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Vietnam Room Air Conditioner Market Assessment and Policy Options Analysis

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CLASP

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Executive Summary

The world is poised to install 700 million new room air conditioners (ACs) by 2030 and 1.6 billion by 2050.[1] In terms of greenhouse gas (GHG) emissions, that is like adding several countries to the planet. Millions of households and commercial entities in developing and emerging economies - from Vietnam to Nigeria to Brazil - have the financial resources to control their indoor climate for the first time. These same countries are getting hotter with climate change, contributing to the massive wave of both space cooling and refrigeration, and accelerating global GHG emissions. Ambitious international agreements like the Kigali Amendment to the Montreal Protocol (MP) are essential to successfully address the cooling crisis and limit warming – as are stringent and well-enforced energy performance standards for cooling products. According to a recent CLASP analysis, transitioning to energy-efficient ACs in 150 countries would cut 620 TWh of electricity and 480 MT of CO_2 annually in 2030 – and save consumers $56 billion USD on their electricity bills.[2] A simultaneous hydrofluorocarbon (HFC) phasedown under the MP could avoid another 100 billion tons of CO_2 equivalent.[3]

The Kigali Cooling Efficiency Program (K-CEP) focuses on the energy efficiency of cooling to increase and accelerate the climate and development benefits of the Kigali amendment to phase down HFCs. K-CEP is a philanthropic initiative to support the Kigali Amendment of the Montreal Protocol. CLASP has received a grant to support the implementation of K-CEP in priority countries in Southeast Asia, including Vietnam. The goal of CLASP's K-CEP program is to raise efficiency standards, improve testing efforts, provide training and other capacity building activities targeted to local needs, and implement national market transformation initiatives where appropriate.

CLASP, in collaboration with the Ecology and Environment Institute (EEI), conducted a comprehensive characterization of the room AC market in Vietnam, and analyzed impacts from various energy efficiency policy scenarios. EEI collected product-level data for 1,773 AC models sold across 20 retail stores, conducted a review of government reports, and interviewed relevant stakeholders, such as manufacturers, importers, end-users and representatives from government agencies. The data gathered on the room AC market includes size, product characteristics, usage, and the power sector. CLASP analyzed three policy scenarios and estimated potential energy savings and avoided emissions at the national level, and lifecycle cost (LCC) savings for consumers under each scenario:

- business-as-usual under current minimum energy performance standard (MEPS)
- a 20% increase in MEPS
- a market transition to the best available technology

Revising the MEPS by 20% over the current levels could reduce energy consumption from ACs by approximately 6% in 2030 and accelerate a market transformation to high-efficiency ACs. The AC market assessment and policy analysis report provides the technical evidence to support a revision of MEPS in Vietnam, and assesses national impacts, benefits to consumers, and effects to local manufacturers.

Overall findings and recommendations

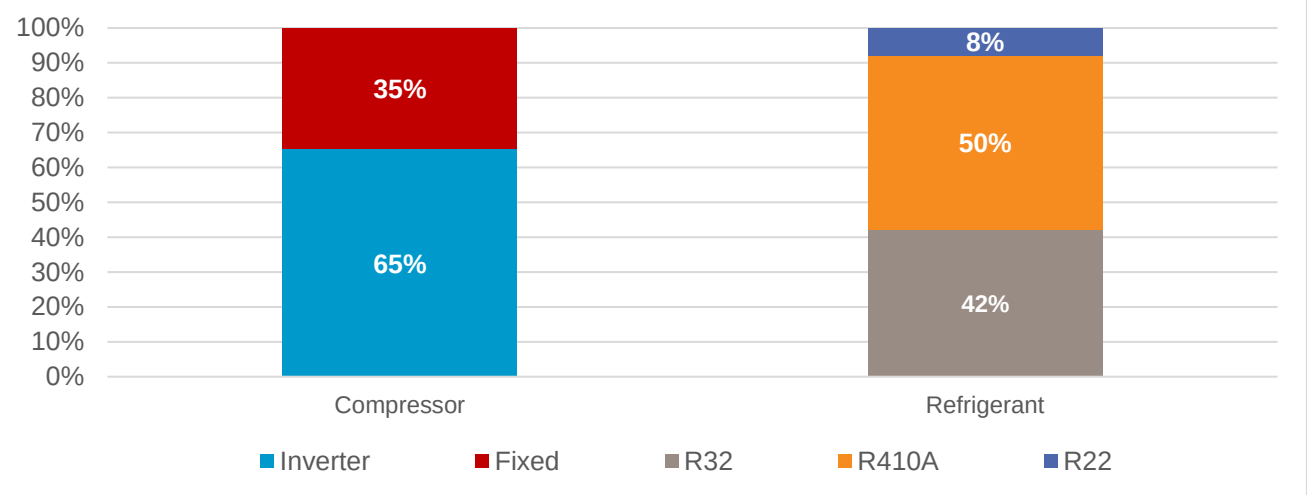
The Vietnamese AC market is primarily import based – approximately 13% of ACs in the retail survey were produced domestically by six manufacturers. Most of the ACs in Vietnam are manufactured in Thailand, Malaysia or China. Panasonic, Daikin and LG have the largest market shares.

The AC market in Vietnam is dominated by single split inverter AC units with cooling capacities of 9000, 12000, and 18000 Btu/hr. Since 2013, inverter penetration has increased by approximately 31%, driven by the adoption of a seasonal performance metric in 2015 (the cooling seasonal performance factor, or CSPF). In

[1] Lawrence Berkeley National Laboratory (LBNL). (2015). *Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Condition.* LBNL-1003671. Available at: https://eta.lbl.gov/publications/benefits-leapfrogging-superefficiency
[2] Accelerating the Global Adoption of Climate-Friendly and Energy Efficient ACs, https://united4efficiency.org/products/room-air-conditioners/
[3] Harris, J. A Climate Victory in the Making. The Negotiations over the Montreal Protocol. Council on Foreign Relations.

2017, the AC market size in Vietnam was estimated at slightly around 2.4 million units with an average annual growth rate of 25% over the previous 5 years.[4] About 42% of ACs on the market use R-32 refrigerant and 50% use R-410A refrigerant – this too is a significant transition since 2013, when R-22 refrigerant was used in 71% of ACs on the market.

Figure 1: Compressor and refrigerant technology in ACs in Vietnam (N=1773)



Vietnam last revised the MEPS for ACs in 2015, and the rapid market transformation towards more efficient technologies has outpaced both the MEPS and the energy label. In Vietnam, standards and labeling (S&L) policy for ACs regulates both inverter and fixed-speed units using the Cooling Seasonal Performance Factor (CSPF) energy performance metric. The current MEPS for split ACs are 3.10 W/W for ACs with cooling capacities below 15,000 Btu/hr, 3.00 W/W for ACs between 15,000 and 24,000 Btu/hr, and 2.80 W/W for ACs between 24,000 and 41,000 Btu/hr. ACs on the market have CSPFs ranging from 3.01 – 7.20 W/W. The best available technology is more than twice as efficient as the least efficient product. Fixed-speed split ACs identified in the retail data collection had CSPFs ranging from 3.02 – 4.07 W/W, while inverter split ACs had CSPFs ranging from 3.41 – 7.20 W/W.

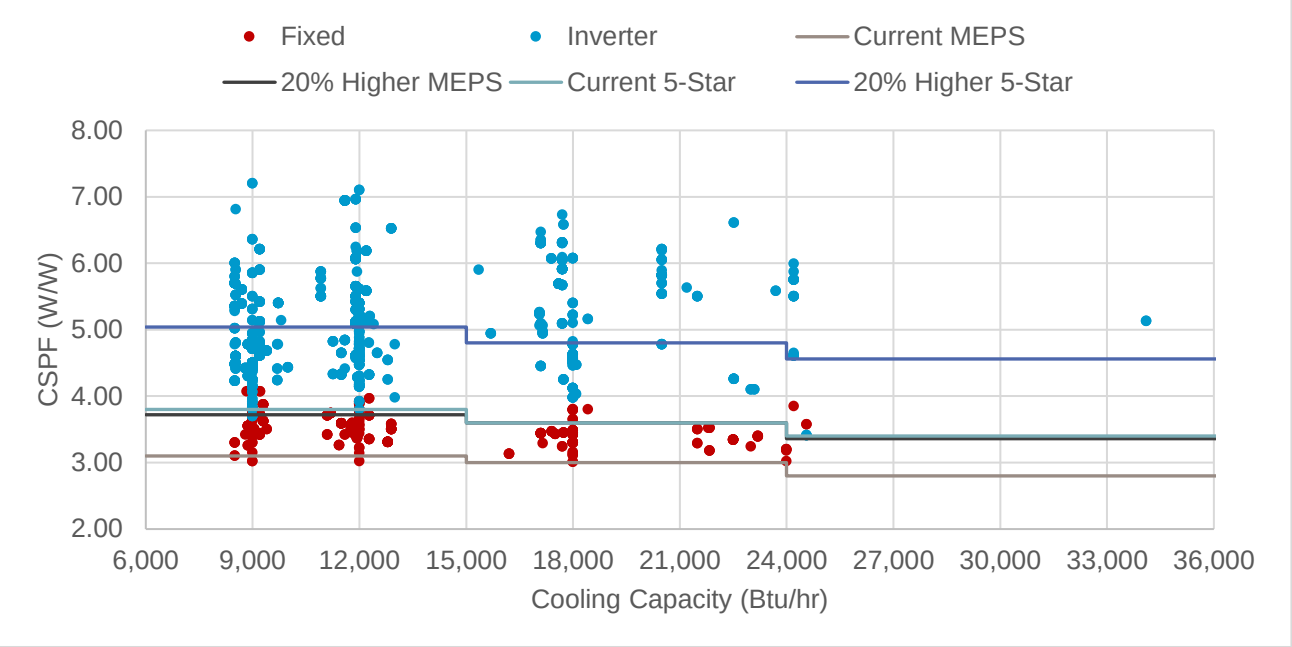
The high proportion (76%) of 4-5 star models on the market indicates that Vietnam should rescale the star rating system for ACs and revise the MEPS. The efficiencies of most ACs found on the market are far above the current 2015 MEPS, indicating that the market is ready for more stringent MEPS. By raising MEPS and rescaling the 1-5 star rating system used on the energy label, Vietnam can transform the market towards high-efficiency ACs.

Increasing MEPS would result in the elimination of some locally manufactured ACs. There are a few local AC manufacturers or assemblers, mainly Hoa Phat (Funiki), Midea and Reetech, who would need to adapt their business strategies and product lines to accommodate higher MEPS or see a significant number of their models eliminated from the Vietnamese market. These companies may require additional support to meet more stringent MEPS; however, as there is no local manufacturing of compressors, changes to production lines should not require overwhelming investment.

Increasing MEPS would provide benefits at the national level as well as to consumers. Consumers of small and large capacity room ACs would receive LCC savings under a scenario in which MEPS are increased by 20%. At the national level, Vietnam can make progress towards the NDC target of 8% emissions reduction and reduce annual energy consumption from ACs by revising the MEPS. Revising AC MEPS alone could provide 2.1 MT CO_2 in emissions reductions, equivalent to 3.3% of the 63 MT CO_2 Vietnam aims to eliminate in 2030.

[4] Euromonitor data.

Figure 2: Efficiencies by compressor type - current vs. recommended policy (N=1391)



Recommendation 1 – Increase MEPS for ACs by 20% above the current MEPS. Vietnam's MEPS are already higher than the 2020 ASEAN target of 3.08W/W for ACs under 3.52kW.[5] To achieve additional energy and emissions savings from the AC S&L program, Vietnam could revise MEPS to encourage and accelerate a market transformation to high-efficiency ACs. By increasing MEPS 20% above their current levels, Vietnam could reduce energy consumption from ACs by approximately 5% in 2030, equivalent to 2.1 TWh of electricity and 2.1 MT of CO_2. This increase is slightly more conservative than raising the MEPS to the current 5-star level. We estimate that under this scenario about 22% of models would be non-compliant (5.6% of locally produced and 16.1% of imported products would be non-compliant).

Recommendation 2 – Revise the energy labeling ratings upwards across the 1-5 star levels, and consider normalizing the distribution. The current labeling ratings have not kept up with the market. With 70% of models in the 5-star category, consumers are not able to differentiate high-efficiency models. The lowest efficiency small capacity 5-star split AC has a CSPF of 4.20 W/W and the highest efficiency 5-star model is 69% more efficient at 7.10 W/W. Revising the labeling ratings upwards by 20% alongside and increase in MEPS is only somewhat successful at correcting the distribution of 1-5 star models. CLASP further recommends that the ratings be adjusted using a normal distribution for each cooling capacity range under regulation.

Recommendation 3 - Update the MEPS and labeling ratings every 2-3 years to accelerate the market transformation towards highly-efficient ACs. CLASP recommends that government agencies in Vietnam develop a policy roadmap, including energy efficiency targets for the AC sector, and commit to evaluating AC policy every 2-3 years to continuously improve or ratchet MEPS and labeling categories. The AC industry will benefit from knowing energy efficiency targets in advance, in order to plan for new investments and/or upgrading of production lines. Government agencies in Vietnam can build on this market assessment, and continue gathering AC sales and product data to inform the update and adoption of more stringent efficiency policy, keeping up with advancements in technology and enabling the market transformation in Vietnam.

[5] In 2015, under the ASEAN-SHINE framework, ASEAN member states agreed to harmonize national MEPS for ACs by 2020. Using CSPF, the target is 3.08 W/W for ACs with cooling capacities under 3.52kW (roughly equivalent to 12,032 Btu/hr).

Market Assessment

1 Background and Introduction

The Kigali Cooling Efficiency Program (K-CEP) is a philanthropic initiative to support the Kigali Amendment of the Montreal Protocol. K-CEP focuses on the energy efficiency of cooling products to increase and accelerate the climate and development benefits of the Kigali Amendment to phase down hydrofluorocarbons (HFCs). CLASP received a grant to support the implementation of K-CEP in priority countries in Southeast Asia, including Vietnam. CLASP has developed a strategy to deliver maximum CO_2 reductions through targeted policy and market interventions that are most likely to yield impacts and/or generate momentum for energy efficiency within the Montreal Protocol process. The goal of CLASP's K-CEP program is to raise efficiency standards, improve product testing practices, provide training and other capacity building activities targeted to local needs, and implement national market transformation initiatives where appropriate.

Vietnam's 2011 Law on Energy Saving and Efficiency forms the legal basis for Vietnam's national energy efficiency programs. The law provided policies and measures to promote the economical and efficient use of energy, and outlines the rights, obligations and responsibilities of organizations, households and individuals in the economical and efficient use of energy. At the international level, Vietnam committed to reducing national greenhouse gas (GHG) emissions by 8% by 2030, relative to a business-as-usual scenario and using solely domestic resources, in their Intended Nationally Determined Contributions (INDC) submitted to the United Nations Framework Convention for Climate Change (UNFCCC). With additional international support, this commitment can increase to 25%. The room air conditioner (AC) sector has a strong potential to contribute to these objectives.

This market assessment and policy analysis provides the technical evidence to support a revision of minimum energy performance standards (MEPS). It defines the Vietnamese efficiency baseline for ACs and evaluates impacts from various policy scenarios for the country as a whole, as well as for consumers and local industry. Government agencies can use this information to quantify potential energy and GHG emissions savings in support of national energy efficiency targets or NDC commitments, and estimate other potential benefits from revising the standards and labeling (S&L) program.

CLASP together with a local partner, the Ecology and Environment Institute (EEI), conducted a comprehensive characterization of the room AC market in Vietnam. This market assessment includes a detailed account of room AC market size, product characteristics, usage, and the energy sector. EEI collected product-level data during in-person visits to retail stores, conducted a review of government reports, and reached out to stakeholders, such as manufacturers, importers, and representatives from government agencies. CLASP estimated the potential energy savings and avoided emissions at the national level, and the lifecycle cost (LCC) savings for consumers from various policy scenarios.

The report is divided into two parts, *Market Assessment*, and *Policy Options and Impacts Assessment*.

Sections 1 through 5 of the report discuss the activities and findings related to the room AC market assessment:

- **Section 1** provides an introduction, background and the project objectives;
- **Section 2** describes the approach including the scope and key activities;
- **Section 3** provides a market overview including the key players and a discussion on the supply chain;
- **Section 4** describes the market assessment findings; and
- **Section 5** provides background information on the energy sector.

