SCALING UP SUSTAINABLE COOLING IN NIGERIA'S NATIONALLY DETERMINED CONTRIBUTION

ENERGY EFFICIENT AIR CONDITIONER TOOLKIT FOR RETAILERS AND MANUFACTURERS

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WELCOME

Welcome to the Energy Efficient Air Conditioner Toolkit for Retailers. Our primary objective with this toolkit is to sensitize retailers, such as manufacturers and importers, on the importance of choosing energy-efficient air conditioners. We achieve this by empowering you with the requisite information on the benefits of energy-efficient air conditioners, sharing what the minimum energy performance standards (MEPS) are, the difference between Energy Efficiency Ratio (EER) and Seasonal Energy Efficiency Ratio (SEER), throwing more light on inverter air conditioners and basic features of an energy guide label.
We aim to promote a better understanding of energy efficiency in air conditioners, its benefits for Nigeria and how it can help the nation achieve its Nationally Determined Contributions while preserving the environment.

ABOUT THE TOOLKIT

This toolkit is subdivided into eight sections. The first section provides an overview of the Nigeria Sustainable Cooling Project, the project objectives, and expected outputs. It also introduces energy efficiency and the overall benefits to the Nigerian citizenry and the environment.

The second section provides a step-by-step guide to marketing strategy for energy-efficient air conditioners (AC) for retailers.

The third section aims to convey basic knowledge of the housekeeping energy saving tips for ACs.

Section four offers valuable insights on AC types to assist in selecting the appropriate AC for cooling your space. You will also gain clarity on energy efficiency metrics, minimum energy performance standards (MEPS) and labels for ACs.

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1.0 INTRODUCTION

1.1 Overview of the Nigeria Sustainable Cooling Project

In the tropical region where Nigeria is situated, extreme heat poses a persistent and significant challenge. With a growing population and need for cooling for a healthy and safe society, there is rapidly growing demand for air conditioning. This, in turn, exacerbates strain on the electricity grid and can impact the climate due to the associated emissions from energy consumption and the use of refrigerants in appliances which may be thousands of times more potent at trapping heat compared to carbon dioxide. Passive cooling solutions such as use of shading, reflective outdoor coatings, green roofs, and other building design features tailored for local temperature and humidity conditions are critical, but significant demand remains for mechanical cooling from air conditioners for many applications. Improving the energy efficiency of cooling appliances (using less energy to perform the same task – that is, reducing energy waste) while switching to lower Global Warming Potential (GWP) refrigerants can have significant benefits in terms of electricity bill savings for consumers, energy security and grid reliability improvements, new market opportunities for retailers, and reduced impacts on the environment.

It is against this background that the project on "Scaling Up Energy-Efficient and Climate-Friendly Cooling in Nigeria's NDC Revision (Nigeria Sustainable Cooling Project) was officially launched on 3rd February 2022 by the Government of Nigeria through the Energy Commission of Nigeria and the United Nations Environment Programme (UNEP) United for Efficiency Initiative (U4E). The project aims to accelerate the adoption of energy-efficient air conditioners (ACs) that utilize climate-friendly, low-GWP refrigerants across residential, commercial, and public buildings. This initiative contributes to achieving Nigeria's Nationally Determined Contributions (NDCs) to climate goals in a cost-effective and sustainable manner.

Main Objectives

The primary objectives of the "Scaling Up Energy-Efficient and Climate-Friendly Cooling in Nigeria's NDC Revision" project are to:

- Accelerate the transition to energy-efficient and climate-friendly ACs in Nigeria;
- Increase awareness of the benefits of energy-efficient ACs among retailers, thereby increase market penetration of more efficient ACs and with lower GWP refrigerants.

The key project activities include:

- Awareness/Sensitization campaigns focused on the general public, businesses, and consumers for behavioral change;
- Market assessment on ACs in major cities with a focus on setting Nigerian energy efficiency policies for ACs;
- Capacity Building on AC installation and servicing in partnership with existing training centres;
- AC refrigerant management and disposal assessment, recommendations, and virtual training.

