TUNISIA AIR CONDITIONER MARKET ASSESSMENT

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May 2023

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Acknowledgements

The work described in this study was funded by USAID EE4D Contract No. SUB-2021-10755.

The authors would like to thank Mr. Fathi El Hanchi, Abdelkader Baccouche, and Souheil KSOURI from the Agence Nationale pour la Maitrise de L'énergie (ANME) for providing continuous input and review throughout this study. Our gratitude extends to all the participants of several stakeholder engagement workshops who provided insightful feedbacks during the elaboration of this analysis. This report was also reviewed by Naïm Darghouth, Research Scientist in the Electricity Markets and Policy Department at Lawrence Berkeley National Laboratory.

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AC	air conditioners; air conditioning
ANME	Agence Nationale pour la Maitrise de L'énergie
CETIME	Centre Technique des Industries Mécaniques et Electriques
COP	coefficient of performance
EER	energy efficiency ratio
MEPS	minimum energy performance standard
MIESME	Ministry of Industry, Energy and Small and Medium Enterprises
NDCs	nationally determined contributions
RAC	room air conditioner
SEER	Seasonal Energy Efficiency Ratio
SCOP	Seasonal Coefficient of Performance
STEG	Tunisian Electricity and Gas Company

1. Introduction

In terms of energy efficiency, Tunisia is among the pioneering developing countries. The World Bank ranked Tunisia among the top 20 nations in the area of energy efficiency out of 111 countries. For more than three decades, the country has been committed to promoting energy efficiency, which has contributed greatly to the country's decoupling of energy consumption from economic growth, as documented since 2001. Tunisia's energy-efficiency policies have also reduced energy demand significantly and created industrial and service sectors devoted to energy efficiency.

The national energy balance has moved toward increasing external dependence, however, and energy costs and the environmental impacts of current energy systems have increased, leading the Tunisian government to revise and strengthen its energy-efficiency policies.

This new approach resulted in the adoption in 2016 of an energy transition strategy that aims to enable a gradual and balanced change in the energy model, based on development of diversified energy sources and the maximum exploitation of available capacity for energy efficiency. This strategy encompasses the objective of reducing energy demand by 30% by 2030 compared to 2010, in accordance with Tunisia's commitments stipulated in its nationally determined contributions (NDCs) from the 2015 Paris Agreement.

The potential for reducing energy intensity remains to be seized, especially in the building sector, which represents more than 50% of the available efficiency potential. This potential involves various programs, in particular the thermal regulation of new buildings and the certification of household appliances, including air conditioning (AC) devices.

Air conditioners contribute significantly to peak power demand during Tunisia's hot summers. In 2021, the Tunisian Electricity and Gas Company (STEG) recorded a peak demand of 4,472 megawatts in August, estimating that 44% of that demand was due to the operation of air conditioners.

The Tunisian government, through its Agence Nationale pour la Maitrise de L'Energie (ANME) and all of its partners, is called on to take advantage of the significant potential for energy efficiency and to achieve the objectives it has set for itself by accelerating the implementation of programs that expand the adoption of efficient appliances, including air conditioners.

This report aims to assess the Tunisian market for air conditioners, particularly in terms of energy performance. The report provides an overview of the size and characteristics of the AC market in Tunisia, including product types, origins, and proportion of imports to locally manufactured units; an estimation of the informal market; energy performance; and price. The report focuses on ACs that are covered by the 2009 decree published by Tunisia's Ministry of Industry, Energy and Small and Medium Enterprises (MIESME), which established minimum energy performance standards (MEPS) and labels for residential room air conditioners (RACs) having a cooling capacity of less than 12 kW. Our primary sources of data were a national survey, government database, industry reports, stakeholder interviews, and online shops as described in more detail later in the document. This report provides a foundation for assessing current regulations regarding ACs and precedes a cost/benefit analysis that (1) examines the effects of setting more stringent MEPS and (2) presents recommendations for revising current labels (Virginie E Letschert et al., 2023).

2. Current Regulations

Tunisia's MEPS and labeling program for household products was launched in 2004. The program, which is governed by the MIESME and implemented by the ANME, covers the following products:

- Refrigerators and freezers
- Room air conditioners less than 12 kW or 40,000 Btu capacity
- Incandescent lightbulbs
- Washing machines

2.1 National Regulations for Air Conditioners

On April 21, 2009, the MIESME published a decree that stipulated minimum energy performance standards and efficiency labels for RACs having a cooling capacity less than 12 kW (MIESME, 2009). Table 1 shows the national regulations for energy efficiency ratio (EER) and coefficient of performance (COP) corresponding to each energy class and Figure 1 shows labels for electrical products that are regulated in Tunisia.

- EER, which is used to determine the energy efficiency of an air conditioner in cooling mode, is defined as the cooling capacity output (kW) divided by the power input for cooling (kW) of a unit when providing cooling under standard rating conditions.
- COP is used to determine the efficiency of a unit in heating mode. COP is defined as the capacity for heating (kW) divided by the rated power input for heating (kW) of a unit when providing heating under standard rating conditions.

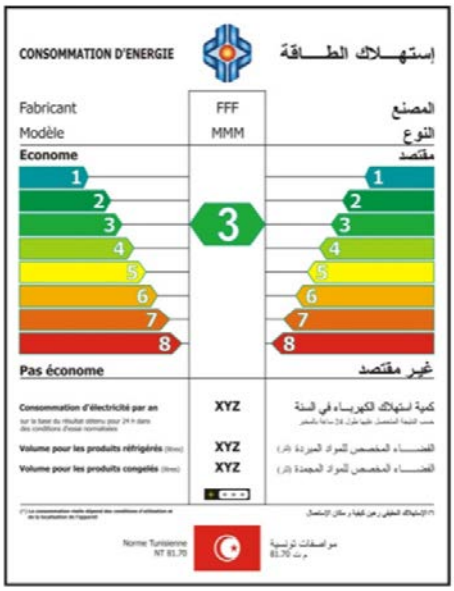
Table 1: Energy efficiency classification of air conditioners in cooling and heating mode

Energy Class	EER	COP
1	3.38 < EER	3.80 < COP
2	3.38 >= EER > 3.20	3.80 >= COP > 3.60
3	3.20 >= EER > 3.00	3.60 >= COP > 3.40
4	3.00 >= EER > 2.80	3.40 >= COP > 3.20
5	2.80 >= EER > 2.60	3.20 >= COP > 2.80
6	2.60 >= EER > 2.40	2.80 >= COP > 2.60
7	2.40 >= EER > 2.20	2.60 >= COP > 2.40
8	2.20 >= EER	2.40 >= COP

Source: MIESME, 2009

Figure 1 shows a label for the energy performance of residential appliances in Tunisia.