Sections 6 through 11 discuss the analysis of various policy scenarios, including impacts:

- **Section 6** provides an overview of energy policies and frameworks in Vietnam;
- **Section 7** provides an overview of the S&L policies and program for room ACs;
- **Section 8** describes the methodology and analysis for different scenarios; discusses different policy options considered for the analysis;
- **Section 9** discusses the policy scenarios and results of the impact analysis;
- **Section 10** discusses impacts to consumers, manufacturers and the country as a whole under three scenarios; and
- **Section 11** concludes the report and provides recommendations.

2 Methodology

Understanding the characteristics and energy consumption of ACs on the market is fundamental to the definition of AC efficiency policy in Vietnam. CLASP engaged EEI to conduct on the ground data collection and provide insights on the room AC market. CLASP's analysis of the primary and secondary data collected by EEI forms the basis of the recommendations for efficiency targets identified in this report. CLASP and EEI applied the following approach to data collection and analysis.

Step 1 - Primary retail data collection. EEI conducted in-person visits to retail stores to collect product-level data of models available for sale. The data collected for each AC model includes the manufacturer, model number, country of manufacture, energy consumption, size, price, and other relevant information.

The resulting dataset includes retail data on 1,773 AC models sold across 20 retail stores. There were six room AC manufacturers in Vietnam as of December 2017, and all of these manufacturers were covered under the survey. Product types covered included portable, cassette, floor standing, and single split room ACs. Of the 1,773 ACs in the dataset, 608 are unique models, while 65.7% of models in the dataset are duplicates sold in multiple stores, often at different prices. For the purposes of understanding prevalence of certain product characteristics in the Vietnamese AC market, duplicates were not removed from the dataset.

In some cases, some of the product attributes were not reported, and as a result, analysis of particular product attributes excludes models for which data on that particular attribute was not reported. [6]

Table 1: Stores covered by retail survey

No.	Stores	Number of AC Models
1	Home Center	287
2	Pico	195
3	Media Mart	189
4	Tran Anh	152
5	Sai Gon	140
6	Dien May Xanh	130
7	Eco-Mart	97
8	Dien May Cho Lon	88
9	Thien Hoa	89
10	Nguyen Kim	82
11	Gree Vietnam	60
12	Phan Khang	59
13	Supermarket 30-4	54
14	LG Vietnam	43
15	Aqua Vietnam	31
16	Mitsubishi Heavy	26
17	Mitsubishi Electric	19
18	Sam Sung	13
19	Toshiba	10
20	Hitachi Vietnam	9
	Total	**1,773**

Step 2 - Secondary data collection. To supplement and verify results from the primary data collection, as well as to collect information to provide a comprehensive overview of the rom AC sector, EEI collected secondary data. EEI conducted a review of government reports and interviewed relevant stakeholders, such as

[6] For all of the figures in this market assessment, the number of models for which relevant data was available is reported using the format: (N = ##).

manufacturers, importers, end-users and representatives from government agencies, to gather data on the size of the room AC market, AC product characteristics and usage, and the power sector.

Secondary data was collected from sources including the General Department of Vietnam Customs (Customs), the General Statistics Office (GSO), the Vietnam Society for Refrigeration and Air Conditioning Engineers (VISRAE), as well as research studies, reports, market surveys, and public manufacturer's information.

Table 2: Sources of secondary data

Source of secondary data	Data collected
General Department of Vietnam Customs – MOF	**Market size:** data on import/export of ACs (2014-2017)
General Statistics Office – MPI	**Market size:** data on domestic production of ACs (2014-2016). The data on ACs manufactured in 2017 had not been updated by GSO, so data on manufactured ACs in 2017 was surveyed from domestic ACs manufacturers.
Designated National Authority of Vietnam – MONRE	**Energy:** national electricity grid emission factor (tCO_2/MWh)
Electric Regulation Authority of Vietnam - MOIT	**Energy:** domestic electricity price
Department of Energy Conservation and Sustainable Development - MOIT	**Product characteristics**: data on models, energy efficiency, and energy label levels
Department of Climate Change - MONRE	Previous national surveys on HCFC, HFC and ODS for crosscheck purposes
VISRAE	Related studies in the AC sector
Other relevant parties	Studies and reports from other relevant parties for crosscheck purposes

Step 3 – Market and impact analysis and policy recommendations

The data collected by EEI was the basis for the Vietnam room AC market analysis, the formulation of policy analysis, and the impacts analysis conducted using the Policy Analysis Modeling System (PAMS). Data collected for this project and used in the policy impacts analysis is complemented by data from Euromonitor and the World Bank. The methodology for PAMS analysis is outlined in detail in **Section 9.**

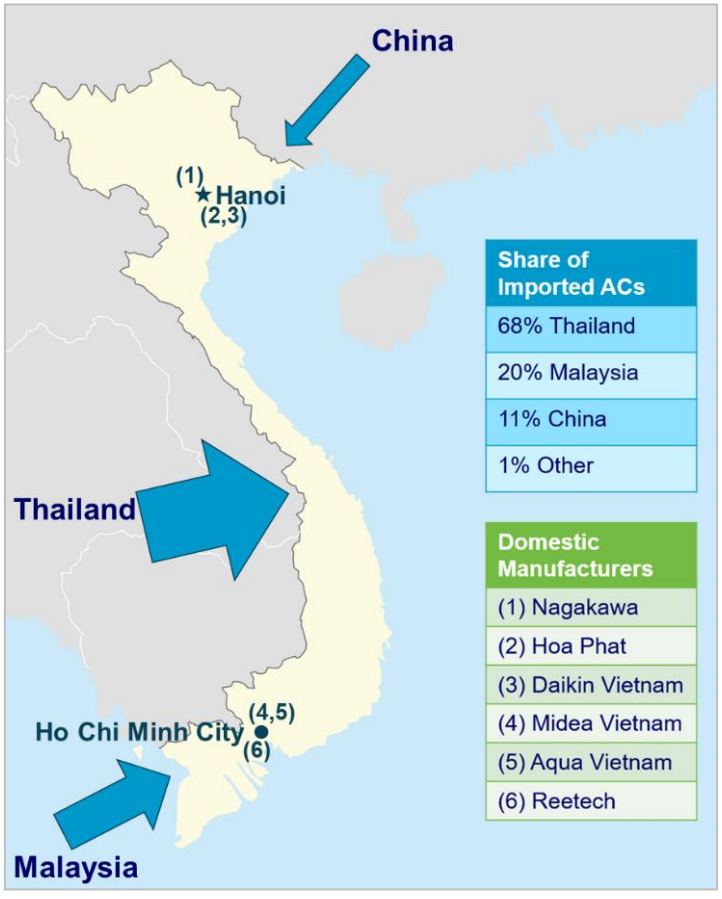
3 Room AC Industry at a Glance

3.1 Supply Chain Analysis

The Vietnam room AC market is primarily import based. Approximately 86% of ACs available on the market are imported from Thailand, Malaysia and China. Nearly all imported ACs enter Vietnam via marine shipping methods through two major ports of entry: Ho Chi Minh City in the south and Hai Phong in the north.

Given the proximity of the world's two largest AC manufacturing countries, Thailand and China, the small size of Vietnam's domestic AC industry is not surprising. Currently, around 13% of ACs are assembled domestically, using a mix of 77% imported and 23% domestically-manufactured components. The domestically-manufactured components used include electric wire, plastic covers, foam, and packaging. There are no domestic manufacturers of compressors or motors for ACs, the majority of which are imported from Thailand, Malaysia, and China. ACs assembled domestically are primarily transported by road to wholesale distributors, from whom smaller retailers obtain their inventory.

Figure 3: Map of domestic manufacturers and import shares



CLASP and EEI identified six domestic manufacturing facilities in Vietnam, three located in the north near Hanoi and three located in the south near Ho Chi Minh City.

- Nagakawa Vietnam has a facility in Vinh Phuc province, just north of Hanoi.
- Hoa Phat Refrigeration Company produces ACs under the Funiki label at Phoi Noi A Industrial Park in Hung Yen province.

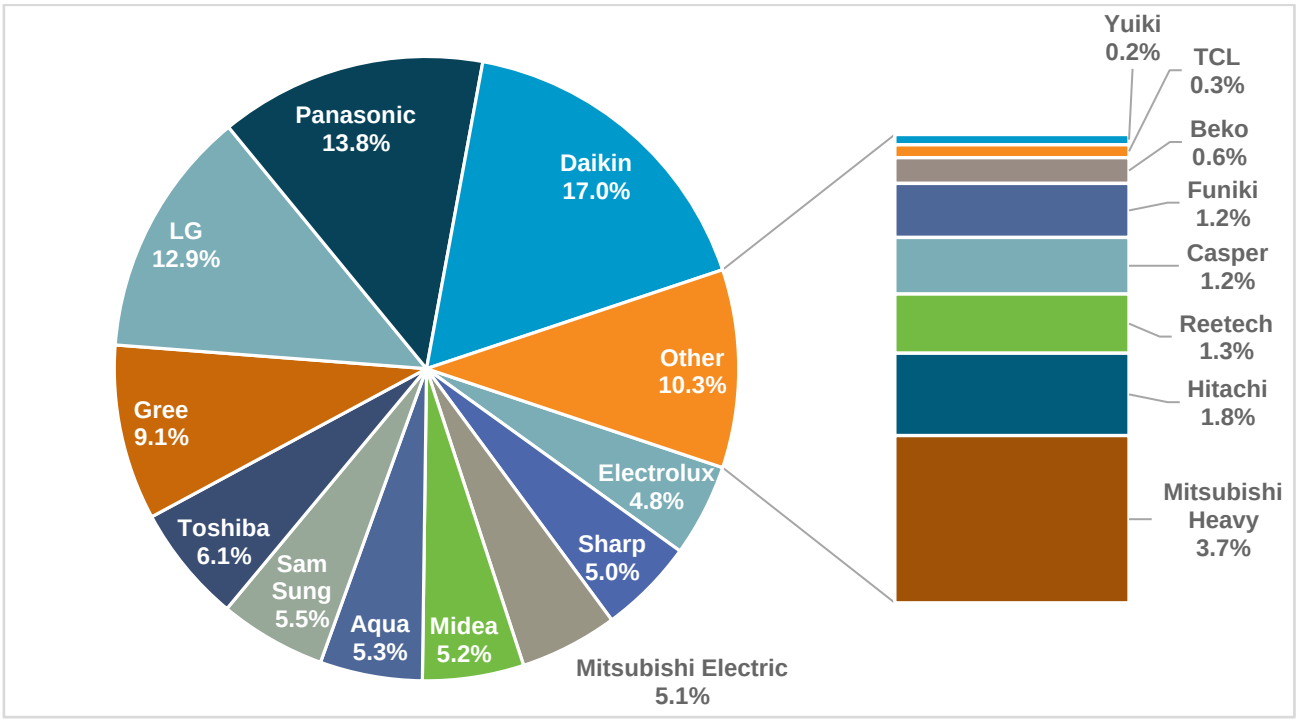
- Daikin Vietnam has a 1 million unit per year factory in Thang Long II Industrial Park in Hung Yen Province.
- Midea has a facility in Singapore Industrial Park in Binh Duong province.
- Aqua, one of Haier's brands in Southeast Asia, has a facility in Bien Hoa Industrial Park II in Dong Nai province.
- Reetech has a facility in Ho Chi Minh City's Tan Binh Industrial Park.

3.2 Prevailing Brands

According to the data gathered from retail stores, the following brands dominate the Vietnamese market:

- Japanese brands (52.5%): Daikin, Panasonic, Sharp, Mitsubishi, Toshiba, Hitachi
- South Korean brands (18.4%): Samsung, LG
- Chinese brands (14.6%): Gree, Midea, TCL, Aqua (owned by Haier)[7]
- Thai brands (6.5%): Casper
- European brands (5.4%): Electrolux (Swedish) and Beko (Turkish)
- Vietnamese brands (2.7%): Funiki (owned by Hoa Phat) and Reetech

Figure 4: Major AC brands in Vietnam (N=1773)

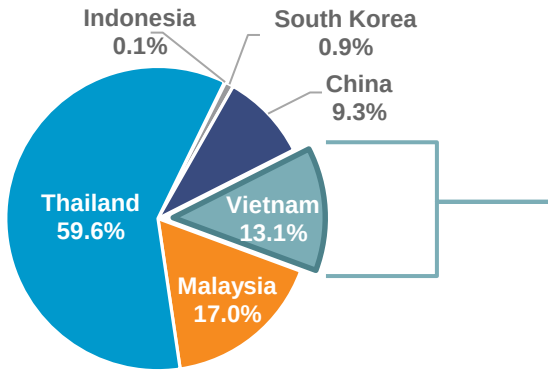


Although Japanese brands hold the largest market share, the majority of ACs are not produced in Japan. Manufacturing or assembly predominantly occurs within the Southeast Asian region or, to a lesser extent, in

[7] According to China Daily, Haier took over Sanyo Ha Asea Co. in 2012 and renamed it AQUA Vietnam Electrical Appliance Company (AEC). http://www.chinadaily.com.cn/m/qingdao/2016-01/25/content_23231716.htm

China. Of the 1,773 models for which product information was gathered, nearly 77% were imported from another Southeast Asian country, and 13% of the models were assembled in Vietnam. This is consistent with market data provided via manufacturers' surveys, which suggests that around 15% of the 2017 domestic stock of ACs in Vietnam were manufactured or assembled domestically.[8]

Figure 5: Country of origin/manufacture for ACs in Vietnam (N=1773)



Market Share of Brands Manufacturing/Assembling in Vietnam	
Midea	4.9%
Aqua	2.8%
Electrolux	2.0%
Reetech	1.3%
Daikin	1.3%
Funiki	0.8%

According to the retail survey, the brands manufacturing or assembling in Vietnam include Midea, Haier (Aqua), Electrolux, Reetech, Daikin, and Hoa Phat (Funiki). Nagawka, a brand which was identified by EEI during the secondary data collection process, also has a production facility in northern Vietnam; however, CLASP was not able to assess the market share of Nagakawa. Similarly, although 2% of models in the retail survey were Electrolux brand and listed Vietnam as their country of origin, CLASP could not identify a local manufacturing facility for Electrolux.

3.3 Key Players

Major multinationals in the room AC industry are present in Vietnam, however the bulk of AC's are imported. The growing demand for ACs in Vietnam has triggered some manufactures to ramp up AC production for the Vietnamese market, despite the lack of special incentives for AC manufacturers.[9] Daikin invested 10 billion yen to build the company's 1-million unit per year factory in Hung Yen province, which opened in 2018. Meanwhile, Panasonic is increasing output at its factory in Malaysia in order to increase supply for Vietnam.[10]

With respect to key players in AC testing, there are two state-owned AC testing centers:

- Institute of Energy and Mining Mechanical Engineering under the Vietnam National Coal - Mineral Industries Holding Corporation (VINACOMIN)
- Quality Assurance and Testing Center 3 (QUATEST 3) under the Directorate for Standards, Metrology and Quality (STAMEQ) – Ministry Of Science and Technology (MOST)

Additionally, some manufacturers and assemblers, including Daikin Vietnam, Panasonic, and Midea, also possess AC energy efficiency testing labs.

[8] The domestic stock of ACs in 2017 was approximately 3.4 million. This number is derived from estimates of AC imports (2.5 million), ACs manufactured in Vietnam (0.5 million) and ACs exported from Vietnam (0.07 million).
[9] According to Vietnam Law on Investment 2014 and Decree No.118/2015/ND-CP - "Guidelines for some articles of the law on investment" issued by the government in 2015, AC manufacturing is not on the list of investment incentive fields.
[10] Tomiyama, Atsushi and Daisuke Ito. (2018). "Air conditioner makers battle for Vietnam's red-hot market." Nikkei Asian Review. Available at: https://asia.nikkei.com/Business/Business-Trends/Air-conditioner-makers-battle-for-Vietnam-s-red-hot-market

The Vietnam Society of Refrigeration and Air Conditioning Engineers (VISRAE) was established on April 28, 2004 under the state management of the Ministry of Science and Technology and is a member of the Vietnam Union of Science and Technology Associations (VUSTA). VISRAE's main objectives in the air conditioning sector are to:

- Encourage the creativity of the members, contributing to the development of the room AC industry;
- Disseminate scientific knowledge, refrigeration and air conditioning technologies to the community;
- Improve knowledge and skills for members and the community through training courses, workshops;
- Raise awareness to scientific and technological advancement in room ACs;
- Participate in the compilation, translation, and review of sector standards and national standards, as well as technical and professional documents related to the field of refrigeration, air conditioning in accordance with the law;

Other organizations involved in the Vietnamese AC market include the School of Heat Engineering and Refrigeration (SHEER) at Hanoi University of Science and Technology (HUST). SHEER provides trainings and studies in the AC sector.