The project outputs of this project include:

- Awareness campaign to promote sustainable cooling and raise awareness and buy-in;
- Revision of the existing draft room AC minimum energy performance standards (MEPS) and energy labels;
- Technical capacity building for technicians to support proper installation of new, energy-efficient, climate-friendly room air-conditioners.

The expected project outcomes encompasses:

- AC MEPS and labels revised and with an implementation plan;
- Reduction in indirect greenhouse gas (GHG) emissions via reduced electricity consumption (reduction of fossil fuel combustion at power plants);
- Reduction in direct greenhouse gas emissions by accelerating the transition to lower GWP refrigerants (legacy refrigerants destroy the ozone layer and accelerate global climate change);
- Energy efficient and climate friendly space cooling included in the NDC targets;
- Enhance technician's capacity on refrigerant management and disposal.

1.2 Energy Efficiency and its Benefits

Energy efficiency standards (such as MEPS and label requirements) along with related efforts other such as promoting user behavior changes and adopting low-emissions refrigerants brings a variety of benefits to consumers, the environment, manufacturers, retailers and society as a whole:

i. Benefits for Consumers:

- Lower energy costs: significantly reduces household energy bills and contributes to broader economic savings at the national level.
- Reduced energy consumption. In Nigeria, it is estimated that an energy-efficient AC can decrease energy usage by approximately 45% compared to low-efficiency models, ensuring substantial long-term savings.
- Improved cooling performance: deliver optimal cooling while consuming less energy, ensuring comfort even during peak heat periods.
- Enhanced durability and reliability: high-quality, energy-efficient models often have advanced technologies that improve durability and require less maintenance, reducing repair costs over time.

ii. Benefits for the Environment:

- Reduction in indirect greenhouse gas emissions associated with electricity production. The implementation of MEPS and energy labels for air conditioners in Nigeria is projected to significantly decrease greenhouse gas emissions associated with electricity production. From the implementation date in 2026 through 2040, an estimated 39 million tonnes of CO_2-equivalent emissions could be avoided.
- Reducing direct greenhouse gas emissions by using low-emission refrigerants like R290 and R32. For air conditioners, this transition is estimated to avoid 27 million tonnes of CO2-equivalent emissions accumulated by the year 2040 in Nigeria;
- Mitigates fossil fuel's adverse environmental and human health effects.

i. Benefits for Governments:

- Reducing demand for energy imports and/or generation with energy efficiency policies is a cost-effective measure to meet energy demand. It is estimated that the implementation of MEPS and labels for air conditioners will generate energy savings of around 11.5 TWh per year (2040);
- Reduces fiscal burden by lowering government expenditure on electricity subsidies, leading to significant savings for the national budget.
- Contributes to meeting national and international climate goals and targets;
- Promotes national energy security by reducing dependence on imported fuels.

ii. Benefits to Manufacturers/Industry

- Encourage manufacturers to invest in research and development, leading to new job opportunities and increasing competitiveness at both local and global levels by offering more quality products;
- Achieve a reduction in production costs for higher-quality products through economies of scale, as these products were rarely used before the implementation of the standards;
- Offering energy efficient and climate friendly products can leverage this as part of its brand identity, appealing to environmentally conscious consumers;
- Companies that are proactive in their energy efficiency efforts often enjoy a more positive public image.

Figure 1 benefits of promoting energy efficiency

2.0 A GUIDE FOR RETAILERS OF ENERGY-EFFICIENT AIR CONDITIONERS

Nigeria's rising energy bills and calls for cleaner energy solutions underscore the crucial role of energy efficiency in ensuring a safe environment. Energy saved is equivalent to energy generated. In fact, energy efficiency is a triple-thread solution with many benefits. The International Energy Agency (IEA) stated that "In response to the energy crisis, countries are prioritizing energy efficiency action due to its ability to **simultaneously meet affordability, supply security, and climate goals.**"

Consequently, the AC industry has steadily researched and improved the energy efficiency of air conditioning systems through the introduction of advanced technologies that collectively improve overall system efficiency, including variable-speed drives, novel compressors, fans, motors, and heat exchanger designs, electronic expansion valves, and advanced controls.
However, the Nigerian market is flooded with air conditioners of varying efficiency levels, making it difficult for consumers to identify and select energy-saving models. To address this, the Nigerian government is introducing two key measures. The first measure focuses on the implementation of a MEPS, which will phase out the least efficient air conditioners from the market, mandating compliance from all manufacturers and importers. The second measure focuses on the implementation of an energy efficiency label that will inform consumers about the efficiency levels of available models, so they can make more informed decisions.

