Thailand Room Air Conditioner Market Assessment and Policy Options Analysis

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CLASP

This report has been produced by CLASP and Niwat Phansilpakom, June 2019.

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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 Thailand 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 Thailand. 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 Niwat Phansilpakom, conducted a comprehensive characterization of the room AC market in Thailand, and analyzed impacts from various energy efficiency policy scenarios. Niwat Phansilpakom collected product-level data for 2,146 AC models, 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, supply chains, 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) and labels;
- a policy scenario where MEPS are increased by 20% over the current level one criteria of the EGAT No. 5 label[4] for fixed speed units, the criteria for level five of the EGAT No. 5 label is increased by 20% over the current level five criteria for inverter units, and both policies are extended to apply to all units under 60,000 Btu/hr; and
- a market transition to the best available technology.

Revising the MEPS and EGAT No. 5 label could reduce energy consumption from ACs by approximately 18% in 2030 and accelerate a market transformation to high-efficiency ACs. The room AC market assessment and policy analysis report provides the technical evidence to support a revision of MEPS in Thailand, and assesses national impacts, benefits to consumers, and effects to local manufacturers.

Overall findings and recommendations

Thailand has a highly developed AC industry with a deep local supply chain. The Thai Room AC industry is one of the largest in the world, with only China producing more ACs.[5] Thailand accounts for approximately

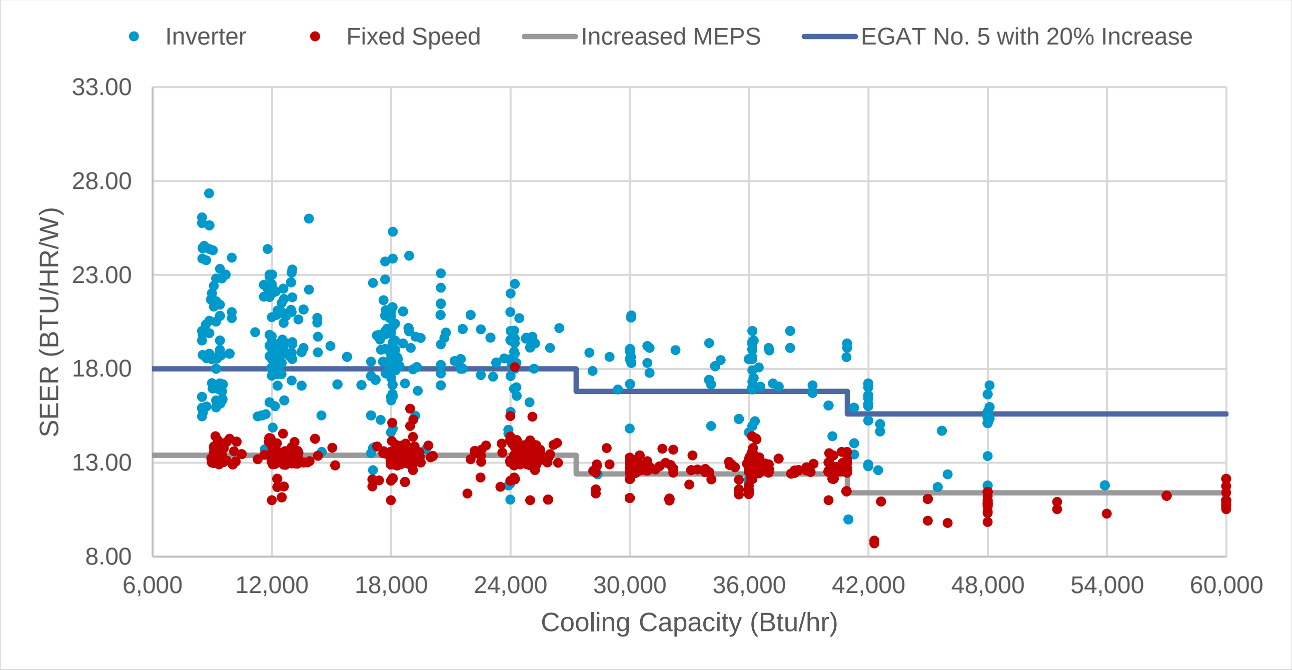
[1] Lawrence Berkeley National Laboratory (LBNL). (2015). *Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Condition.* LBNL-1003671. Available at: https://eta.lbl.gov/publications/benefits-leapfrogging-superefficiency
[2] Accelerating the Global Adoption 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.
[4] The No.5 Label is a comparative label with ratings from 1 to 5, with No. 5 being the most efficient and No.1 being the least efficient. However, since the program is voluntary, manufacturers only opt to obtain the EGAT No. 5 label if their products achieve the fifth level.
[5] Euromonitor 2018

9% of global room AC production and 22% of world AC exports.[6,7] Approximately 91% of the models sold on the Thai market are made in Thailand, and approximately 70% of the components for these models are sourced domestically. However, Thai AC manufacturers have found the production of inverter units to be a challenge, as many local manufacturers lack the capacity to design products that make optimal use of the inverter compressor. This has led to stiff competition from imported Chinese compressors and assembled units, as they are often able to outcompete the Thai-made highly efficient products on price.

The Thai AC market has evolved rapidly over the past six years. The market share of inverter units has at least doubled since 2013, from 16% to 32% of available models, with manufacturers stating that inverter units now make up a majority of sales for products under 25,000 Btu/hr. At the same time, AC manufacturers have transitioned away from R-22, a high global warming potential (GWP), ozone-depleting substance, which was used in 79% of products on the market in 2013. R-410A, which is used in 62% of available models, and R-32, which is used in 34% of available models, now dominate the market.

Highly efficient products are cost-effective in Thailand. Moving to the best available technology is cost-effective for consumers for all AC unit capacities. The lifecycle energy performance benefits outweigh the increased costs of these high-efficiency units by at least 2:1, with even higher benefit-to-cost ratios at the higher capacities. Similarly, the payback period for purchasing the most efficient 48,000 btu/hr AC unit is just over six months, though the payback periods for the most efficient 12,000 btu/hr AC units are closer to four years.