4 Room AC Market Characteristics

4.1 Room AC Types Available

Single split units dominate the AC market in Vietnam, accounting for 91.1% of the models available from surveyed retailers. Floor standing and cassette ACs jointly account for another 8.3% of models, with a very small number of portable models (**Figure 6**). Window ACs are not popular in Vietnam.

Figure 6: Room AC types (N=1773)

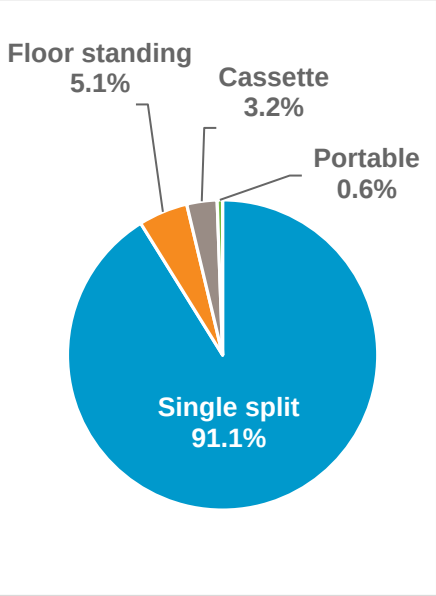
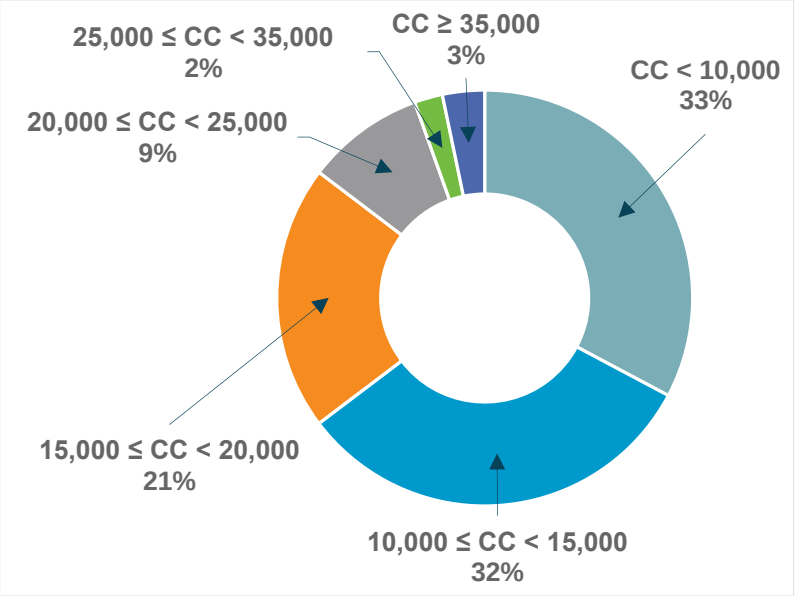


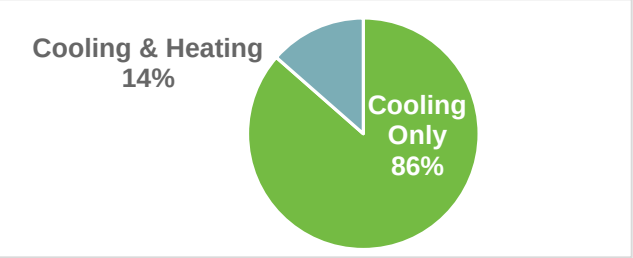
Figure 7: Cooling capacities (in Btu/hr) (N=1773)



ACs with cooling capacities around 9,000 and 12,000 Btu/hr are the most popular models in Vietnam, with ACs with less than 15,000 Btu/hr accounting for 65% of the market, while ACs with cooling capacities between 15,000 and 20,000 Btu/hr account for approximately 21% of the market (**Figure 7**). In the dataset, there were 225 models with cooling capacities of exactly 9,000 Btu/hr, 173 12,000 Btu/hr models, and 125 18,000 Btu/hr models. For this reason, representative models at these three cooling capacities were chosen for the impacts assessments described in **Sections 9 and 10**.

Most of the ACs sold in Vietnam only provide cooling; only 14% of ACs models had both heating and cooling functions. In the northern region and central regions of Vietnam, low morning and evening temperatures from November through March create a small demand for heat pump models.[11]

Figure 8: Cooling and heating functions (N=1773)



[11] Japan Air Conditioning, Heating & Refrigeration News (JARN). 2018. "Vietnam, A New Star in the Southeast Asian Market." Accessed June 27, 2018. https://www.ejarn.com/detail.php?id=52349&l_id

4.2 Refrigerants and Inverter Technology

Refrigerant type data was available for all of the ACs in the analysis. The most prevalent refrigerant used in ACs in Vietnam is R-410A, followed closely by R-32 (**Figure 9**). R-22, maintains only an 8% market share. ACs using R-22 were less expensive on average than those using R-410A for the same cooling capacity and type, while R-410A units were less expensive than those using R-32. Compared to a 2013 study conducted by CLASP, R-32 penetration is significantly higher – in 2013, R-22 accounted for 71% of ACs on the market and R-410A accounted for 27%.[12]

Figure 9: Types of refrigerants in Vietnam (N=1773)

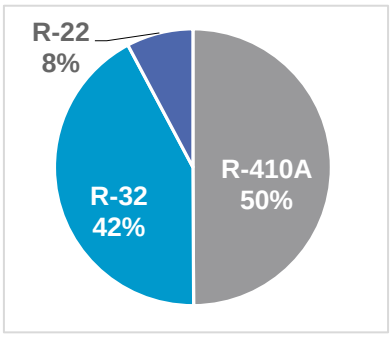
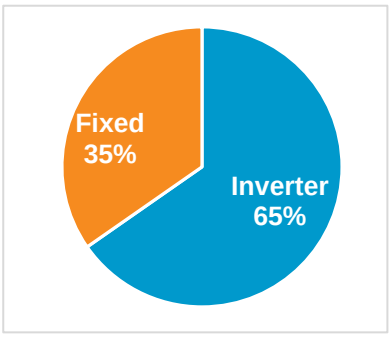


Figure 10: Types of compressors in Vietnam (N=1773)

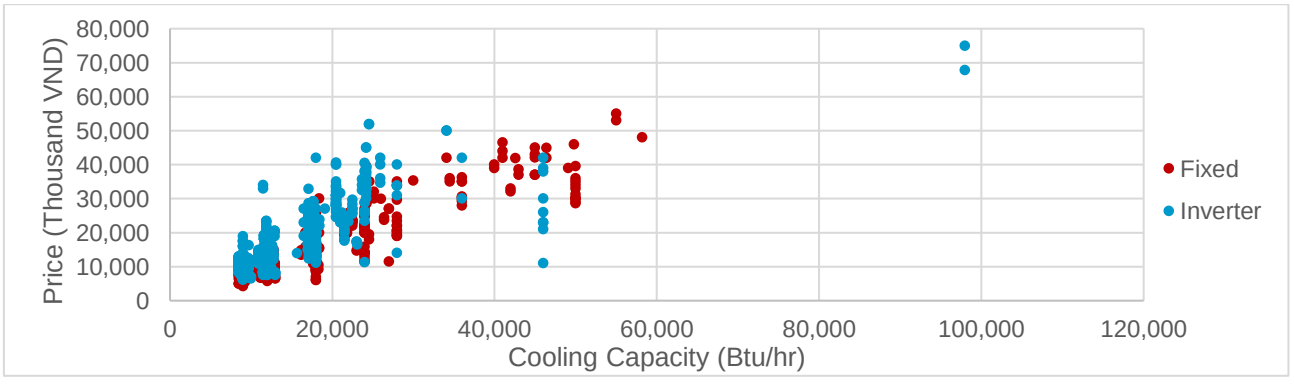


Inverter technology has a larger overall market share than fixed speed (**Figure 10**); however, at cooling capacities above 36,000 Btu/hr, fixed speed technology is more prevalent. Inverter ACs are more prevalent despite their slightly higher average prices, as discussed in **Section 4.3**. Compared to the market data from 2013, inverter penetration has increased by approximately 31%.[13]

4.3 Prices

The cooling capacity of ACs has a significant impact on overall price – as the size of the AC increases, so too does the purchase price. The linear relationship between price and cooling capacity is consistent across both fixed speed and inverter ACs.

Figure 11: Cooling capacity vs. price by compressor type (N=1706)



[12] ASEAN-SHINE. (2015). Promotion of higher efficiency air conditioners In ASEAN: A regional policy roadmap. https://storage.googleapis.com/clasp-siteattachments/ASEAN_SHINE_AC_Regional_Roadmap__Report_Final-new-2.pdf
[13] Ibid.

Figure 12: Price ranges for fixed speed ACs (N=585)

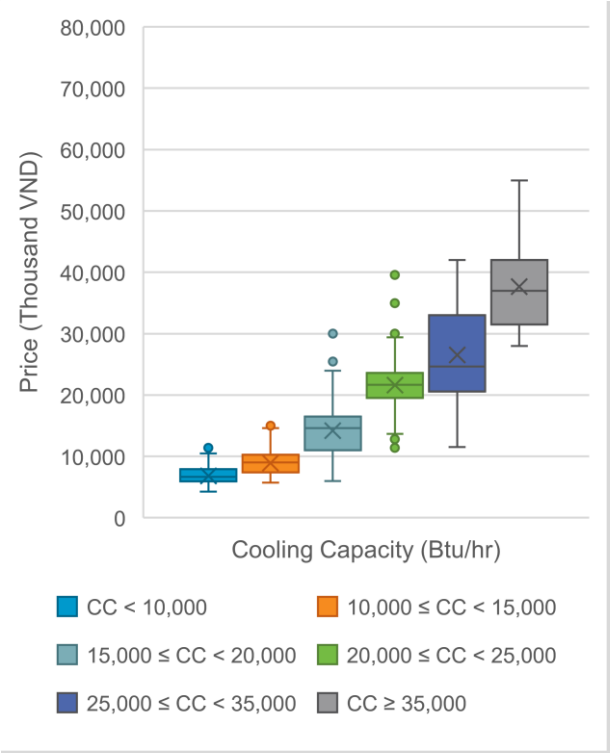
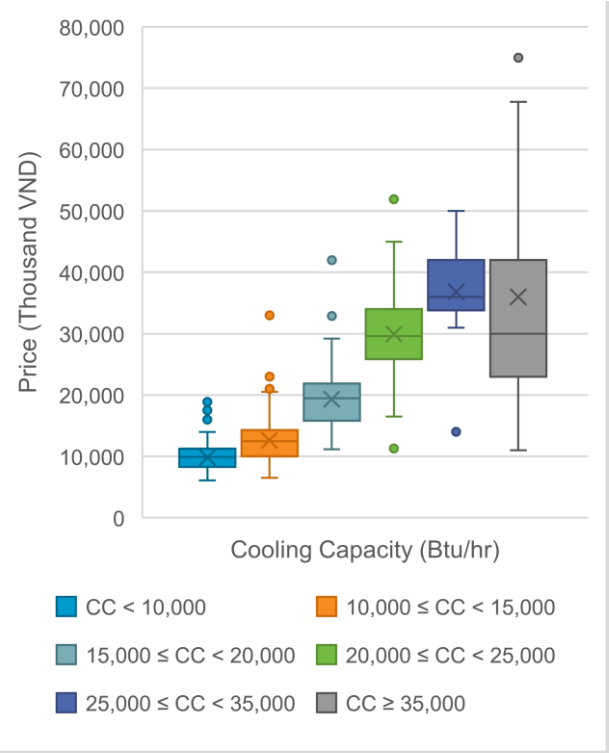


Figure 13: Price ranges for inverter ACs (N=1121)



The compressor type does have some impact on price - inverter ACs have slightly higher average prices. For the most popular cooling capacities of 9,000 12,000, and 18,000 Btu/hr, the average price of an inverter unit was 40%, 45%, and 27% more expensive, respectively.

Out of the 1,706 models with price data, there are 583 unique models. Prices for each model varied from retailer to retailer. Sometimes, prices varied very little, as in the case of one 8,500 Btu/hr Daikin inverter AC sold for 11,600 VND in four stores and 10,990 VND in another. However, price can vary significantly – ten different retailers offered a 17,700 Btu/hr Panasonic inverter AC at prices ranging from 18,800 to 21,390 VND, a 14% difference in price between retailers.

4.4 Energy Efficiency and Performance Metrics

The energy efficiency ratings for ACs are determined based on MEPS for ACs of different cooling capacities.

Since November 9, 2015, Vietnam has mandated MEPS for ACs using Cooling Seasonal Performance Factor (CSPF), a metric which relates energy performance in watts per watt (W/W) and takes into account seasonal variations in performance.[14] Prior to 2015, Vietnam allowed both CSPF and another metric, energy efficiency ratio (EER), for use in certifying the energy efficiency of ACs.[15] Thus, while 87% of the models found during the retail data collection bore labels reporting energy efficiency in CSPF, sometimes along with other

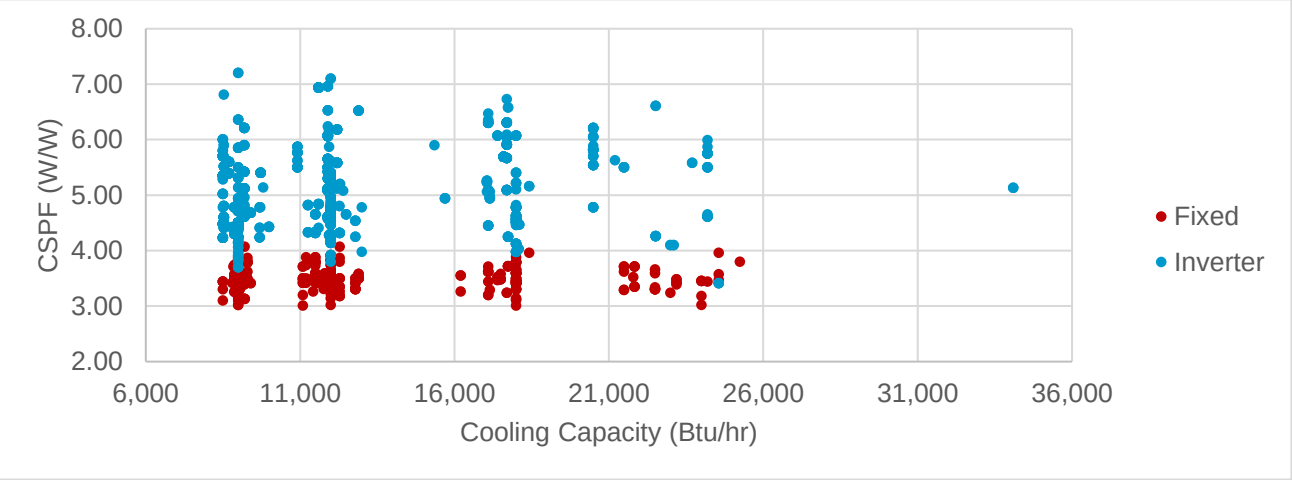
[14] The relevant Vietnamese regulation for non-window AC energy efficiency is TCVN 7830:2015 - Non-ducted air conditioners - Energy Efficiency.