Retailers of air-conditioners are expected to learn Energy Efficiency Marketing Strategy (EEMS) which emphasizes the reduction of energy consumption and carbon footprint without compromising quantity and quality of services. More than just educating consumers on the products, the EEMS aims to shift their behaviours towards energy-efficient choices and lifestyles. In today's world of energy transition and climate change mitigation, retailers of air-conditioners are expected to be engaged with green marketing which highlights environmental benefits; energy conservation marketing which prioritizes reducing energy waste; and energy-saving marketing which emphasizes cost savings for consumers.

The following subsections offer practical tips for retailers to enhance sales of higher energy-efficient air conditioners.

2.1 Inverter versus fixed speed air conditioner

In simple terms, an inverter air conditioner is equipped with a compressor that can change its velocity (variable speed) to regulate the required quantity of cooling at each moment to maintain the desired room temperature without switching ON and OFF the compressor. In contrast, the fixed-speed compressor maintains the desired room temperature by swinging ON and OFF, which results in energy losses and higher energy consumption when compared to inverter units. Even within the range of inverter models, some are more efficient than others. To choose the best option, use the new energy label to compare models (see Figure 3). More stars indicate higher energy efficiency, resulting in greater savings on electricity bills. Always refer to the Nigerian energy label when comparing the energy efficiency of air conditioners. Other metrics, such as the Energy Efficiency Ratio (EER), may not provide a fair basis for comparison across different air conditioning technologies.
Apart from higher energy efficiency, inverter air conditioners offer other benefits over fixed-speed models due to their variable speed compressor:

- 30% to 50% lower operating costs due to reduced energy consumption (higher efficiency).
- Substantial fuel savings when used with a backup generator, along with reduced voltage fluctuations caused by the compressor due to lower power consumption.
- Maintains a more constant room temperature (higher thermal comfort).
- improved integration with solar photovoltaic systems due to better alignment with the peak demands
- The higher upfront cost of an inverter AC is offset by savings on electricity bills.
- It is safer for household wiring due to its reduced power consumption, which minimizes the risk of overloading electrical circuits.

While inverter air conditioners adjust their capacity based on room requirement, it is very important to install a properly sized unit. Ensure that the room size and the AC capacity are assessed before making a purchase (see Section xx for more information on AC sizing).

2.2 Choosing the Right Sized AC

Choosing an air conditioner capacity that is too large for your space can result in energy waste, higher electricity consumption, and inflated utility bills. To ensure efficient cooling and energy savings, it's essential to select an air conditioner with the appropriate cooling capacity for the room size.

In Nigeria, the cooling capacity of air conditioners is typically measured in British Thermal Units per hour (BTU/hr), although some manufacturers or importers may use other units like Horsepower (HP), tons, or kiloWatts (kW). The ideal capacity can vary based on factors such as the region, building type and size, and thermal characteristics (e.g., insulation).

If precise calculations are not available, you can start with general sizing guidelines found online. Table 1 provides examples of common air conditioner capacities based on room sizes. However, keep in mind that these are general guidelines; adjustments may be needed based on specific factors, such as direct sunlight exposure or the presence of heat-generating appliances like kitchen equipment.

[1]Sizing the air conditioner, web example: https://www.alliancecc.com.au/calculate-air-conditioner-size/

Table 1: Typical room sizes for AC sizing in different units

Room size	Common AC capacity
Around 15 meter square	9,000 BTU/hr
Around 25 meter square	12,000 BTU/hr
Around 35 meter square	18,000 BTU/hr
Around 50 meter square	24,000 BTU/hr

Once the room size is determined, consider adjusting the air conditioner capacity based on the typical activities or conditions in the room. For instance,

- If the room is heavily shaded, reduce capacity by 10 percent.
- If the room is very sunny, increase capacity by 10 percent.
- If more than two people regularly occupy the room, add 600 BTU/hr for each additional person.
- If the unit is used in a kitchen, increase capacity by 4,000 BTU/hr.
- Consider where you install the unit. If you are mounting an air conditioner near the corner of a room, look for a unit that can send the airflow in the right direction.