Figure 1: Products on the Thai AC market and recommended policies



Increasing MEPS and the EGAT No. 5 label requirements and expanding product coverage to all products under 60,000 Btu/hr 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% over the current EGAT No. 5 label's level one for fixed speed units; the modelling used for this analysis does not account for potential decreases in the upfront purchase price of ACs that occurs over time, which would increase benefits for consumers. Similarly, consumers who prioritize purchasing products with the EGAT No. 5 label would receive lifecycle benefits and rapid payback periods from a 20%

[6] COMTRADE 2015
[7] Euromonitor 2018

increase in the label requirements over the current requirements for inverter units. These lifecycle benefits from both MEPS and labeling are particularly large for consumers of currently unregulated products with capacities between 40,944 Btu/hr and 60,000 Btu/hr. At the national level, by revising AC MEPS and EGAT No. 5 label requirements, Thailand can reduce annual energy consumption from ACs and make progress towards the NDC target of 25% emissions reduction in 2030 compared to business as usual. A 25% reduction would be equivalent to 138.8 MT CO_2, of which AC MEPS and labeling revisions alone can provide 8.4 MT CO_2 or 6% of the intended reduction. Of this 8.4 MT CO_2, 6 MT can come from a labeling revision and 2.4 MT can come from a MEPS revision.

Some locally manufactured products would be eliminated by increasing MEPS and many others will no longer be eligible for the EGAT No. 5 label. 32% of all Thai-produced AC units on the market would be eliminated by the increase in MEPS and only 26% of the models on the market, nearly all of which are inverter units, would still be eligible for the EGAT No. 5 label. Given the strong preference for the EGAT No. 5 label, this means that local manufacturers would need to upgrade their production lines to produce high efficiency inverter units in order to remain competitive. A World Bank technology transfer project is currently underway to support this upgrade for several local manufacturers.

Recommendation 1: Increase MEPS for ACs by 20% above the current EGAT No. 5 label level one requirement for fixed speed units. The vast majority of products on the Thai market already significantly exceed the MEPS, which shows that the market has evolved rapidly since the last MEPS revision in 2010. The MEPS increase would yield significant lifecycle cost savings for consumers, with the consumer benefits outweighing costs by more than 4:1 for lower capacity units and more than 14:1 for higher capacity units. Furthermore, the MEPS increase would reduce CO_2 emissions by 4.3 MT through 2030. Although the increased MEPS would remove 31% of products from the market, including 32% of Thai-made products, all Thai manufacturers currently make several models that would be able to comply with the new MEPS, indicating that the necessary technology and production lines already exist.

Recommendation 2: Increase the EGAT No. 5 label requirement by 20% over the current requirement for inverter units and apply this requirement to both fixed speed and inverter units. Under the current system with different labeling requirements for inverter and fixed speed units, a fixed speed unit with the EGAT No. 5 label and one star might be less efficient than an inverter unit that cannot achieve the EGAT No. 5 label at all. This system encourages consumers to purchase less efficient fixed speed units, as the label can cause them to believe such units to be more efficient than inverter units. Moving to a technology-neutral approach with a single set of requirements for all types of AC units would allow consumers to make better-informed purchasing decisions and would cost-effectively reduce CO_2 emissions by approximately 32.4 MT through 2030.

However, given the challenges that some Thai manufacturers have faced in producing high efficiency inverter units, only 26% of models currently on the market would be able to achieve the EGAT No.5 label, including relatively few units made by Thai companies. Therefore, it may be best to implement the EGAT No. 5 labeling requirement revisions after the World Bank technology transfer program is complete, as it will support Thai manufacturers in building their capacity to produce such high efficiency inverter units.

Recommendation 3: Expand MEPS and EGAT No. 5 label coverage to all products under 60,000 Btu/hr. Expanding policy coverage to these products provides substantial consumer benefits, as the MEPS would provide consumers with a payback period of under 4 months and the EGAT No. 5 label would provide consumers with a payback period of under 6 months. In addition, expanding these policies to higher capacity products would yield substantial national benefits of approximately 13.7 TWh of electricity savings and 8.6 MT of CO_2 emissions reductions through 2030.

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 Thailand. 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.

Over the past few decades, Thailand's energy demand has drastically increased as a result of fast economic and population growth, and is expected to rise further in the future. Due to limited availability of domestic energy resources, Thailand's strong dependence on costly energy imports poses a serious threat to Thailand's energy security. As a net energy importer, over 60% of Thailand's energy consumption comes from imports.[8]

As such, energy efficiency is a significant part of the country's energy policies and Thailand has been on the forefront of standards and labeling programs for energy-using products, starting from 1995 when the first standard for refrigerators and freezers was developed. The labeling program for appliances has been very successful over the years, and the number of products covered by the program has increased steadily. By 2014, the Thai labeling program covered more than 24 product categories, delivering significant energy savings and CO_2 reductions.

This market assessment was conducted to evaluate the Thai market for room ACs, the status of existing AC energy efficiency policies, and the potential for cost-effective revisions to these policies.

CLASP, together with a local partner, Niwat Phansilpakom,[9] conducted a comprehensive characterization of the room AC market in Thailand. This market assessment includes a detailed account of the room AC market size, product characteristics, usage, and the energy sector. Niwat Phansilpakom 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.

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 the overview of the market including the key players and a discussion on 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 Thailand;
- **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** provides recommendations for policy revisions based on these impacts.

[8] Source: Asian Development Bank. 2015. *Fossil Fuel Subsidies in Thailand Trends, Impacts, and Reforms*
9 Niwat Phansilpakom is an expert in the field of appliance energy efficiency in Thailand and participated in this project independent of his affiliation with any other organizations.

2 Methodology

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

Step 1 - Primary retail data collection. Niwat Phansilpakom conducted interviews with manufacturers and 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. 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.[10]

The resulting dataset includes 2,146 unique AC models. Product types covered included floor/ceiling, cassette, standing, and single split room ACs (which are either wall-mounted or concealed).