[15] From 2012-2015, MEPS were regulated under TCVN 7830:2012 - Non-ducted air conditioners - Energy Efficiency, which allowed both CSPF and EER to be used for reporting energy performance.

measurements of energy performance, 16% of models reported EER only and 3% reported only the coefficient of performance (COP). The current MEPS for ACs are summarized in **Table 7, in Section 7.**

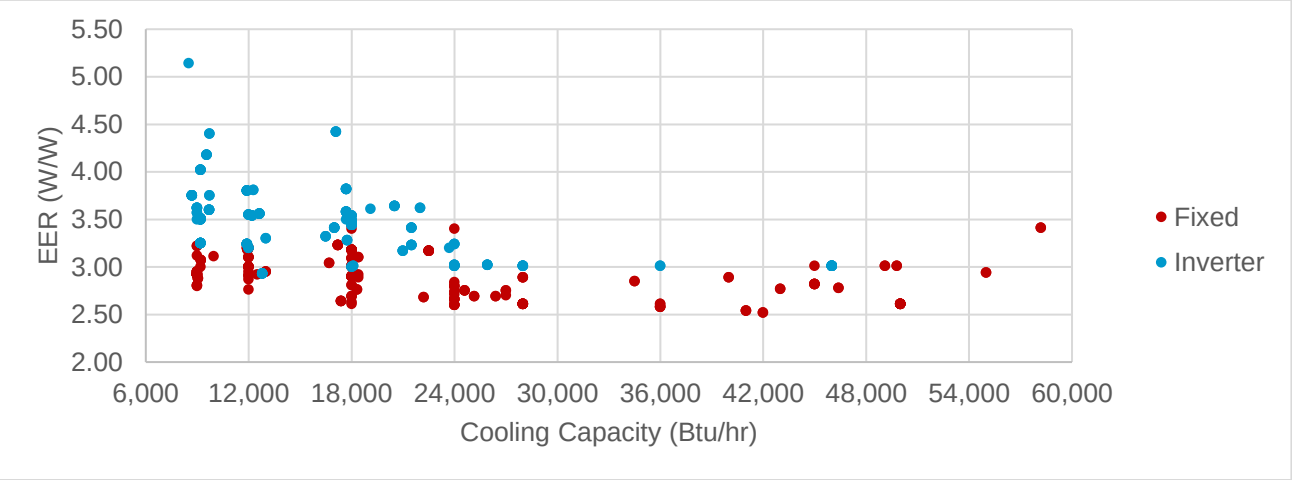
Of the ACs for which CSPF was reported, there were both high-performing and low-performing models across the range of cooling capacities on the Vietnamese market. However, compressor type was strongly correlated with energy performance – the lowest performing models on the market all use fixed-speed compressors, while the highest performing models use inverter technology. Fixed-speed split ACs identified in the retail data collection had CSPFs ranging from 3.01 – 4.07 W/W, while inverter split ACs had CSPFs ranging from 3.41 – 7.20 W/W.

Figure 14: Cooling capacity vs. efficiency (CSPF) by compressor type (N=1391)



The relatively higher energy performance for inverter ACs holds true in the smaller sample size of models for which EER was reported. There, the EERs ranged from 2.52 – 3.41 W/W for fixed speed ACs and 2.50 – 5.14 W/W for inverter ACs.

Figure 15: Cooling capacity vs. efficiency (EER) by compressor type (N=414)



4.5 Energy Labeling Practices

Energy performance labeling is mandatory in Vietnam. Nearly all of the models (97.9%) identified during the retailer visits bore an energy label of some kind. Of these labeled models, 99.7% had certified Vietnamese energy labels. The Vietnamese energy label is a comparative label that provides star ratings from 1-5 (**Figure 17**). The more stars, the more efficient the model is. A certified energy label provides the following information: manufacturer's name, product origin, model number, rated power, energy efficiency, the relevant regulation, and certification number. Vietnam's Ministry of Industry and Trade (MOIT) oversees the energy labeling program.

CLASP collected star-rating information on 584 unique AC models – 62.8% of these models fall into the 4-5 star category, while only 5% of models are rated at the lowest efficiency level of 1-star. This indicates a need not only for more ambitious MEPS, but also for a rescaling of the star ratings.

Figure 16: Star ratings market share (N=584)

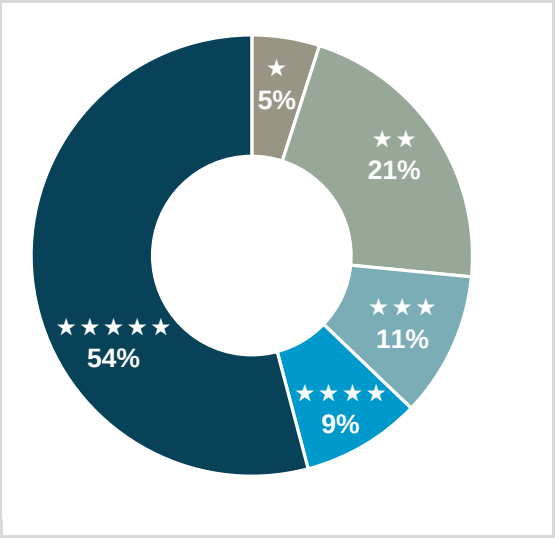


Figure 17: Vietnam endorsement label and energy label

4.6 Consumer Practices and Preferences

Consumers, especially those in rural areas, typically purchase ACs in-person at retail stores and supermarkets, because they wish to see the available products before making a decision. While some retailers in urban areas offer online purchasing options, allowing consumers to order an AC unit online and pay via credit card.

The purchasing price of an AC is often the primary factor considered by consumers looking to buy a new AC. Although higher efficiency ACs often cost less to operate, in markets where consumers' electricity rates are low, the size of the initial investment to own an AC is critical. In Vietnam, installment payment plans are available from many large retailers to spread the upfront cost of a new AC across a number of months.

5 Power Sector

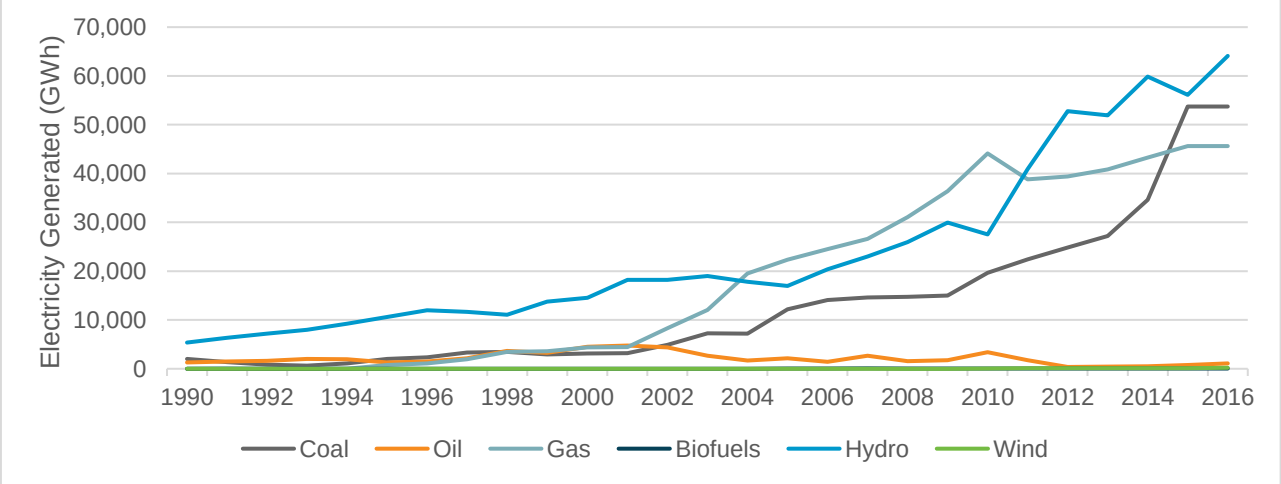
5.1. Power Generation & Consumption

In 2016, Vietnam consumed 158,736 GWh of electricity. Transmission and distribution losses were 2,205 GWh or about 10.3% of total energy produced. Of the 158,736 GWh of energy consumed, the industrial sector consumed the largest amount of electricity at 54%, followed by the residential sector at 35%, and the commercial and public sector at 10%.

Vietnam generates approximately 62% of the country's annual energy consumption through the combustion of fossil fuels.[16] At 39% of power generation, hydropower provides the largest share in generation, with coal in a close second at 33%. Natural gas has a significant share of 28% and only 1% of electricity is produced from oil-based sources and biofuels. Outside of hydro, other renewables played a small role in 2016 – wind contributed 201 GWh (less than 1%) in 2016.

Vietnam's reliance on coal-fired power plants has grown rapidly. As can be seen in **Figure 18**, coal based generation has nearly caught up with hydropower, and with plans to build more coal-fired power plants over the next decade, coal will soon surpass hydropower.

Figure 18: Vietnam electricity generation by fuel source[17]



As Vietnam has continued to invest in coal-fired power generation facilities, the national grid emissions factor has increased rapidly (**Table 3**). From 2012 to 2016, CO_2 emissions associated with electricity generation increased by 63%. With coal-fired power gaining a greater share of the electricity generation fuel mix in Vietnam, the electrical grid emissions factor will likely continue to rise. The state-owned utility, the Vietnam Electricity Group (EVN), currently has 4,304MW of thermal power plants under way and 2,135MW of new hydropower in development.[18] Following the April 2017 Decisions on mechanism for solar power development in Vietnam, EVN has planned for investment in 870MW of grid-connected solar power, and 85MW of wind power.

Energy efficiency policy to counter growth in electricity demand is not only critical for ensuring the power sector continues to keep pace with rapid urbanization and industrialization, but is also necessary for Vietnam to meet Nationally Determined Contributions (NDC) targets under the Paris agreement. In the NDC submitted to the United Nations Framework Convention for Climate Change (UNFCCC), Vietnam has committed to reducing national GHG emissions by 8% by 2030 relative to a business-as-usual scenario, adding that their contribution

[16] IEA World Energy Balances 2018. Viet Nam: Electricity and heat for 1990-2016. https://webstore.iea.org/world-energy-balances-2018
[17] Ibid.
[18] Vietnam Electricity. Generation Projects. Accessed Dec. 4, 2018. https://en.evn.com.vn/c3/pages-t/Generation-Projects-6-167.aspx

can be increased to 25% given financial support from the international community.[19] Under Vietnam's business-as-usual scenario, projected 2030 CO2 emissions are 787.4 MT CO2. An 8% reduction would be equivalent to 63 MT CO_2, while a 25% reduction would be equivalent to 196.9 MT CO_2.

Table 3: National electricity grid emissions factors (2012-2016)

Year	2016	2015	2014	2013	2012
Grid Emissions Factor (tCO_2/MWh)	0.9185[20]	0.8154[21]	0.6612[22]	0.5657[23]	0.5603[24]

5.2. Power Distribution & Electricity Rates

Vietnam has made remarkable progress in the last few decades in increasing access to electricity for the rural population, and now boasts nearly 100% electrification across the country – in 1990, only 68% of rural areas had access to electricity.

EVN, established in 1994, dominates the power sector. Vietnam consolidated the various power generators under EVN, and later transformed EVN into a state owned limited liability corporation in 2010. Under EVN, there are three Power Generation Corporations (EVNGENCOs 1, 2, 3), one power transmission corporation (National Power Transmission Corporation - EVNNPT), five regional power distribution corporations (for the North, Central, South, and the two cities of Hanoi and Ho Chi Minh), and 20 dependent-accounting units. In total, EVN owns 25,884 MW (61.4%) of the 42,135 MW of total installed capacity in Vietnam. The remainder is split between the state-owned oil and gas group PetroVietnam, a state-owned mining company, VINACOMIN, and other private investors with smaller ownership stakes. [25]

EVN is in the process of expanding generation through the construction of both fossil fuel and renewable power generation facilities. Over the years, EVN has performed various demand side management (DSM) and energy efficiency activities, including assisting dragon fruit growers by replacing incandescent light bulbs with compact fluorescent lamps, organizing energy efficiency family competitions, and Earth Hour campaigns.[26]

As the primary electricity provider, EVN serves 24.85 million customers. Electricity tariffs are mandated through the Ministry of Industry and Trade (MOIT) and approved by the Prime Minister. A low, unified average tariff is applicable across the country. Since 2012, the average electricity tariff has increased by 29.7%, averaging 6.7% annual growth. MOIT announced the most recent 8.36% increase to the electricity tariffs on March 20, 2019, as part of an effort to adjust to the fact that input prices for power generation enterprises are no longer sponsored by the state.[27] Low urban and rural residential rates are cross-subsidized by higher rates to industry and commercial buildings, as well as to foreign customers. Marginal adjustments to the average tariff of no

[19] Viet Nam First NDC. 03/11/2016. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Viet%20Nam%20First/VIETNAM%27S%20INDC.pdf
[20] Ministry of Natural Resources and Environment - Department of Climate Change, Official letter No. 243/BDKH-GNPT dated 6/4/2018
[21] Ministry of Natural Resources and Environment - Department of Meteorology, Hydrology and Climate Change, Official letter No. 315/KTTVBDKH-GSPT dated 17/03/2017. http://www.noccop.org.vn/Data/vbpq/Airvariable_ldoc_73vnCV%20EF%202015.pdf
[22] Ministry of Natural Resources and Environment - Department of Meteorology, Hydrology and Climate Change, Official letter No. 605/KTTVBDKH-GSPT dated 19/05/2016 http://www.noccop.org.vn/Data/vbpq/Airvariable_ldoc_vnBao%20cao%20cuoi%20cung%20EF%202014.pdf
[23] Ministry of Natural Resources and Environment - Department of Meteorology, Hydrology and Climate Change, Official letter No. 605/KTTVBDKH-GSPT dated 19/05/2016 http://www.noccop.org.vn/Data/vbpq/Airvariable_ldoc_vnBao%20cao%20cuoi%20cung%20EF%202014.pdf
[24] Ministry of Natural Resources and Environment - Department of Meteorology, Hydrology and Climate Change, Official letter No. 539/KTTVBDKH dated 21/04/2014 http://www.noccop.org.vn/Data/vbpq/Airvariable_ldoc_70vnBao%20cao%20EF%202012.pdf
[25] Vietnam Electricity. Annual Report 2017. https://en.evn.com.vn/userfile/User/huongbtt/files/2018/2/AnnualReport2017.pdf
[26] Information provided by EEI.
[27] Viet Nam News. 2019. "With latest increase, electricity prices move towards market mechanism" Economy - Vietnam News. Accessed March 29, 2019. https://vietnamnews.vn/economy/507549/with-latest-increase-electricity-prices-move-towards-market-mechanism.html

greater than 5% are allowed when fuel inputs and other market factors necessitate doing so. The average annual tariffs are summarized in **Table 4.**

Table 4: Average electricity prices in Vietnam

Period	Average Price without VAT (VND/kWh)	Average Price without VAT (USD/kWh)
03/2019 - present	1864.44	0.080
12/2017 – 03/2019	1720.65	0.074
03/2015 – 11/2017	1622.01	0.070
08/2013 – 03/2015	1508.85	0.065
12/2012 – 07/2013	1437.00	0.062

The electricity tariffs actually faced by room AC users are generally higher than the average rate, because EVN utilizes a block rate structure, whereby the marginal tariff increases based on how much electricity customers consume within a single billing period. Customers consuming below 200kWh per month may indeed face, on average, something close to the MOIT mandated 1864.44 VND/kWh average electricity tariff. However, this level of electricity consumption would not allow for use of a room AC, because the most popular ACs in the Vietnamese market use between 60 and 123 kWh/month.[28] Most room AC users thus fall into the higher tiers of electricity consumption. See **Table 5** below for a complete summary of EVN household consumer tariffs, as revised on March 20, 2019.[29]

Table 5: EVN retail electricity tariffs for household consumers

Customer Group	Rate (VND/kWh)	Rate (USD/kWh)
Retail price for household electricity		
For the first 50 kWh (0 – 50 kWh)	1,678	0.072
For the next 50 kWh (51 – 100 kWh)	1,734	0.075
For the next 100 kWh (101 – 200 kWh)	2,014	0.087
For the next 100 kWh (201 – 300 kWh)	2,536	0.109
For the next 100 kWh (301 – 400 kWh)	2,834	0.122
For the next kWh (401 kWh onwards)	2,927	0.126
Retail price for household electricity via prepaid card meter	2,461	0.106

[28] Based on the following example: a typical 9,000 Btu/hr AC with a CSPF of 3.40 W/W used for 925 hours per year, would use approximately 60 kWh per month. A typical larger capacity model of 18,000 Btu/hr with a CSPF of 3.30 used for 925 hours per year would use approximately 123 kWh per month. See Section 8.2 for more information.

[29] Vietnam Electricity. (2019). "Retail electricity tariffs." Electricity Price. https://en.evn.com.vn/d6/gioi-thieu-d/RETAIL-ELECTRICITY-TARIFF-9-28-252.aspx

Policy Options and Impacts Assessment

6 Legal & Regulatory Framework Overview

Vietnam has a longstanding energy efficiency policy first issued in 2003, which has been revised and strengthened over the years with MOIT at the helm. In addition to this national policy, Vietnam ratified the Montreal Protocol in 1994, and has since steadily worked to phase out ozone depleting substances used in air-conditioning since.

Vietnam's national energy efficiency policy was first initiated by the issuance of the Governmental Decree on Thrifty and Efficient Use of Energy (No. 102/2003/ND-CP) in 2003. The decree outlined the efficient use of energy in production establishments, buildings, and daily activities, as well as for energy consuming equipment and means. The Decree also sets measures to promote the efficient use of energy, such as incentives policies, consumer awareness promotion, and research.

