(2).

achieving the stated targets. The post-2015 NEES proposed further targets for reduced final energy consumption from 2015 to 2030.[34] The targeted, economy-wide reduction of 29% by 2030 is disaggregated into targets for the respective economic sectors: Industrial (15%); Public and Commercial (37%); Residential (33%); Agricultural (30%); and Transport (39%).

The country has established several programmes to encourage energy management, with a selection of the most pertinent ones highlighted in Table 5.

Table 5: List of EE and demand management programmes in South Africa

Programme	Description	Relevance
S&L Programme	Implementing compulsory MEPS and EE labelling for household appliances and lighting (refer to the discussion below).	Includes MEPS and labelling for ACs.
Building Standards (Mandatory)	SANS 10400–XA – This standard deals with EE in a building. It sets requirements for maximum demand as well as maximum consumption per square metre (m^2)/year. It also requires projects to generate 50% of the hot water by means of non-resistance electrical heating.	Applicable to all new buildings and residential developments. Projects are required to implement EE interventions, inclusive of cooling and heating.
Building Standards (Voluntary)	Green Star Certification – Requires projects to meet the SANS 10400–XA standards and to go beyond them. Net-Zero Certification – Requires building projects to be designed so that onsite generation can cover the building's total consumption. EDGE – A voluntary certification system that requires projects to save 20% of energy, water, and materials against a baseline.	Different levels of achievement (4, 5, 6 star) to allow the project to go beyond the regulatory standard. Applicable to all building types and encourages projects to ensure efficiency and on- and off-site renewables to achieve carbon neutrality. In South Africa, EDGE is limited to residential developments.
Cool Roof Demonstration Programme[35]	Demonstration project with municipalities to coat 25,000m^2 of roof area across the country. Implementation includes training and certification of local, unemployed residents who are then employed to apply the specialised coating.	Demonstration of the benefits of cool surfaces and relevance to different climate zones in the country.

34 Gazette No. 40515 of 23 December 2016, Post-2015 NEES Draft v1.1 (DoE Notice 948 of 2016).
35 A cool roof is one that has been designed to reflect more sunlight and absorb less heat than a standard roof. Cool roofs can be made of a highly reflective type of paint, a sheet covering, or highly reflective tiles or shingles. Nearly any type of building can benefit from a cool roof, but the climate and other factors must be considered before deciding on a technology.

Programme	Description	Relevance
Eskom IDM Programme	Load management, EE, and demand response interventions implemented to meet regulatory requirements and system requirements. Since inception in 2004, the programme focus has varied, depending on the specific grid constraints. Funding for the IDM Programme has largely been discontinued since 2014, with only select, strategic interventions supported. The programme has continued to provide technical assistance (e.g., technical advisors), education (e.g., schools programme), and communication and awareness (e.g., Power Alert) efforts, rather than funding for efficiency interventions.	Demand response (load curtailment) has traditionally focused on large industrial consumers, although an aggregator for smaller loads has been investigated. Recent system constraints have favoured load-shifting interventions to limit load shedding.[36]
12 L Tax incentive	A tax allowance/deduction from taxable income on the basis of demonstrable EE savings created through the implementation of EE measures.	Demonstrable EE interventions by commercial and industrial consumers, inclusive of cooling and heating.
Municipal Energy Efficiency Demand Side Management (EEDSM)	Grant funding available to municipalities to reduce the electricity demand of existing public infrastructure.	Efficiency upgrades to HVAC are covered.
Carbon Tax	A new tax (June 2019) in response to climate change, aimed at reducing GHG emissions. Follows the polluter-pays principle, intends for firms and consumers to take the negative, adverse costs (externalities) of climate change into account in future production, consumption and investment decisions.	Encourages any interventions to reduce emissions below the carbon tax threshold.
Critical Infrastructure Programme	Cost-sharing grant to encourage infrastructure investments (new or existing)). Available to private investors, companies, and municipalities.	Although not directly related, grant objectives included lowering costs and improving competitiveness – indirectly supporting improved resource efficiency.

36 Load shedding is implemented countrywide as controlled, rotational power cuts to protect the electricity power system from a total blackout when there is an imbalance between the demand for electricity and available supply.

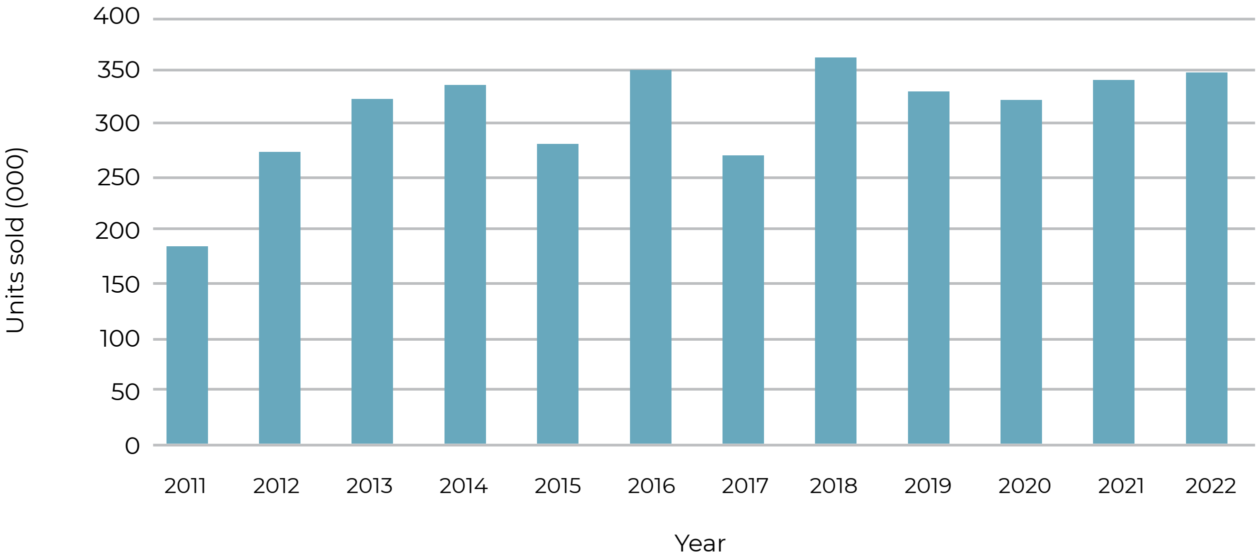
4. Market Overview

4.1 Air Conditioning

Several recent market studies and growth projections, coupled with a comprehensive market assessment of residential and small commercial ACs commissioned for South Africa under the DMRE's S&L Programme, provide an indication of the anticipated RAC market trajectory in the country. The combined perspective of industry studies intended to gauge market potential and impact studies prepared from an energy and sustainability standpoint reinforces the rapid growth rates anticipated for the market.

Global AC stock is set to soar,[37] becoming one of the top drivers of total energy demand by 2050.[38] Market research forecasts the Africa AC market to expand at a Compound Annual Growth Rate (CAGR) of 9.4% during the forecast period 2016–2024,[39] significantly escalating CO_2 emissions from this sector. Increasing population numbers, better performing economies, infrastructure development and new construction, urbanisation, and rising disposable income are all forecasted to contribute to accelerated adoption of AC throughout Africa.[40] This is equally true for South Africa; Figure 9 shows an overview of the size and characteristics, as well as projected sales, of the local market. AC sales in the South African market increased from 180,000 in 2011 to 350,000 in 2016 and then have remained flat, affected by slow economic growth. However, this is seen as temporary, as ultimately CAGR will resume in line with improved economic growth, disposable income, and as local temperatures rise. This temporary respite provides the country with a golden opportunity to develop and implement a cooling plan before the expected growth of 5% to 6% in the South African market resumes.

Figure 9: Annual AC imports (2011–2018) and expected sales (2019–2022) (Source: DMRE S&L Programme)



The commercial sector has been the primary market, responsible for 60% of small commercial and residential AC units sold in the country. Market penetration in the residential sector remains low, with ACs currently still a luxury item. The bulk of ACs are owned by the Living Standards Measure[41] (LSM) 9 and 10 groups, having a share of 29% and 56% respectively, while the average ownership in the country is 4%, demonstrating a great disparity in access to cooling across household LSM categories. The annual uptake of ACs in homes is however beginning to see an upward trend. As the standard of living in households increases and ACs become more affordable, the penetration of ACs will increase in the mid-LSM groups (6 to 8).

37 International Energy Agency (IEA). 2018. The Future of Cooling. https://www.iea.org/reports/the-future-of-cooling
38 IEA. 2019. 'Share of Global Electricity Demand Growth to 2050'. https://www.iea.org/data-and-statistics/charts/share-of-global-electricity-demand-growth-to-2050
39 Goldstein Research. February 2020. 'Africa Air Conditioner Market by Product Type (Split, Rooftop, Chillers, VRF), by End-User (Residential & Commercial), by Region (Nigeria, Egypt, South Africa, & Others), With Forecast 2024'.
40 Building Services Research and Information Association (BSRIA). February 2019. 'Air Conditioning, Ventilation & Refrigeration, Worldwide Market Intelligence'. Market growth forecast at around 5% CAGR between 2017–2023 compared to global forecast of 4.9% for the same period.
41 The LSM is developed by the South African Audience Research Foundation (SAARF) to distinguish households into ten LSM groups to classify living standards and disposable income, with LSM 1 being the decile with the least means and LSM 10 being the decile with the greatest means.

Following global trends, South Africa is seeing variable-speed AC units (or inverter units) taking a growing share of the market, representing an estimated 40%[42] of market share. This technology offers significant efficiency improvements (20%–40%).

The vast majority (97.5%) of AC models available in the market use R410A — a third-generation refrigerant that offers zero ozone depletion but high global warming impacts compared to older-generation refrigerants. The remaining 2.5% of AC models still use R22, a hydrochlorofluorocarbon (HCFC) and second-generation refrigerant with high GWP, despite having lower ozone-depletion potential. In 2020, the South African market does not yet have any models using fourth-generation refrigerants that would be required to meet the commitments under the Montreal Protocol and Kigali Agreement.

The largest share of ACs available in the South African market is manufactured in China (90%) and South Korea (6%). This presents an opportunity to align with the increasingly stringent efficiency requirements of these countries of origin, avoiding dumping of obsolete products from these markets in South Africa. Additionally, higher efficiency ACs are already readily available in these countries of origin at comparable prices, so the shift to these more stringent standards would have minimal impact on affordability/access to these solutions.

Chillers

Cooling in large buildings is provided by chillers. A 2018 DMRE[43] study provided characteristics about the South Africa market. All chillers are imported, and there are approximately 20 brands represented. Products on the market range from 2 kW to 2,400 kW, thus mini-chillers and smaller-to-medium-sized chillers (with a capacity below 100 kW) should not be overlooked. Chillers profiled in the study were found to have an Energy Efficiency Ratio (EER) and Coefficient of Performance (COP) range of 2.68 to 5.932 and 3.07 to 3.38 respectively. The following refrigerants were identified: R407c, R134a, R410a, R717 and R22.

42 CLASP. August 2018. *'Africa Air Conditioner Market Scoping Study'.*
43 Urban-Econ. 2018. *'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: Next Set of Electrical Appliances'.*

Key Role Players

Regulatory data shows a growing number of organisations and AC brands active in the South African market. South Africa does not have any AC manufacturers. Consequently, the main market players consist of importers, wholesalers, retailers, or the secondary market of direct sales, installers or service technicians (Table 6).

Table 6: Main role players in South African AC market

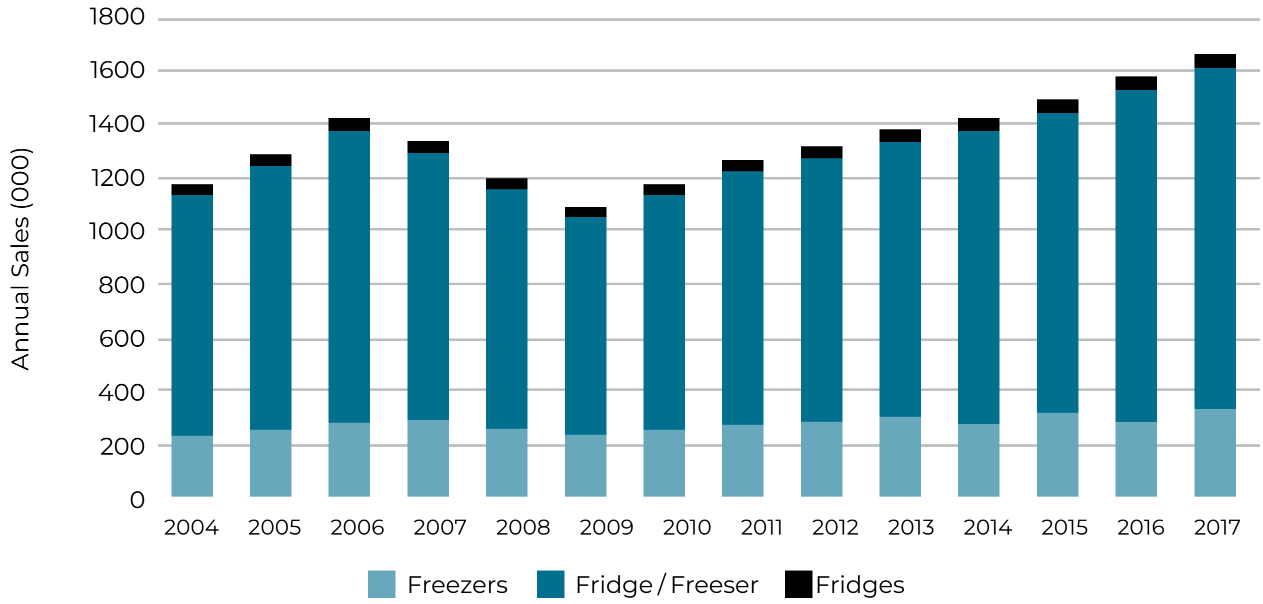
Category of Entity	Description
Importers	• **A local Distributor** – a local company nominated by the manufacturer to sell its products within a certain location or consumer segment. • **A Distribution Agency** – a company that distributes household electronics across various categories as a subsidiary of a global company, such as Samsung. • **Local Importers Retailers/Installers** – a retailer who selects, orders and imports its 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.
Wholesalers	A number of wholesalers located across the country stock a variety of brands/ product lines in their geographic locality. They in turn supply the local installation trade.
Retail and Other Sales Level Channels	**Retailers** – retail outlets or online stores that sell units to the end consumer. This form of retail accounts for less than 27% of total sales. This includes both shops and the emerging trend of online sales. In both online and in-store purchases, the retailers will refer customers to installers for non-freestanding portable units. **Non-Retail (Direct) Sales** – direct retail includes: • AC installers who sell AC units as part of their service. • Large project tenders or negotiated preferred-supplier deals for bigger contracts, e.g., new office blocks or building refurbishments. This form of retail accounts for more than 73% of AC sales.
Installers or Service Technicians	The South African Refrigeration and Air Conditioning Contractors Association (SARACCA) is the industry association for AC and refrigeration contractors in the country. Membership is not mandatory, but in accordance with the Pressure Equipment Regulation,[44] all practitioners who handle equipment operating at 50 kilopascals or above must be registered on behalf of the Department of Labour. SARACCA is the industry association responsible to do so on behalf of the South African Qualification and Certification Committee.