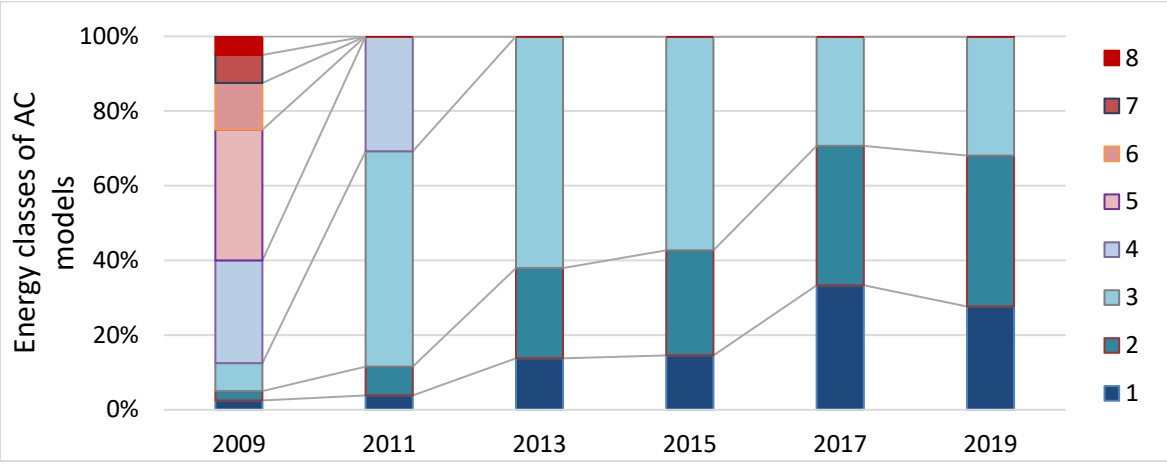
Figure 1. Energy performance label for electrical products in Tunisia



MEPS for RACs came into effect in 2010, becoming more stringent yearly until 2012. In 2010, only RACs having an energy label of 5 or higher were allowed to be sold in the Tunisian market. (A lower number indicates higher efficiency.) Starting in 2011, only RACs having an energy label of 4 or higher were allowed to be sold int eh country. By 2012, an energy label of 3 or higher was required for sale in Tunisia, thus moving the market toward ever-more efficient RAC appliances (ECONOLER, 2019).

Figure 2 shows the growing impact of the national regulation. The figure shows the percentages of the various energy classes of ACs sold in the Tunisian market between 2009 and 2019 based on information in ANME's national registry database. In 2019, energy class 2 represented the largest proportion of products sold (40%), followed by energy classes 3 (32%) and 1 (28%). When the RAC MEPS were first implemented, most of the market was dominated by lower-efficiency products, with classes 1, 2, and 3 making up only 18% of products sold. In 2013, most RACs on the market were energy class 3 (75%), followed by class 2 (20%) and class 1 (5%).

Figure 2. Transformation of Room Air Conditioner Market (2009-2019)



Source: ANME, 2021

2.2 Stakeholder Participation

Stakeholder participation in developing the energy standard and labeling program is an important aspect of a successful endeavor. Stakeholder feedback enables better market deployment and garners support for the implementation phase. Table 2 summarizes the key stakeholders and their roles in Tunisia's energy-efficiency programs.

Table 2. Stakeholders in Tunisia's standards and labeling program

Organization	Roles
Ministère de l'industrie, de l'énergie et des petites et moyennes entreprises (MIESME)	Adopt policies that set high goals for saving energy and reducing emissions of greenhouse gases; promulgate regulations and decrees that set standards for products
Agence Nationale pour la Maîtrise de l'Energie (ANME)	Implement the MEPS regulations and energy labeling by monitoring the program, assessing the market, assessing impacts and need for revising regulations, developing a certification database, and engaging stakeholders
Ministère du commerce et de l'artisanat- central and régional administration	Control the cost and quality of consumer products sold on the Tunisian market, including household appliances (air conditioners), by ensuring product safety, fair economic transactions, and consumer protection
Centre Technique des Industries Mécaniques et Electriques (CETIME)	Measure the energy performance of electrical appliances: air conditioners, refrigerators, washing machines, and ovens for domestic use and others through control, analysis, and test laboratories
Direction Générale des Douanes (Ministère des Finances)	Ensure compliance with customs laws and regulations and ensure the collection of customs duties and taxes levied on imports, including household appliances such as air conditioners.
Société Tunisienne de l'Electricité et du Gaz (STEG)	Supply the national market in electric energy and gas to meet the needs of all its customers (residential, industrial, tertiary) and ensure reliability of the system
Institut National de la Normalisation et de la Propriété Industrielle	Specialize in the standardization and protection of industrial property. Certify compliance with standards for products, services, and management systems and manage national standards compliance benchmarks
Fédération Nationale de l'Electricité, de l'Electronique et de l'Electroménager	Reporting to the Tunisian Union of Industry, Trade and Handicrafts, this national professional organization is dedicated specifically to ensuring the protection of the sector of craft businesses and small businesses in electricity and electronics

2.3 Monitoring, Verification, and Enforcement

Before a product enters the Tunisian market, the Ministry of Commerce performs market verification in accordance with the provisions of decree of September 18, 1993. Article 7 of the April 21, 2009, decree specifies that an independent laboratory must carry out tests on each model of a device to determine their energy performance. The manufacturer or importer is required to send ANME a copy of the test results, along with draft labels and information sheets, before a given model of the device can be sold. The agency verifies that the information contained in the documents is consistent with the results recorded in the test reports, then approves placing the model on the market.

With support from the United Nations Economic and Social Commission for Western Asia, ANME recently launched an online platform for applying for labeling called "E-tiquette." This platform streamlines the energy labeling process and facilitates the collection of statistics to better monitor the market and control the operation of the regulations. The online application for manufacturer or importer covers three appliances: refrigerators, air conditioners, and washing machines. The purpose of E-tiquette is to simplify the energy classification procedure, increase the credibility of energy labels, and better inform consumers of the energy aspects of household appliances. The ultimate aim is to provide effective, useful, and easy-to-use information about the products sold to better monitor the market and inform consumers. The platform provides the following advantages as described in (de La Rue Du Can et al., 2022) :

- A source of authoritative information about the energy performance and other characteristics of the products available on markets
- An incentivize for manufacturers to comply with the law
- Up-to-date information to distribution supply chain and consumers about products that qualify and other product features.
- A database that allows policy makers to track market trends.

2.4 EU Performance Class

The Tunisian standards and labeling program is based on the energy performance classes and metrics developed by the EU in 2002 (European Commission, 2002). However, in 2011, the EU issued its Regulation No. 626/2011—Energy labeling of air conditioners—to revise MEPS and introduce the Seasonal Energy Efficiency Ratio (SEER) and Seasonal Coefficient of Performance (SCOP) for determining the energy efficiency of air conditioning units in cooling and heating modes, respectively (European Commission, 2011).