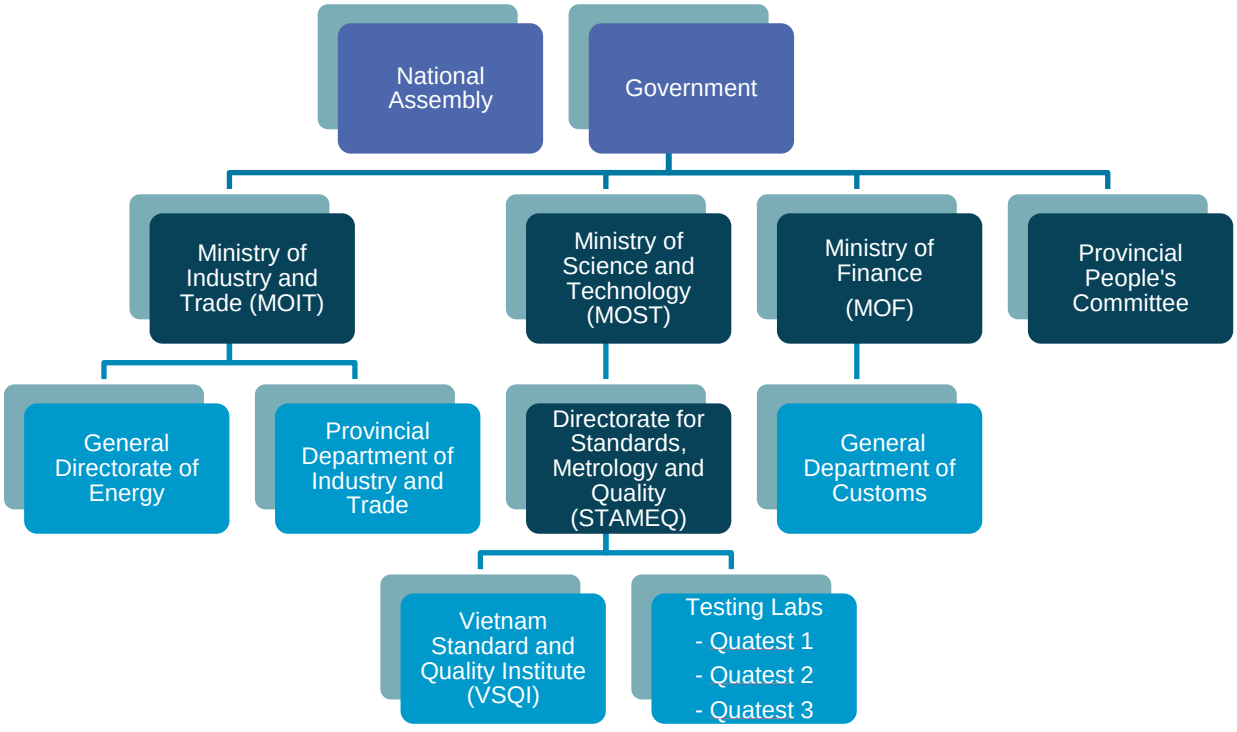
Vietnam National Energy Efficiency Program (VNEEP), initiated in 2006 by Decision No: 79 /2006 / QD-TTg, was the first-ever comprehensive program designed to improve energy efficiency in all sectors in Vietnam. The program was divided into two phases:

- Phase One (2006~2010): 3~5% energy savings from 2006 level
- Phase Two (2011~2015): 5~8% energy savings from 2006 level

Six components and a total of 11 projects were specified in VNEEP in order to achieve these savings.

On June 17, 2010, the 12th National Assembly approved the Law on Energy Saving and Efficiency. The law became effective on Jan 1, 2011, forming the legal basis for Vietnam's national energy efficiency programs. The law provides policies and measures to promote economical and efficient use of energy, and outlined the rights, obligations and responsibilities of organizations, households and individuals in the economical and efficient use of energy.

Figure 19: Institutional structure of Vietnam's energy efficiency S&L program[30]



[30] Vietnam Standards and Quality Institute. Presentation on Energy Efficiency Program for Air Conditioner in Viet Nam on July 11, 2017.

Ministry of Industry and Trade (MOIT) is the permanent body of the Program Steering Committee chair, which is responsible for coordinating with ministries and other relevant organizations to implement programs and activities. The General Directorate of Energy (GDE) is the responsible department within MOIT for managing VNEEP.

Under GDE, the Energy Conservation Office manages and implements the energy performance standards and labeling program. The Department of Science, Technology and Energy Efficiency is responsible for providing technical inputs and recommendations.

The Directorate for Standards, Metrology and Quality (STAMEQ) under the Ministry of Science and Technology (MOST) is the national standardization agency. STAMEQ is responsible for advising Government on issues in the fields of standardization, metrology, productivity and quality management in the country and representing Vietnam in relevant international and regional organizations. STAMEQ has three testing facilities, namely QUATEST 1, QUATEST 2, and QUATEST 3. Of the three, QUATEST 3 facility is the only lab with air conditioner testing capacity.

Vietnam Standards and Quality Institute (VSQI) is a functioning department under STAMEQ responsible for implementing activities including standardization, technical regulations, quality of barcodes and national quality awards. VSQI is the key organization responsible for developing the National Standards of Vietnam (TCVN).

Vietnam officially ratified the Montreal Protocol on January 26, 1994.[31] In 2002, the Ministry of Natural Resources and Environment (MONRE) was established and assigned as the focal point for implementation of the Montreal Protocol. Since then, Vietnam has been steadily working to phase out ozone depleting substances (ODS), such as CFCs and HCFCs, used in air-conditioning. In 2010, Vietnam fulfilled its obligation to completely phase out CFCs, Halon and CTC, and in 2015 Vietnam met its obligation to phase down 10% of baseline HCFC consumption by phasing out HCFC-141b used in foam production. Most recently, Vietnam completed HCFC Phase Out Management Plan Stage I (2012-2017), and initiated HCFC Phase Out Management Plan Stage II with support from the Multilateral Fund. This program aims to support Vietnam in phasing out 35% of baseline HCFC by 2024.

As of the publication date of this report, Vietnam had yet to ratify the Kigali Amendment to the Montreal Protocol. If ratified, Vietnam will follow the phase-down schedule for countries under Article 5 Parties Group 1, summarized in **Table 6**.

Table 6: Kigali phase out schedule for Article 5 Parties: Group 1

Baseline Years	2020, 2021, & 2022	
Baseline Calculation	Average product/consumption of HFCs in 2020, 2021, and 2022 + 65% of HCFC baseline production/consumption	
Reduction Steps	**2024**	Freeze consumption/production levels
	2029	10% reduction in consumption/production of HFCs and HCFCs
	2035	30% reduction in consumption/production of HFCs and HCFCs
	2040	50% reduction in consumption/production of HFCs and HCFCs
	2045	80% reduction in consumption/production of HFCs and HCFCs

[31] Vietnam Environment Administration. (2018). "MONRE marks 24 years of Vietnam's ratification and implementation of the Montreal Protocol." Accessed Dec. 4, 2018. http://vea.gov.vn/en/news/news/Pages/MONRE-marks-24-years-of-Vietnam%E2%80%99s-ratification-and-implementation-of-the-Montreal-Protocol.aspx

7 Room AC Policy Framework (S&L)

Vietnam has minimum energy performance standards (MEPS) for air conditioners as well as nine other household appliances or pieces of equipment.[32] STAMEQ, under MOST, prepares and develops standards in consultation with stakeholders such as universities, industry, government, associations, testing laboratories, and specialists, which are submitted to MOST for adoption. Regulated products are labeled using a mixture of comparative and endorsement labels; however, for room ACs, the use of the comparative energy label is mandatory. MOIT is responsible for ensuring ACs on the market are in compliance with the MEPS.[33]

Responsibility for managing the energy efficiency S&L program in Vietnam is divided between four key government agencies as follows: [34]

- **MOIT** – Policy drafting, database management, awareness training, market surveillance, monitoring of the S&L program, and sanctions
- **MOST** – Energy efficiency standards development, MEPS, testing labs
- **MOF –** Incentives and supporting policies, procurement guidelines, customs clearance
- **Provincial People's Committee** – Market surveillance, sanctions

The method for testing ACs in Vietnam is TCVN 6576:2013 (equivalent to ISO 5151:2010) *Non-ducted air conditioners and heat pumps - Testing and rating for performance*. The evaluation method used is TCVN 10273-1:2013 (equivalent to ISO 16358-1:2013) *Air-cooled air conditioners and air-to-air heat pumps - Testing and calculating methods for seasonal performance factors - Part 1: Cooling seasonal performance factor*. Vietnam uses test condition T1.

Use of the energy label is mandatory. *Circular No 36/2016/TT-BCT On Energy Labeling for Means and Equipment Using Energy Under Management of the Ministry of Industry and Trade* outlines conformity assessment and labeling requirements.[35] AC manufacturers must register each product with MOIT and apply for an energy label. To do so, manufacturers need to prepare application dossiers and send product samples to the MOIT-designated testing center, which can be third-party or manufacturer laboratories in-country and abroad. After manufacturers receive the testing results, they send completed application dossiers to MOIT for certification. MOIT evaluates the application and makes a decision as to whether or not to grant an energy label certificate for the product. Manufacturers are then permitted to use the energy label for a maximum of three years upon successful application, and must print and affix the energy labels to their products.

Vietnam first implemented MEPS for ACs in 2007 under TCVN 7830:2007 *Air conditioners – Energy Efficiency*, and revised the AC MEPS in 2012 and again in 2015. Until 2013 the MEPS were voluntary. The latest MEPS revision mandated the use of the CSPF energy performance metric and extended the regulation to cover inverter ACs. The current standard in force is TCVN 7830:2015 *Non-ducted air conditioners – Energy Efficiency.* Under the previous 2012 standard, MEPS applied to all ACs with capacities under 48,000 Btu/hr; however, the 2015 standard only covers ACs up to 41,000 Btu/hr. **Table 7** summarizes the current AC MEPS in Vietnam.

[32] Tubular fluorescent lamps, compact fluorescent lamps, electromagnetic ballasts for fluorescent lamps, electronic ballasts for fluorescent lamps, refrigerators/freezers, electrical washing machines, electric rice cookers, electric fans, and television sets. MEPS for LEDS and storage water heaters are in development. Vietnam Standards and Quality Institute. Presentation on Energy Efficiency Program for Air Conditioner in Viet Nam on July 11, 2017.

[33] *Decision No. 24/2018/QD-TTg Promulgating the list of low-efficiency equipment that has to be discarded and low-efficiency generating sets that are prohibited from being built, and the roadmap to implementation thereof.*

[34] Ibid.

[35] *Circular No 36/2016/TT-BCT On Energy Labeling for Means and Equipment Using Energy Under Management of the Ministry of Industry and Trade.* https://vanbanphapluat.co/circular-36-2016-tt-bct-energy-labeling-for-means-equipment-using-energy

Table 7: MEPS for ACs in Vietnam (CSPF)

Type of AC	Capacity (Btu/h)	Grade				
		1 Star (MEPS)	2 Star	3 Star	4 Star	5 Star
Single	-	≥ 2.80	≥ 3.00	≥ 3.20	≥ 3.40	≥ 3.60
Split	CC ≤ 15,000	≥ 3.10	≥ 3.40	≥ 3.60	≥ 3.80	≥ 4.20
	15,000 ≤ CC < 24,000	≥ 3.00	≥ 3.20	≥ 3.40	≥ 3.60	≥ 4.00
	24,000 ≤ CC < 41,000	≥ 2.80	≥ 3.00	≥ 3.20	≥ 3.40	≥ 3.80

Vietnam, as a member of the Association of Southeast Asian Nations (ASEAN), endorsed the 2015 ASEAN-SHINE target to harmonize MEPS for ACs below 3.52 kW (12,032 Btu/hr) cooling capacity to 3.08 W/W by 2020. At 3.10 W/W, Vietnamese MEPS for split ACs under 12,032 Btu/hr, which represent 59% of the market, are already above the ASEAN MEPS target.

Given the successful market transformation brought by the introduction of the CSPF and the high penetration of efficient technology in Vietnam, there is room for the government of Vietnam to be more ambitious during the next MEPS and star ratings revisions.

Vietnam has put in place mechanisms to ensure compliance with the labeling program. Market surveillance of retailers and manufacturers takes place once a year. Departments of Industry and Trade at the local provincial level are responsible for the market surveillance effort. The market surveillance mechanisms are as follows:

- Market monitoring to ensure that all eligible products are registered and label display surveys to check that regulated products have energy labels, display correct labels, and that labels are placed correctly on products at the point of sale. It is the responsibility of the vendor to ensure that product labels are not misused or wrongly placed.
- Verification/check testing to ensure that the energy performance of product meet the declared values. Products are randomly selected from the market and tested by designated laboratories.

The enforcement of MEPS and energy labels is also carried out by Departments of Industry and Trade at the provincial level, but little enforcement has been done to date. *Decree 134/2013/ND-CP Regulation sanction against administrative violation in the field of electricity* outlines forms of violations, sanctioning levels, and remedial measures in different energy fields including energy efficiency.[36]

[36] See Articles 30-32. *Decree No. 134/2013/ND-CP regulations on sanction against administrative violation in the field of electricity*. https://vanbanphapluat.co/decree-no-134-2013-nd-cp-regulations-on-sanction-against-administrative-violation-in-the-field-of-electricity

8 Introduction & Methodology for Policy Analysis

CLASP evaluated policy scenarios to assess impacts from increasing the room AC MEPS to various efficiency levels, using the Policy Analysis Modelling System (PAMS), developed by CLASP and Lawrence Berkeley National Laboratory to help policymakers assess the costs and benefits of S&L programs.[37]

PAMS is an easy-to-use tool that helps policymakers assess the benefits of S&L programs and identify cost-effective targets for MEPS levels. It is an Excel workbook designed to give first-order policy impacts projections with minimal preparatory research on the part of local policymakers. The model can also be used to perform robust technical analysis to support the development of MEPS, by customizing the tool with any country-specific data that is available.

PAMS can estimate savings potential from implementing policies that improve the energy efficiency of products in any economy. The impacts are examined from two perspectives – the consumer and national perspective:

- **At the consumer level,** savings are estimated using the lifecycle cost (LCC) metric - the total costs of owning the appliance, including the purchase price and operating cost throughout its life. Savings are measured between the business-as-usual and improved policy scenarios.
- **At the national level**, energy savings are expressed in terms of the reduction in national energy consumption due to more efficient appliances as well as in terms of avoided CO_2 emissions resulting from reduced electricity consumption.

In this analysis, CLASP used the market assessment findings to customize the tool with relevant data for Vietnam, and evaluated the impacts to consumers as well as impacts at the national level for selected policy scenarios. Additionally, CLASP estimated the impacts to the manufacturers by estimating the number of models eliminated from the market under more stringent MEPS.

8.1. Cost-Efficiency Relations

Many factors such as brand, appearance, technologies used, refrigerant used, or smart functionalities, may affect the prices of AC. However, usually improved efficiency increases the up-front cost of the appliance resulting in a higher price. CLASP uses cost-efficiency curves to establish the relationship between price and efficiency, in order to assess the impacts to the consumer of raising MEPS. The best way to develop a cost-efficiency curve is through an engineering analysis where individual costs and efficiency improvements are accounted for in each component of the AC. This process often requires substantial resources to complete. In this market assessment, CLASP develops a relationship between cost and efficiency through the collected market data and regression analysis.

We performed a multiple regression analysis on CSPF, cooling capacity, and price. The regression model uses data from 1,344 observations of ACs, with cooling capacities ranging from 8,500 to 34,100 Btu/hr and CSPFs ranging from 3.01 to 7.20 W/W, to approximate a linear relationship between the dependent variable, Price, and two independent variables, CSPF and Cooling Capacity. The output of the regression analysis can be found in Appendix A. The R Square value of the regression model was 0.749, indicating that the linear model using cooling capacity and efficiency explains approximately 75% of the variation in price. Additionally, the p-values for both variables (i.e. CSPF and cooling capacities) are smaller than 0.01, indicating the relationship between both variables and AC prices is highly statistically significant.

The relationship between the three variables can be expressed by the following equation:

$$Price = -14{,}368.60 + 2{,}626.78(CSPF) + 1.197(Cooling\ Capacity)$$

Where: Price is in Thousands of VND/unit, CSPF is in W/W, and Cooling Capacity is in Btu/hr.