44 Regulations under the Department of Labour, Occupational Health and Safety Act, Act 85 of 1993.

4.2 Refrigeration

The stock of refrigerators owned and operated by households increased from almost 11 million units in 2010 to about 14 million in 2016.[45] Refrigerator ownership increases rapidly as living standards improve and households gained access to electricity, corresponding to an 85%[46] penetration rate. Refrigerators are key appliances that meet a basic need to conserve food and they form a large share of low-income households' energy bills.[47] The 2017 General Household Survey[48] found the number of households with a refrigerator or combined fridge-freezers to be 12.3 million, suggesting many households owning more than one. Figure 10 shows annual sales over the period 2011 to 2018. Based on historical trends, projections are that approximately 27.8 million refrigerators will be used by South African households by 2040, doubling the current stock within 20 years.[49] The need for refrigeration is also met with the ownership of freezers, with a penetration of 29% per households in 2015. The stock of freezers is currently estimated at 5.3 million.

Figure 10: Annual refrigeration sales (2011–2018) (Source: DMRE S&L Programme)



Domestic refrigerators and fridge/freezers are estimated to last for up to 14 to 17 years. Refrigeration appliances in South Africa remain in use for longer periods than in developed countries, with appliances typically finding a second or even third life in lower-income households. Old, inefficient technologies therefore remain in the market for considerably longer than in developed countries. Limited recycling facilities are available for appliances that have reached the end of their functional life, and as of 2020, no evidence could be found at these facilities that appliances are currently pre-treated for environmentally sound recovery, treatment, or safe disposal of harmful gasses or hazardous materials.

Commercial refrigeration covers a wide range of equipment types that are used by businesses, retailers, and restaurants for food storage. Maintaining a cold chain for perishable agricultural products from harvest/ production to consumption contributes to assuring food security, reducing food wastage, and increasing agricultural incomes for small-scale food producers. SEforALL estimates that 6.2% of South Africans are undernourished, with the absolute number of undernourished people growing 1.2 million between 2012 and 2017. Cold chains are also essential for pharmaceutical products and contribute to increasing access to vaccines and medicines, notably to distant clinics in hot climates served by poorly developed transport networks.

45 Urban-Econ. 2017. '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: Existing Electrical Appliances'.
46 South African Audience Research Foundation (SAARF). All Media and Product Survey (AMPS) Statistics for the period 2007 to 2017.
47 SAEEC. 2013. https://eta-publications.lbl.gov/sites/default/files/energy_efficient_refrigerators_1.pdf
48 Stats SA. 2017. General Household Survey. https://www.statssa.gov.za/publications/P0318/P03182017.pdf
49 Lawrence Berkeley National Laboratory. 2020. 'South Africa's Appliance Energy Efficiency Standards and Labeling Program Impact Assessment'. https://eta-publications.lbl.gov/sites/default/files/south_africa_appliance_energy_efficiency_sl_impacts._final_february_2020_1.pdf

Commercial refrigeration is usually split into two main categories: refrigerated display cabinets, and refrigerated storage cabinets.

Refrigerated display cabinets are used in retail outlets to store food and other items that are intended to be accessed by purchasers of those items. This covers a variety of display fridges and freezers, including those with transparent doors or lids, open-fronted cabinets with shelves, horizontal freezers, and drinks chillers — all of which display food for sale (the food is visible to the purchaser and accessible by them). Display cabinets usually operate in a conditioned space (such as a shop).

Refrigerated storage cabinets (also known as professional or service cabinets) are used behind the scenes in kitchens, restaurants, or catering services, and may have transparent or opaque (solid) doors or lids. Refrigerated storage cabinets are designed to store chilled or frozen food at food-safe temperatures, but not to display products for sale to the public. They are an essential part of the cold chain and are found in restaurants, institutions such as hospitals, nursing homes, and canteens. Often, storage cabinets are required to operate under more onerous ambient conditions, (e.g., in commercial kitchens).

The industry is dominated by local manufacturers, but companies importing commercial refrigeration products from overseas are also notable. Key industry players involved in local manufacturing/assembly activities are listed in the referenced research report.[50]

Commercial refrigeration units vary in terms of size. With respect to power consumption, one can find a commercial refrigeration unit with maximum power consumption as low as 130 watts (W) and another unit with consumption of up to 6.7 kW – e.g., an island freezer.

Comparatively little statistical data are available for the commercial and industrial refrigeration market in South Africa. This is partly ascribed to larger installations seldom being modular and industry market growth being considered over equipment or component sales.

Regional projections for Middle East and Africa predicted strong growth in commercial refrigeration, with an advance of more than 6.0% CAGR[51] in the retail and beverage sector (i.e., ~24% of the commercial refrigeration market). In Africa, including South Africa, growth is expected to be fuelled by advances in the food-retail industry, medium-size grocery stores or supermarkets, hypermarkets, and restaurants.[52]

Industry trend information suggests that South Africa is slowly seeing a change of refrigerants for commercial applications. Following the phase-out of R22, R404A became most commonplace as both a medium-temperature and low-temperature refrigerant. More recently, natural refrigerants including CO_2 (R744) and ammonia (NH_3), have found favour in warmer climates, including in South Africa.[53]

The market for domestic refrigerators offers a wide selection of models. It is estimated that at least 44 brand manufacturers cater to the domestic market, offering more than 780 models. Small refrigerators (with a volume of <340 litres) offer the greatest variety compared to medium and large refrigerators (of a capacity >340 litres).

The market for stand-alone refrigerators is dominated by international manufacturers, of which some have local manufacturing and component assembly plants in South Africa (Table 7). Examples of these include Defy and KIC. In contrast, the much larger market for fridge-freezer combinations is led by locally manufactured or assembled appliances.

50 Urban-Econ. September 2018. '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: New Electrical Appliances'. In 2018, these companies included Just Refrigeration, Coolline, Mac Brothers, Zero Appliances, and Igloo SA.
51 AMPS, SAARF.
52 ResearchAndMarkets.com. 'MEA Commercial Refrigeration Equipment Market (2013–2023)'.
53 Cold Link Online. 2019. 'An Insider's Look at Supermarket Refrigeration in SA'.

Table 7: Distribution between imports and locally manufactured refrigeration appliances (2017)[54]

Appliance	Total Units Sold Per Year	Estimated Value of the Market (R million)
Fridges	41,400	140
Fridge-freezers	1,301,300	9,651.8
Freezers	329,900	1,194

Market players include local manufacturers and assemblers, importers or distributers, and retailers — both in store and online.

No refrigerants are manufactured in the country, which means all manufactured refrigerants are imported. A quota system is in place for refrigerants covered under the Montreal Protocol, with fewer than 15 quota holders allowed to import refrigerants into the country.

4.3 Buildings

Building insulation plays a key role in combating thermal transfer through building envelopes, thus reducing cooling- and heating-energy demands. Effective insulation solutions are applied in a continuous layer to walls, floors, and roofs in order to avoid creating thermal bridges (opportunities for thermal transfer). The direct relationship between CO_2 emissions, thermal comfort, and HVAC equipment in buildings offers an opportunity to reduce GHG and ozone-depleting gasses. To achieve acceptable thermal comfort levels in buildings where passive measures do not meet the occupants' thermal comfort needs, HVAC equipment is installed to control indoor temperatures. The operation of HVAC equipment is linked to CO_2 emissions through energy consumption and further GHG and Ozone Depletion Potential (ODP) impact from the use of refrigerants in the systems. Estimates for the amount of time people spend indoors vary from 70%–90% depending on regional, social, and economic factors. Given that serviceable lifespans of buildings in South Africa range from as little as 10 years to as much as 150 years, the extremely high proportion of time spent indoors combined with the environmental impact of achieving acceptable thermal comfort levels represents a significant opportunity to reduce environmental impact.

The South African property sector is categorised by two distinct groups determined by ownership: publicly owned property and privately owned property. The group of public-sector properties consists primarily of administrative office, healthcare, educational, residential, and a range of other specialised building types. Private-sector buildings can be divided into four broadly defined investment categories: office, retail, industrial, and residential. A report published by the Property Sector Charter Council[55] provides a snapshot of the size of the full spectrum of property types in South Africa and estimates the change in the size of the property market between 2010 and 2014 (Table 8).

Table 8: South African property market size[56]

SECTOR	2010	2014	UNIT	% CHANGE
Office	29.2	32.2	Million m^2	10.3
Retail	37.3	39.8	Million m^2	6.7
Hotel	58,8	61,5	Number of rooms	4.6
Residential Home		790	Million m^2	
InformaL Residential Home		1,294,904	Number of households	

54 Urban-Econ. 2017. '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: Existing Electrical Appliances'.
55 Property Sector Charter Council. October 2015. 'Market Size Estimation, The South African Property Sector for the Financial Year 2014/2015. http://www.propertycharter.co.za/
56 Figures exclude the public sector and refer to institutionally owned, professionally managed property. Privately owned property, which is not publicly listed or registered, is excluded.

In 2014, the formal residential[57] sector was estimated at 6.1 million properties[58], representing 790 million m². The South African Human Rights Commission reported that in October 2017, that the number of households in informal settlements had increased since 1995, rising from 1,170,902 in 1995 to 1,294,904 in 2011.[59]

Historically, air-conditioning has been utilised extensively in the commercial-property sector, with office and retail buildings experiencing very high penetration rates. A report from Building Services Research and Information Association (BSRIA) estimates that penetration in the commercial sector has increased recently to reach 75% in 2018 and is expected to increase to 85% by 2023.

In the office sector, premium, A, and B grade offices require air-conditioning to meet market demands while lower graded offices and offices built prior to 1980 are typically not air-conditioned. The 2020 South African Property Owners Association (SAPOA)[60] office vacancy report showed that 80% of SAPOA registered office space falls into the categories requiring air-conditioning. However, SAPOA registered properties represent only 54% of total private office space. Assuming that properties not registered with SAPOA primarily have a low uptake of HVAC installations of 40%, the overall estimated penetration of HVAC in private office space is 61%. Regional shopping centres and the majority of fully enclosed shopping centres utilise HVAC, while strip malls, value marts, and small-to-medium-sized retail centres typically do not air-condition common areas. Individual tenant approaches vary. Penetration of HVAC system in hotels is very high. Public-sector office buildings, or only certain spaces within them, are often not air-conditioned due to the impact on operating costs.

57 For the purposes of this Property Sector Charter Council study, 'formal residential' included three broadly defined categories: estate, freehold, and sectional title.

58 Using an average unit size of 125 m2 (within the 17-year range given by BMI Construction Group), but an average size of 36 m2 for social housing (as quoted by City of Johannesburg), gives a total area of around 790 million m2. (Source: PSCC)

59 South African Human Rights Commission. May 2018. 'Response to Questionnaire: Informal Settlements and Human Rights Submission to the UN Special Rapporteur on the Right to Adequate Housing'.

60 SAPOA tracks vacancy rates in the South African property sector to provide member organisations with data which can be used for benchmarking and planning in the development, management, and operation of commercial property. https://www.sapoa.org.za/about-sapoa/vision/; https://www.sapoa.org.za/research/office-vacancy-report/

5. Policies and Programmes

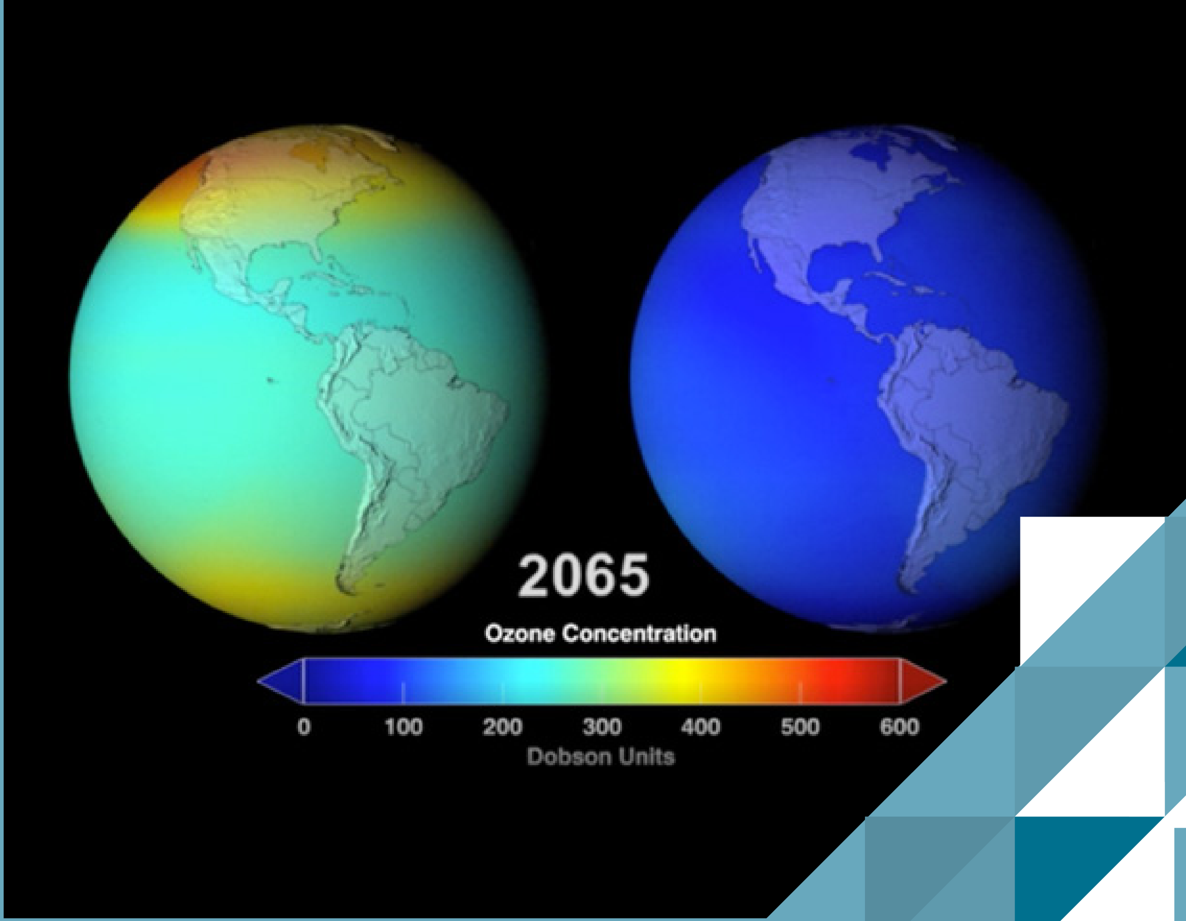
5.1 Montreal Protocol and Kigali Amendment

South Africa signed the Montreal Protocol since it came into effect in 1989 to protect the global ozone layer by phasing out ODS. Under this treaty, refrigerants such chlorofluorocarbons (CFCs) have been totally banned, and HCFCs are in the phase-down schedule. The treaty was amended in October 2016 to include the phase-down of HFCs which, like the ODS they are replacing, are potent GHGs that have a significant potential contribution to climate change. As these gasses are mostly used in cooling systems and refrigeration materials used in buildings, minimising their negative impact on climate is imperative.