The introduction of variable-speed compressors into most markets worldwide has led to adopting new metrics to measure more accurately the performance of ACs. Variable-speed compressors enable an AC unit to reduce energy consumption while responding to changes in cooling requirements due to changes in temperature, especially in countries that experience extreme variations in daily temperatures.

SEER ratings have been introduced in many countries to assess how local temperature conditions affect variable-speed load requirements. SEER metrics provide a more accurate measure of the energy performance of an AC, because energy consumption is measured during both full-load and part-load operation at various temperature points. SEER is calculated by combining the operating performances at full and part load. Moving to SEER ratings requires taking measurements at more than one temperature setting.

Tunisia's current regulation is based on EER and will need to transition to SEER to enable better measuring the evolution of the market. Converting from EER to SEER is not straightforward, as the SEER metrics require additional energy consumption measurements that are not included in the EER. In the upcoming cost/benefit report we use the following equation defined in Park et al. (2020) to convert EER to SEER for fixed-speed drive RACs:

$$EU\ SEER = 1.113\ X\ \alpha\ X\ EER - 0.639$$

α ~ 1.062 representing the ISO reference temperature bin hours

EU Regulation No. 626/2011 defined nine energy classes, from A+++ (most efficient) to G (least efficient), as shown in Table 3.

Table 3. Energy levels for RACs in EU regulation

Energy Efficiency Class	**SEER**	**SCOP**
A+++	SEER> 8.5	SCOP > 5.1
A++	6.1 < SEER < 8.5	4.6 < SCOP < 5.1
A+	5.6 < SEER < 6.1	4 < SCOP < 4.6
A	4.1 < SEER < 5.6	3.4 < SCOP < 4
B	4.6 < SEER < 5.1	3.1 < SCOP < 3.4
C	4.1 <SEER < 4.6	2.8 < SCOP < 3.1
D	3.6 < SEER < 4.1	2.5 < SCOP < 2.8
E	3.1 <SEER < 3.6	2.2 < SCOP < 2.5
F	2.6 < SEER <3.1	1.9 < SCOP < 2.2
G	SEER < 2.6	SCOP < 1.9

Source: European Commission, 2011

The EU regulation stipulated that MEPS had to move higher every two years from 2013 to 2019, phasing out the lowest-efficiency labels to push the market toward more efficient air conditioners. Table 4 shows the energy labels allowed in various years. By 2019, only labels between D and A+++ could be sold in the EU market.

Table 4. Energy levels for RACs allowed in EU by year

Energy Efficiency Class	2013	2015	2017	2019
A+++				
A++				
A+				
A				
B				
C				
D				MEPS
E			MEPS	
F		MEPS		
G	MEPS			

Source: European Commission, 2011

As of 2021, the EU began changing energy labels back to the simpler A through G scale shiting the sacle and removing the "+" signs. So far, however, updated regulations haves been issued only for refrigerators and freezers, dishwashers, washing machines, electronic displays including TVs, and lighting. The revised scaling for air conditioners remains pending and likely will be issued in the coming years (European Commission, 2022).

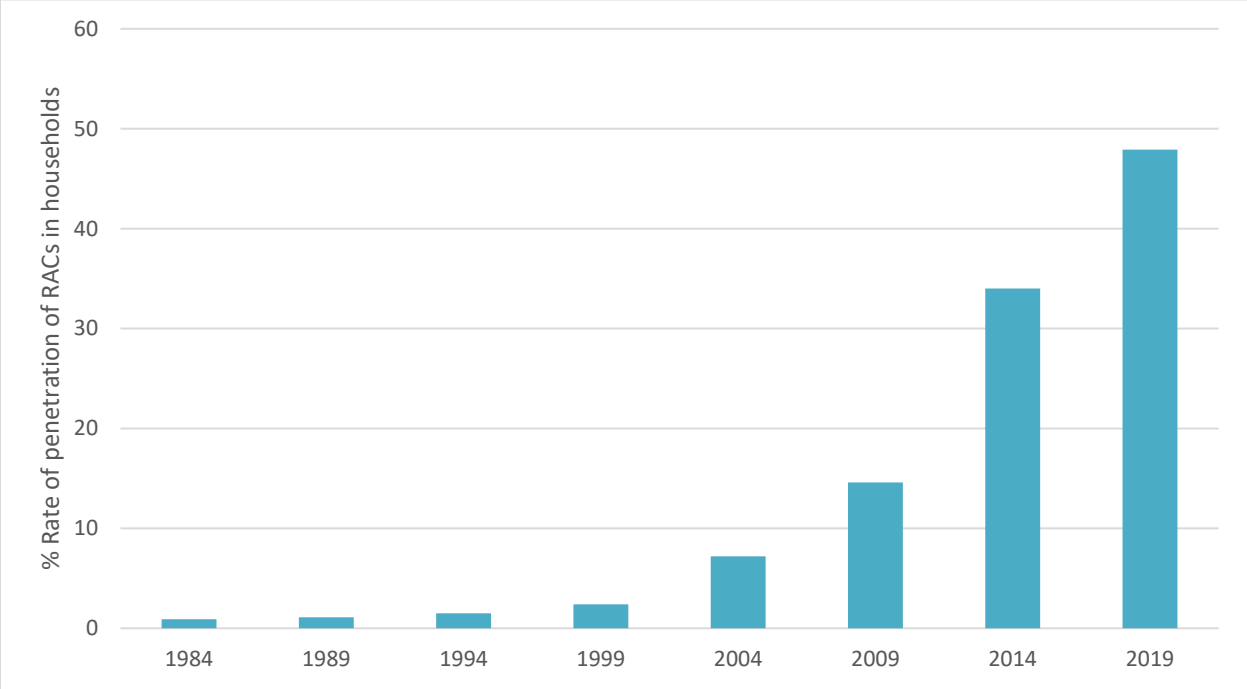
3. Market Size

Every five years since 1984, the Department of Studies and Planning at STEG has carried out a survey on the use of energy in the residential sector. In 35 years, eight surveys (1984, 1989, 1994, 1999, 2004, 2009, 2014, and 2019) have been carried out based on samples of from 2,000 to 4,000 electrified households. The primary objective of the survey is to acquire an in-depth knowledge of the final residential uses of electricity and of the range in energy sources used (natural gas, LPG, kerosene, coal, and wood).

3.1 Stock of Air Conditioners

STEG's surveys reveal the rapid increase in ownership of ACs per household, as shown in Figure 3. In 2019 the ownership rate reached 47.9% with an overall stock of 1,681,000 devices, compared to a 34% ownership rate in 2014, 14.6% in 2009, and 1.1 % in 1989. In the 2014 survey, the STEG estimated that the average number of ACs in households owning an AC was 1.3 (STEG, 2021).