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 room AC sector, Niwat Phansilpakom collected secondary data. Niwat Phansilpakom conducted a review of government reports and interviewed relevant stakeholders, such as the Electricity Generating Authority of Thailand (EGAT), the Electrical and Electronics Institute (EEI), and the Customs Department. The information collected included market share by AC type, domestic sales volumes, testing facilities in the country, imports and exports of AC units, AC usage statistics, and the details on the power sector

Niwat Phansilpakom supplemented this data with data from EGAT and product catalogs, and then compared the collected data with market data from GFK Market and Euromonitor. The purpose of this review and comparison was to control data quality and ensure that the data collected did not represent a radical departure from data collected by other entities.

Table 1: Data Sources

Source of secondary data	Data collected
Electricity Generating Authority of Thailand (EGAT)	Room AC product data and efficiency for cooling capacities up to 60,000 BTU/hr
Electrical and Electronics Institute (EEI)	• The number of manufacturers and details • Domestic sales volume • Testing facilities
Customs Department	Import/Export value

[10] 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 = ##).

Source of secondary data	Data collected
Manufacturers and distributors	**Thai Companies** • Bitwise Thailand Ltd. - Tasaki • Supreme CNB. Ltd. - Supreme • PPJ engineering Ltd. – Star Aire • Central Air Ltd. • Eminent Air Ltd. **Foreign Companies** • Daikin industry Ltd. • Mitsubishi Electric Consumer Products Ltd. • LG Electronics Ltd. • Haier Electric Thailand Ltd. • Fedders Thai Ltd. • Toshiba-Carrier Ltd.
Marketplace • Modern trade store • AC or Home appliance retail store • Online market place	Complete market site visit • Power Buy (Central Department Store) • Power Mall (The Mall Department Store) • Home Pro • Tesco Lotus • Big C • Future shop/Modern Air/Wiset Air • Sahapat TV/Thaimart/Ekchanachaikij • Lazada/ Shopee
Room AC Market Research Checks	Review of room AC data GFK market, Euromonitor

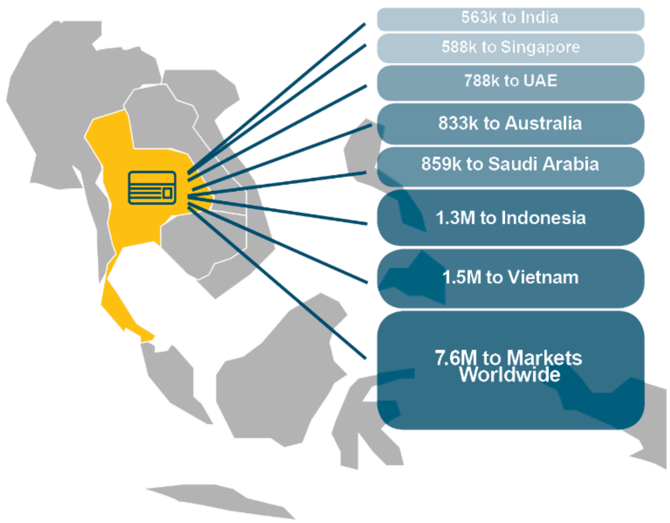
Step 3 – Market and impact analysis and policy recommendations

The data collected by Niwat Phansilpakom was the basis for the Thailand 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

The Thai Room AC industry is one of the largest in the world, with only China producing more air conditioners.[11] Thailand accounts for approximately 9% of global room air conditioner production and 22% of world AC exports.[12] Thailand exports AC units to many countries around the world, though its largest export markets, Vietnam and Indonesia, are within the Association of Southeast Asian Nations (ASEAN) and apply preferential tariffs for Thai ACs under the ASEAN Free Trade Area. **Figure 2** highlights the main export destinations for Thai-made ACs.

Figure 2: Thai AC export destinations



3.1 Supply Chain Analysis

AC Production

The Thai room AC industry has a well-developed domestic supply chain. A total of 177 companies ranging from large multinational corporations to local small and medium enterprises are involved in the production of AC components in Thailand. Of these companies, 53% are Thai-owned, while the remainder are either joint ventures between multinationals and local companies or are fully foreign-owned. These companies manufacture a full range of AC components, including compressors and their components, heat exchangers, fans and fan motors, and AC electronics such as printed circuit boards (PCBs) and sensors.

Similarly, Thailand also has 56 companies producing finished ACs. Of these, 39 are Thai-owned, while the remaining 17 are foreign-owned. The Thai-owned producers of finished AC units primarily operate as original equipment manufacturers (OEMs) for major international brands, though these Thai producers may also market products under their own brand names. Products sold under Thai brand names may be produced by the company that owns the Thai brand or by other OEMs. Nearly all inverter AC units sold under Thai brands are imported fully-assembled from China.

Manufacturing inverter AC units has proven a major challenge for Thai manufacturers. While the multinational AC companies operating in Thailand have been very successful at producing inverter AC units, the local Thai manufacturers often lack the capacity to design and produce inverter AC units that properly make use of the inverter compressor for maximum efficiency. These Thai companies often instead opt to import their inverter

[11] Euromonitor 2018
[12] COMTRADE 2015

AC units from China. Addressing this issue is a key goal of an ongoing World Bank technology transfer program for Thai manufacturers.[13]

Approximately 70% of the components used in AC units assembled in Thailand are sourced domestically, while approximately 30% are imported. Compressors (both fixed speed and inverter), coils and heat exchangers, motors, cases and fans are all primarily sourced domestically. The Thai AC component industry does not only supply AC assemblers in Thailand, but throughout the world. In 2018, Thai exports of AC components were valued at more than $725M.[14]

Electronic components such as PCBs and sensors, remote controls, as well as crucial metals such as aluminum and copper, are primarily imported. The PCBs and sensors are particularly important for the production of inverter air conditioners. There has also been a trend of growing component imports, particularly compressor imports from China for products sold under Chinese, Japanese, and Korean brands. This trend has been attributed to the Chinese compressors being able to compete on price at higher energy efficiency levels. Additionally, this increased competition from Chinese compressors has manifested itself in increasing imports of assembled condensing units, as these often cost less than the condensing units assembled in Thailand with imported compressors.[15] In 2015, total Thai imports of AC components were valued at just over $200M.[16]

AC Imports, Distribution, and Retail

Despite being the world's second largest AC producer, manufacturing over 10 million AC units in 2017 compared to a domestic market of under 1.7 million units, Thailand continues to import finished AC units. In 2017, Thailand imported just under 700,000 finished AC units from China, Malaysia, South Korea, and Vietnam.[17] If all of these AC units are sold in Thailand, they would account for approximately 41% of the market, though it is likely that some are re-exported to other countries, and AC imports vary significantly from year to year.