Once the total indicative cooling capacity is calculated, round it down to the nearest thousand. This value will guide you in selecting the appropriate unit.

2.3 Other considerations when Marketing Energy Efficient Air-Conditioners

(i)To market energy efficient and climate friendly air conditioners, one should emphasize its benefits, such as:

- Cost savings and energy bill reductions
- Improved indoor comfort (more stable temperatures)
- Environmental impact
- Improved indoor health (less mold, better air quality)

(ii)Given the various benefits energy efficiency offers, it's important to use compelling visuals to convey these messages. Mention features that save energy during use, such as scheduling shut-off, which provide convenience and further savings.

(iii) Highlight that units that use climate-friendly refrigerants like R290 and R32, which have a much lower environmental impact compared to R22 and R410A

(iv) To engage effectively with customers across the digital world they live in, digital platforms like blogs, social media, and webinars are also important.

(v) Marketing incentives and rebates are effective to encourage adoption,

(vi) Collaborative partnerships and customer testimonials can also amplify the message.

2.4 Air conditioners covered by the Nigerian energy efficiency standard

The Nigerian energy efficiency standard covers air-to-air air conditioners for human comfort with a cooling capacity up to 20 kW (≈ 68,200 BTU/h). Table 2 shows some examples of the types of air conditioners that are covered in the Nigerian standard and that will be obligated to display the energy efficiency label and comply with the minimum energy efficiency level specified in the standard.

Table 2. Examples of air-to-air air conditioners under the scope of the proposed regulation for Nigeria

Example of air-to-air Air Conditioner	Comments
	**Single-Split air conditioner with a wall mounted indoor unit. Other types of indoor units are possible.**
	**Single-Split air conditioner with a ceiling ducted indoor unit. Other types of indoor units are possible.**
	**Single-Split air conditioner with a floor standing indoor unit. Other types of indoor units are possible.**

Multi-Split air conditioner. The picture shows different types of indoor units that can be connected to it, such as wall mounted, floor mounted, ceiling cassette, ceiling ducted, etc. Other types of indoor units are possible.

Self-contained air conditioner, primarily for mounting in a window or through the wall. All components of the unit are fit into a single box.

Single duct portable air conditioner. A Single Duct air conditioner that is not portable, is also under the scope.

Single-Split air conditioner with a non-ducted portable indoor unit. The outdoor unit might be portable or fixed.

Double Duct air conditioner. This example is a fixed type with through the wall installation for the ducts. There are also Double Duct portable air conditioners.

3.0 HOUSE-KEEPING ENERGY SAVING TIPS FOR AIR-CONDITIONERS

To maximize the air conditioner's efficiency and minimize energy consumption, consider these practical tips illustrated in Figure 2:

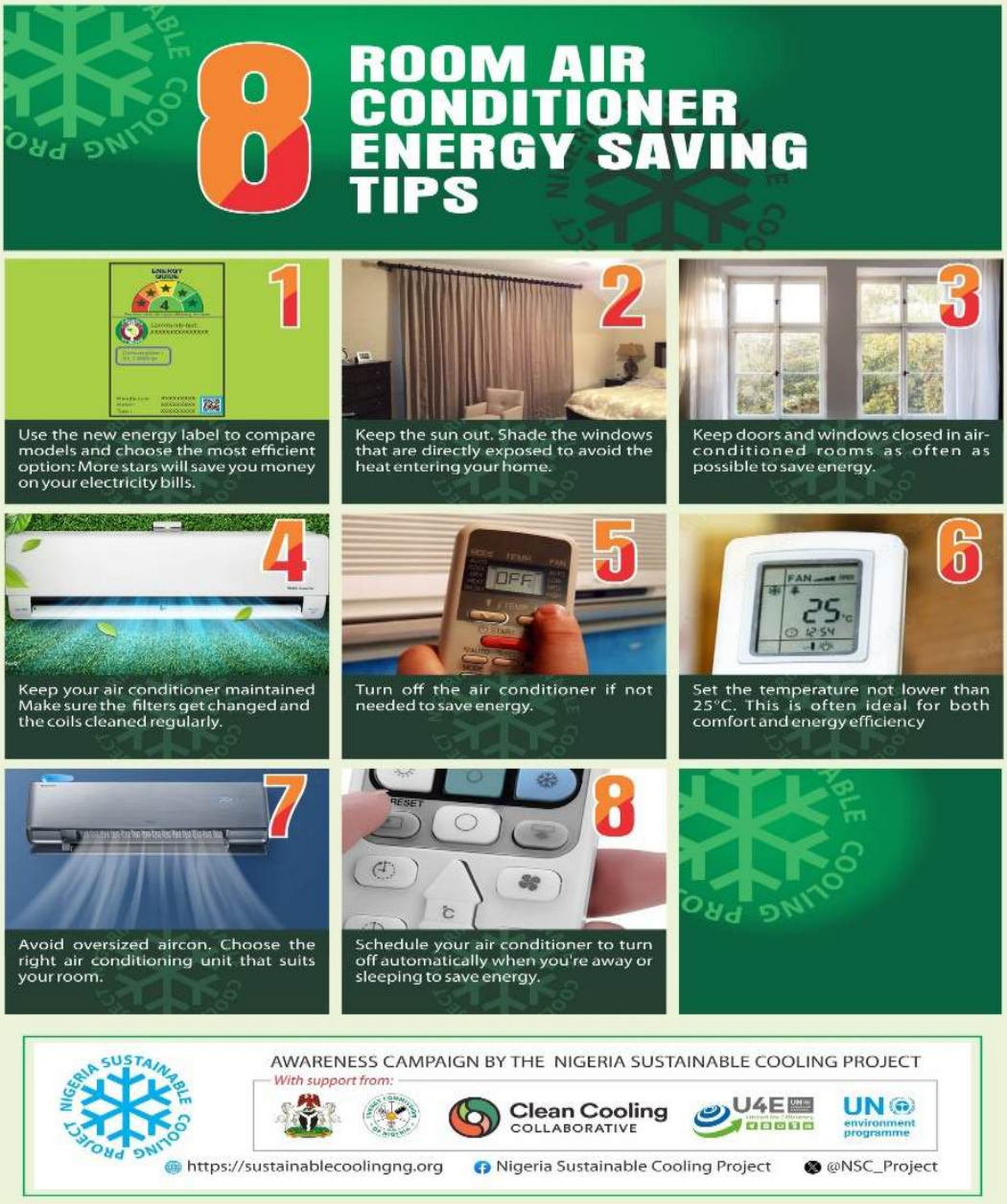

Figure 2. Energy Efficiency and conservation tips

4.0 ENERGY EFFICIENCY REQUIREMENTS FOR AIR-CONDITIONERS

4.1 Energy Efficiency Metrics

An important enhancement in the new Nigerian Standard is the introduction of the Nigerian Seasonal Energy Efficiency Ratio (NSEER) to define the minimum energy efficiency levels required for air conditioners in the Nigerian market and to establish the energy efficiency label levels. In the previous standard the Energy Efficiency Ratio (EER) metric was used. Table 3 highlights the main differences between NSEER and EER metrics.

NSEER considers the climate conditions in Nigeria, including energy losses under these conditions, which accounts for the benefits of air conditioners that perform efficiently at a wider range of ambient temperatures.

This ensures that air conditioners are evaluated based on real-world usage in Nigeria.

During conformity assessments, only NSEER values calculated according to the Nigerian Standard will be accepted, as other countries may use different climate conditions, leading to varying energy efficiency results. However, in most of the cases, the test points are consistent in countries that follow the same reference standard (ISO 16358-1:2013 in Nigeria), meaning that no extra test points might be needed to calculate NSEER. Be sure to apply the specifications in the Nigerian Standard to guarantee that the declared performance will be accepted during conformity assessment and market surveillance procedures.