Figure 3. Penetration of Air Conditioners in Tunisian Households



Source: STEG, 2021

The overall energy consumption by the stock of air conditioners amounted to 757.3 GWh in 2019 versus 445.2 GWh in 2014 and 122.3 GWh in 2009 (STEG, 2021, 2015). In 2019 the power demand, in the event of simultaneous operation of the stock of air conditioners, was estimated at 1,560 MW. During the past decade, Tunisia has witnessed an increase in electricity consumption and peak demand that is due largely to AC energy use. The annual peak demand grew by 4.75% per year between 2011 and 2015, which initiated significant investment in infrastructure, costing STEG 240M USD from 2011 to 2015 (Khalfallah and Hanchi, 2017).

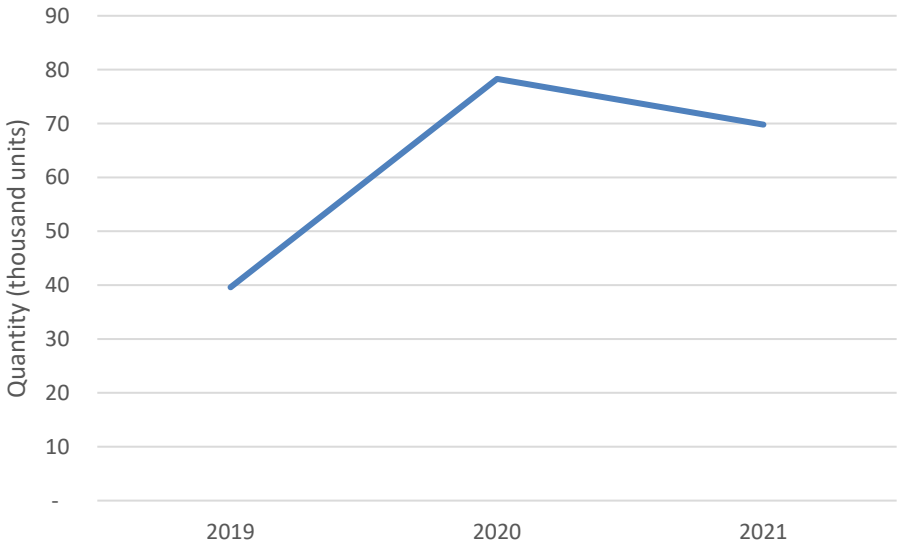
3.2 Annual Sales of ACs

Annual sales of ACs can be broken down by units produced within Tunisia and units imported both formally and informally. Future sales are projected based on historical sales as described in the subsections.

3.2.1 Local Manufacturers

Total local production of air conditioners in Tunisia was 69,782 units in 2021, a reduction of 11% compared to 2020 but an increase of 76% compared to 2019 (ANME, 2022). Figure 4 shows the evolution of the local market from 2019 to 2021. In Tunisia, the primary companies that assemble ACs locally are EL Athir, Mega, Electromed Service, Afrivision Service, SICAD-COALA, and Domotech.

Figure 4. Local Production of Air Conditioners 2019-2021



Source: ANME, 2022

3.2.2 Imports

The companies that import the greatest number of ACs are Hedi Ben Ayed and STC. We analyzed trade flows using data collected by AMNE from Tunisian customs records. We used a combination of codes from the Harmonized System (HS), the standardized numerical method of classifying traded products that is used by customs authorities around the world, to encompass the regulated classes having a cooling capacity <=12 KW.

- **841510:** Air conditioning machines comprising a motor-driven fan and elements for changing the temperature and humidity, of a kind designed to be fixed to a window, wall, ceiling or floor, self-contained or split-system
- **841520:** Machines and apparatus for AC including a motorized fan and devices for modifying temperature and humidity, including those in which the hygrometer degree is not regulated
- **841581:** Air conditioning machines containing a motor-driven fan, other than window or wall types, incorporating a refrigerating unit and a valve for reversing the cooling/heat cycle (reversible heat pumps)
- **841582:** Air conditioning machines containing a motor-driven fan, other than window or wall types, incorporating a refrigeration unit
- **841583:** Air conditioning machines containing a motor-driven fan, other than window or wall types, not incorporating a refrigeration unit
- **841590:** Air conditioning machines with motor-driven fan and elements for temperature control, or parts therefor

The above categories can be found under the HS classification, “Air conditioning machines; comprising a motor-driven fan and elements for changing the temperature and humidity, including those machines in which the humidity cannot be separately regulated.” Figure 5 shows the total number of units in all six product classes that were imported into Tunisia annually between 2010 and 2021.

Figure 5. Total Imports in Small Air Conditioner Categories

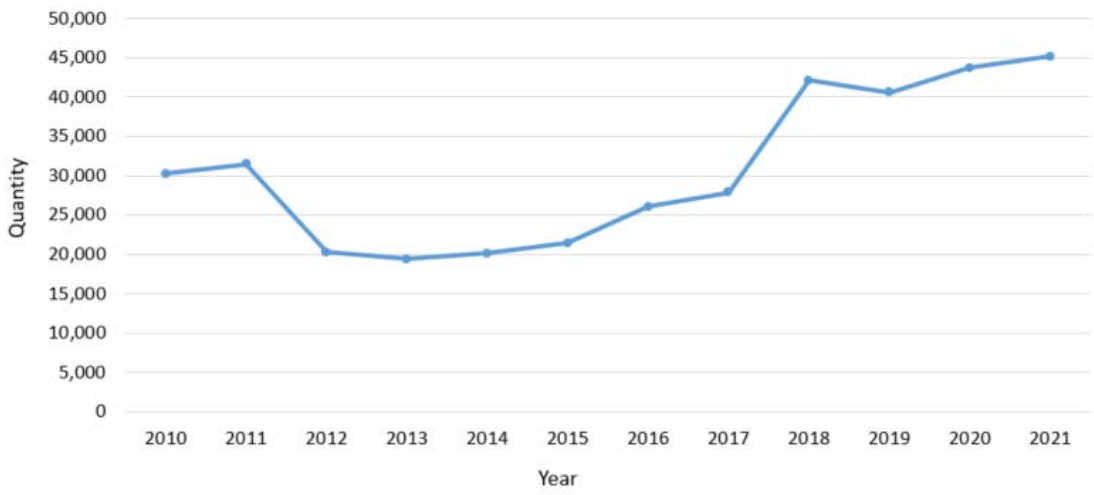
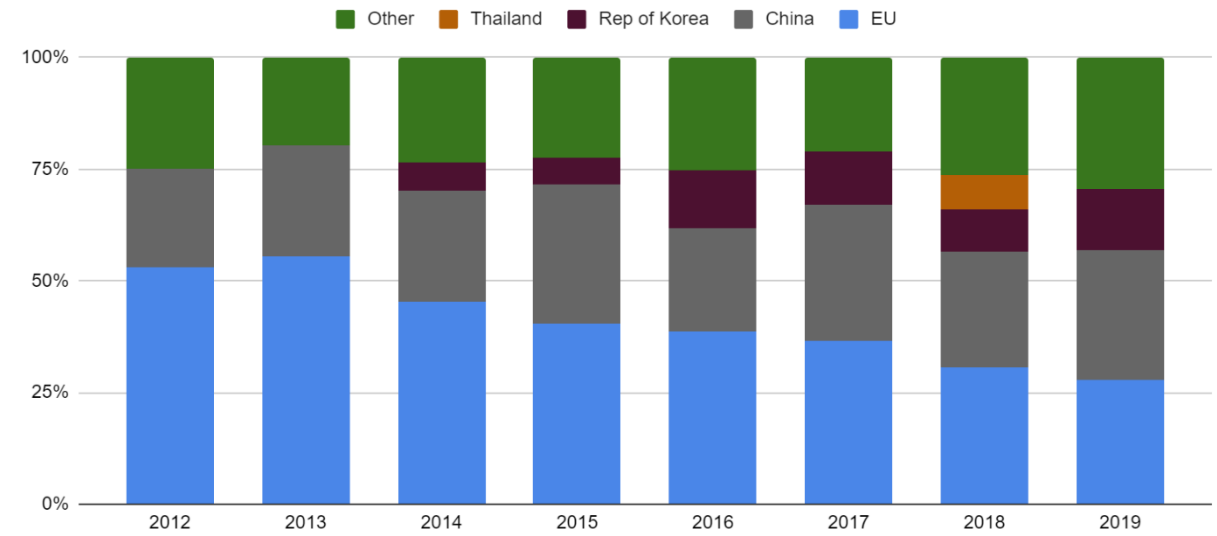