Major retailers of AC units in Thailand include both large department stores and smaller specialty shops focused solely on air conditioners. Retail sales for ACs differ from retail sales for other appliances, as the split ACs that dominate the Thai market require installation by trained technicians. This need for proper installation has led many AC manufacturers to invest in technical training for installation and maintenance staff. In addition, this has meant that AC sales occur primarily in specialty retail shops that provide AC installation and maintenance services as opposed to in large department stores.

Sales to real estate projects and government agencies also constitute an important part of Thai AC manufacturers' sales strategy. While these sales typically offer a lower margin than retail sales, they provide an opportunity to sell a large volume of products in a single sale. These bulk purchases, particularly those made by the government, often specify efficiency criteria such as the EGAT No. 5 label as mandatory for all bids.[18] Some manufacturers prefer not to make bids directly but rather to leave the bidding to their distributors who may have a better understanding of government procurement. In addition, manufacturers will often keep a substantial inventory of AC units ready to ship out in case they win a bid and need to fulfill the order immediately.

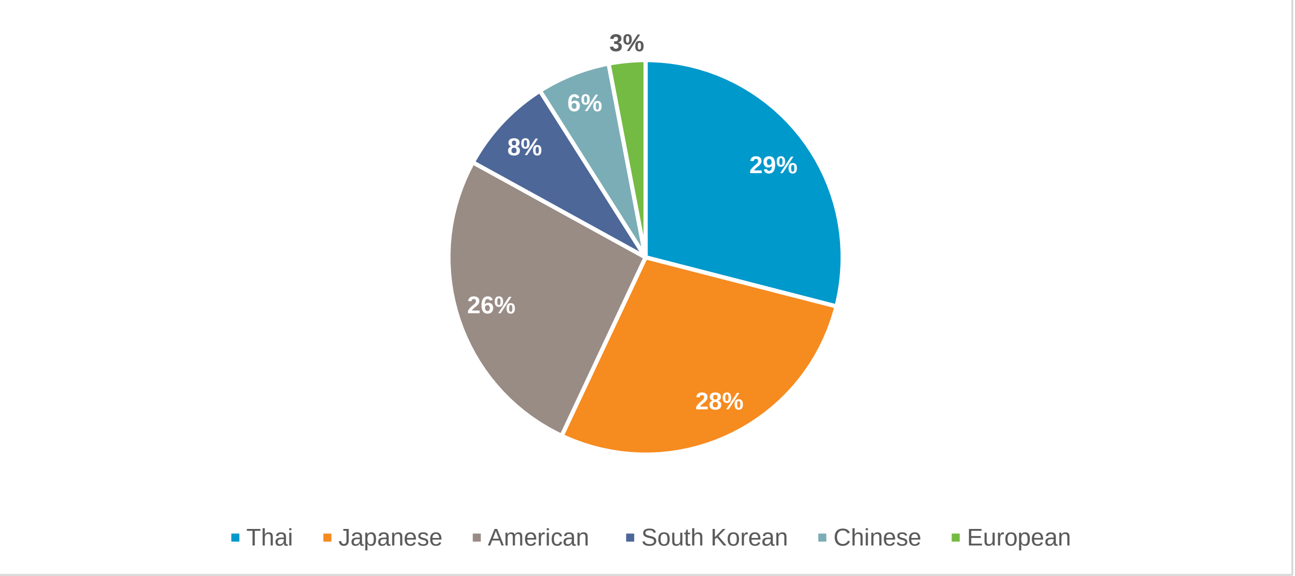
3.2 Major brands

According to the data gathered from manufacturers and retail stores, there are 55 brands available in the Thai market, with the top ten brands accounting for 55% of available products. The following brands are present in the Thai market, with the top 10 brands noted in **bold**:

[13] Based on conversations with the World Bank Montreal Protocol Team, March 2019.
[14] COMTRADE 2018
[15] Based on Information from EEI
[16] COMTRADE 2015
[17] Thai Customs Department 2018
[18] The No.5 Label is a comparative label with ratings from 1 to 5, with No. 5 being the most efficient and No.1 being the least efficient. However, since the program is voluntary, manufacturers only opt to obtain the EGAT No. 5 label if their products achieve the fifth level.

- Thai brands (29%): Bacchus, Casper, Cokan, Cosmos, Daisenko, Daimond, Dipanabishi, Earth, Energyworld, Focus, Furano, Fusion, Hanjo, HICLASS, Kent, Kindai, King Cool, Mavell, Memory, Mitsui Chofu, Mitsushita, Mitsuta, Nikkokendo, Panabishi, Power Aire, PSI, **Saijo Denki**, Skyworth, Sova, Tienfong, Vekin, Vertex, Weather Cool, and Wilson.
- Japanese brands (28%): **Daikin**, Fujitsu, **Hitachi**, **Mitsubishi**, **Mitsubishi Heavy Industry**, **Panasonic**, Sharp, and Toshiba.
- American brands (26%): **Carrier**, Fedders, Singer, **Trane**, and York
- South Korean brands (8%): **Samsung** and **LG**
- Chinese brands (6%): Gree, Haier, Midea, and TCL
- European brands (3%): Aircool (Dutch), Electrolux (Swedish) and Beko (Turkish)