By using the above equation, we calculate cost and efficiency factors and plot cost-efficiency curves for the three most popular cooling capacities found in the Vietnamese market – 9,000 Btu/hr, 12,000 Btu/hr, and 18,000 Btu/hr.

[37] The Policy Analysis Modelling System (PAMS) is available online at https://clasp.ngo/tools/policy-analysis-modeling-system

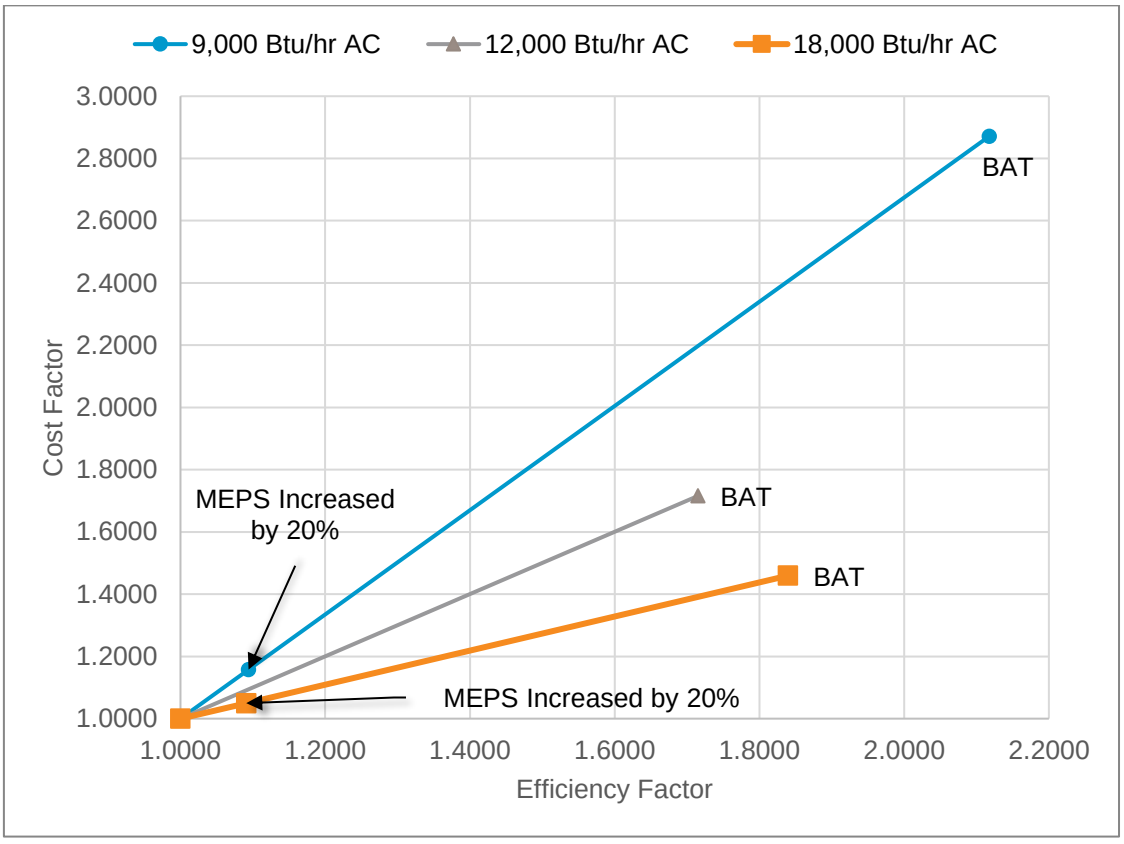
The three most popular cooling capacities were analyzed separately. Baseline CSPF for each capacity was obtained by identifying the CSPF which occurred most frequently among those models which fall below the current 5-star level. Because nearly 60% of models on the market fall in the 5-star category, and the Vietnamese market is dominated by inverter AC, this analysis estimates impacts from removing the lower-efficiency models. Baseline prices were calculated by taking the average price of those under-5-star models on the market with the most common CSPF.

Table 8: Baseline models selected for PAMS analysis

Cooling Capacity	Most Popular CSPF of below 5-Star ACs on the Market	Average Price (VND)	Average Price (USD)
9,000 Btu/hr	3.40 W/W	6,056,000 VND	260.41 USD
12,000 Btu/hr	4.14 W/W	10,561,000 VND	454.12 USD
18,000 Btu/hr	3.30 W/W	16,287,000 VND	700.34 USD

The cost curve for smaller capacity models is steeper indicating that increases in efficiency are more costly as compared to larger capacity models. Starting efficiency for the three base cases (equal to 1.0 efficiency factor in **Figure 20Error! Reference source not found.**) corresponds to the most common CSPF for the selected cooling capacity as shown in **Table 8**.

Figure 20: Cost-efficiency curves for CSPF



8.2. PAMS Analysis

PAMS estimates the impacts of implementing policies that improve energy efficiency of new equipment by calculating the difference between a business-as-usual scenario (i.e., no policies implemented) and a policy scenario (i.e., higher MEPS or Best Available Technology). The model uses a bottom-up approach, based on a stock model and sales forecasts considering first purchase (increase in number of households and ownership levels) and replacement of retired appliances.

In the model, total energy consumption is estimated per year for the stock in use under each policy scenario. Emissions are estimated using an electricity grid CO_2-intensity emissions factor, CO_2/kWh. Estimated total lifecycle costs are estimated considering appliance prices (defined for each scenario using a cost-efficiency curve reflective of the market) and local electricity prices.

CLASP used the following data inputs and assumptions to estimate the impacts under different scenarios:

Underlying macroeconomic data:

- Historical and projected population[38] and urbanization[39] in Vietnam are from UN Population.
- A deposit interest rate of 4.78% (as the consumer discount rate) and a real interest rate of 3.15% are used to estimate cost savings at the consumer and national level. [40]
- A real income growth rate of 5.73% is used.[41]

Underlying power sector data:

- Transmission and distribution (T&D) Loss Factor is 9.20%.[42]
- The most recent grid emissions factor of 0.9185 kg CO_2/kWh is used. This is the grid emissions factor reported for 2016.[43]
- We estimated average electricity tariffs for room AC users based on EVN's block rates for household consumers. Median household energy consumption in Vietnam is approximately 100 kWh per month.[44] Assuming energy consumption from ACs is additional to this baseline, we looked at EVN tariffs for electricity consumed after the first 100 kWh.
    - The estimated energy consumption of the baseline small and medium capacity (9,000 and 12,000 Btu/hr) ACs are 60 kWh/month[45] and 65 kWh/month[46] respectively. This would place small or medium capacity AC users in the 100 kWh or more tiers. Thus, for users of small and medium capacity ACs, we estimated the tariff at 2,578 VND/kWh.[47]

[38] UN, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects: The 2017 Revision
[39] UN Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization Prospects: The 2018 Revision. https://population.un.org/wup/Country-Profiles/
[40] World Bank. 2017. Deposit interest rate (%), Real Interest rate (%) available at: https://data.worldbank.org/
[41] World Bank. 2017. GDP per capita growth (%) is available at: https://data.worldbank.org/
[42] World Bank. 2014. Electric power transmission and distribution losses (% of output) available at: https://data.worldbank.org/
[43] Ministry of Natural Resources and Environment - Department of Climate Change, Official letter No. 243/BDKH-GNPT dated 6/4/2018
[44] Minh Ha-Duong, Hoai-Son Nguyen. (2017). *Is electricity affordable and reliable for all in Vietnam?* The tenth Vietnam Economist Annual Meeting - VEAM 2017, Aug 2017, Ho Chi Minh Ville, Vietnam. https://hal-enpc.archives-ouvertes.fr/hal-01389981v3/document
[45] Calculated as: 9,000 Btu/hr × 0.293 Btu/W ÷ 3.40 W/W × 925 hours/year ÷ 1000 ÷ 12 months = 60 kWh/month
[46] Calculated as: 12,000 Btu/hr × 0.293 Btu/W ÷ 4.14 W/W × 925 hours/year ÷ 1000 ÷ 12 months = 65 kWh/month
[47] Calculated by averaging the tariff rates for consumption after the first 100 kWh (See Table 5).

- The estimated energy consumption of the baseline large capacity (18,000 Btu/hr) AC is 123 kWh/month,[48] which would place users of larger room ACs in the 200 kWh or more tier. Thus, for users of large capacity ACs, we estimated the tariff at 2,766 VND/kWh.[49]

Table 9: Estimated electricity tariffs for room AC users

Cooling Capacity	Estimated Tariff (VND/kWh)	Estimated Tariff (USD/kWh)	Calculations
9,000 Btu/hr 12,000 Btu/hr	2,577.75	0.111	Average of EVN tariffs applied to electricity consumption after the first 100 kWh. See **Table 5**.
18,000 Btu/hr	2,765.67	0.119	Average of EVN tariffs applied to electricity consumption after the first 200 kwh. See **Table 5**.

AC Market Data

- We obtained AC Sales data and forecasts for 2003 to 2022 from Euromonitor, and compared these values with the AC market size reported by EEI. The geometric mean CAGR of sales from 2003 to 2022 was calculated and used to model sales data from 1980 to 2002 and from 2022 to 2030.
- The following market shares for ACs were assumed: 32.8% for 9,000 Btu/hr ACs, 31.9% for 12,000 Btu/hr ACs, and 35.3% for 18,000 Btu/hr ACs.
- Based on average estimates given by manufacturers, importers, and exporter, the average AC lifetime is 10.5 years with 925 operating hours per year.
- Unit energy consumption was calculated based on the baseline values in **Table 8** using the formula:

$$UEC = \frac{Cooling\ Capacity}{CSPF \times 3.412 \times 1000} \times Annual\ operating\ hours$$

- The exchange rate used for conversion to and from VND and USD was 0.000043 VND/USD.[50]

Policy Implementation Assumptions

- The standard year, or year when the policy is implemented, is set at 2020. The analysis focuses on the impacts of a policy implemented from 2020 to 2030.

[48] Calculated as: 18,000 Btu/hr × 0.293 Btu/W ÷ 3.30 W/W × 925 hours/year ÷ 1000 ÷ 12 months = 123 kWh/month
[49] Calculated by averaging the tariff rates for consumption after the first 200 kWh (See Table 5).
[50] Exchange rate taken on November 5, 2018.

9 Policy Options & Results

9.1. Policy Options

CLASP evaluated two policy options in the impacts analysis: increasing MEPS by 20% above their current level and adoption of best available technology.

Increasing MEPS and Star Ratings Levels by 20%

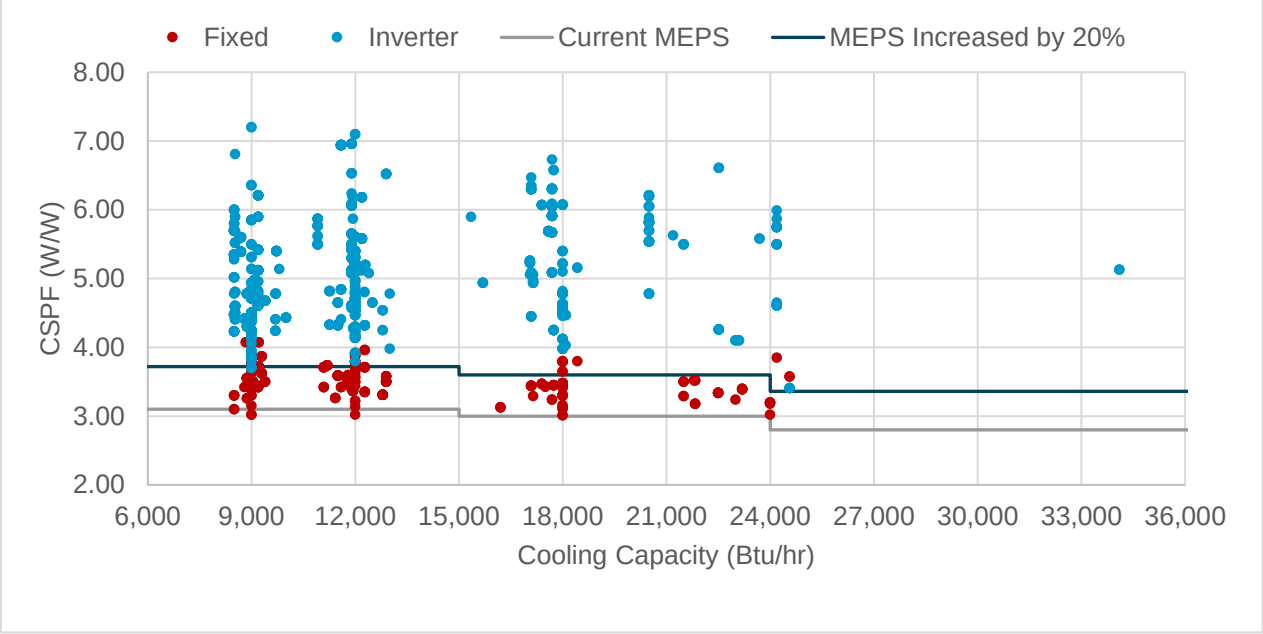
Given that Vietnam's MEPS already exceed the 3.08 W/W ASEAN MEPS target, the first policy scenario CLASP considered is a 20% increase in the current MEPS for split ACs in Vietnam. The current policy does not reflect technological progress, as is illustrated by nearly 60% of ACs in Vietnam falling into the 5-star category and only 5% of ACs currently falling into the 1-star category. Thus, under this policy scenario, the minimum CSPF required for each star level is increased by 20%. The ratings guidelines under this policy scenario are summarized in **Table 10**, and can be compared to those in **Table 7**.

Table 10: 20% increase to MEPS and star ratings plan for split ACs

Type of AC	Capacity (Btu/h)	Grade				
		1 Star (MEPS)	2 Star	3 Star	4 Star	5 Star
Split	CC ≤ 15,000	≥ 3.72	≥ 4.08	≥ 4.32	≥ 4.56	≥ 5.04
	15,000 ≤ CC < 24,000	≥ 3.60	≥ 3.84	≥ 4.08	≥ 4.32	≥ 4.80
	24,000 ≤ CC < 41,000	≥ 3.36	≥ 3.60	≥ 3.84	≥ 4.08	≥ 4.56

Increasing the MEPS and rescaling the star ratings plan by 20% would remove the least efficient ACs, most of which are fixed-speed units, from the market, as is illustrated in **Figure 21** below.

Figure 21: Vietnamese AC market with MEPS increased by 20% (N=1391)



Best Available Technology (BAT)

The second policy scenario for which CLASP conducted an analysis is transitioning the market to the best available technology. The purpose of this analysis is to provide an estimate of the potential energy savings and emissions reductions possible if consumers only used the best AC already available in the Vietnamese market. **Table 11** summarizes the CSPFs and average prices for the BAT for the most popular cooling capacities in Vietnam.

Table 11: Best available technology for three most popular cooling capacities

Cooling Capacity	Highest CSPF on the Market	Average Price (VND)	Average Price (USD)
9,000	7.20 W/W	16,000,000 VND	688.00 USD
12,000	7.10 W/W	17,500,000 VND	752.50 USD
18,000	6.07 W/W	17,800,000 VND	765.40 USD

9.2. Outputs

The tables below show the summary outputs of the PAMS analysis for the three baseline models. Under the 20% increase to MEPS scenario, consumers of smaller capacity (9,000 Btu/hr) and larger capacity (18,000 Btu/hr) ACs benefit from lifecycle cost savings. For medium capacity (12,000 Btu/hr) ACs, because the baseline CSPF for 12,000 Btu/hr is 4.14 W/W, and thus above the 3.72 W/W MEPS of this analysis, there are no consumer benefits, energy savings, or emissions savings at the national level. Under the BAT scenario, there are substantial energy savings and emission reductions associated with using the best available AC at each of the three cooling capacities.

Table 12: PAMS output summary for 9,000 Btu/hr room ACs

Metric	20% Increase to MEPS CSPF 3.72	BAT CSPF 7.20
Consumer Benefits		
Payback Period (years)[51]	6.00	11.61
LCC savings (VND)	287,490	-3,714,161
National Benefits		
Total Electricity Cost Savings through 2030 (billions of VND)	9,888	56,675
Benefit/Cost Ratio	1.09	0.59
Site Energy Savings in 2030 (GWh)[52]	629	3,496
Site Energy Savings through 2030 (GWh)	2,927	17,106
Source Energy Savings through 2030 (Mtoe)	0.36	2.10
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	2.96	17.30

[51] Payback period for consumers is estimated at the product level, and thus differs from the national-level cost/benefit ratio because different discount rates and calculations are used.
[52] Site energy savings refers solely to on-site energy savings from using ACs.