Figure 6 shows the percentage of imports by country of origin for the six categories of small air conditioners imported by Tunisia between 2012 and 2019. In 2019, China was the predominant source, supplying 29% of Tunisia's AC imports, closely followed by the EU (28%). During the period studied, the proportion of imports from the EU decreased from 53% in 2012 in favor of other countries, including China, whose proportion increased from 22% in 2012 to 29% in 2019.

Figure 6. Major Exporters of Air Conditioners to Tunisia by Trade Value ($) [USD], 2012-2019



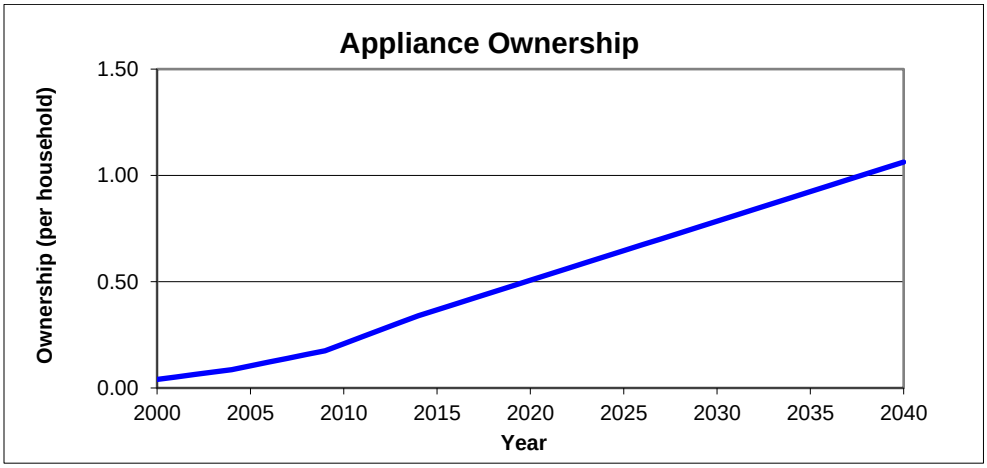
Source: UN Comtrade, 2021

3.2.3 Sales Estimation and Projection

We rely on the Policy Analysis Modeling System (PAMS) model and methodology to estimate sales of ACs in Tunisia (Mcneil et al., 2007). The PAMS methodology utilizes a stock turnover analysis to predict future

sales.[1] The stock of ACs is determined using the STEG surveys described above multiplied by the number of households in Tunisia. The historical growth rate of AC ownership is used to forecast AC ownership to 2040. Ownership of multiple ACs, as reported in the STEG survey (1.3 ACs/household) is also considered. Figure 7 illustrates the growth forecasted using PAMS.

Figure 7. Ownership of ACs per Household Projected to 2040



Then sales in every year of the forecast period are calculated as the sum of the increase in new ACs and the replacement of retired ACs:

$$\text{Sales (y)} = \text{FP(y)}+\text{Rep(y)}$$

Where:
FP(y) = first purchase in year y
Rep(y) = replacement in year y
FP is the difference in stock in every year:

$$\text{FP(y)} = \text{Stock(y)}-\text{Stock(y-1)}$$

Where:
Stock(y) = number of units in operation in the country in year y
Stock(y-1) = number of units in operation in the country in year y-1

In addition to first purchases, replacement ACs are calculated as an annual probability of retirement that changes as a function of AC age, given by:

$$P_{R(age)} = \frac{1}{1 + e^{(age-L)/D_{age}}}$$

Where:
PR(age) = probability of retirement at a given product age

[1] More information is available at: https://ee4d.org/wp-content/uploads/sites/40/2021/08/Policy-Analysis-Modeling-System-PAMS.pdf.

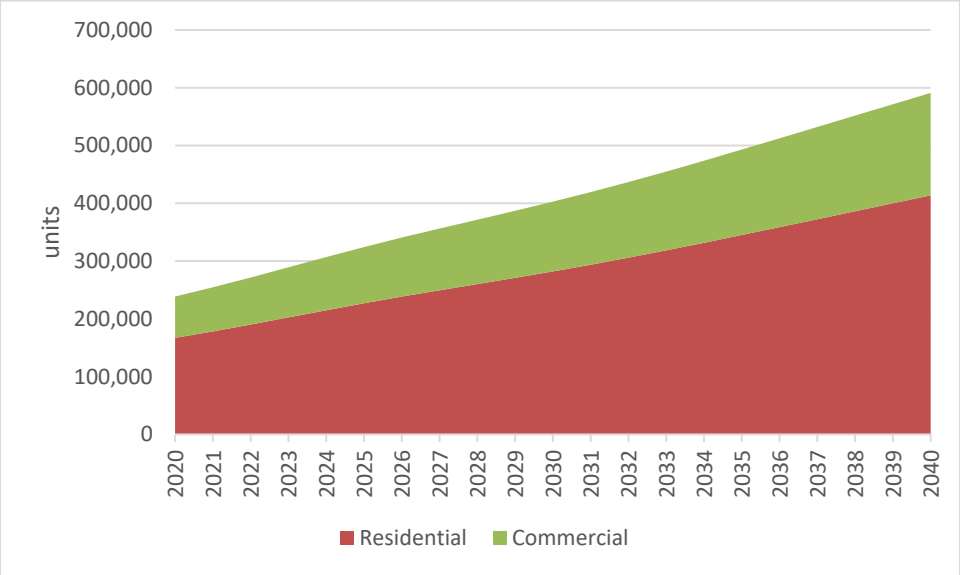
L = average lifetime of the product (10 years for ACs).
D_{age} = mean deviation of replacement ages, assumed to be 2 years

Finally, replacements in each year are given by the relationship:

$$Rep(y) = \sum_{age=1}^{2L} Stock(y-1, age) \times P_{R(age)}$$

The sales calculated for the household sector are then scaled up to include units going to businesses. We assume that 30% of ACs are used in light commercial applications (i.e., retail, offices, and hotels). The resulting sales forecast is presented in Figure 8.