National government is responsible for implementing the provisions of international treaties, which for ODS and climate change falls under the ambit of the DFFE. However, this cannot be achieved in isolation, and DFFE is cognisant of, and sensitive to, the mandates of other government ministries and agencies. Indeed, many of these support the implementation of these delegated objectives, as detailed in Table 9.

Table 9: Shared department responsibilities for ODS transition in South Africa

DEPARTMENT	ROLE
DFFE	• National focal point for the protection of the ozone layer • UV-B data and research • Climate change programme • Hazardous-waste management
Trade, Industry, and Competition (DTIC)	• Industrial policy and technology innovation • Incentives to support industry competitiveness • International Trade Administration Commission (ITAC) permits to import and export ODS and Non-ODS, i.e., HFCs (i.e., global warming substances) • National Regulator for Compulsory Specifications (NRCS) Letter of Authority (LoA) for imported RAC products/equipment
National Treasury and South African Revenue Service (SARS)/ Customs	• Customs and Excise – import taxes • Monitoring of imported/exported consignments/ goods at ports of entries/exits
Agriculture, Land Reform and Rural Development (DALRRD)	• Methyl bromide (MD) phaseout and use
International Relations and Cooperation (DIRCO)	• International agreements
Health (DoH)	• Hazardous Substances Act • Environmental health • Metered dose inhalers
Employment and Labour (DEL)	• Occupational Health and Safety Act • Pressure equipment regulation • Technician training
Higher Education and Training (DHET)	• Training and awareness
DMRE	• EE Strategy • Use of ODS in mines



HCFC Phase-Out Plan

The Government of South Africa developed a HCFC Phase-Out Plan (HPMP), which came into effect on 11 September 2012. The plan detailed the country's HCFC baseline consumption and outlined the strategy, actions and support needed to phase out HCFCs in accordance with its obligations under the Montreal Protocol.

The Government of South Africa reported a consumption of 122.16 ODP tonnes of HCFC in 2017, which is 67% below the HCFC baseline for compliance.[61] This indicates the country is well aligned with its commitment under the Montreal Protocol. This achievement is the result of the total phase-out of HCFC-141b used as blowing agent achieved on 1 January 2016, and the decrease in the consumption of HCFC-22 due to the activities in the HPMP and the 2014 ODS regulation.

To ensure full phase-out of ODS, the Minister of the DFFE promulgated Regulations Regarding the Phasing-out and Management of Ozone-Depleting Substances[62] (respectively, the ODS Regulations and Amended ODS Regulations), the purpose of which is to regulate the management and phasing out of ODS (Sub-Regulation 2). Among the strategies adopted in the regulations is monitoring and controlling the consumption of ODS by prohibiting the import and use of CFCs, halons, and carbon tetrachloride, and the phasing down of HCFCs. In the foam and RAC sectors, some of the relevant provisions in the ODS Regulations are as follows – Sub-Regulations 5(2)(a)(b)&(c):

- Importing of HCFC-141b either in pure form or as a component of blended chemicals for placing in a market or use in the production of polyurethane foam or as a solvent or any other application, from 1 January 2016.
- Importing of any new or used refrigeration and AC systems or equipment containing HCFC-22 or any refrigerant blend containing any HCFC, from 1 July 2014.
- Using HCFC-22, either in pure form or as a component of blended refrigerants, in the construction, assembly or installation of any new refrigeration or AC system or equipment, from 1 January 2015.

61 Pre-session documents of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, 83rd Meeting, Montreal, 27–31 May 2019. Ref: UNEP/OzL.Pro/ExCom/83/36, http://multilateralfund.org/83/pages/English.aspx
62 Government Gazette 37621 Number 351 of 8 May 2014 as amended by Government Gazette 44065 Number 10 of 11 January 2021.

The Amended ODS Regulations introduce the following revisions to the ODS Regulations (non-exhaustive):

- No person may import HCFCs or MB under 'critical use nomination' without an important quota allocation from DFFE (Sub-Regulation 5(a) of the ODS Regulations, as amended).'Critical use nomination' is defined to mean use of MB that is determined by DFFE as a critical use (Sub-Regulation 1 of the ODS Regulations, as amended).
- Substitution of Appendix-A: ODS to include ASHRAE names (Sub-Regulation 6 of the Amended ODS Regulations). The stockpiling of the ODS in Appendix-A is prohibited (Sub-Regulation 4[1] of the ODS Regulations), and a person who imports or exports such substances must, at the end of January of every year, report to DFFE the total quantities imported or exported for the previous year (Sub-Regulation 8[1] of the ODS Regulations).
- A person who imports or exports ODS listed in the Import Control Regulations or Export Control Regulations, promulgated under the ITAC Act, must submit the application for an import or export permit to the DFFE for recommendation, before submitting the application to ITAC (Sub-Regulation 5[b] of the ODS Regulations, as amended) (own emphasis).

South Africa does not manufacture any refrigerants, and the import and sale of HCFC refrigerants is limited to about 30 licensed importers using an import quota system. The quota limits the amount of HCFCs allowed for import by each importer. Percentage reduction of the import quotas is aligned to that of the country's obligation (for the period) as per the Montreal Protocol. The process is managed by ITAC, which issues a permit upon recommendation by the DFFE National Ozone Unit (NOU). In addition, Customs and Excise have allocated tariff codes to identify ODS and HFCs and align tariff codes with international standards, in particular for HCFC blends. Unique codes assigned to all blends containing ODS refrigerants will facilitate the verification of consumption data. The same tariff codes are used by industry for DFFE Recommendations to ITAC when issuing import and export permits. NOU has also conducted random visits to importers of refrigerants across the country to assess compliance with the ODS regulatory measures established under stage 1 of the HPMP.[63]

In the case of any refrigerant that enters the country through electrical apparatuses, such as RAC, the monitoring of the regulation is managed by the NRCS. All models must have a valid LoA from the NRCS, and the application is processed on the basis of an independent test certificate which details the refrigerant the appliance uses. In this way, the country has ensured that no appliances with R22 are imported.

As regulations for phasing out ODS were promulgated, the government instituted mechanisms to curb the illegal trade of these controlled substances, including public awareness campaigns, industry consultations, and roadshows.[64] These engagements provided a forum for information sharing, experiences, and the identification of challenges. They also enabled updates on the progress of the HPMP and on the milestones achieved in implementing the Montreal Protocol on ODS. Furthermore, they helped to begin sensitising industry on upcoming Kigali Amendment obligations on GWP refrigerants (i.e., HFCs such as R-404A, among others). Information sharing also included informing industry stakeholders on alternative, non-ODS technologies, such as ammonia, isobutane, CO_2. Stakeholders were engaged on the importance of the safe handling of refrigerants and the economic viability of refrigerant recovery.

Venting of refrigerants is illegal in accordance with the ODS Regulations and must therefore be discouraged and ultimately ended by demonstrating that it is valuable, necessary, and an obligation. Four national Recovery, Recycling, and Reclamation (RRR) facilities were established in 2019, in Johannesburg, Durban, Cape Town, and Gqeberha. Reporting on HPMP implementation highlights the urgent need to create awareness and take measures to encourage the RRR of refrigerants.

63 Pre-session documents of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, 83rd Meeting, Montreal, 27-31 May 2019. Ref: UNEP/OzL.Pro/ExCom/83/36, http://multilateralfund.org/83/pages/English.aspx

64 DFFE. 2018. 'Hydrochlorofluorocarbons Phase-out Management Plan (HPMP) Roadshow'. https://www.environment.gov.za/events/department_activities/hydrochlorofluorocarbons_phaseout_managementplan_roadshow

HFC Management Strategy

At this time, South Africa, in line with the rest of the world, has started to expand the programme's focus from drastically eliminating ODS usage to include climate protection, by considering the GWP of refrigerants. This culminated in South Africa ratifying the Kigali Amendment to the Montreal Protocol in August 2019. DFFE is now working on the development of the HFC Management Strategy that aims to detail the plans to phase down HFCs and transition to non-HFC refrigerants. The strategy is scheduled for development in this Financial Year, 2020/21. This process will include stakeholder consultation, which is scheduled for Q4 FY 2020/21. The phase-out schedule is centred on a baseline that considers the average HFC for 2020–2022 plus 65% of HCFC baseline production/consumption, as agreed for Annex 5 Group 1 countries (Table 10). The freeze date is 2024. The baseline data are being collected by the DFFE and will ultimately be used to inform the development of the HFC Phase-down Regulation for South Africa to meet its Kigali Amendment obligations and targets.

Table 10: Kigali Amendment phase-down schedules (Source: Montreal Protocol Handbook, 2020, p. 45)

Non-Article 5 parties		**Article 5 parties – Group 1**		**Article 5 parties – Group 2**	
Baseline	**Average HFC for 2011–2013 + 15% of HCFC baseline***	**Baseline**	**Average HFC for 2020–2022 + 65% of HCFC baseline**	**Baseline**	**Average HFC for 2024–2026 + 65% of HCFC baseline**
Freeze	-	Freeze	January 1, 2024	Freeze	January 1, 2028
10* per cent reduction	January 1, 2019	10 per cent reduction	January 1, 2029	10 per cent reduction	January 1, 2032
40* per cent reduction	January 1, 2024	10 per cent reduction	January 1, 2035	20 per cent reduction	January 1, 2037
70 per cent reduction	January 1, 2029	10 per cent reduction	January 1, 2040	30 per cent reduction	January 1, 2042
80 per cent reduction	January 1, 2034	10 per cent reduction	January 1, 2045	85 per cent reduction	January 1, 2047
85 per cent reduction	January 1, 2036				

* For Belarus, Kazakhstan, the Russian Federation, Tajikistan and Uzbekistan, 25% HCFC component of baseline and different initial two steps (1) 5% reduction in 2020 and (2) 35% reduction in 2025
Group 1: Article 5 parties not part of Group 2
Group 2: Bahrain, India, the Islamic Republic of Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia and the United Arab mirates

The Government of South Africa has continued to enforce the HCFC licensing and quota system and the additional set of regulations established in 2014 to control HCFCs, including the ban on imports of HCFC-141b, either pure or as a component of blended chemicals, that came into effect on 1 January 2016, and the two bans that came into force in September 2014 (on imports of any new or used RAC systems containing HCFCs, and on the use of HCFC22 in the construction, assembly, or installation of all new RAC systems).

The country's active RAC service sector has a pivotal role to play as the availability of HCFCs (and in years to come HFCs) for servicing existing equipment will gradually reduce as the phase-out/phase-down programmes progress and sustainable replacements are being phased in. It is essential that equipment owners are encouraged to ensure HCFC- and HFC-based equipment is made 'as leak free' as possible and converted to non-ODS/GWP-based equipment in an appropriate timescale.

5.2 Energy Efficiency Standard and Labelling

The National Energy Act, Act 34 of 2008, empowers the DMRE to regulate the sale of appliances that consume wasteful amounts of electricity. The first regulation, VC 9008, sets the compulsory energy performance specifications for ten residential appliances. It was introduced in 2014 and came into effect in 2015 and 2016. Table 11 lists the key EE stakeholders.

Table 11: Government stakeholders (EE)

	Responsible Ministry	Implementing Agency
Policy and Strategy	DMRE	SANEDI
Regulations	DTIC	NRCS
Product testing	DTIC	South African Bureau of Standards
Compliance and enforcement	DTIC	SABS
Accreditation	DTIC	South African National Accreditation System (SANAS)
GHG emissions	DFFE	DFFE
Industry	N/A	Industry Associations

Air Conditioners

The current MEPS regulation requires a minimum energy performance rating of a B for split-, portable-, and window-type ACs sold in the country.[65] The MEPS are based on the measured EER (cooling efficiency) and the measured COP (heating efficiency) at rated capacity rather than a seasonal rating. The efficiency level that corresponds to a B rating varies across the types of systems regulated in South Africa (Table 12).

Table 12: Comparison of efficiency level by label class for types of ACs in South Africa

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

At a B rating, minimum energy performance levels lie well below the MEPS requirements set in China, Europe, and Japan. Unless this is addressed, South Africa will lag international MEPS practices, with risks associated with other countries dumping outdated models – that use more harmful refrigerants and have lower energetic yield – in South Africa.

The Seasonal Energy Efficiency Ratio (SEER), which has been adopted internationally, including in Europe, Mexico, the United States, and Canada, is under consideration as part of the MEPS review for ACs in South Africa. This metric makes better allowance for more efficient variable-speed or inverter-driven AC units.

Wording in the measurement standard (SANS 54511) has unintentionally excluded ceiling-mounted type split-unit systems, leaving these units unregulated. A discrepancy between the Customs and Excise Tariff book and Regulation has also created a loophole for ACs between 7.1 and 8.8 kW in size.[66]

65 SANS 941, clause 4.2.1 requiring all AC combinations to comply with requirements for energy consumption as specified in SANS 54511.
66 Regulation VC 9008 requires all ACs under 7.1 kW to be registered with the Regulator, while the Customs and Excise Tariff book includes all units up to cooling capacity of 8.8 kW.

Enhancements of the regulatory framework require a review of unintentional omissions, alternative metrics for rating efficiency performance, and improved alignment with technology advances and developments as reflected in evolving performance requirements internationally. The option to define different MEPS levels depending on the GWP of the refrigerant used, as seen in the EU regulations, will further strengthen alignment between environmental and efficiency objectives.

Refrigerators

VC 9008 introduced MEPS for domestic refrigerators and combined fridge-freezers at a B rating and for freezers at a C rating, as detailed in Table 13. When adopted, these ratings were selected to accommodate an adjustment to the MEPS by local manufacturers. Subsequent revisions in the EU regulations mean that European MEPS levels are now substantially tighter than the existing MEPS levels in force in South Africa — the European MEPS levels are set at almost half (0.56) of the maximum energy performance permitted in South Africa. 'C' rated freezers are no longer readily available in the South African market, suggesting the market has organically adapted to higher efficiency levels and global trends.

Table 13: EE classes for refrigerating appliances (SANS 62552)

1	2
Energy efficiency index	**Energy efficiency class**
$I_a < 30$	A++
$30 \le I_a < 42$	A+
$42 \le I < 55$	A
$55 \le I < 75$	B
$75 \le I < 90$	C
$90 \le I < 100$	D
$100 \le I < 110$	E
$110 \le I < 125$	F
$125 \le I$	G

MEPS Review

In line with the DMRE's objective of reviewing MEPS on a regular basis (every three to five years), in 2019, the MEPS for regulated appliances underwent a formal stakeholder consultation review and process, and improved performance levels were agreed to with industry. This was subsequently formalised by the DMRE in February 2020 through the issuance of a directive to the NRCS to revise the regulations.[67] Accordingly, all refrigerators sold in the country will have to meet a MEPS of A; freezers a B; and air conditioners an A when the amendment VC 9008 is promulgated by the DTIC Minister.