Table 3 Comparison between EER and SEER

Metric	Equation	Characteristics
EER	$EER = \frac{Standard\ Capacity}{Standard\ Power\ in}$	• Typically tested at 35°C ambient temperature condition. • Does not consider how the equipment works at different ambient conditions, leading to unfair comparisons for ACs that perform better across a wider range of ambient conditions. • This metric is still required to calculate NSEER.
NSEER[2]	$NSEER = \frac{Annual\ Capacity}{Annual\ Energy\ Consumpti}$	• NSEER considers efficiency at different ambient conditions, allowing for fairer comparisons between different AC technologies. • Based on the standard Nigerian climate, as defined by the Nigerian Standard. • Provides a more accurate estimate of annual energy consumption. • Accounts for energy losses in air conditioners operating in ON-OFF cycles under partial load conditions. • In most cases, test points for NSEER remain consistent across countries using ISO 16358-1:2013,
Metric	Equation	Characteristics
		even with different climate conditions. Be sure to apply the specifications in the Nigerian Standard.

[2] Different names can be given to the seasonal energy efficiency in different countries and standards. For example, ISO 16358-1:2013 calls it Cooling Seasonal Performance Factor (CSPF).

4.2 Minimum Energy Performance Standards for Air-Conditioners in Nigeria

The MEPS set the minimum energy efficiency levels that appliances and equipment must meet or exceed to enter a specific market. The implementation of Nigeria's MEPS is structured into three phases: the first phase begins in 2026, the second in 2029, and the third in 2031. These staggered timelines are designed to encourage energy efficiency improvements while giving manufacturers time to adapt. Manufacturers should carefully review the Nigerian MEPS requirements to ensure that their air conditioners exceed the energy efficiency standards set for each phase. The MEPS were developed with consideration of the Nigerian market, global trends in air conditioning technology, and extensive consultation with key stakeholders.

Table 4 outlines the initial tier of minimum energy efficiency requirements, set to take effect in 2026. These MEPS vary based on the type of air conditioner, its cooling capacity, and the technology used (inverter vs. fixed speed). For most air conditioners, the minimum performance is expressed using the NSEER metric, while single and double-duct units still use the EER metric. Ensure that you apply the correct MEPS for the air conditioner type and the appropriate tier based on when the unit will enter the market.

Table 4 First tier of minimum energy efficiency requirements, effective from 2026 (see the Nigerian Standard for 2029 and 2031 MEPS)

Category of Product	Sub-category	Capacity range in kW	EER	NSEER for fix speed	NSEER for variable speed
Single Split	Non-Ducted	≤ 4.5	-	3.10	4.00
		> 4.5 and ≤ 9.5	-	3.10	3.90
		> 9.5 and ≤ 20	-	3.00	3.80
	Ducted	≤ 20	-	2.90	3.80
Multi-split	Non-Ducted and Ducted	≤ 4.5	-	3.10	4.00
		> 4.5 and ≤ 9.5	-	3.10	3.90
		> 9.5 and ≤ 20	-	3.00	3.80
Self-contained	Non-Ducted and Ducted	≤ 4.5	-	3.10	4.00
		> 4.5 and ≤ 9.5	-	3.10	3.90
		> 9.5 and ≤ 20	-	3.00	3.80
Single and Double duct (Portable and Wall mounted)		≤ 20	2.8	-	-

4.3 The energy efficiency label for Air Conditioners in Nigeria

The Nigerian Energy Efficiency Label aims to help consumers make informed decisions when purchasing air conditioners by providing information on both energy efficiency and energy consumption. This allows buyers to consider not just the initial cost, but also the long-term operating costs due to electricity usage.

Figure 3 shows the mandatory Nigerian energy efficiency label, required for all air conditioners covered under the Nigerian Minimum Energy Performance Standard for Air conditioners (NIS 943: 2024), which is to be implemented in phases: the first phase begins in 2026, the second in 2029, and the third in 2031. The label contains two key pieces of information: the star rating and the model's annual energy consumption. The top section displays a star rating from 1 to 5, with 5 indicating the highest energy efficiency and 1 the lowest. The middle section shows the estimated annual energy consumption in kilowatt hours (kWh).