Table 13: PAMS output summary for 12,000 Btu/hr room ACs

Metric	20% Increase to MEPS CSPF 3.72	BAT CSPF 7.10
Consumer Benefits		
Payback Period (years)	N/A	8.95
LCC savings (VND)	N/A	-965,029
National Benefits		
Total Electricity Cost Savings through 2030 (billions of VND)	N/A	47,757
Benefit/Cost Ratio	N/A	0.77
Site Energy Savings in 2030 (GWh)	N/A	2,946
Site Energy Savings through 2030 (GWh)	N/A	14,414
Source Energy Savings through 2030 (Mtoe)	N/A	1.77
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	N/A	14.58

Table 14: PAMS output summary for 18,000 Btu/hr room ACs

Metric	20% Increase to MEPS CSPF 3.60	BAT CSPF 6.07
Consumer Benefits		
Payback Period (years)	2.38	4.01
LCC savings (VND)	1,849,693	7,085,142
National Benefits		
Total Electricity Cost Savings through 2030 (billions of VND)	24,176	117,146
Benefit/Cost Ratio	2.72	1.70
Site Energy Savings in 2030 (GWh)	1,448	6,755
Site Energy Savings through 2030 (GWh)	6,626	32,888
Source Energy Savings through 2030 (Mtoe)	0.81	4.04
CO_2 Emissions Mitigation through 2030 (MT CO_{2e})	6.70	33.27

10 Impacts Assessment Results

10.1 Impacts to Consumers

We assessed the impacts to consumers under two policy scenarios:

- **20% increase to MEPS scenario** savings are only substantial for consumers of smaller capacity ACs of 9,000 Btu/hr and larger capacity ACs of 18,000 Btu/hr and higher. The payback period for smaller capacity models is 6 years, with estimated LCC savings of 287,490 VND. Due to the low electricity tariff we estimated at 2,578 VND/kWh and long average product lifetime of 10.5 years, consumer lifecycle cost savings are relatively limited for these smaller units, which generally have lower purchase prices. Large capacity units have a shorter payback period of just 2.38 years and estimated LCC savings of 1,849,693 VND. The greater consumer benefits can be attributed to the higher costs of electricity, due to both operational differences and the higher estimated tariff of 2,766 VND/kWh for owners of larger units. There were no lifecycle cost savings to consumers for the middle range models, because the baseline CSPF of 4.14 W/W for these models is already well above the MEPS.
- **BAT scenario** showed no lifecycle cost (LCC) savings for all AC sizes, and payback periods were extremely long.

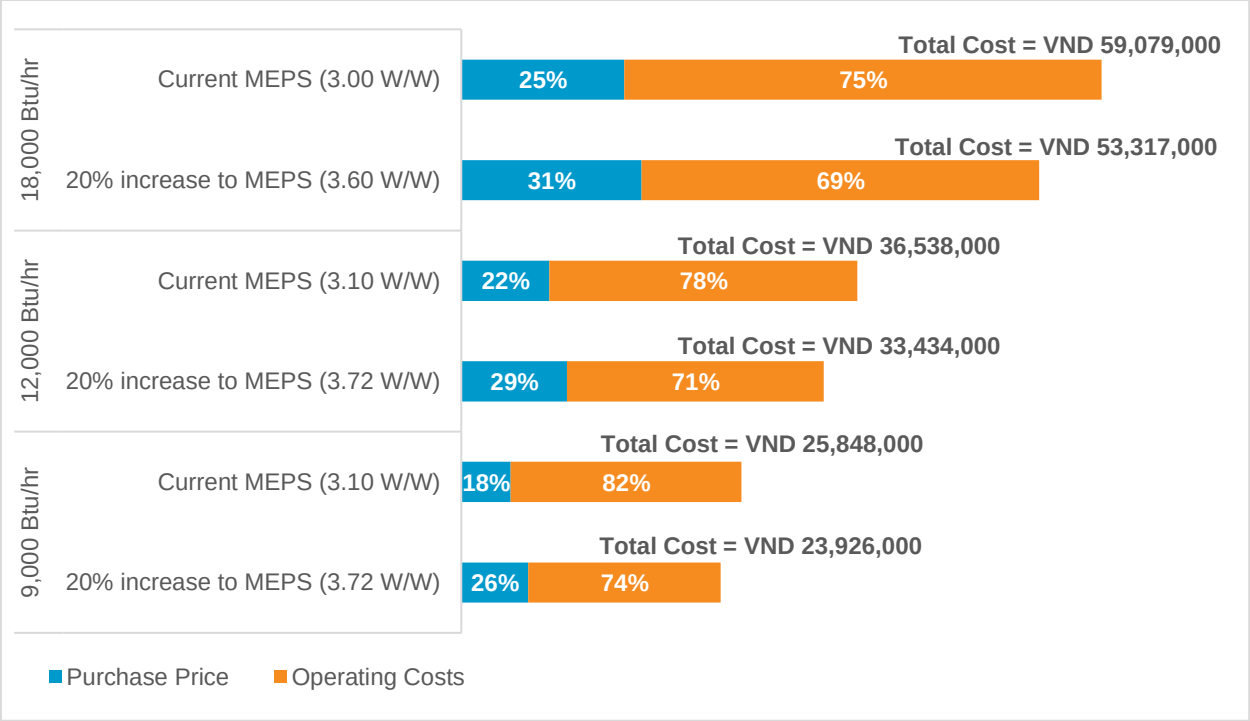
Table 15: Consumer benefits of a 20% increase to the current MEPS

Cooling Capacity	Most Popular CSPF on the Market	LCC Savings (VND)	LCC Savings (USD)	Payback Time	Benefit/Cost Ratio
9,000 Btu/hr	3.40 W/W	287,490 VND	12.36 USD	6.00 years	1.09
12,000 Btu/hr	4.14 W/W	NA	NA	NA	NA
18,000 Btu/hr	3.30 W/W	1,849,693 VND	79.54 USD	2.38 years	2.72

CLASP conducted additional analysis to estimate the increase in the up-front equipment price that would be faced by lower income consumers purchasing the less popular 1-star models. The median price of lower efficiency 1-star models would increase by approximately 6-7% for ACs at the three popular capacities we analyzed.[53] For the three baseline capacities, the median price for lower efficiency models increased by VND 400,000, VND 450,000, and VND 630,000 for 9,000 Btu/hr 12,000 Btu/hr, 18,000 Btu/hr ACs, respectively. This is equivalent to a price increase of USD 17-23 per model.

[53] CLASP looked at median prices, as opposed to average prices, for 1-star models in order to avoid potential skewing of the data by outliers at the upper and lower ends of the price ranges for 1-star models at the three baseline capacities.

Figure 22: Modeled consumer total lifecycle cost comparisons for ACs at the MEPS



Lifecycle cost savings are highly sensitive to fluctuations in the price of electricity. In Vietnam, the trade-off to subsidized electricity is reduced consumer benefit from energy efficiency policy.

CLASP conducted a sensitivity analysis to estimate the impacts of changes in price, electricity tariff, operating time, and product lifetime. From this analysis, which compares a 20% change to the aforementioned model inputs, we see that changes in the electricity tariff and in the number of hours consumers use their ACs have the most direct impacts.

Figure 23: Sensitivity analysis for LCC savings for 9,000 Btu/hr ACs

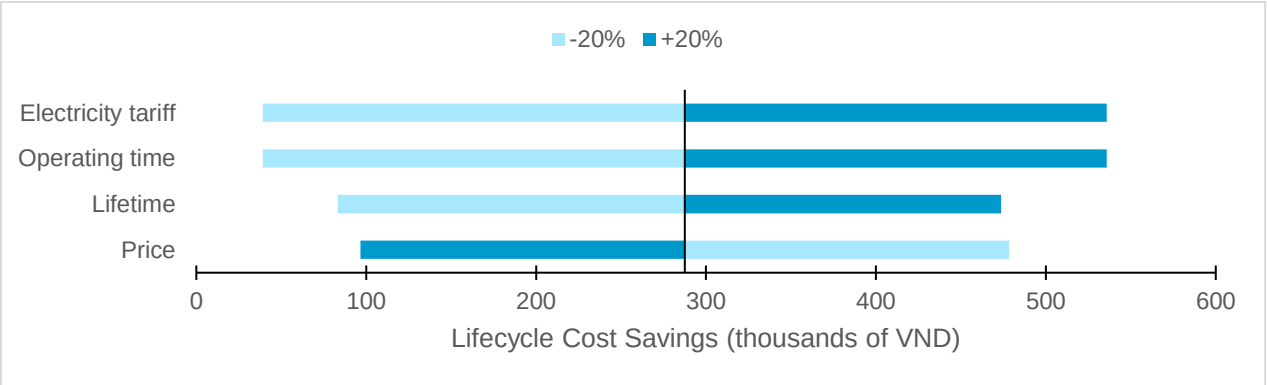


Figure 24: Sensitivity analysis for LCC savings for 12,000 Btu/hr ACs

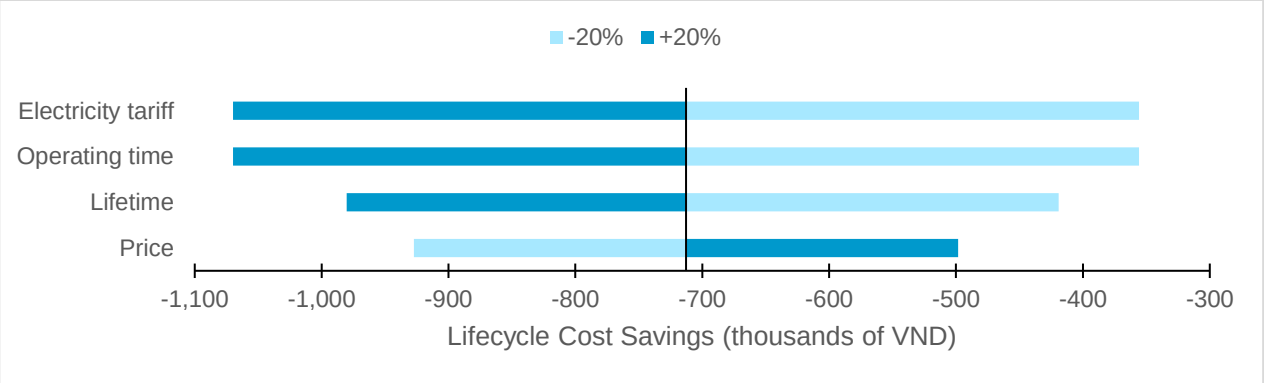
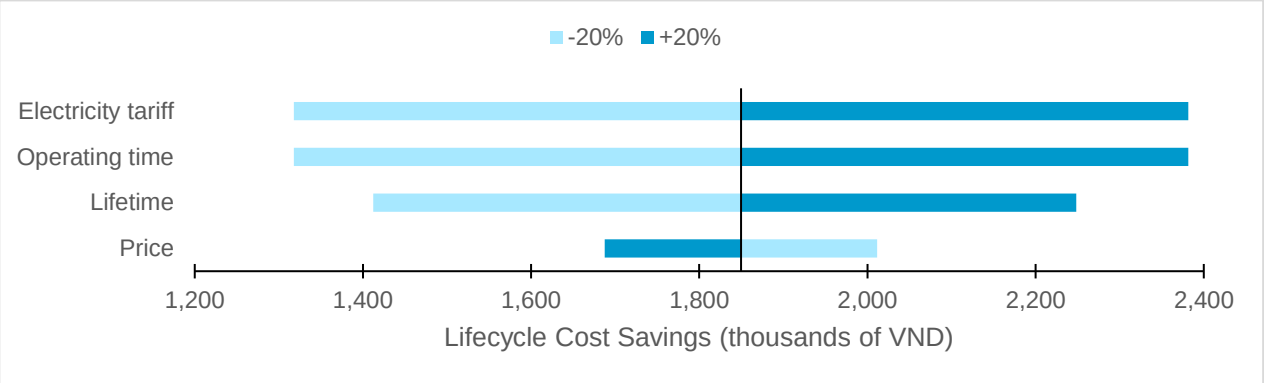


Figure 25: Sensitivity analysis for LCC savings for 18,000 Btu/hr ACs



10.2 Impacts to Manufacturers

According to the data collected in the retail survey, all of the 1,393 models for which energy efficiency information was reported using CSPF, 99.8% of the models across all capacities were in compliance with the current MEPS. More stringent MEPS would eliminate models from the market that are not compliant with the new requirements. We evaluated impacts on the manufacturers by considering how many models currently on the market would be eliminated under the two policy scenarios.

- **Under the 20% increase to MEPS scenario**, 22% of models, the vast majority of which are fixed speed models, would be removed from the market.
- **Under the BAT scenario**, nearly all models would be removed from that market.

Another component of the scenario in which Vietnam increases MEPS by 20% is the accompanying revision to the Vietnamese energy label's start rating system. **Table 16** summarizes the impact of a 20% increase to MEPS as well as a 20% increase to the minimum levels for each star rating category.

Table 16: Change in compliance and distribution of star ratings under 20% increase in MEPS (N=1393)

	Non-Compliant	1 Star	2 Star	3 Star	4 Star	5 Star
Current MEPS	0.2%	3.7%	11.4%	8.5%	6.2%	70.1%
20% Increase to MEPS	22.0%	6.0%	5.0%	11.6%	19.0%	36.4%
Difference	+ 21.8%	+ 2.4%	- 6.5%	+ 3.1%	+ 12.8%	- 33.7%

To understand the impact this policy would have on specific manufacturers, CLASP analyzed the retailer data to determine which brands would potentially see a significant number of their lower efficiency, fixed speed ACs removed from the market. **Table 17** summarizes the results of this analysis. The policy would affect all of the domestically operating brands for which energy efficiency data was available.

Table 17: Non-compliant models under 20% increase to MEPS (N=1393)

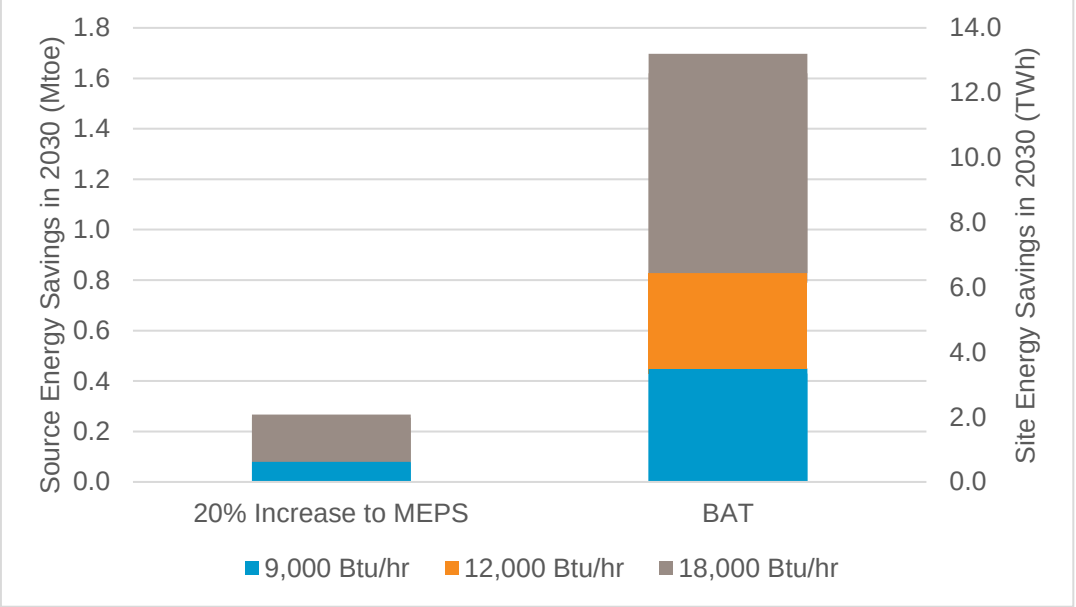
	Brand	% of models eliminated	# of non-compliant fixed speed models	# of non-compliant inverter models
Domestic assembly / manufacturing	Aqua (Haier)	12.5%	11	-
	Daikin	13.0%	33	-
	Electrolux	26.5%	22	-
	Hoa Phat (Funiki)	100 %	9	-
	Midea	42.9%	2	4
	Reetech	55.0%	11	-
Total Across Domestic		**19.7%**	**79**	**4**
No domestic assembly / manufacturing	Beko	0%	-	-
	Casper	40.9%	9	-
	Gree	37.5%	51	-
	Hitachi	0%	-	-
	LG	0%	-	-
	Mitsubishi Electric	38.9%	35	-
	Mitsubishi Heavy	16.4%	9	-
	Panasonic	24.2%	50	-
	Samsung	2.3%	2	-
	Sharp	14.8	13	-
	TCL	100%	5	-
	Toshiba	42.3%	41	-
	Yuiki	No CSPF data	No CSPF data	No CSPF data
Total Across Foreign		**23.2%**	**215**	**0**
Total Across all Brands:		**22%**	**303**	**4**

10.3 Impacts at the National Level

Energy Savings

- Under a business as usual scenario, in which no changes are made to Vietnam's MEPS for ACs, CLASP projects that by 2030 Vietnamese AC users will consume 35.6 TWh of energy annually. On the supply side, accounting for heat rate and transmission and distribution losses, generating this amount of electricity will require 4.4 megatonnes of oil equivalent (Mtoe) annually in 2030.
- Under the 20% increase to MEPS scenario, significant energy savings of just over 2.1 TWh of electricity in 2030 are possible. AC use-driven energy consumption in 2030 can be reduced by approximately 6%. Over a ten-year period, the cumulative site energy savings could reach nearly 9.6 TWh of electricity. On the supply side this translates to a reduction in source energy demand of approximately 0.25 Mtoe annually in 2030, and a cumulative reduction 1.2 Mtoe in the ten-year period from 2020-2030.
- Under the BAT scenario in which Vietnam transitions to the best available AC on the market, an estimated 37% reduction in 2030 energy use is possible, relative to business-as-usual. Essentially, the technology to reduce room AC-related energy consumption by one third is already market-ready.