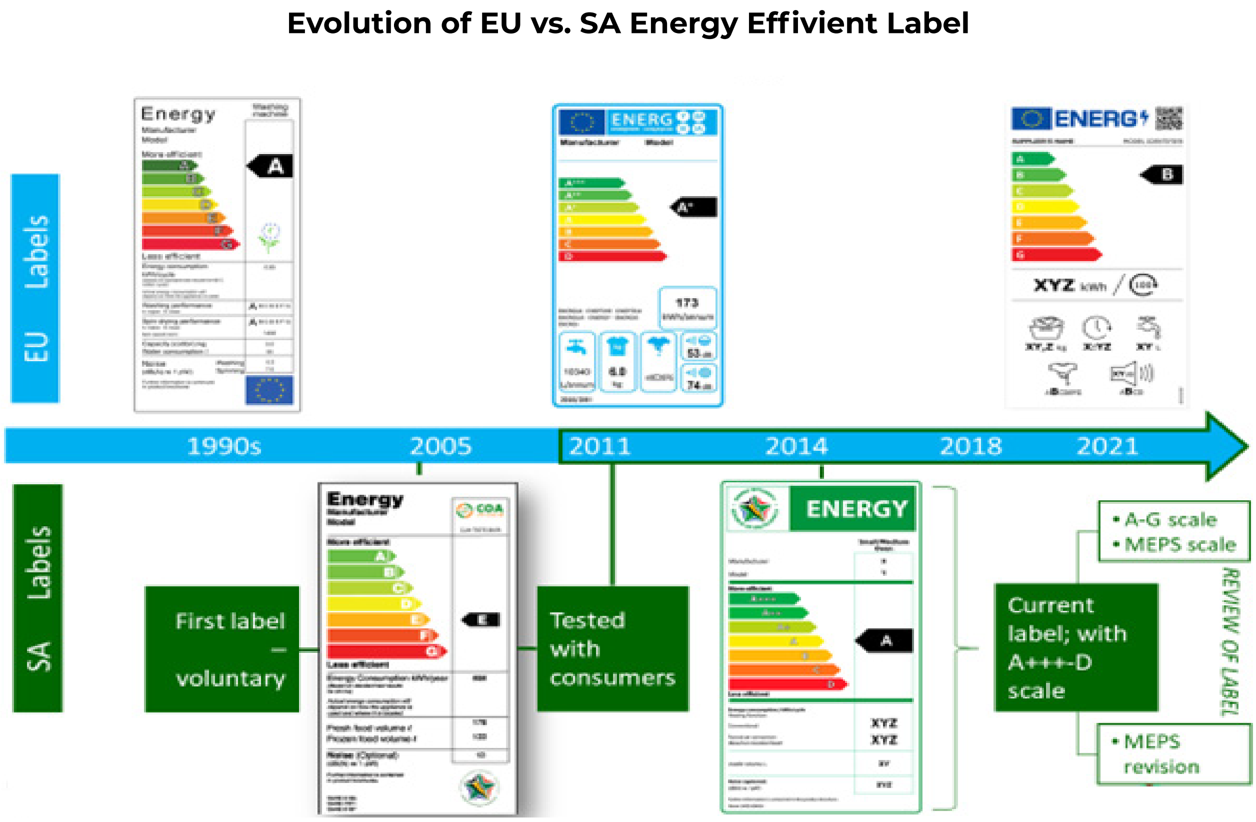
67 DMRE (2019) https://www.savingenergy.org.za/dmre-directive-to-nrcs-to-strengthen-meps/

Labels

A (second) review of the design and content of the existing energy label was conducted to assess its effectiveness in informing consumers about EE when they buy an appliance. Every country and culture is unique, and words, letters, numbers, symbols, and colours have unique connotations within each one. Appropriate handling of these subtleties and careful framing of energy information can enable better delivery of messages or, if ignored, impede effective interpretation of intended messaging. South Africa adopted the European Union's (EU's) energy label in 2004 when it introduced a voluntary labelling scheme for refrigerators and freezers, for two reasons. First, most of the country's residential appliance imports were from the EU. Second, the EU programme was established and provided an easy-to-adopt option. However, the label was customised to clearly communicate that it is a government initiative targeting South African consumers. This was done by including the SA EE star logo (replacing the EU flag) and listing the national standards (Figure 11).

In 2011, the EU EE label was redesigned to: (1) Accommodate improved energy performance which was done by introducing 'beyond A' categories by rescaling from A+++ to D; and (2) To shift from text to neutral icon language to allow for a single label across all territories. Shortly thereafter, SA consumer research in 2012[68] established the feasibility of continuing to adopt the EU-styled label but strengthened the SA brand identity on the label through repositioning the SA Energy Efficient star for prominence. It also added the word 'ENERGY' in bold and green as the label heading and adopted the revised scale A+++ to D, but it was decided not to adopt the icon neutral language and the English text descriptors were maintained. This label was launched in 2014 and is the current EE label in use across appliance categories in the SA market. The evolution of the EU and SA energy label is depicted in Figure 11. See Annex 1 for a more detailed overview of the current label.

Figure 11: Design progression of EU and SA energy label



The second review[69] involved consultation with consumers, industry, and government stakeholders. Table 14 summarises the primary drivers and objectives of the research, and the outcomes.

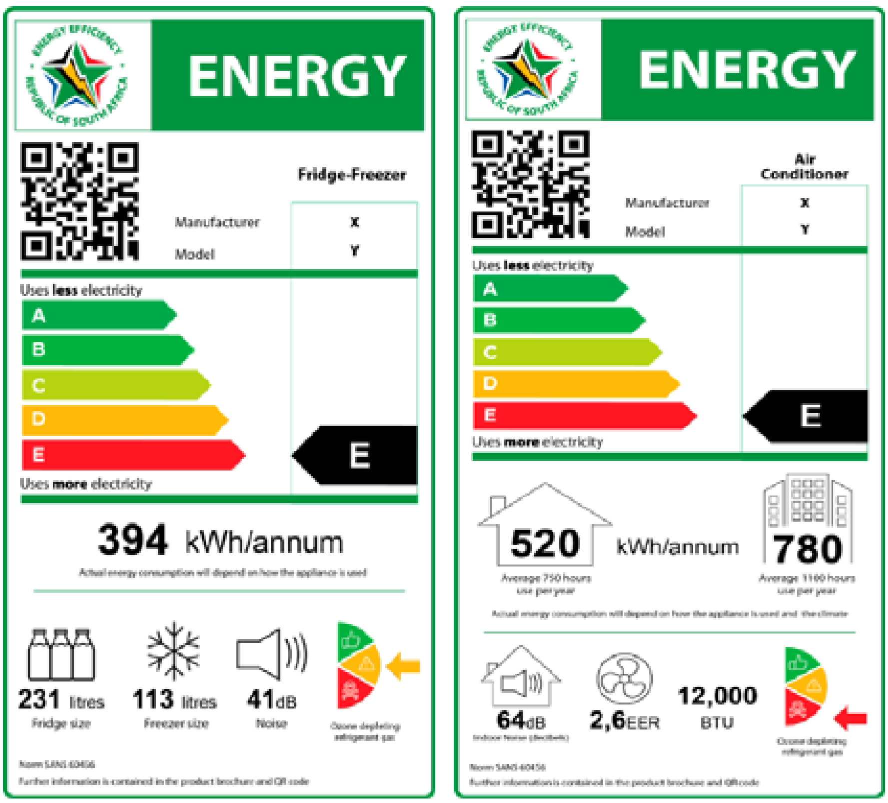
68 Covary, T. (2012). FRIDGE Report:'Energy Performance and Labelling Requirements for Specific Electrical Appliances and Equipment'.
69 Research IQ 2020. 'Market Research to Inform Changes to the Mandatory Energy Efficiency Label for Residential Appliances'. https://www.savingenergy.org.za/wp-content/uploads/2020/06/22Apr20_UNDP_Pr-Renew_Research-report_final.pdf

Table 14: Outcomes of stakeholder research to revise the energy label

Key Objective	Recommendation
Comprehension of current label	· High recognition · The label is being used as an endorsement (rather than a comparative) label by consumers, i.e., reflecting a good choice · Perception placed by manufacturer stronger than that placed by government
Revert from A+++–D to A–G scale	· A–G scale overwhelmingly preferred
Key elements of the scale	· MEPS to be depicted as lowest energy class on the energy scale, not the case with the current label · MEPS is always red · Move MEPS standard down by one class across all categories to ensure the A class is empty, with fewer than 5% to 10% within the B class level, to avoid frequent rescaling
Introduction of QR code to link appliance to product registration database	· Highly supported
Infographics	· Mix method → symbol + keyword descriptor
Additional useful information	· Add refrigerant gas indicator to RAC appliances · Add British thermal unit (Btu) capacity for the AC

Figure 12 illustrates the proposed energy label design layouts for RAC based on the research findings. The DMRE has indicated that the revision process is to commence from 2021. Note: These designs are the outcomes of the research and are for illustrative purposes only. They have not been officially endorsed or adopted by the DMRE.

Figure 12: Proposed revision to energy label for Refrigerators and AC

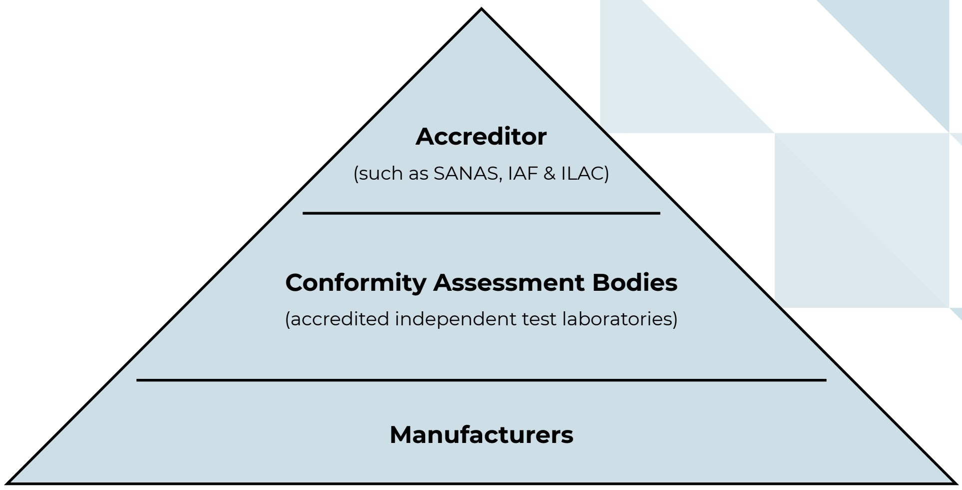


Monitoring, Verification, and Enforcement (MVE)

The National Regulator for Compulsory Specifications Act (No. 5 of 2008) empowers the NRCS, an agency of the DTIC, to administer and maintain mandatory specifications in the interest of public safety and health, or for environmental protection. The NRCS issues compliant products an LoA, which is valid for a three-year period. Without the LoA, a product may not be sold in the South African market. An LoA is required for every 'type and model' before 'offered for sale' in the country.[70]

The NRCS's Conformity Assessment Policy[71] selects the third-party approach to regulate any material, commodity, product, installation, process, system, person, or body under its mandate (Figure 13). The NRCS defines third-party conformity assessment as follows: 'performed by a person or body that is independent of the person or organisation that provides the object and of user interest in that object'.

Figure 13: Third-party conformity assessment approach (Source: NRCS)



The NRCS electro-technical department regulates 12 product types, which range from appliances to lighting, power tools, voltage cables, and plugs – all of which must meet national standards for Health and Safety (H&S) – as well as energy performance. To effectively regulate products, and in alignment with international practice, the NRCS has adopted a two-step process:

- Pre-approval: Approving a product prior to market entry.
- Product testing, at the national laboratory or any accredited independent test laboratory;
- Application to the Regulator to distribute the product, supported by a test report from an independent and accredited testing facility; and
- Regulatory approval.
- MVE: Monitoring the market to identify and penalise non-compliant products.
- Sample products from market, for testing at an accredited laboratory;
- Compare test results to product application specifications;
- Compliance (no action)/Non-compliance (sanctions including product confiscation, sampling and/or fine).

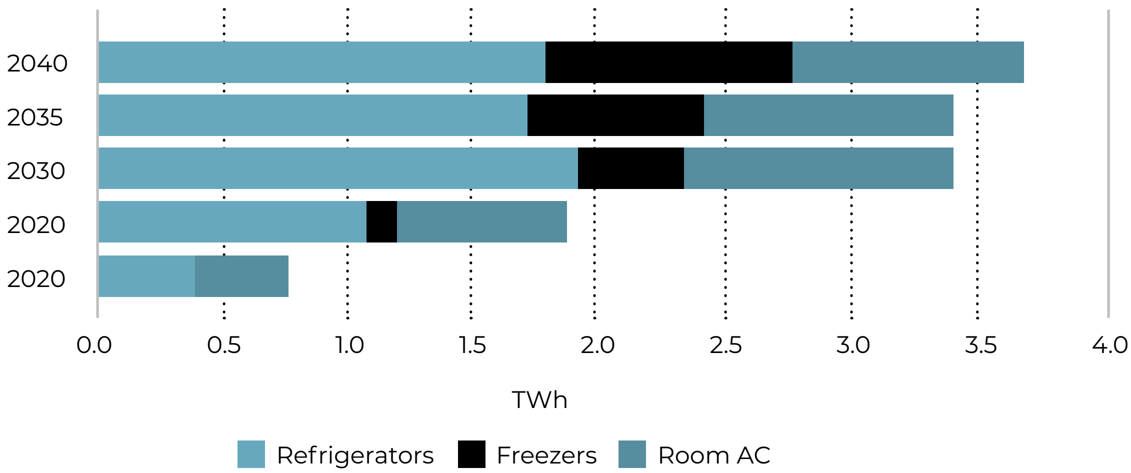
The third-party conformity approach and model implemented by NRCS provides a well-structured mechanism to maximise market compliance but can only be effective if it is supported by appropriately funded and resourced market surveillance action, which undertakes regular and targeted testing. In 2021, the levels of market check-testing were low, compounded by limited access to accredited local test facilities — South Africa does not have an AC test laboratory. These challenges are being considered by the DMRE in consultation with NRCS and its parent Ministry (DTIC) to find solutions to these challenges.

70 NRCS (2018) Electrotechnical Letter of Authority: ET/SCF018 ISSUE 11 REVISED 08 Jan 2018.
71 NRCS. 2018. 'The Conformity Assessment Policy of the National Regulator for Compulsory Specifications (NRCS)'. https://www.nrcs.org.za/siteimgs/Policy/NRCS%20CPO%20112-01%20Conformity%20Assessment%20Policy.pdf

S&L Energy Savings (2015 to 2020)

Figure 14 provides the electricity savings for cooling products because of the introduction of MEPS under the S&L Programme in 2016 and its revision in 2021. As new sales of efficient cooling products gradually replace the existing stock, electricity savings increase until the product reaches the end of life of equipment of about 15 years. Electricity savings reach 3.3 TWh in 2030 and 3.8 TWh in 2040 – the equivalent of avoiding the construction of a 160 MW coal power plant and reducing 3.8 $MtCO_2$ of emissions.