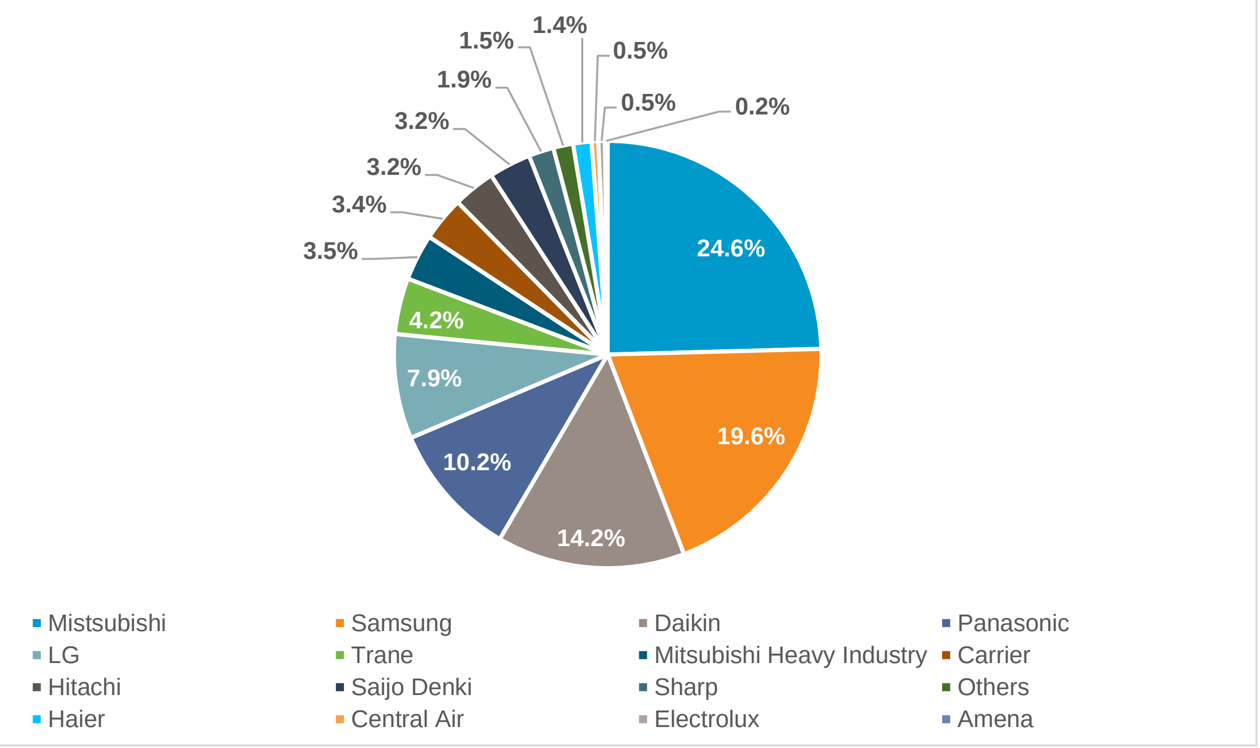
Figure 3: Thai market share by brand country of origin[19]



Although foreign brands dominate the market, units produced under these brands are primarily manufactured in Thailand. In some cases, local subsidiaries of the multinational AC companies that owns the foreign brands manufacture ACs sold under these brands. In other cases, Thai OEMs manufacture units sold under these brands in accordance with their contracts with multinational AC companies. The only brands that exclusively import products are Gree (from China), TCL (from China), and Panasonic (from Malaysia). Several other brands, including Thai brands, market a mix of locally manufactured and imported products.

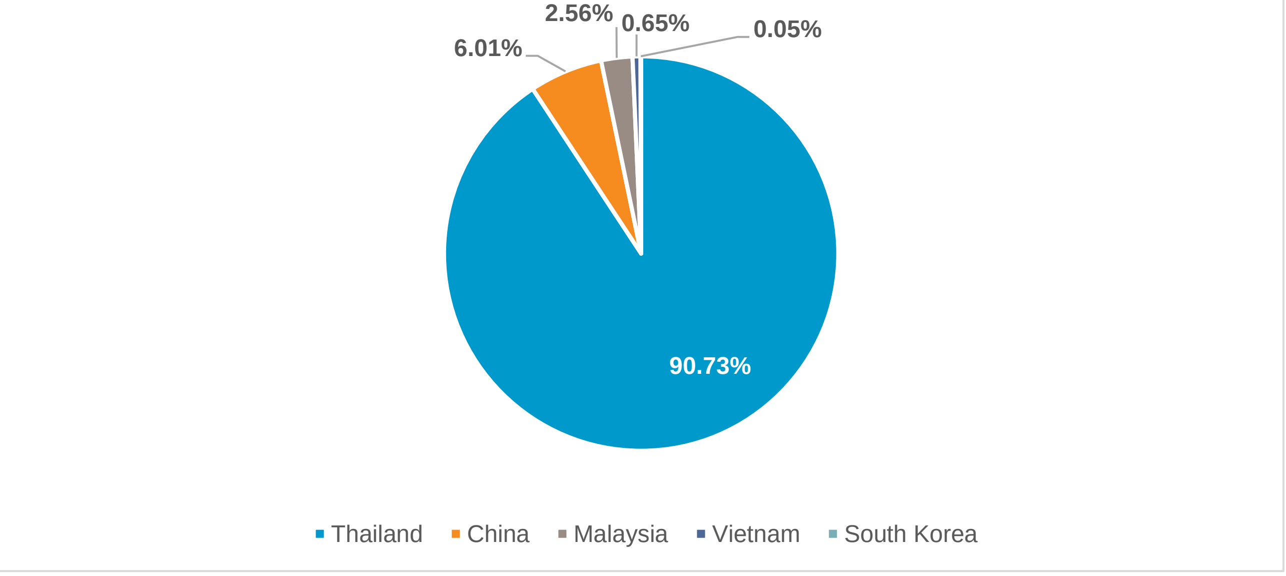
[19] Based on CLASP Data, 2018

Figure 4: Thai market share by brand, 2017[20]



Overall, more than 90% of ACs available on the Thai market are manufactured or assembled in Thailand. Approximately 65% of the available imported products are from China, with smaller shares from Malaysia, Vietnam, and South Korea.