Figure 8. Estimated Sales of ACs in Tunisia, 2020-2040



Based on the PAMS modeling tool, the AC market was estimated to comprise 238,000 units sold in 2020 and is expected to grow to 600,000 units by 2040. Although this estimate is conservative compared to that of the World Bank Group (2016), it was discussed and supported in several stakeholder workshops.

3.2.4 Informal Market

The AC market in Tunisia includes a significant number of products, which are cheaper and less efficient, that are smuggled in from neighboring countries. The World Bank estimated Tunisia's informal market to represent about 80% of all ACs sold in 2013 (World Bank Group, 2016). The primary reasons for this informal market to exist is the lack of enforcement of border controls for incoming trade from neighboring countries and the numerous taxes and duties placed on air conditioners, which include a tax to finance the Energy Transition fund. The World Bank estimates that the total tax rate doubles the price of imported products (cost, insurance, and freight). Khalfallah and Hanchi (2017) estimated that in the formal market a 9,000 BTU air conditioner is sold for 750 Tunisian dinar (TND), as compared to only 450 TND on the informal market.

Based on our analysis of the 2020 market, we estimated that the informal market supplies about 45% of total AC sales. This estimate is based on the sales remaining after local production and imports are accounted for.

4. Product Characteristics

As part of this study, the authors developed a database of the popular models of air conditioners sold in Tunisia. We distinguish product classes based on whether a unit provides cooling only or is reversible (i.e. also has a heating function), as well on product size and energy performance.

4.1 Data Collection

We developed a database of the popular models of ACs available in Tunisia using data collected from retailer websites and the product registration data ANME collects. The data cover various aspects of the products, including manufacturers; retailers; product class (inverter, fixed speed, reversible, cooling only); size; price; and unit energy consumption. We identified 128 unique models being sold online in Tunisia. We used the following retailer websites to develop a database of air conditioners sold online on the Tunisian market. Since no data exist on the characteristics of actual sales, we use these data collected on the type of product available on the Tunisian market as a proxy to the characteristics of sales, see (Gerke et al., 2017) for more detail on this assumption.

- **Jumia**: https://www.jumia.com.tn/catalog/?q=climatiseur
- **Tunisianet**: https://www.tunisianet.com.tn/457-climatiseur-tunisie-chaud-froid
- **Affariyet**: https://www.affariyet.com/48-climatiseurs
- **Promouv**: http://www.promouv.com/prix-gros-electro-en-ligne/chaud-froid/climatiseur-chaud-froid-tunisie.html
- **Mytek**: https://www.mytek.tn/electromenager/gros-electromenager/climatiseur.html
- **Mega**: https://www.mega.tn/electromenager/climatisations/climatiseurs

4.2 Product Classes and Manufacturers

An air conditioner can be classified as cooling only or as reversible, meaning it can provide both heating and cooling. Most models available on the Tunisian market (79%) are reversible (Figure 9). The compressor can be fixed or variable speed. Variable-speed compressors (also known as inverters) are able to adjust their speed in response to temperature fluctuations and therefore operate more energy efficiently than do fixed-speed air conditioners. At 34%, variable-speed technology has a limited market presence in Tunisia, as shown on Figure 10.

Figure 9. Reversible vs. cooling only technology for ACs in Tunisia

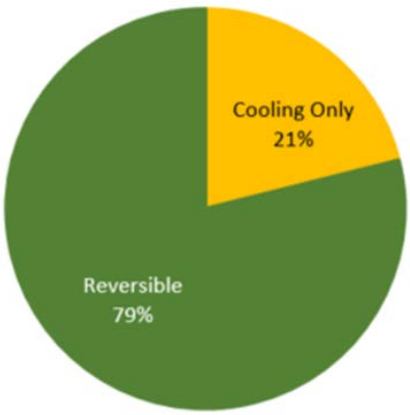


Figure 10. AC compressors in Tunisia (128 models)

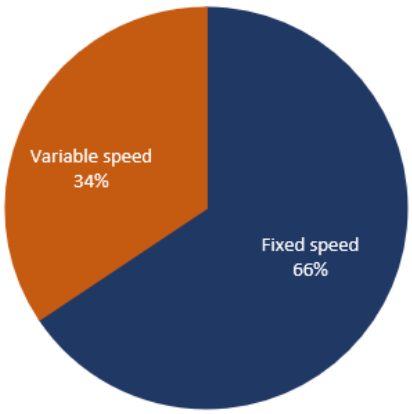
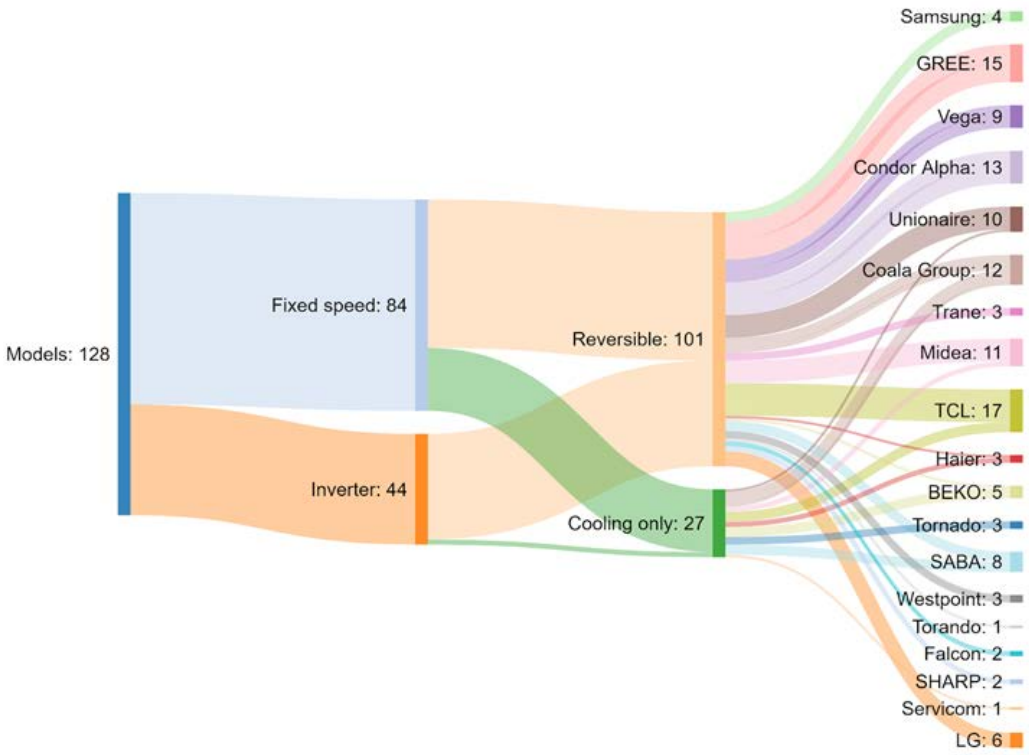


Figure 11 shows a flow chart of product categories and their manufacturers.