Figure 14: Annual electricity savings for cooling products regulated under the S&L Programme (2016 and 2021 revision)



Source: DMRE, SANEDI, USAID and Lawrence Berkeley National Laboratory. February 2020. 'South Africa's Appliance Energy Efficiency Standards and Labelling Program, Impact Assessment'. https://www.sanedi.org.za/img/Events/South%20Africa%20Appliance%20Energy%20Efficiency%20SL%20Impacts.%20Final%20February%202020.pdf

Labels, Communication, and Outreach

Since 2012, the S&L programme has undertaken numerous awareness activities targeting industry and civil society. Selected examples include the following:The revised energy label was launched by the Minister of Energy at the Africa Energy Indaba in 2015. This received widespread national media attention.

- Industry workshops, which are attended by all government implementing agencies, to provide updates, engage on issues of concern, discuss long-term policy objectives and next steps.
- The S&L Programme launched a website (www.savingenergy.org.za) and is active on Facebook and Twitter. The website targets industry, consumers, and other interested parties (e.g., academics, international colleagues). Some of the content available on the website includes:
    - Research reports, industry workshop presentations, legislation, and compliance requirements;
    - Overview and explanation of the S&L Programme for consumers; and
    - Awareness and promotional videos from previous campaigns.
- In-store awareness and promotional events. For example, a nationwide promotion at the country's biggest retailer of efficient appliances was undertaken in 2018. Consumers were offered a cash incentive (discount) if they chose a pre-selected EE appliance. In 2019/20, a six-week in-store campaign to inform consumers of the benefits of LED general service lamps
- (over CFLs and incandescents) was successfully completed.
- The NRCS and DFFE undertake regular industry workshops in their capacity to inform industry of new regulations and national policy. Updates are also provided to the public through in-store awareness campaigns.

It is imperative for the programmes (S&L and ODS refrigerant phase-out) to continue sharing information with industry and consumers to maintain awareness and keep reminding them of the fundamental importance of these climate change policies – especially when new regulations or changes to the programme are forthcoming. For example, the rescaling of the energy label to remove the + symbols to revert to the original

A–G scale must be explained and carefully managed. Consumers faced with outdated (old) and new labels will be confused and bound to opt for appliances with the familiar + markings, which may be less efficient – a loss to the consumer and the programme.

South Africa continues to battle with electricity supply shortages and generation plants that are predominantly fossil-fuel based. EE, as the first fuel, has a significant role to play in addressing both these dilemmas, and a suitably structured and expanded programme which is appropriately communicated has much to offer the South African economy. The programme must build on the experience from previous awareness initiatives, maintain an up-to-date website, be active on social media, and partner with other ministries to find innovative ways to promote the most efficient and lower ODS cooling products.

Finally, the success of South Africa's S&L Programme, encouragement, and support from international agencies (such as UN Industrial Development Organization (UNIDO), UN Environment, CLASP and others) has led to a Southern African Development Community (SADC) Directive for the introduction of a regional S&L Programme. This effort is being coordinated by the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), which is headquartered in Namibia, and MEPS for lighting, refrigeration, and transformers have been prioritised. To date, draft lighting regulations were circulated for comment to eleven Southern and three East African countries in 2021, with the process being chaired by South Africa's NRCS. Work on developing technical standards for eight regional countries for refrigerators and transformers commenced in 2021 and is scheduled to be completed by mid-2022. South Africa, as a regional forerunner in S&L, stands ready to assist and support the region.

5.3 Buildings

Building Codes

In 2011, the SANS 10400–XA Energy Usage in Buildings Regulations were added to the National Building Regulations for Energy Usage in Buildings. These regulations (Table 5), read with SANS 204, support the National Building Regulations, which are mandatory. All new buildings must comply with the regulations, as must any extensions and additions to existing buildings. Requirements cover water heating, building orientation, and the thermal performance of the envelope (walls, roof, and windows) to help stay within the maximum allowable energy consumption.[72]

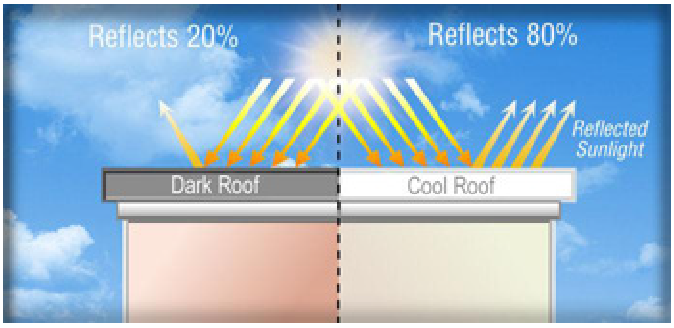
In terms of compliance with SANS 10400–XA, buildings can choose between the prescriptive route and the performance route (aka the reference route). Provincial and local governments are the major authorities who take the responsibility for code implementation and enforcement, with some support from third parties.

The implementation of the SANS 10400–XA EE regulations has driven the inclusion of insulation in new and refurbishment building projects. Insulation of new and existing buildings is a cost-effective and mostly practical intervention. The high diurnal temperature variation in many South African regions also offers a good case for the integration of thermal mass design. Materials with high thermal mass offer inertia against the temperature variance by storing heat energy over a period of time and releasing it later in the day/night cycle. Thermal mass and insulation materials should be considered in an integrated design and retrofit approach.

However, capacity and skills restraints within local authorities have resulted in inconsistent implementation of the regulations governing building insulation and building energy use in new and refurbishment building projects. Further opportunities exist over and above the measures introduced by the standard. Passive design principles such as shading, natural ventilation and lighting, building orientation, window ratios, material selection, reflective coatings, and insulation, remain underutilised as an inexpensive means to avoid artificial heating and cooling.[73] Planning should include development of educational material and opportunities for creating and encouraging greater awareness among building professionals, property developers, and building owners.

72 SANS 204 has tables which stipulate the maximum energy demand and the maximum annual energy consumption for various kinds of buildings in the various climatic areas of South Africa.

73 Cooling Coalition. March 2021. 'Not Passing on Passive Cooling: How Philanthropy can Help Accelerate Passive Cooling Solutions and their Climate Benefits'. https://coolcoalition.org/not-passing-on-passive-cooling-how-philanthropy-can-help-accelerate-passive-cooling-solutions-and-their-climate-benefits/



Cool Roofs

Cool roofing consists of coating roofs with a durable, reflective membrane which reflects the heat of the sun. This strategy can significantly cool a home and reduce the need for energy for mechanical cooling. It is an inexpensive and highly effective passive energy, low-tech cooling intervention. SANEDI established a Cool Surfaces Programme in 2013 with the support of the US Department of Energy and the Global Superior Energy Performance Partnership (GSEP) – Global Cool Cities Alliance (GCCA)[74]. SANEDI estimates that in high-rise buildings, cool roofing has the potential to decrease top-floor air-conditioning energy use by as much as 20%. Combined with efficient equipment, cool roofs provide urban areas with a low-energy cooling solution and a substantially lower carbon footprint. Cool roofing also holds the potential to decrease ambient outdoor temperatures. Used comprehensively throughout an urban area, cool roofs can reduce urban heat island effect.[75] It is an inexpensive and highly effective passive-energy intervention.

Moreover, cool roofs provide an opportunity to increase cooling access to the communities that most need it in very poorly insulated homes, sometimes with corrugated metal roofs, that suffer from high heat indoor transfer during summer months. In a low-cost housing project in Groblershoop in the Northern Cape, cool roofs with reflective coatings reduced the daytime indoor temperatures from above 34 °C to 25 °C and made these homes more comfortable. SANEDI is planning to deploy 26,000 m^2 of cool roofing technology in several municipalities, including in the City of Cape Town, in partnership with the Thermal Insulation Products and Systems Association SA with support from K-CEP. The purpose of the rollout is also to show the power of passive cooling when cool coatings are used in conjunction with insulation. The intention is to use the collected data as evidence for the mandatory inclusion of passive thermal control in the Energy Efficiency Building Code 10400–XA.[76]

Building Certification

On 8 December 2020, the Government Gazette published 'Regulations for the Mandatory Display and Submission of Energy Performance Certificates for Buildings'.[77] The objective of these regulations is to introduce mandatory requirements for the display of Energy Performance Certificates (EPCs) in non-residential buildings and to make provision for the submission of EPC by organs of state and owners of buildings for non-residential buildings which have a dominant occupancy classification as set out in the National Building Regulations as:

- Buildings owned or tenanted by an organ of state falling into the above category of 1,000 m^2 or more; and
- Privately owned buildings falling into the above category of 2,000 m^2 or more (which is not occupied by an organ of state).

EPCs must be displayed within two years of the regulations coming into effect, i.e., by 8 December 2022, and are valid for five years. EPCs should comply with SANS 1544: 2014 Energy performance certificates for buildings.[78] The DMRE will be responsible for monitoring the display of EPCs. In November 2022 the DMRE announced the regulations deadlines was extended by three years to 2025.

The Green Building Council South Africa (GBCSA) was founded in 2007 to develop green building certification and provide training on green buildings. It is a member of the World Green Building Council. As of February 2021, a total of 644 certifications had been awarded by GBCSA as green buildings, with 87 certifications awarded in 2019, up from 2018 certifications which totalled 78 buildings.[79] However, only seven buildings were awarded NZEB status over these two years.

74 See https://www.sanedi.org.za/Cool%20Surface.html
75 Lawrence Berkeley National Laboratory. Heat Island Group. Cool Roofs. https://heatisland.lbl.gov/coolscience/cool-roofs
76 Million Cool Roofs Challenge. 2020. 'Cools Roofs: Offering a Sustainable Solution to all South Africans'. https://www.coolroofschallenge.org/news-and-blogs/2020/5/12/cools-roofs-offering-a-sustainable-solution-to-all-south-africans
77 Government Gazette publication: https://www.gov.za/documents/national-energy-act-regulations-mandatory-display-and-submission-energy-performance-0#
78 SABS. SANS 1544:2014 (Ed. 1.00). https://store.sabs.co.za/catalog/product/view/_ignore_category/1/id/209447/s/sans-1544-ed-1-00/
79 GBCSA 2020 Annual Report plus Current Figures Obtained from GBCSA. https://gbcsa.org.za/2019-integrated-annual-report-released/

6. The National Cooling Plan

Table 15: Efficient-cooling roadmap for South Africa

		Current Situation		**Proposed Actions**
Standard and Labeling Program	Efficient Cooling Equipment			
	Air Conditioners	> 7.1 kW	No MEPS	Adopt MEPS for larger size ACs.
		< 7.1 kW	Current B 2023 A	Adopt U4E model regulations which are aligned with the new 2022 China MEPS to reduce risk of dumping and increase size to 8.0 kW.
	Refrigerators MEPS	2023 A 2026 A+		Consider commercial refrigeration. Rescale energy classes.
	MVE	Registration database Testing for refrigeration		Develop a monitoring, verification and enforcement (MVE) plan to check and increase compliance to the regulations.
	Labels	Comparative label		Update the label to reflect rescaling and include refrigerant gas indicator icon: i.e., good, average, or poor.
Buildings Code	Cool Buildings			
	Building Codes Implementation	Lack of application of national Building Code		Develop capacity building and tools to assist building sector stakeholders and code officials to implement the current building code.
	Cool Roofs	Cool roof projects are being deployed		Scale up cool roof adoption by including a cool roof requirement in Building Code and standardizing product categories.
	Net Zero Energy Buildings	Low uptake		National and local government needs to set near term targets for the building sector to integrate passive designs and achieve NZEB construction.
Financing	Acceleration of Efficient Cooling through Financing			
	Financing	No major cooling financing program		Map out efficient cooling financing needs and market gaps and design new financing programs to accelerate uptake of sustainable cooling access.
Circular Economy	Circular Economy			
	Waste Management	No recycling facilities available		Implement DFFE industry waste management plan (under development) for electronic equipment to provide recycling facilities supported by regulations.

6.1 Minimum Energy Performance Standards

MEPS regulations for split ACs, refrigerators, and freezers came into effect in 2016. This was followed by the implementation of awareness-raising programs. Efforts to increase compliance rates and revisions were issued in 2020. While this programme is the most comprehensive in the region, and huge strides have been made in building strong foundations, challenges remain, and opportunities to adopt international best practices remain – there is also the opportunity to expand the programme to include larger cooling products prevalent in the commercial sector.

Large ACs

Cooling-electricity use in the commercial sector represents 26% and has not been regulated yet. The current MEPS of the S&L Programme only covers ACs up to 7.1 kW (24 000 Btu/h) cooling capacity. Most of the ACs used in the commercial sector are larger, and these include multi-split systems, Variable Refrigerant Volume systems, Variable Refrigerant Flow systems, rooftop units, and chiller systems that are not covered by the programme. Many countries have implemented standards for these types of ACs which are more prevalent in advanced economies. For example, in the United States, the US Department of Energy implemented new efficiency standards for commercial ACs, which increased the MEPS of commercial rooftop units by about 13% in 2018 and by an additional 15% in 2023, leading to the largest energy savings impacts in the history of the US S&L programme.[80] If similar regulations were implemented in South Africa, the energy savings impact would result in CO_2 emissions reductions of around 3.6 $MtCO_2$ per year. Other countries that have adopted or are currently working on developing standards for large ACs include Mexico, China, and Brazil.

Smaller ACs

Current MEPS for small ACs are generally reasonable but could be strengthened to be more in line with global best practice. In particular, as the market share of variable-speed units increases, the adoption of new metrics can help stakeholders measure the performance of ACs more accurately. Variable-speed compressors enable an AC unit to respond to changes in cooling requirements due to changes in temperatures, which reduces energy consumption, especially in countries with high variation in daily temperatures. Seasonal EER metrics provide a more accurate measure of the energy performance of the AC than the traditional EER. In SEER metrics, the performance of the AC is measured during full-load and part-load operations at different temperature points, depending on the country's climate. SEER metrics require at a minimum one more data point in part-load conditions compared to an EER metric. The International Organization for Standardization developed ISO 16358 in 2013 to rate fixed-speed and variable-speed ACs under a common metric.

UNEP developed model regulations for countries to adopt and provide guidelines to implement the standards. The UN's U4E initiative consulted dozens of experts from various sectors and global regions to assess best practices and new developments and to develop these model regulations. They are based on China's MEPS that will take effect in 2022 and should have significant impacts on the cost and availability of EE ACs in the countries that adopt these regulations. As shown in the market assessment, most ACs (90%) are imported from China. There, adopting MEPS that align with international practices will significantly reduce the risk of dumping and increase the number of more efficient products entering the market.

Refrigeration

Commercial refrigeration covers a wide range of equipment types which are used by business, retailers, and restaurants for food storage. Commercial refrigeration is usually split into two main categories: refrigerated display cabinets, and refrigerated storage cabinets. Both product types should be regulated to remove inefficient products from the market.