Figure 5: Country of origin for ACs available in Thailand[21]



[20] Euromonitor, 2017
[21] Based on CLASP Data, 2018

3.3 Other Key Players

The Thai Industrial Standards Institute (TISI), in collaboration with Department of Alternative Energy Development and Efficiency (DEDE), runs the minimum energy performance standards (MEPS) program. The Electricity Generating Authority of Thailand (EGAT) runs the labeling program. **Section 7** provides further details on these programs**.**

The Electrical and Electronics Institute (EEI) conducts AC testing for the MEPS and labeling programs. EEI possesses three AC test chambers with which they can test nine fixed speed or six inverter AC units each day. EEI also conducts some testing for manufacturers to support research and development as well as exports.

4 Room AC Market Characteristics

4.1 Room AC Types Available

Split units dominate the Thai AC market. These include both wall-mounted split units and concealed split units. At larger capacities, standing, cassette, and floor/ceiling units are more common. Window and portable units are not present in the market. The figures below represent models available on the market, without weighting according to the sales per model or the frequency with which models appear on store shelves.

Figure 6: Room AC types (N=2146)

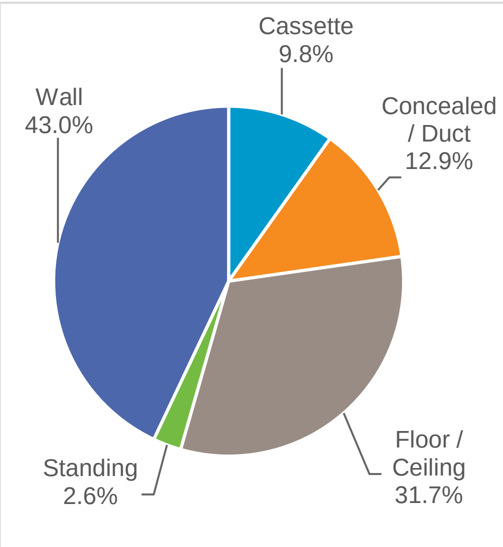
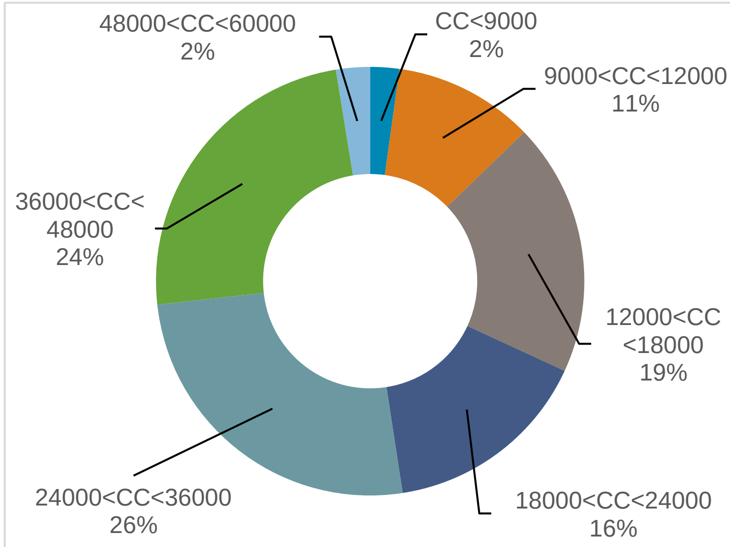


Figure 7: Cooling capacities available in (in Btu/hr) (N=2146)



The most popular cooling capacities are between 11,000 Btu/hr and 15,000 Btu/h, with ACs under 15,000 Btu/hr accounting for the majority of sales, even though they are only approximately 30% of the models available on the market.[22] Despite the higher sales volumes at the lower capacity, the majority of models available for sale on the market are above 24,000 Btu/h. For this reason, representative models at cooling capacities of 12,000 Btu/h, 24,000 Btu/h, 36,000 Btu/h, and 48,000 Btu/hr were chosen for the impacts assessments described in **Sections 9 and 10**, but with the sales heavily weighted towards the lower capacities.

4.2 Refrigerants and Inverter Technology

R-410A remains the most common refrigerant among products available in the Thai market, followed by R-32 (**Figure 8**). Also, 83 products were still listed as using R-22, though prices were only available for 26 of these products, indicating that most of these R-22 units may no longer be for sale. In addition, R-407C was found in 11 floor / ceiling models, all of which had capacities over 18,000 Btu/h.

This move to R-410A and R-32 is a significant shift as compared to 2013, when R-22 accounted for 79% of the market and R-410A accounted for 19% of the market. At that point, R-32 was not yet observed in the market.[23]

[22] Data from EEI, 2018.
[23] 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

Figure 8: AC refrigerants in Thailand (N=2146)

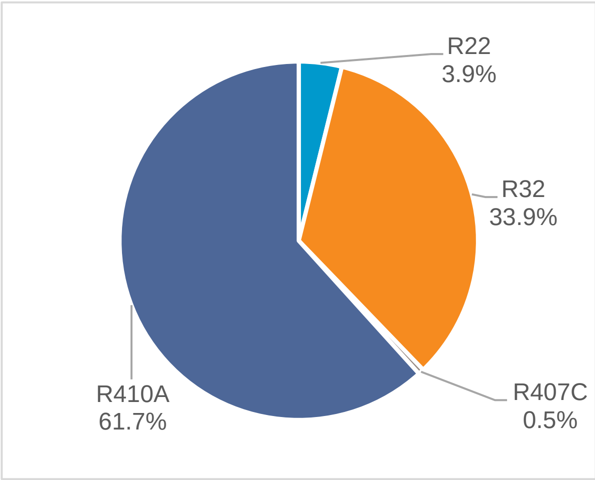
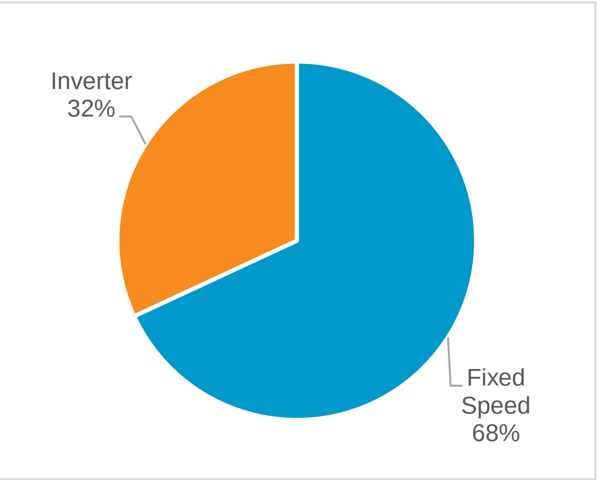