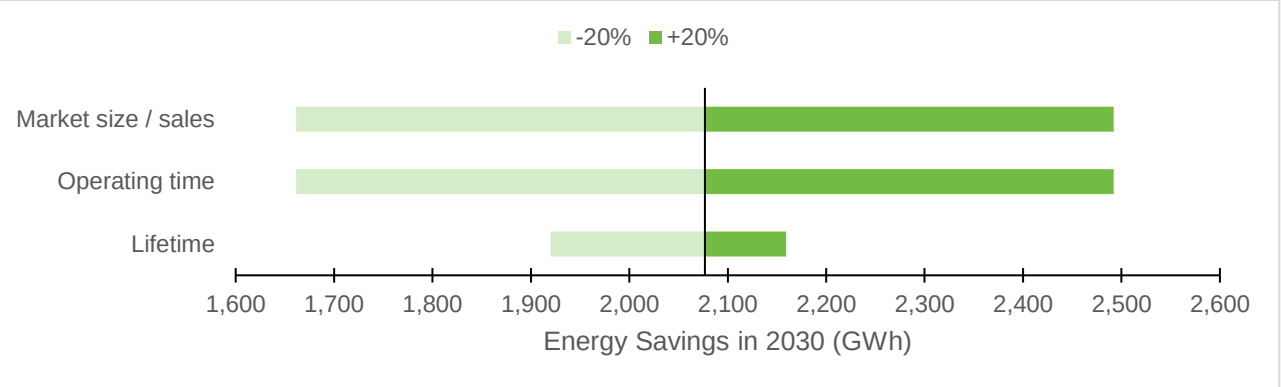
Figure 26: Energy savings in 2030 under different policy scenarios[54]



CLASP conducted a sensitivity analysis to estimate the impacts of changes in operating time, product lifetime and market size on site energy savings in 2030. From this analysis, which compares a 20% change to the aforementioned model inputs, we see that a 20% increase or a decrease in AC market size or operating time results in a direct and proportional increase or decrease to potential site energy savings in 2030. However, the relationship between lifetime and energy savings is less direct. A 20% increase to the average lifetime of all ACs, results in a 3.97% increase in potential site energy savings, while a decrease in average lifetime results would decrease 2030 site energy savings by 7.55%.

[54] Source energy savings represents the supply-side primary energy savings at the generation site in terms of reduced fossil fuel demand, and thus the metric of megatonnes of oil equivalent (Mtoe) is used. Some energy is lost during the generation and transmission and distribution of electricity. Site energy savings represents the demand-side electricity savings that occur on site in the homes of residential AC users, and is measured in terawatt hours (TWh).

Figure 27: Sensitivity analysis for site energy savings in 2030

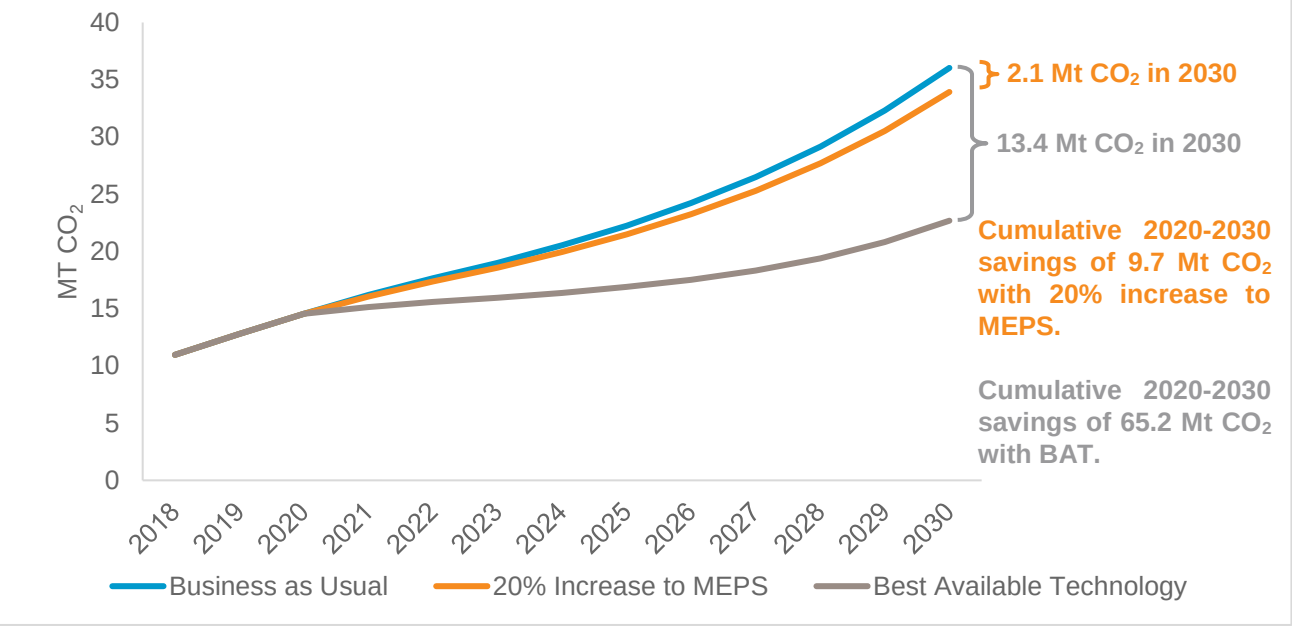


Emissions reductions

In 2030 Vietnamese AC users will consume 35.6 TWh of energy annually, resulting in up to 36 MT of CO_2 emissions.

- **The 20% increase to MEPS scenario** can deliver emissions reduction of 2.1 MT CO_2 in 2030. The projection for cumulative reductions for the period from 2020 through 2030 is 9.7 MT CO_2.[55]
- **Under the BAT scenario**, the CO_2 from operating ACs in households can be reduced by about 13.4 MT CO_2 in 2030. Market ready technology exists to reduce domestic space cooling related emissions in Vietnam by a cumulative 65.2 MT CO_2 through 2030.

Figure 28: Avoided CO_2 emissions over time and in 2030



[55] Emissions from refrigerants are not considered for this analysis.

11 Conclusions and Recommendations

The Vietnam Room Air Conditioner Market Assessment and Policy Options Analysis provides the technical evidence to support a revision of MEPS. The Vietnamese AC market is ready for an increase in MEPS and revisions to the labeling ratings. Government agencies can use this information to define their efficiency baseline for ACs, quantify potential energy and GHG emissions savings in support of national energy efficiency targets or NDC commitments, and estimate other potential benefits from revising the S&L program.

The analysis in this report is based on product data for 1,773 models from 20 retail stores in Vietnam. The analysis is limited to the primary data collected through the retail store visits. This assessment of the room AC market in Vietnam provides evidence for the development and implementation of more stringent energy performance standards and labeling in Vietnam

Inverter ACs dominate the Vietnamese market, and prices for efficient and inefficient ACs are converging. Prices for inverter models have fallen low enough that the cost difference between smaller capacity, less efficient fixed speed ACs and efficient, inverter ACs size can be quite low. For an example from the retail survey, a 5,890,000 VND fixed speed 9,000 Btu/hr AC with a 3.15 CSPF available from one retailer cost just 200,000 VND less than a 9,000 Btu/hr inverter AC with a CSPF of 4.94. Between these two products, a consumer could enjoy a 56% increase in efficiency for just a 3.4% increase in price.

The high proportion (76%) of 4-5 star models on the market suggests that Vietnam needs to rescale the star ratings ACs. By increasing MEPS and all five levels by 20%, 22% of models would be eliminated from the market and the proportion of models ranked 5-star would adjust to a better distribution across levels. **Figure 29** illustrates this analysis: raising MEPS and rescaling the star levels would eliminate most of the fixed speed ACs, except for a few which fall into the 1-2 star levels. Such a policy would transform the Vietnamese market towards high-efficiency ACs.

Figure 29: Vietnamese AC market with revised MEPS and labels (N=1391)

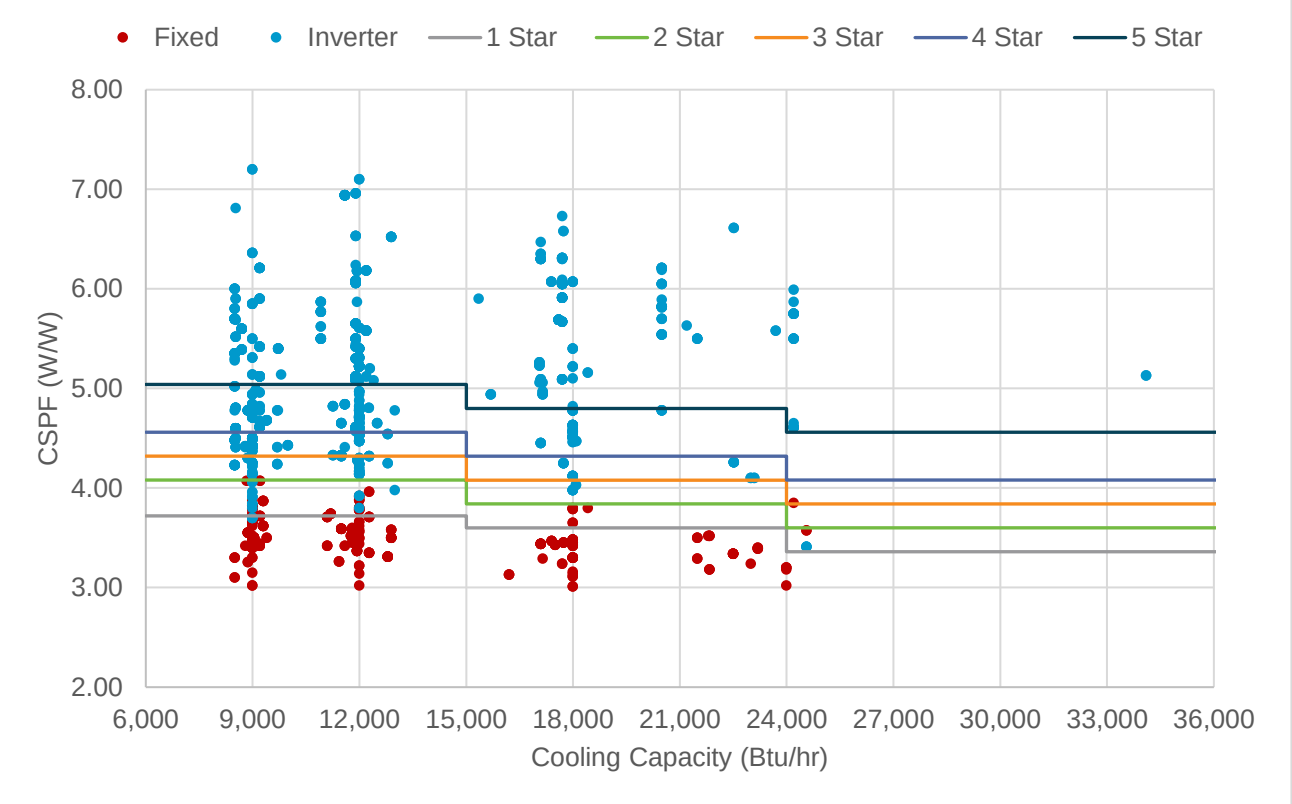


Table 18: Impact of revising star ratings (N=1391)

Scenario	% of Models on Market					
	Non-Compliant	1 Star (MEPS)	2 Star	3 Star	4 Star	5 Star
Current Ratings Levels	0.2%	4%	11%	9%	6%	70%
20% Increase to Ratings Levels	22%	8%	6%	15%	24%	47%

Some locally manufactured products would be eliminated by increasing MEPS. There are a few locally operating AC manufacturers or assemblers who would need to adapt their business strategies and product lines to accommodate higher MEPS or see a significant number of their models eliminated from the Vietnamese market. These companies, mainly Hoa Phat (Funiki), Midea and Reetech may require additional support to conform with higher MEPS. Haier (Aqua), Daikin and Electrolux would be less impacted by the policy.

Increasing MEPS would provide benefits at the national level as well as to consumers. Consumers of small and large capacity ACs would receive lifecycle cost savings under a scenario in which MEPS are increased by 20%, and the modelling used for this analysis does not account for potential decreases in the upfront purchase price of ACs that occurs over time. At the national level, by revising AC MEPS Vietnam can reduce annual energy consumption from ACs and make progress towards the NDC target of 8% emissions reduction in 2030. An 8% reduction would be equivalent to 63 MT CO, of which AC MEPS revision alone can provide 2.1 MT CO_2 or 3.3%.

Recommendation 1: Increase MEPS for ACs by 20% above the current MEPS. Vietnam's MEPS are already higher than the ASEAN MEPS target of 3.08W/W for ACs under 3.52kW. Thus, to achieve energy and emissions savings from the AC S&L program, Vietnam must adopt new MEPS that encourage market transformation for higher efficiency ACs. The analysis of policy scenarios showed that by increasing MEPS 20% above their current levels, Vietnam could reduce energy consumption from ACs by approximately 5% in 2030, equivalent to 2.1 TWh of electricity and 2.1 MT of CO_2. Even though we estimated that under this scenario about 22% of models would be non-compliant (5.6% domestically plus 16.1% imported products would be non-compliant), local manufacturers can transition their production lines to incorporate new technologies that are readily available.

Recommendation 2: Revise the energy labeling ratings upwards across the 1-5 star levels, and consider normalizing the distribution. The current labeling ratings have not kept up with the market. With 70% of split models in the 5-star category, consumers receive little guidance to differentiating between 5-star models – the lowest efficiency small capacity 5-star split AC has a CSPF of 4.20 W/W and the highest efficiency 5-star model is 69% more efficient at 7.10 W/W. Revising the labeling ratings upwards by 20% alongside an increase in MEPS is only somewhat successful at correcting the distribution of 1-5 star models. CLASP further recommends that the ratings be adjusted using a normal distribution for each cooling capacity range under regulation.

Recommendation 3: Update MEPS and the labeling ratings every 2-3 years to continue market transformation towards more efficient ACs. CLASP recommends that the Vietnamese government agencies continue to build on this analysis, and to gathering market, AC sales and product data. Comprehensive data can be used to inform the update and adoption of more stringent efficiency policies to keep up with advancements in technology and continue market transformation in Vietnam.

Appendix A: Regression Analysis Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.865203325
R Square	**0.748576794**
Adjusted R Square	0.748201815
Standard Error	3391.435035
Observations	1344

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	45922633216	22961316608	1996.318275	**0.0000000000**
Residual	1341	15423956170	11501831.6		
Total	1343	61346589386			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-14368.6	532.693	-26.9736	**2.23E-128**	-15413.6	-13323.6	-15413.6	-13323.6
Energy Rating (CSPF)	2626.775	99.77492	26.327	**1.77E-123**	2431.043	2822.507	2431.043	2822.507
Cooling Capacity (Btu/h)	1.196792	0.021572	55.48	**0**	1.154474	1.23911	1.154474	1.23911