80 NRDC. 17 December 2015. 'DOE Issues Biggest Energy Saving Standard Yet for Roof Top Air Conditioners'. Blog post. https://www.nrdc.org/experts/meg-waltner/doe-issues-biggest-energy-saving-standard-yet-roof-top-air-conditioners

6.2 Market Monitoring, Verification and Enforcement

The effectiveness of any legislation is largely a product of MV&E activities to ensure compliance. For all its successes, the South Africa S&L Programme has also faced key challenges to enforce compliance, and efforts are needed to address specific gaps. The NRCS, in cooperation with the DMRE and DFFE, is seeking to enhance its MVE approach to ensure that consumer confidence is not undermined by limited regulatory activity and anecdotal evidence of non-compliance. Notably, the following key elements of an enforcement strategy should be addressed to ensure that South Africa's S&L Programme yields the impacts expected:

Monitoring

The programme has developed a product-registration database that is implemented by the NRCS.[81] This important foundation of the programme needs to be enhanced and used as a tracking tool to monitor compliance of ACs and refrigeration models to the regulations. The programme has also developed a QR code to facilitate product registration and rapid access to information about a product's characteristics for consumers. These electronic operational improvements are key milestones that need now to be leveraged to provide data to better monitor the market. Training on data analysis for monitoring would also contribute to build capacity on the utilisation of these electronic resources.

Verification

For increasing verification of compliance, NRCS and SARS need to set targets and develop guidelines for facilitating inspection checks of imported containers, warehouses, suppliers, websites, and stores.

An accredited test laboratory for refrigerators and freezers exists at the SABS Pretoria campus. However, South Africa does not have an AC test laboratory, and there are no test facilities in Sub-Saharan Africa. Moreover, given South Africa's geographic position, it is uneconomic and too time-consuming to use test facilities in Asia, EU, and the Americas. Test labs are necessary to conduct random checks of energy performance. There is also a need to explore the possibility to develop a business model for a regional AC test laboratory, potentially through a private–public partnership arrangement.

Enforcement

A strong legal and regulatory framework with clear and relevant stipulations is the basis of ensuring products meet mandated health, safety, and environmental requirements.[82] Sanctions allowed under the NRCS Act include product recalls, returning the product to its country of origin, or confiscating and destroying such non-compliant products; but the Act does not provide for the use of financial penalties without involving the courts. This limits the effectiveness of the Regulator, as approaching the courts is lengthy and expensive, and seen as a last resort. Thus, the Act may not sufficiently deter non-compliance, and financial penalties should be introduced.

The Regulator should publish its annual enforcement strategy which details the testing schedule, with stated outcomes, so as to strengthen market confidence. Publicly disclosed test outcomes and the naming of non-compliant brands and models will assert additional pressure to avoid non-compliance.

6.3 Building Codes

Building Code Implementation

Building energy codes set minimum EE standards for building technologies and design elements to reduce energy consumption for cooling, heating, lighting, and other forms of electricity usage. As noted in Section 4.3, the national 2011 SANS 10400–XA Energy Usage in Buildings Regulation, while mandatory, lacks systematic application. Subnational governments are at the front line of building code implementation and are crucial in tailoring codes to local circumstances, ensuring strong code enforcement and catalysing support at the local level. It is critical to have sufficient budget, staff, and analytical resources to support code

81 The new online registration database was launched on 1 February 2021 and can be accessed https://www.applianceregistrationdatabase.org.za/user/register.
82 World Resources Institute. 2013. 'Robust, Recognizable, and Legitimate: Strengthening India's Appliance Efficiency Standards and Labels through Greater Civil Society Involvement'.

implementation. At the local level, there is often a need to devote resources to training government staff and/or independent institutions to support compliance and enforcement. In addition, software tools and building material libraries are important to assess potential building material trade-offs and/or to perform whole building simulations. Various software tools are available to support compliance processes and can be chosen based on unique code features and local considerations.

Cool Roofs

Cool-roof technologies and their benefits in reducing cooling-load demand and the urban heat island effect are generally well understood and accepted, with research, standardisation and policy most advanced and established in the United States. Cool roofs represent a key tool in delivering access to cooling in an affordable and sustainable way and contribute to reducing indoor temperatures, especially during a heatwave. As noted by SEforAll, 'More highly reflective cool roofs and walls help support faster progress on the Paris Climate Agreement, Sustainable Development Goals and the Montreal Protocol.'[83] The implementation of cool-roof technology on unconditioned buildings can offer improved comfort and may avoid the need to install cooling equipment, and for conditioned buildings, it contributes to a reduction in cooling-load demand.

The implementation of cool roofs can be encouraged by showcasing voluntary initiatives and green-building ratings as well as through mandatory requirements and financial-incentive programs. For example, in the United States, California's Title 24 Building Energy Efficiency Code recognises that roofing plays a major role in home EE, and the code sets a prescriptive requirement for cool roofs for residential and non-residential buildings[84] South Africa already has some experience in deploying cool-roof technologies, and has a nascent industry that can be fostered by new policy. It is therefore recommended that standardisation of product performance be created to provide industry benchmarks between different cool-roof products and to provide confidence to the building industry on the performance of the products. Incentive and regulation through legislation and building codes is then an effective way to move the building industry in South Africa towards widespread implementation of cool-roof technology.

Net-Zero Energy Buildings

NZEBs combine EE and renewable-energy generation to consume only as much energy as can be produced onsite through renewable resources. Achieving zero energy is an ambitious yet increasingly achievable goal that is gaining momentum across geographic regions and markets. Private commercial property owners have a growing interest in developing NZEBs to meet their corporate goals, and in response to national and local government goals towards emissions reduction.

A guide was recently published by the GBCSA in partnership with key stakeholders in the field to provide guidance and references to approaching a net-zero project for new and existing commercial buildings, mainly offices, with some reference to the residential sector.[85] The focus of the report is on Net Zero Carbon building.[86]

The report points out that in a typical commercial office building, energy used for heating and cooling can constitute 50% of consumption, and therefore NZC building should integrate the design of 'passive' elements to achieve 'Comfort Without Aircon' whenever possible.

Alternative cooling solutions such as evaporative cooling, ground source (or geothermal) heating and cooling, and cool-roof and rooftop gardens are among the innovations that may also be explored for relevance in South Africa.

Low-cost solar photovoltaics now provide an alternative, clean power source where cooling requirements exceed the capability of well-designed, passively cooled buildings. Additionally, where cooling solutions are required, opportunity lies with enhancing technical expertise to ensure appropriate equipment selection, right-sizing of equipment, proper installation and maintenance for optimum functioning of installed cooling solutions and technologies.

83 SEforAll. 2019. 'Million Cool Roofs Challenge Aims to Spur Community Cooling Innovation. https://www.seforall.org/news/million-cool-roofs-challenge-aims-to-spur-community-cooling-innovation
84 Cool Roof Rating Council. California Building Energy Efficiency Standards (Title 24, Part 6). https://coolroofs.org/resources/california-title-24
85 GBCSA. 2020. 'Getting To Zero: A Guide to Developing Net Zero Carbon Buildings in South Africa'. https://gbcsa.org.za/guide-to-developing-net-zero-carbon-buildings-in-sa-launched/
86 The GBCSA defines an NZEB as 'a building that is highly energy-efficient, with the remaining energy requirement generated from renewable energy, preferably on-site or off-site where absolutely necessary'. There should be zero net carbon emissions on an annual basis (net zero).

Appendix A illustrates opportunity areas to address building-related EE opportunities. Passive design, materials, and building services form three separate categories of building interventions which offer high-, moderate-, and low-impact opportunities for new or existing buildings. Given the extensive and diverse range of building typologies in South Africa, general comments have been made across broadly defined categories.

6.4 Financing for Efficient Cooling

Financial incentives, also known as economic instruments, leverage private investments to pull higher efficiency technologies into the market. From country to country, financial incentives, types of frameworks used to implement these, and the actors that administer them vary considerably in scope and form. They range from rebate programmes administered by utilities under an Energy-Efficiency Resource Standards (EERS) regulatory framework (California, USA) to the distribution of ecopoints rewarding customers for buying highly efficient cooling products (Japan).[87] They can be designed to address additional pressing concerns of growing AC use such as power-supply reliability due to increased peak demand, GWP of refrigerants used in ACs, and increasing efficient-cooling access. They can employ different financing approaches such as the following:

Demand management by the electricity company: Financing can be provided through demand response programmes and on bill financing (where the loan is repaid through electricity bills).

Grants: Grants can enable access to cooling programmes for low-income households, schools, off-grid medical centres, and others.

Cooling as a service: Offers a pay-per-service model with integrated financial tools to recapitalise technology providers who own, maintain, and operate the equipment.

Government budgets: Notably during periods of economic recovery, financing can come from stimulus funds and foster job creation and economic spending, and at the same time promote a clean-energy transition.

Public–private partnerships: These can demonstrate new technologies.

Credit lines: A dedicated credit line can be used to spur EE improvement in cooling-equipment investments.

International financial institutions: Global Environment Facility (GEF) has been funding EE projects for many years through its implementing agencies: UNDP, UNEP, and World Bank. The more recent Green Climate Fund (GCF) has developed new programmes, including those focused on EE.

The GCF programming cycle is long and ranges from the elaboration of a country's strategic climate document through project preparation facility and to GCF investment requests. However, the GCF's Readiness Support has been developed to enable countries to receive grants to support access to climate financing, institutional capacities, strategic planning, and early stages of project development for up to USD 1 million per country per year. Countries interested in applying need to work with their National Designated Authorities (NDAs) and Focal Points to submit readiness proposals to GCF. In South Africa, the NDA is the DFFE.[88] The GCF has recently recognised the importance of addressing cooling efficiency.[89]

The GCF also has a policy that half its adaptation funding goes to Sub-Saharan Africa. Initiatives that increase access to cooling, cold chains for agriculture and medicines, and cooler cities could qualify for adaptation funding. Such measures can sometimes qualify as both mitigation (reducing GHG emissions) and adaptation.

The GCF Green Cities Facility and the GEF Sustainable Cities Impact Programme both also offer concessional support for cities to pursue sustainable urban planning, EE in buildings, and utilisation of green space and infrastructure, which could be applicable to South Africa. Other adaptation climate funds that could include

87 US Department of Energy. 23011. 'Country Review of Energy-Efficiency Financial Incentives in the Residential Sector'. https://www.osti.gov/servlets/purl/1026816
88 DFFE. https://www.greenclimate.fund/countries/south-africa#contact
89 GCF. 2020. GCF and UNEP Webinar on 'Scaling-up GCF Projects on Energy-Efficient and Climate Friendly Cooling'. https://www.greenclimate.fund/event/gcf-and-unep-webinar-scaling-gcf-projects-energy-efficient-and-climate-friendly-cooling

access to cooling funding include the Adaptation Fund, also administered by the GEF.

However, financing for access to cooling solutions remains a significant challenge as pointed out in a recent report by SEforALL.[90] Table 16 shows examples of financing cooling programmes in a range of countries in Africa with funding from different sources.

Table 16: Example of financing efficient-cooling programmes

Incentive Type	Country	Description	Supporting Agency
Replacement Programme	Ghana Senegal	ECOWAS Refrigerators and Air Conditioners (ECOFRIDGES) accelerates the switch to better cooling solutions in Ghana and Senegal through innovative financial mechanisms developed with the African Development Bank.[91]	UNEP
CaaS	Rwanda	The Rwanda Cooling Finance Initiative (R-COOL FI) consists of leasing of cooling products in the commercial sector and on-bill financing (using the utility to pay back the purchase of the product over a period of time) for the residential sector, to remove price barriers and support the market transition to EE appliances with low GWP refrigerants.	UNEP
Bulk Procurement	India	EESL's Super-Efficient Air Conditioning Programme (ESEAP) increases availability of affordable super-efficient room ACs by buying them in bulk and streamlining their distribution and installation.	Energy Efficiency Service Limited (EESL) and World Bank
Standardised Energy Performance Contracts	Latin America	Energy Savings Insurance (ESI) schemes mitigate investment risks through the development of standard contracts between SMEs and technology service providers, energy savings insurance, savings validation and financing.[92]	Inter-American Development Bank (IDB)

Many financing models are possible and can be applied in various contexts and designed differently to target multiple benefits, including emissions reduction, economic recovery, cooling access, and peak-demand management, for example. Efficient-cooling financing needs and market gaps should be assessed in South Africa to identify financing models that can best remove investment barriers. Some of these financing barriers can be addressed with risk-reduction programmes that require modest capital investment while others require substantial subsidies and can only be addressed with grants. Finally, the financing schemes should also look into making sustainable cooling solutions affordable for different economic tiers of population in the country.

90 SEforAll. 2020. 'Financing Access to Cooling Solutions: Knowledge Brief'. https://www.seforall.org/system/files/2020-03/FinancingCooling-SEforALL.pdf
91 BASE. 'Supporting the Transition to Sustainable Domestic Cooling'. https://energy-base.org/projects/ecofridges-initiative-in-west-africa/
92 University College London (UCL). 2021. 'Energy Savings Insurance: Finding Solutions for Climate-Friendly Cooling'. https://www.ucl.ac.uk/global-governance/news/2021/jan/energy-savings-insurance-finding-solutions-climate-friendly-cooling

6.5 Circular Economy, and Waste Management

Moving towards a more circular economy has multiple benefits not only for the environment but also for the economy. These include job creation, increasing competitiveness, stimulating innovation, and boosting economic growth, as shown in the European New Circular Economy Action Plan (2020),[93] for example. Adopting a circular economy approach is also one of the UN recommendations for achieving sustainable development goals.

Although no international treaties on Waste Electrical and Electronic Equipment (WEEE) exist, certain aspects related to hazardous substances are regulated by treaties such as the Basel Convention of 1989 regarding transboundary movement of hazardous waste; the Montreal Protocol of 1987 and the Kigali Amendment of 2016 regarding ODS such as CFCs and GHGs (HFCs); the Stockholm Convention of 2001 regarding persistent organic pollutants such as polychlorinated biphenyls; as well as the Minamata Convention of 2013 regarding mercury – many of which have been ratified by the South African Government.

Globally, many countries and regions have developed and implemented regulatory frameworks to manage electronic waste and the responsible disposal of refrigerants. Various WEEE management systems, anchored in legislation, exist internationally, and these place upstream or downstream fees or taxes on Electrical and Electronic Equipment to ensure that costs for collecting, transporting and recycling appliances are covered.

A study undertaken by the S&L Programme[94] confirmed that appliances in South Africa remain in use for longer periods than in developed countries due to old appliances often being sold or donated to indigent households, with the outcome that energy-inefficient appliances enjoy a second life and are in operation for extended periods. Although it was confirmed that appliances reaching the end of their functional life are available for recycling, very few appliances were observed at recyclers claiming to do recycling of large appliances. No evidence could be found that appliances are currently pre-treated for the environmentally sound recovery, treatment, or safe disposal of harmful gasses or hazardous materials. The investigations confirmed that sufficient feedstock is available to commission and operate an appliance recycling plant in the country's most populous province.