Figure 9: AC compressor types in Thailand (N=2146)

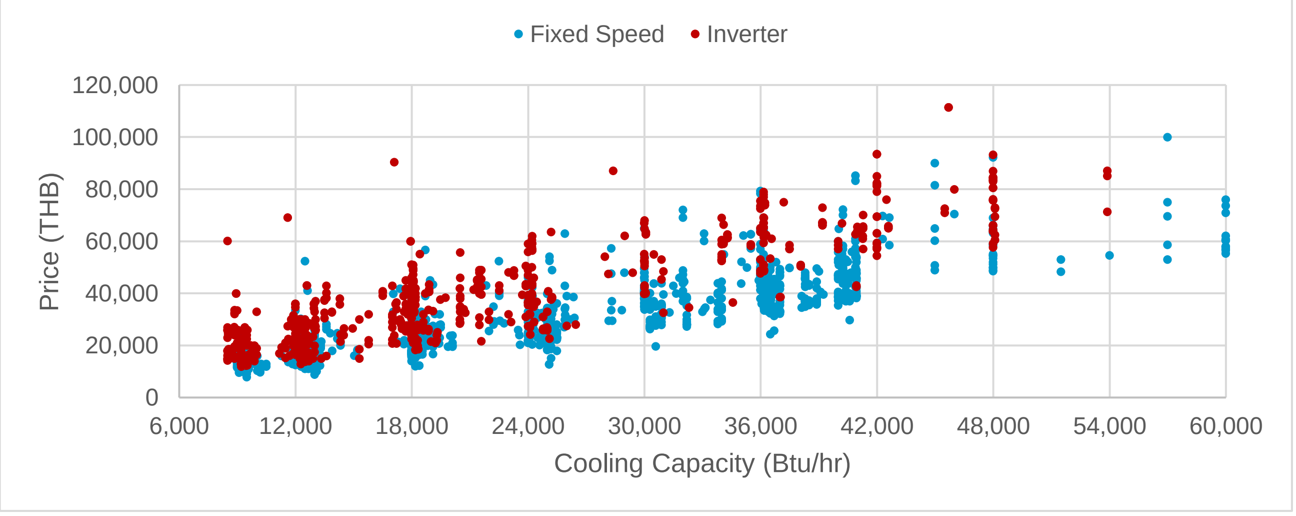


Fixed speed ACs continue to make up the majority of the ACs available, despite significant growth in the market share of inverter ACs in recent years. In interviews, manufacturers stated that inverter ACs make up the majority of sales for units under 25,000 Btu/h, though they were unable to provide exact figures. Even the 32% share of available models, without weighting according to sales or how frequently models appear on store shelves, represents a significant increase in the share of inverter models as compared with 2013, when inverter models comprised 16% of the market.[24]

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 10: Cooling capacity vs. price by compressor type (N=1806)



[24] 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

The compressor type does have some impact on price - inverter ACs have higher prices, by 28% on average. These higher prices for inverter units may partially explain the lower inverter market share in Thailand as compared to some other ASEAN countries, such as Vietnam.

Figure 11: Price Ranges for Fixed Speed ACs (N=1185)

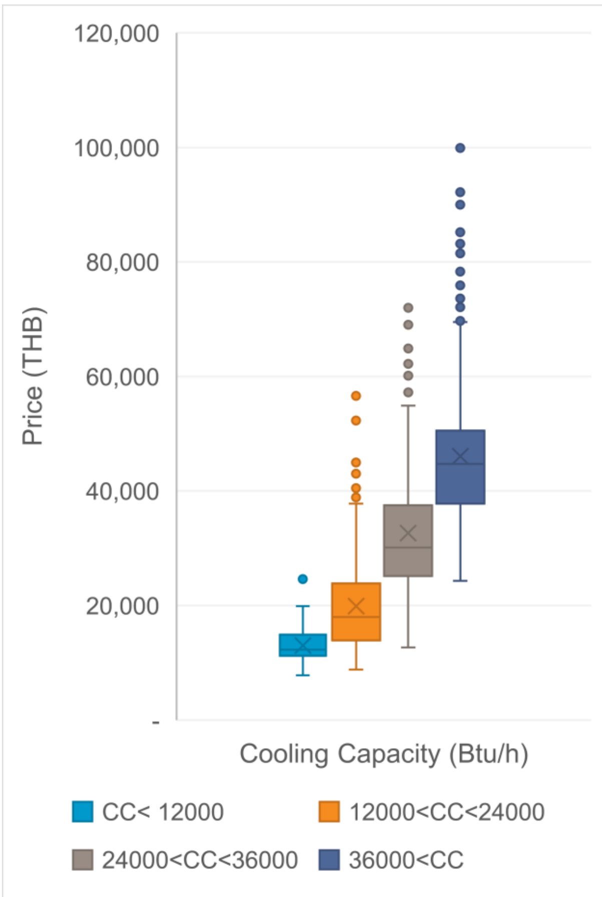
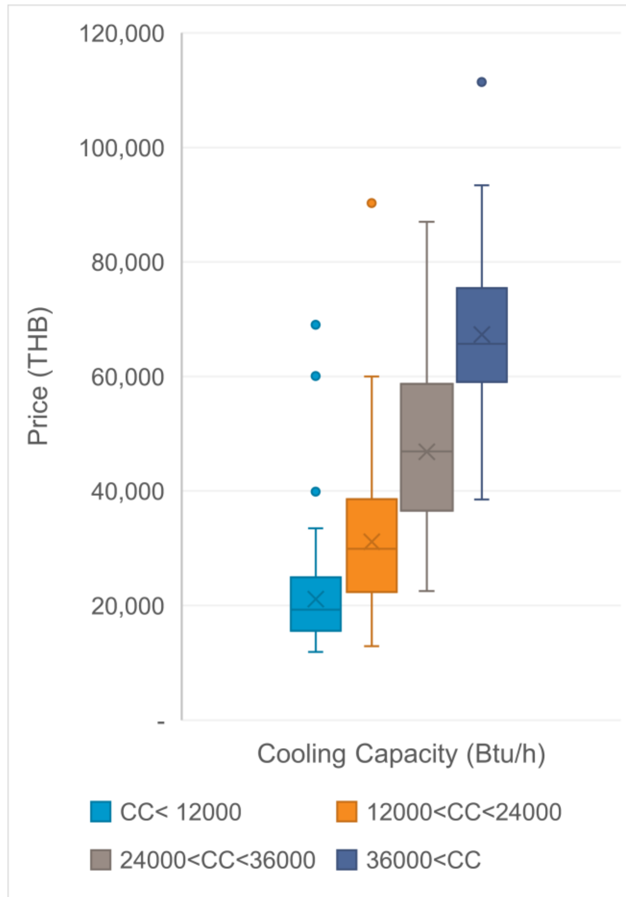