Figure 11. ACs available on the Tunisian Market by Technology Type



The Tunisian market comprises various manufacturers, with TCL (13%), GREE (11.7%), and Unionaire (7.8%) being the largest suppliers. GREE, Midea, Haier, and TCL are based in China; Unionaire is based in Egypt. Condor Alpha, Vega, and Coala Group are based in Tunisia. Local production consists of assembly lines using parts manufactured in other countries. According to the data collected, the origins of ACs sold are:

- Chinese brands (36%): GREE, Haier, TCL, and Midea
- South Korean brands (7.8%): Samsung and LG
- European brands (10%): Beko (Turkish), Westpoint (French), Servicom (Italy), and Tornado (Sweden)

4.3 Product Size and Energy Performance

There are five cooling capacities of ACs available on the Tunisian market: 9,000, 10,000, 12,000, 18,000, and 24,000 Btu/hr. Of the 128 models surveyed, the most common cooling capacity was 12,000 Btu/hr (36%), followed by 18,000 Btu/hr (23%) and 9,000 Btu/hr (20%). Figure 12 shows the breakdown of ACs by common cooling capacities.

Figure 12: AC Cooling Capacities in Tunisia, Btu

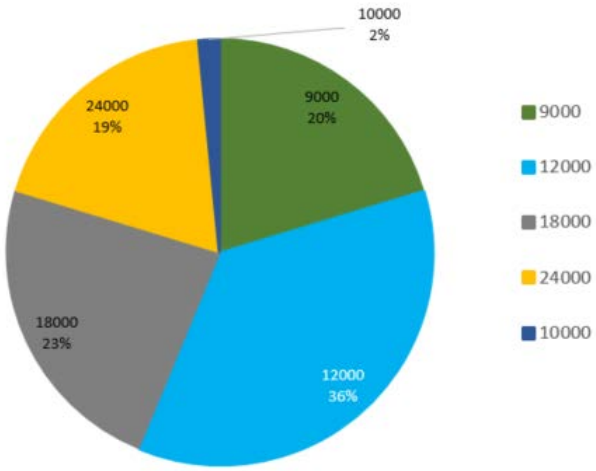
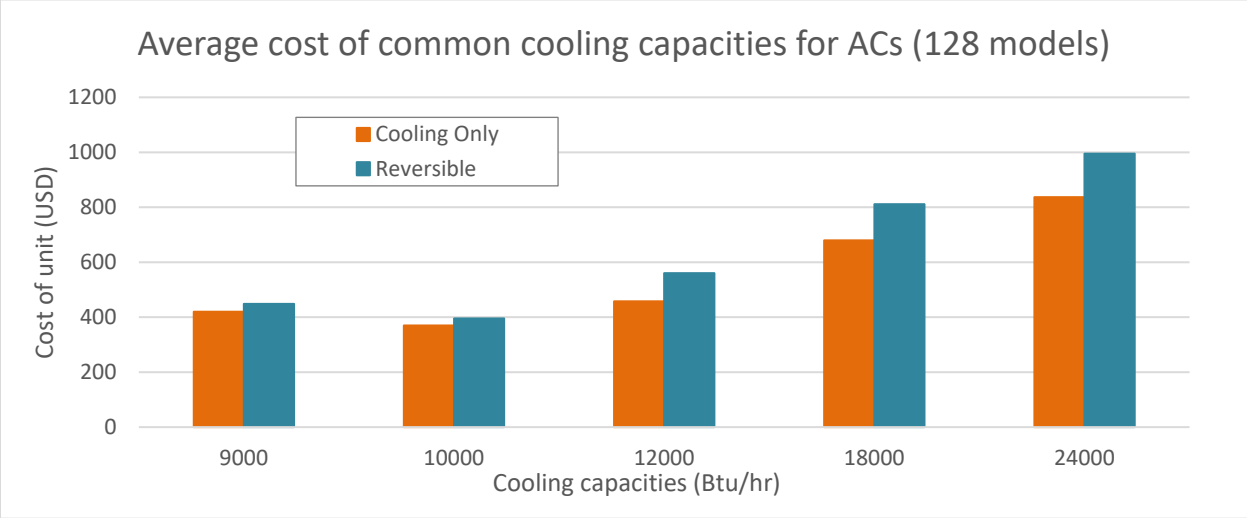


Figure 13 shows the average prices of ACs in Tunisia for popular cooling capacities for cooling-only and reversible categories. As the cooling capacity increases, so does the average price of an air conditioner. The average price of a reversible 24,000 Btu/hr is approximately $995. The cheapest product, which is a 10,000 Btu/hr cooling-only model, is available for $369. For all cooling categories, the price of a reversible AC is higher than that of a cooling-only AC by about 15%.

Figure 13. Average Cost of Common AC Cooling Capacities in Tunisia (no. of models = 128)



Note: 1 United States Dollar equals 2.73 Tunisian Dinar

Energy performance data such as EER or SEER values are rarely available for models sold through retailer websites. In some cases, power input data were provided. Of the 128 unique models, only 2 models declared SEER and 12 declared EER. Using the equation below we were able to calculate EER for 26 models based on the cooling load and input power data available from retailer and/or manufacturer websites:

$$Cooling\ power\ output\ (in\ W) = \frac{Cooling\ capacity\ (Btu)}{COP\ (3.41)}$$

$$EER = \frac{Cooling\ power\ output\ (in\ watts)}{Power\ input\ for\ cooling\ (in\ watts)}$$

Figure 14 shows the EER versus cooling capacity of the products for which data were collected. Even though under current regulations, the MEPS for ACs is Class B (3.0 W/W), the lowest EER available on the market is 2 W/W. Figure 14 illustrates that inverter models have a wider range of EER than do fixed-speed models.