A business model has been developed, and this is to be pursued further by the South African Government, supported by the Section 28 notice that was published on 6 December 2017 by DFFE for the EEE industry to submit waste-management plans for approval. This process, in 2020, is ongoing, and the final outcome is to effectively manage and reduce electronic waste and refrigerants.

93 European Parliament. 2020. Draft Report on the New Circular Economy Action Plan. https://www.europarl.europa.eu/doceo/document/ENVI-PR-652387_EN.pdf

94 Delta BEC. 2018. 'Feasibility to Determine the Viability of an Integrated Appliance Recycling System'. https://www.savingenergy.org.za/wp-content/uploads/2020/07/P18095_REPORTS_04-FINAL-REPORT_REV-00-Final-report.pdf

7. Conclusion

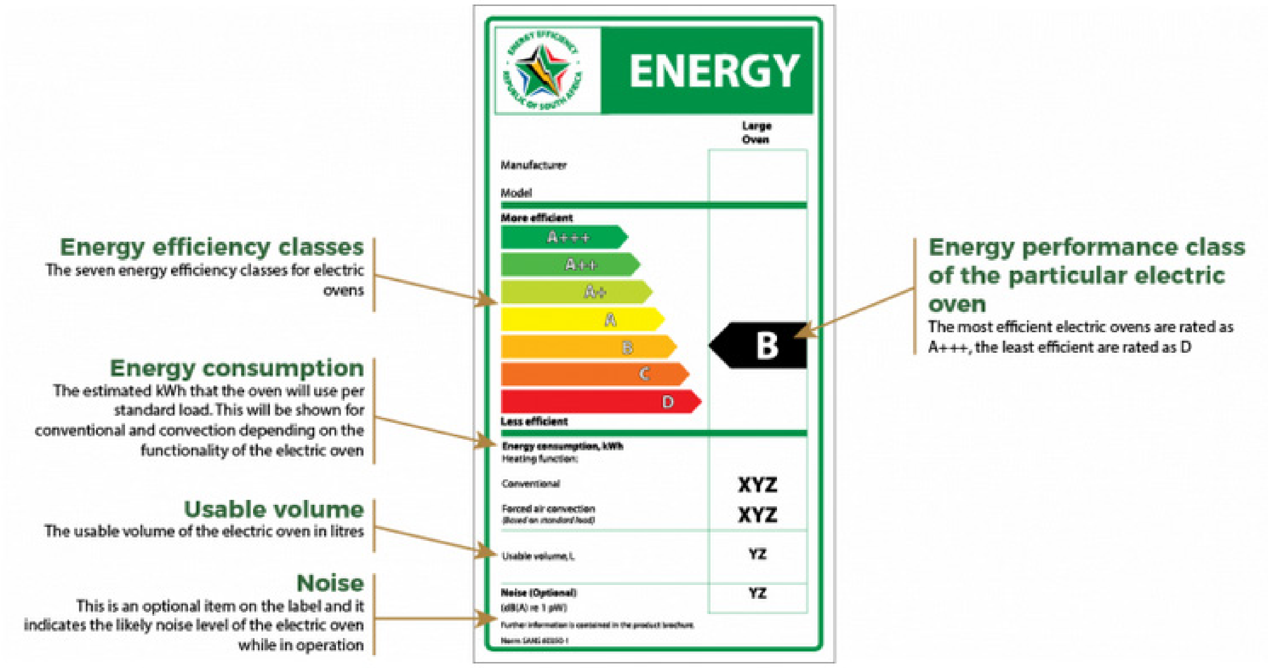
Electricity use for cooling products represents about 31% of building electricity consumption in 2017, and it is projected to increase to 35% by 2030. No single silver bullet exists to address the challenge of electricity use for cooling. The National Cooling Plan of South Africa shows the importance of implementing an integrated policy to accelerate market transformation of efficient-cooling equipment in conjunction with transitioning to low GWP refrigerants used in cooling equipment. This approach includes MEPS to eliminate the least-efficient products from the market and sets benchmarks for cooling products sold. It also includes endorsement labels to help communicate product efficiency to buyers, financing mechanisms to accelerate the uptake of more efficient products, and policies for market monitoring, surveillance and testing to ensure compliance. The implementation of the building code and its revision are also considered to include cool roofs and to set national and regional targets for reaching a high penetration of NZEB construction in the near term.

Over the last seven years, South Africa has implemented a strong foundation for EE investment in cooling. Opportunities exist to scale South Africa's efforts to transform its market towards more efficient cooling products and cooler buildings by showing the benefits of cooling efficiency that include: mitigation of GHGs, bill savings for customers, reduction of pollution, increasing clean cooling access for all, and leveraging financing opportunities to accelerate market transformation. South Africa has one the most emissions-intensive electricity production systems in the world, which presents significant potential for large emissions reductions through EE. We estimate that if the NCP is implemented, the country could save 13.3 $MtCO_2$ by 2030. This is a significant contribution that could be made for the South Africa nationally determined contribution, which is the at the heart of the Paris Agreement to fight climate change and limit global warming by 2100 to below 2 °C, with 1.5 °C as a target.

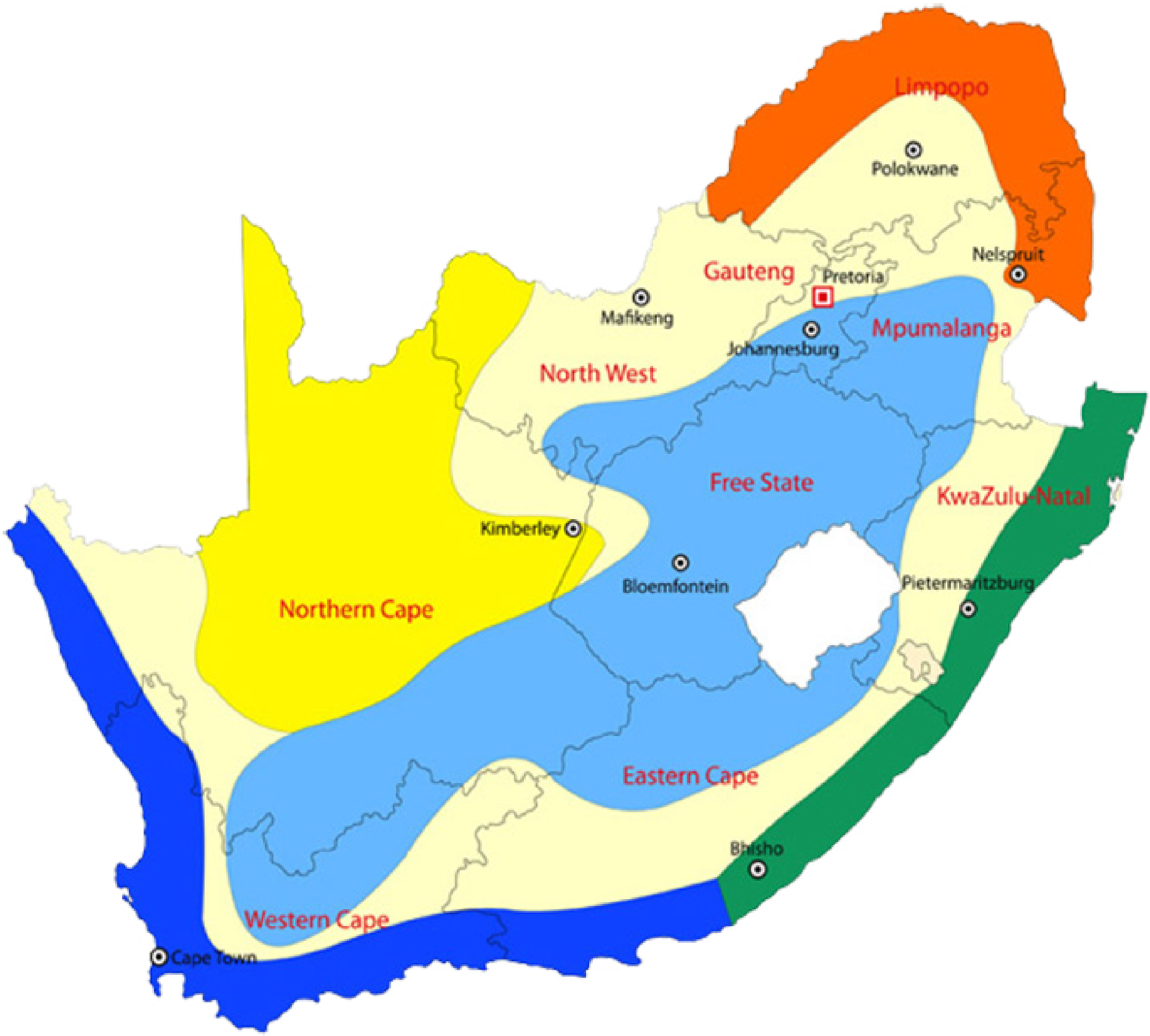
8. Annexes

Annex 1: South Africa equipment EE label

An example of a label for an electric oven is shown below. Labels for various categories of apliances differ depending on the functioning of the appliance, however, all labels include seven energy efficiency classes and the energy efficiency class of tha particular appliance is labelled clearly.



Annex 2: Climatic zone map of South Africa



Zone	Description	Major Centre
1	Cold interior	Johannesburg, Bloemfontein
2	Temperate interior	Pretoria, Polokwane
3	Hot interior	Makhado, Nelspruit
4	Temperate coastal	Cape Town, Port Elizabeth
5	Sub-tropical coastal	East London,durban, richards Bay
6	Arid interior	Upington, Kimberley

(Source: SANS 204:2011 – Edition 1. SOUTH AFRICAN NATIONAL STANDARD – Energy Efficiency in Buildings)

APPENDIX A

Building Design: Commentary	OFFICE		RETAIL				INDUSTRIAL		RESIDENTIAL	
	Current	Opportunity	Current	Opportunity			Current	Opportunity	Current	Opportunity
				Super regional	Regional & small regional	Community & Neighbourhood				
PASSIVE DESIGN										
Orientation	Not addressed	Floor area ratios and investment returns govern orientation. Unlikely to be addressed	Not addressed	Low impact due to building massing.	Low impact due to building massing.	Low impact. Subject to vehicular and pedestrian access.	Not addressed	Low impact. Standard practice allows for roof lights, clerestory lighting and side lights in the façade. Building massing results in deep floorplans. Relatively low impact on heat gains. NEW BUILDINGS	Free standing houses frequently address orientation. Medium and high density housing governed by town planning layout and density ratios	Moderate impact can be achieved through optimal orientation within limitations imposed by topography, town planning, neighbouring properties NEW BUILDINGS
Shading	Occasionally addressed	High impact when correctly designed and installed NEW & EXISTING BUILDINGS	Not addressed	Low impact due to minimal outdoor window openings	Low impact due to minimal outdoor window openings	Moderate impact. Outdoor walkways, seating areas and access points integrated as shading devices in addition to window shading. NEW BUILDINGS	Not addressed	Low impact. Standard practice allows for roof lights, clerestory lighting and side lights in the façade. Building massing results in deep floorplans. Relatively low impact on heat gains. NEW BUILDINGS	Typically overlooked in favour of style preferences and cost optimisation	High impact opportunity due to the opportunity to address incorrect orientation on existing buildings. Optimal design will balance seasonal heat transfers. NEW & EXISTING BUILDINGS
Window / Wall ratios	Highly varied and frequently driven by aesthetic decision. Fully glazed buildings are aspirational and occur most frequently in the premium office sector	High impact due to the thermal heat transfer impact on building cooling demands. NEW BUILDINGS	Not addressed	Low impact due to minimal outdoor window openings	Low impact due to minimal outdoor window openings	Low impact. Shopfront design governs majority of window / wall ratios	Not applicable	Not applicable	SANS10400XA has driven awareness and altered approach to window sizing and placement. Deemed to satisfy vs rational design compliance to SANS 10400XA highlights the ability to retain large glazed areas if rational design shows compliance.	Moderate impact due to the relatively low window coverage in the majority of residential design. Luxury market homes frequently address regulatory compliance and energy efficiency through high performance glazing. NEW BUILDINGS

Building Design: Commentary	OFFICE		RETAIL				INDUSTRIAL		RESIDENTIAL	
	Current	Opportunity	Current	Opportunity			Current	Opportunity	Current	Opportunity
				Super regional	Regional & small regional	Community & Neighbourhood				
Natural lighting	Not addressed	High impact due to energy demands of lighting systems. Measures include floor plate design, strategic glazing sizing and location, glare control NEW BUILDINGS	Occasionally addressed for common areas. Typically through roof lights, skylights and clerestory lighting.	High impact for appropriately designed natural lighting to provide full or partial common area lighting without increased heat load. NEW BUILDINGS	High impact for appropriately designed natural lighting to provide full or partial common area lighting without increased heat load. NEW BUILDINGS	High impact for appropriately designed natural lighting to provide full or partial common area lighting without increased heat load. NEW BUILDINGS	Addressed through integration of roof lights, clerestory lighting and side lights in the façade. gains.	Moderate impact through the introduction of additional and innovations on clerestory lighting and side lights. Overhead rooflights to be omitted. NEW BUILDINGS	Not typically addressed due to reliance on artificial lighting	Moderate impact due to relatively low contribution of lighting to energy consumption in homes. Significant portion of occupied hours is at night. NEW BUILDINGS
Natural ventilation	Not addressed	100% natural ventilation unlikely due to indoor cooling demands, occupancy densities, equipment heat loads. Hybrid systems represent most viable solution. NEW BUILDINGS	Not addressed	Moderate impact. Only applies to common areas. 100% natural ventilation unlikely due to indoor cooling demands, occupancy densities, equipment heat loads. Hybrid systems represent most viable solution. NEW BUILDINGS	Moderate impact. Only applies to common areas. 100% natural ventilation unlikely due to indoor cooling demands, occupancy densities, equipment heat loads. Hybrid systems represent most viable solution. NEW BUILDINGS	High impact for common area ventilation. Unlikely to be applied to tenant retail spaces. NEW BUILDINGS	Addressed through hybrid mechanical and natural ventilation systems	Moderate impact. Typically heating and cooling demands are met through hybrid mechanical and natural ventilation systems. NEW BUILDINGS	Variable. Comprehensive natural ventilation is seldom achieved. Partial natural ventilation is frequently achieved through relatively simple layout design and short ventilation distances between openings.	High impact can be achieved in the luxury market where natural ventilation replaces air-conditioning. Long term impact will be achieved in newly built middle income housing markets where air-conditioning is unlikely to be retrofitted if comprehensive natural ventilation design has been included. NEW BUILDINGS
MATERIALS										
Insulation: roof, walls, floor	Typically addressed on roofs due to regulatory compliance SANS 10400 XA	Moderate impact for roof due to relatively low roof / building area ratios. Exposed soffit basements below occupied spaces offer additional opportunity for thermal barriers. NEW & EXISITNG BUILDINGS	Typically addressed on roofs due to regulatory compliance SANS 10400 XA	Low impact due to achievement of regulatory compliance and marginal performance gains limited by building design of superstructure and substructure relationship.	Low impact due to achievement of regulatory compliance and marginal performance gains limited by building design of superstructure and substructure relationship.	Low impact due to achievement of regulatory compliance and marginal performance gains limited by building design of superstructure and substructure relationship.	Typically addressed on roofs due to regulatory compliance SANS 10400 XA	Roof insulation: High impact due to significant thermal transfer through large roof area. NEW & EXISITNG BUILDINGS Wall and floor insulation low impact.	Typically addressed on roofs due to regulatory compliance SANS 10400 XA	Roof insulation: High impact due to significant thermal transfer through roof area. NEW & EXISITNG BUILDINGS Wall insulation: Impact to be assessed in relation to thermal mass performance of high density, uninsulated walls. Regionally dependent NEW BUILDINGS