As a manufacturer or importer, you are required to affix this label in a visible position on each unit entering the market. Ensure the label's information is accurate and complies with the Nigerian Standard to avoid penalties. If a retailer requests a replacement label for a unit, you are obligated to provide it free of charge.

[3]The estimated annual energy consumption is calculated based on standard usage conditions outlined in the Nigerian Standard, providing a basis for comparison across different models. However, actual energy consumption may vary depending on factors such as location and the user's specific usage patterns.

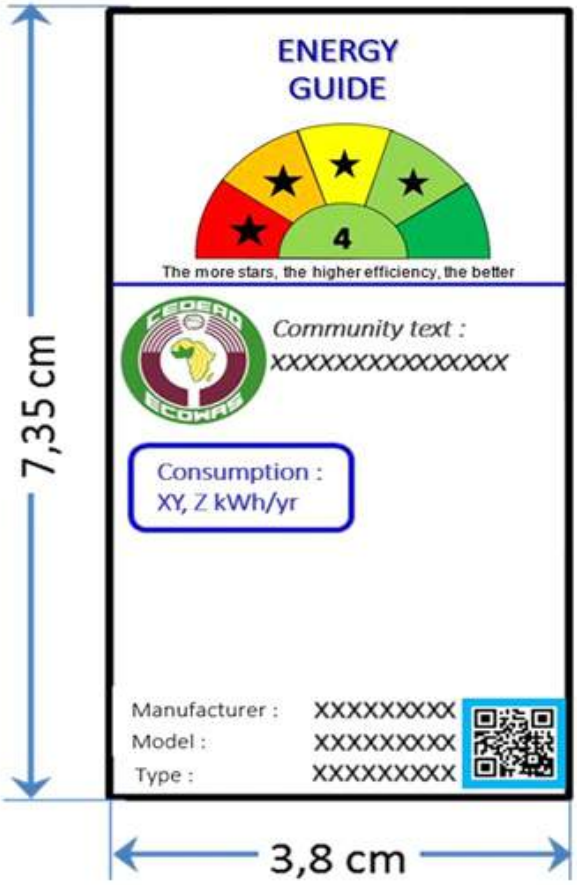

Figure 3: ECOWAS Label

Table 5 outlines the energy efficiency levels required to achieve different star ratings. The label is based on the Nigerian seasonal efficiency NSEER, except for single and double duct units, which use the EER metric. To ensure fair comparison across different air conditioners, regardless of type, size or compressor technology, a uniform label is used for all air conditioner. The star rating scale is designed to reflect consistent efficiency improvement between consecutive classes. For example, for a model to progress from a two-star rating to a three-star rating, representing an NSEER increase from 3.60 to 4.20, the model would need to improve efficiency by 17%, the same percentage needed to move from 4 to 5 stars.

It is important to note that although the Nigerian standard introduces MEPS in stages (2026, 2029 and 2031), the label levels remain the same unless revised by the Nigerian government. As MEPS become more stringent, there might be energy star ratings in the label that are no longer used. All appliances must comply with MEPS, and the ones that comply are classified according to the label levels.

Table 5 Proposed label based on NSEER (EER for single and double duct air conditioners)

Energy Classes	NSEER ranges*	Energy efficiency improvement to pass to next class
1 Star	NSEER < 3.60	-
2 Star	3.60 ≤ NSEER < 4.20	17%
3 Star	4.20 ≤ NSEER < 4.95	18%
4 Star	4.95 ≤ NSEER < 5.80	17%
5 Star	5.80 ≤ NSEER	-

*For the single and double duct air conditioners, the same energy efficiency ranges are used with EER

ANNEX A - BASIC COMPONENTS OF AN AC

Air conditioning appliances improve thermal comfort and air quality in indoor spaces by lowering temperature and humidity. The cooling process is based on the application of a refrigeration cycle removing unwanted heat from the room and transferring it to the outdoors. In general, air conditioners use an electric driven vapor compression cycle. The vapor compression cycles are performed by refrigerants, in a process comprising four sequential steps:

- compression;
- condensation;
- expansion; and
- evaporation.