Figure 14. EER for Common AC Cooling Capacities in Tunisia (no. of models = 128)

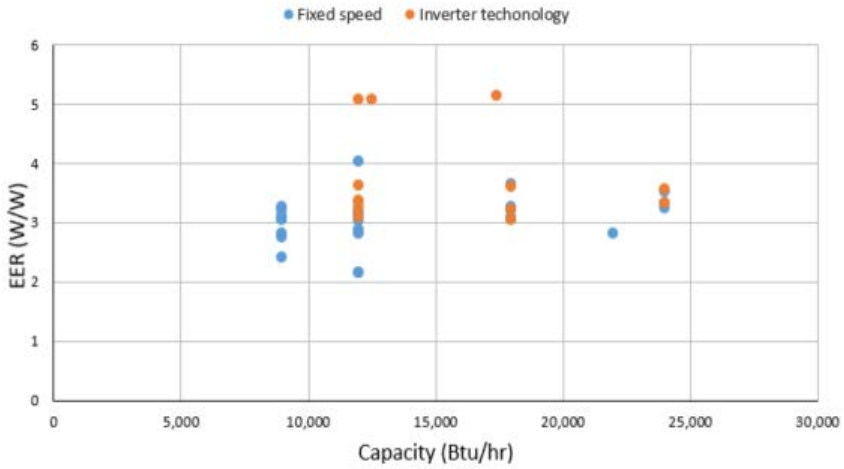
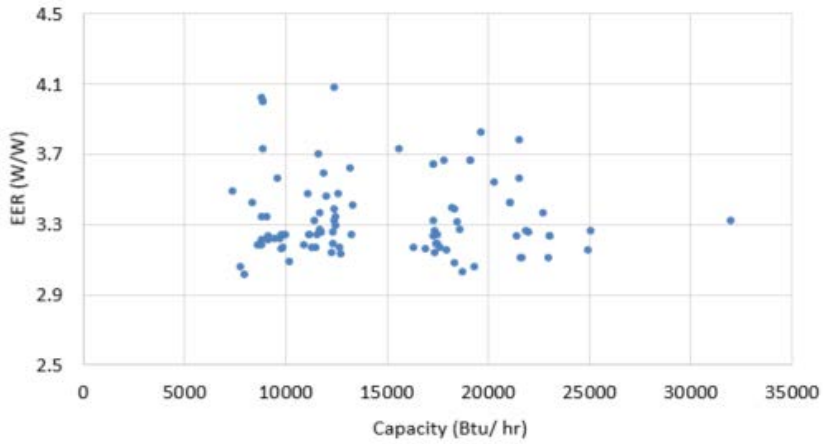


Figure 15 plots the EERs for common cooling capacities of RACs sold on the Tunisian market based on the certification database ANME provided. This dataset has a tighter band of EER, ranging from 2.9 to 4.1 W/W, as compared to the EER for the data gathered by the LBNL team, which fall between 2 and 5.2 W/W.

Figure 15. EERs for Common AC Cooling Capacities in Tunisia (no. of models = 99)



Source: ANME, 2021

Figure 16 shows the EER versus cost of the RACS on the Tunisian market. Prices of products are not highly sensitive to EER, but most likely are correlated to the sizes of units.

Figure 16. EER vs. Cost for Models Evaluated Using Online Market Assessment

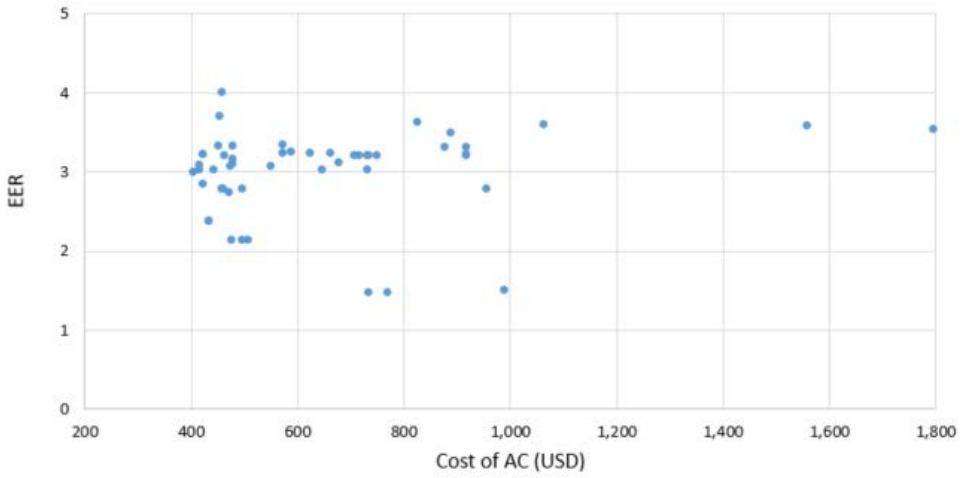


Table 4 summarizes the energy-efficiency characteristics of AC products based on our online market assessment. For models having less than 40,000 Btu capacity (<12 kW), the data are divided between cooling only and reversible ACs. Interestingly, the minimum and maximum cooling capacities for both technologies are the same (2,639 and 7,038 W, respectively). The maximum EER is higher for reversible ACs (5.8) than for cooling-only units (4.08). The minimum EER, however, is higher for cooling-only ACs (2.75). Compared to the maximum cooling capacity, the maximum heating capacity is higher for ACs that use reversible technology (7,200 W). The minimum heating capacity (2,551 W) is lower than the minimum cooling capacity (2,639 W) for reversible ACs. The COP ranges from 2.24 to 3.75.

Table 4: Efficiency distribution for the model database

Cooling Cap (Btu/hr)		Cooling Capacity (W)			EER			Heating Capacity (W)			COP		
		Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
<12 kW	Cooling only	2639	7038	4351	2.75	4.02	3.14						
	Reversible	2639	7038	4281.5	2.1	5.8	3.24	2551	7200	4173.3	2.24	3.75	3.13

5. Conclusions

The market for ACs in Tunisia is growing rapidly, having reached approximately 240,000 units sold per year. The growing demand for cooling is putting enormous strain on the electricity system, as well as increasing Tunisia's dependence on energy imports and driving up greenhouse gas emissions. Our analysis shows that many ACs coming on the Tunisian market are of low efficiency, leaving tremendous potential for energy savings. Many of the units on the market are unregulated, entering illegally through the informal market. The efficiencies of units on the informal market most likely are lower than those on the formal market. Our analysis also shows that the range of prices is correlated primarily to the size of the model rather than to its efficiency. Therefore, setting higher efficiency standards for cooling products could save significant energy while having little impact on the purchasing prices of ACs. Standards and labeling represent one of the easiest steps that the government of Tunisia can take to reduce the need

for new power plants, cut emissions, and reduce energy costs for customers and the nation. The market assessment described herein will be used to identify a baseline efficiency to be established for ACs in Tunisia. The next endeavor will be to conduct a regulatory impact analysis for setting energy efficiency standards and labels for refrigeration products.

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