Building Design: Commentary	OFFICE		RETAIL				INDUSTRIAL		RESIDENTIAL	
	Current	Opportunity	Current	Opportunity			Current	Opportunity	Current	Opportunity
				Super regional	Regional & small regional	Community & Neighbourhood				
Innovative building technologies[1]	Variable. Innovation is frequently directed at structural design which seldom impacts thermal performance.	Moderate impact. Wide range of building technologies currently in use and will continue. Passive design measures likely to yield greater impact.	Variable. Innovation is frequently directed at structural design which seldom impacts thermal performance.	Moderate impact. Wide range of building technologies currently in use and will continue.	Moderate impact. Wide range of building technologies currently in use and will continue.	High impact. Limited range of building technologies currently in use. Potential for improved thermal performance of building envelope. NEW BUILDINGS	Variable. Innovation is frequently directed at structural design which seldom impacts thermal performance.	Moderate impact. Wide range of building technologies currently in use and will continue.	Typically not addressed. Masonry construction prevails in the residential sector.	High impact as a result of significant improvement in thermal performance of building envelope. Dependent on material and skills supply chain evolution NEW BUILDINGS
High performance glazing[2]	Rapidly changing approach largely due to compliance with SANS 1044 XA	NEW BUILDINGS: Moderate impact where transition to glazing specifications which exceed regulatory standards, driven by lower thermal gains and building heat loads. EXISTING BUILDINGS: High impact opportunity to retrofit existing buildings with regulatory compliant (or better) glazing	Not addressed	Low impact due to minimal outdoor window openings	Low impact due to minimal outdoor window openings	High impact. Exposed shopfronts offer thermal control barrier. NEW & EXISITNG BUILDINGS			Rapidly changing approach largely due to compliance with SANS 1044 XA	High impact opportunity to reduce thermal transfer through windows and openings. Retrofits to existing buildings are viable. NEW & EXISITNG BUILDINGS
Reflective roof coatings	Typically addressed	Moderate improvement in current practice can be achieved through additional solar reflectivity specifications for roofing materials NEW & EXISTING BUILDINGS	Not addressed	High impact potential needs to be considered in conjunction with solar PV roof coverage and benefits. NEW & EXISITNG	High impact potential needs to be considered in conjunction with solar PV roof coverage and benefits. NEW & EXISITNG	High impact potential needs to be considered in conjunction with solar PV roof coverage and benefits. NEW & EXISITNG	Not addressed	High impact potential needs to be considered in conjunction with solar PV roof coverage and benefits. NEW & EXISITNG	Not addressed	Moderate impact. Regionally dependent due to winter thermal gains (reduced space heating demands) from warm roof.

Building Design: Commentary	OFFICE		RETAIL				INDUSTRIAL		RESIDENTIAL	
	Current	Opportunity	Current	Opportunity			Current	Opportunity	Current	Opportunity
				Super regional	Regional & small regional	Community & Neighbourhood				
BUILDING SERVICES:										
HVAC	Typically addressed at end of life of HVAC plant	High impact due to high energy consumption of HVAC systems. Relative complexity of mechanical systems and variations of system types introduces a wide range of solution opportunities. Refrigerants used have significant GHG emissions potential. NEW & EXISITING BUILDINGS	Typically addressed at end of life of HVAC plant	High impact due to high energy consumption of HVAC systems. Relative complexity of mechanical systems and variations of system types introduces a wide range of solution opportunities. Refrigerants used have significant GHG emissions potential. NEW & EXISITING BUILDINGS	High impact due to high energy consumption of HVAC systems. Relative complexity of mechanical systems and variations of system types introduces a wide range of solution opportunities. Refrigerants used have significant GHG emissions potential. NEW & EXISITING BUILDINGS	High impact due to high energy consumption of HVAC systems. Relative complexity of mechanical systems and variations of system types introduces a wide range of solution opportunities. Refrigerants used have significant GHG emissions potential. NEW & EXISITING BUILDINGS	Typically addressed at end of life of HVAC plant where occupied spaces and offices include HVAC.	Moderate impact. Majority of industrial buildings have a relatively small proportion of occupied spaces and offices which include HVAC. Relative complexity of mechanical systems and variations of system types introduces a wide range of solution opportunities. Refrigerants used have significant GHG emissions potential. NEW & EXISITING BUILDINGS	Only relevant to luxury market	Moderate impact as HVAC will remain unaffordable for all but the luxury market for the short - medium term. Preferable to address other market segments through natural ventilation design NEW & EXISITING BUILDINGS
Refrigerants	Varied implementation. CFC and HCFC no longer in use.	High impact. Refrigerants currently in use retain extremely high ODP and GWP ratings. New plant design and replacement of refrigerants to be addressed. NEW & EXISTING BUILDINGS	Varied implementation. CFC and HCFC no longer in use.	High impact. Refrigerants currently in use retain extremely high ODP and GWP ratings. New plant design and replacement of refrigerants to be addressed. NEW & EXISTING BUILDINGS	High impact. Refrigerants currently in use retain extremely high ODP and GWP ratings. New plant design and replacement of refrigerants to be addressed. NEW & EXISTING BUILDINGS	High impact. Refrigerants currently in use retain extremely high ODP and GWP ratings. New plant design and replacement of refrigerants to be addressed. NEW & EXISTING BUILDINGS	Varied implementation. CFC and HCFC no longer in use.	Moderate impact. HVAC plants typically used to control thermal conditions in a relatively small component of total area. Refrigerants currently in use retain extremely high ODP and GWP ratings. New plant design and replacement of refrigerants to be addressed. NEW & EXISTING BUILDINGS	Varied implementation. CFC and HCFC no longer in use.	High impact. Refrigerants currently in use retain extremely high ODP and GWP ratings. HVAC installations in residential likely to increase rapidly in future. New plant design and replacement of refrigerants to be addressed. NEW & EXISTING BUILDINGS
Mechanical ventilation	Varied implementation dependent on space use e.g. internal toilets	Moderate impact when implemented in conjunction with hybrid HVAC / Natural ventilation systems NEW BUILDINGS	Varied implementation dependent on space use e.g. internal toilets	Moderate impact when implemented in conjunction with hybrid HVAC / Natural ventilation systems NEW BUILDINGS	Moderate impact when implemented in conjunction with hybrid HVAC / Natural ventilation systems NEW BUILDINGS	High impact where common areas include enclosed, partially enclosed and open spaces. NEW BUILDINGS	Addressed through hybrid mechanical and natural ventilation systems	Moderate impact. Typically heating and cooling demands are met through hybrid mechanical and natural ventilation systems. NEW BUILDINGS	Varied implementation dependent on space use e.g. internal toilets	Moderate impact when implemented in conjunction with hybrid mechanical / natural ventilation systems NEW BUILDINGS

Building Design: Commentary	OFFICE		RETAIL				INDUSTRIAL		RESIDENTIAL	
	Current	Opportunity	Current	Opportunity			Current	Opportunity	Current	Opportunity
				Super regional	Regional & small regional	Community & Neighbourhood				
Lighting	Fully evolved change to lighting specification due to compliance with SANS 1044 XA and cost of operation benefits linked to highly efficient fittings	High impact for energy efficient lighting retrofits EXISITNG BUILDINGS	Fully evolved change to lighting specification due to compliance with SANS 1044 XA and cost of operation benefits linked to highly efficient fittings.	High impact for energy efficient lighting retrofits EXISITNG BUILDINGS	High impact for energy efficient lighting retrofits EXISITNG BUILDINGS	High impact for energy efficient lighting retrofits EXISITNG BUILDINGS	Fully evolved change to lighting specification due to compliance with SANS 1044 XA and cost of operation benefits linked to highly efficient fittings	High impact where lighting demands require high lux levels over large areas. End of life replacements represent additional opportunity. NEW & EXISTING BUILDINGS	Fully evolved change to lighting specification due to compliance with SANS 10400XA and cost of operation benefits linked to highly efficient fittings	High impact for energy efficient lighting retrofits EXISITNG BUILDINGS
Water heating	Not typically a significant contributor to building energy demands and thus not a high priority. Interventions limited to regulatory compliance.	Moderate impact to address water heating points for bathroom and kitchen facilities. NEW & EXISTING BUILDINGS	Varied implementation dependent on hot water demands. Frequently linked to tenant activities.	High impact where integrated design approach is taken to include solar thermal plants and heat exchangers. Draw down distances may be prohibitive to centralised plants. NEW AND EXISTING BUILDINGS	High impact where integrated design approach is taken to include solar thermal plants and heat exchangers. Draw down distances may be prohibitive to centralised plants. NEW AND EXISTING BUILDINGS	High impact where integrated design approach is taken to include solar thermal plants and heat exchangers. Draw down distances may be prohibitive to centralised plants. NEW AND EXISTING BUILDINGS	Varied implementation dependent on hot water demands. Frequently linked to tenant activities.	High impact where integrated design approach is taken to include solar thermal plants. Heat exchangers have high impact potential when linked to appropriate industrial activity and manufacturing. NEW AND EXISTING BUILDINGS	Compliance with SANS 10400XA has driven evolution energy efficient systems for new and refurbished buildings. Water heating is typically the largest energy consumer for residential buildings and is thus an additional driver for energy efficiency in water heating.	NEW BUILDINGS Moderate impact due to completed transition to energy efficient water heating systems EXISITNG BUILDINGS High impact due to legacy of inefficient water heating systems.
Space Heating	Heat generated by occupants and appliances reduces heating demands for many office buildings. HVAC systems frequently 'double treat' air i.e. cool external air and then heat at distribution point in order to achieve the desired temp.	High impact can be achieved through optimised HVAC system efficiencies NEW & EXISTING BUILDINGS	Varied implementation. HVAC systems frequently 'double treat' air i.e. cool external air and then heat at distribution point in order to achieve the desired temp.	High impact can be achieved through optimised HVAC system efficiencies NEW & EXISTING BUILDINGS	High impact can be achieved through optimised HVAC system efficiencies NEW & EXISTING BUILDINGS	Moderate impact due to frequent naturally ventilated common areas. High impact can be achieved in tenant spaces through optimised HVAC system efficiencies NEW & EXISTING BUILDINGS	Not applicable	Not applicable	Variable. Occupant preference in response to short, cold winters in majority of regions. Space heating systems currently utilised are frequently energy intensive due to lack of integration into building design and high thermal transfer through building envelope during cold periods.	High impact due to energy intensive use during cold periods. Centralised and integrated space heating is unaffordable and unviable for all but the luxury market due to relatively short cold periods. Preferable to address through passive design elements. NEW & EXISITNG BUILDINGS

Building Design: Commentary	OFFICE		RETAIL				INDUSTRIAL		RESIDENTIAL	
	Current	Opportunity	Current	Opportunity			Current	Opportunity	Current	Opportunity
				Super regional	Regional & small regional	Community & Neighbourhood				
Renewable energy	Varied implementation typically to address base load demands. Solar PV currently the most viable renewable energy solution. Prohibitive legislative environment limits growth and impact.	High impact for low rise office buildings. Energy demand matches solar production hours. Reduced impact for high rise buildings due to roof area limitations for solar PV. Legislative changes will unlock significant growth of renewable energy. NEW & EXISTING BUILDINGS	Varied implementation typically to address base load demands. Solar PV currently the most viable renewable energy solution. Retail building operating hours offer optimal demand profile for solar production hours. Prohibitive legislative environment limits growth and impact.	High impact. Energy demand matches solar production hours. Building massing typically facilitates excellent solar plant layouts. Legislative changes will unlock significant growth of renewable energy. NEW & EXISTING BUILDINGS	High impact. Energy demand matches solar production hours. Building massing typically facilitates excellent solar plant layouts. Legislative changes will unlock significant growth of renewable energy. NEW & EXISTING BUILDINGS	Moderate impact. Energy demand matches solar production hours. Building massing not consistently ideal for solar plant layouts. Legislative changes will unlock significant growth of renewable energy. NEW & EXISTING BUILDINGS	Varied implementation typically to address base load demands. Solar PV currently the most viable renewable energy solution. Prohibitive legislative environment limits growth and impact.	High impact. Energy demand matches solar production hours. Building massing typically facilitates excellent solar plant layouts. Low energy demands for warehousing offer opportunity to meet energy demand generating hours. Legislative changes will unlock significant growth of renewable energy. NEW & EXISTING BUILDINGS	Varied implementation. Typically utilised by luxury market for energy security. Solar PV cannot be optimised under the current legislative environment due to the high cost of on site energy storage and prohibitive conditions for grid tied feed-in and net-metering systems.	High impact potential if legislative environment is altered to facilitate grid-tied systems. Energy demand does not matches solar production hours and viability is dependent on legislation change. NEW & EXISTING BUILDINGS
Energy efficiency technologies[3]	Significant uptake due to high electricity prices	High impact when matched with accurate performance data and ongoing monitoring and verification NEW & EXISTING BUILDINGS	Significant uptake due to high electricity prices	High impact when matched with accurate performance data and ongoing monitoring and verification NEW & EXISTING BUILDINGS	High impact when matched with accurate performance data and ongoing monitoring and verification NEW & EXISTING BUILDINGS	High impact when matched with accurate performance data and ongoing monitoring and verification NEW & EXISTING BUILDINGS	Significant uptake due to high electricity prices	High impact when matched with accurate performance data and ongoing monitoring and verification NEW & EXISTING BUILDINGS	Limited uptake due to relatively high CAPEX requirements.	High impact for simple, affordable technology which guides behavioural change. NEW & EXISTING BUILDINGS

1IBT Includes a wide range of technologies of which only a few are widely used in SA: Steel frame, Light steel frame, structural insulated panels
2Includes laminate glazing with UV and thermal rated laminates, double glazing, triple glazing
3Includes metering and verification equipment, smart meters, motion sensors, BMS (building management systems)

Notes:
Not addressed: this term is used to describe action taken to implement building perfromance improvements by the majority of stakeholders as part of typical building practice. Exceptions will occur.
High, moderate and low impact signifies potential for building performance improvement leading to reduced emission contributions to greenhouse gases, ozone depletion and global warming.
NEW BUILDINGS / EXISITNG BUILDINGS identifies whether the performance improvement intervention should be applied to new building projects or refurbishment of existing buildings.
Opportunities identified on the basis of trend analysis and best practice building design, construction and operation. No detailed modelling exercises have been completed on specific building interventions.
Retail buildings vary significantly in design, construction and operation across the categories identified. Office, industrial and residential buildings also vary, however consistency in the nature of design, construction and operation allows for single category analysis