The main components of the widely used split air conditioner include an indoor unit installed inside the room to be cooled (the evaporator) and an outdoor unit installed outside the room in open space (condenser and compressor), as shown in

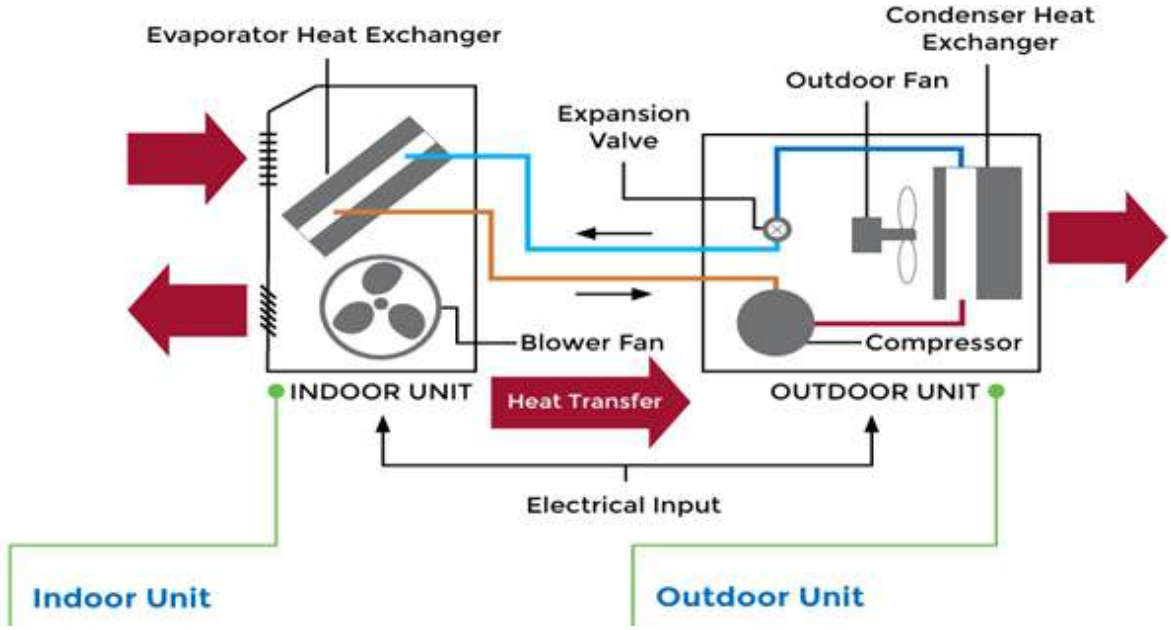

Figure 4 Schematic Drawing of a Typical Air-conditioners (Source: UNEP-U4E)

- **Indoor Unit:** The indoor unit produces the cooling effect inside the room. It is a box-type housing in which some parts of the air conditioner are enclosed:
  - ✔ The evaporator coil,
  - ✔ **The air filter**, located just before the cooling coil, removes dirt particles from the room air and helps supply clean air to the room.
  - ✔ **The cooling fan or blower** sucks the hot and unclean air from the room and supplies cool and clean air back by passing it over the cooling coil and air filter.
  - ✔ drain pipe, and
  - ✔ louvers or fins.

- **Outdoor Unit:** The outdoor unit contains some parts of the split air conditioner: compressor, condenser, condenser cooling fan and expansion valve.
  - ✔ **The compressor** compresses the refrigerant and increases its pressure before sending it to the condenser. During this process, heat is generated in the compressor and removed through heat exchangers to the outdoor ambient.
  - ✔ **The condenser** removes the heat from the refrigerant. It is made of coiled copper or aluminum tubing, which has a high rate of conduction. It is covered typically with aluminum fins so the heat from the refrigerant can be removed at a faster rate.
  - ✔ **The condenser cooling fan**, located in front of the compressor and the condenser coil, blows surrounding air from the open space over the compressor and the condenser with the aluminum fins, thus cooling them.
  - ✔ **The expansion valve** is used to lower the temperature and pressure of the refrigerant.

In addition, a tubing connects the indoor and outdoor units carrying the refrigerant.

The characteristics of these components, such as whether the compressor is inverter or fixed-speed, and how they work together, will determine the overall energy efficiency of the air conditioner.

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