Figure 12: Price Ranges for Inverter ACs (N=621)

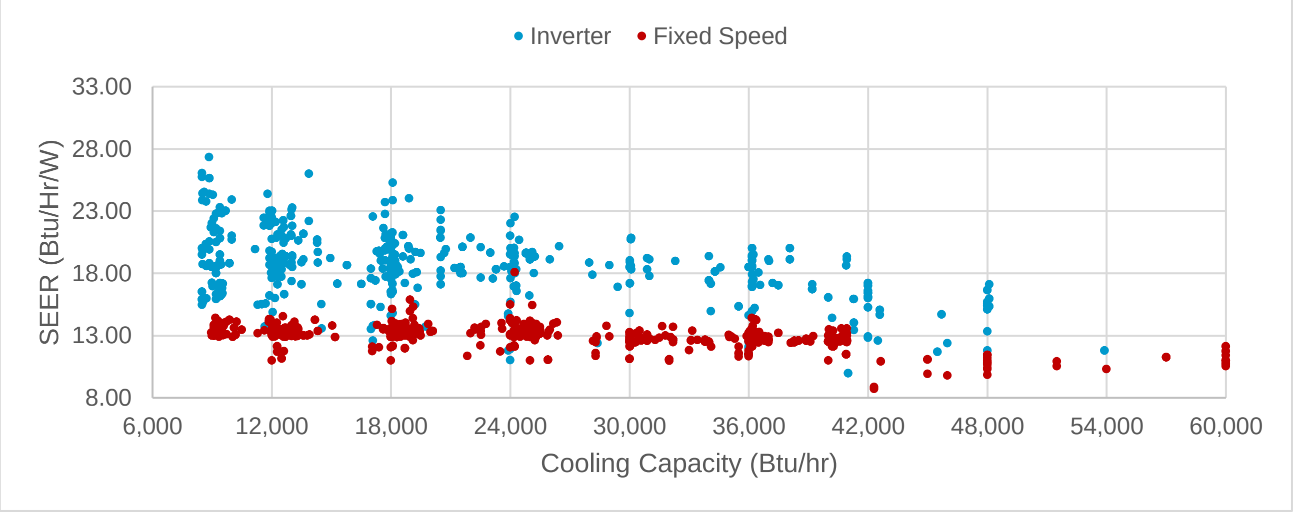


4.4 Energy Efficiency and Performance Metrics

Since 2015, Thailand has labeled inverter ACs using the Seasonal Energy Efficiency Ratio (SEER), which represents the ratio of the total cooling output over the year to the total energy consumption for cooling over the year. In 2017, Thailand began moved the labels for fixed speed ACs to SEER. However, as the EGAT No. 5 label is voluntary, only 89% of the models in the dataset reported their efficiency level in SEER, with the remaining 11% reporting their efficiency levels using other metrics, such as energy efficiency ratio (EER) and co-efficient of performance (COP). Where possible, CLASP converted these metrics into SEER.[25]

[25] Conversion into SEER is only possible for fixed speed AC units reporting in EER. The conversion is based on the formula EER = SEER x 0.875

Figure 13: Cooling Capacity vs. Efficiency (SEER) by Compressor Type (N=1804)

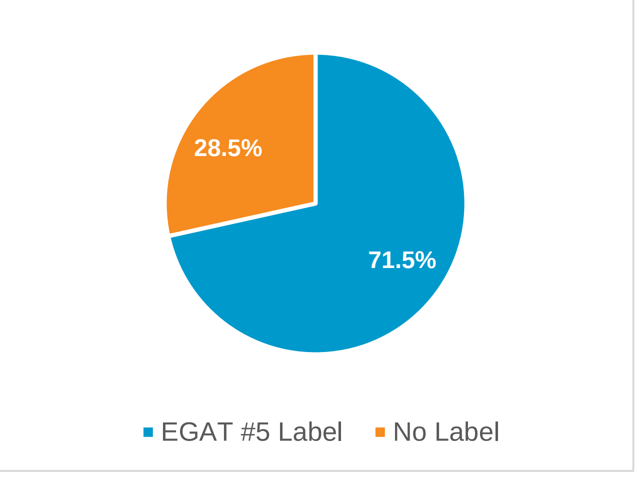


While there are a range of efficiencies for both compressor types, the inverter units generally have a higher efficiency. Inverter unit efficiencies range from SEERs of 9.97 to 27.33, with an average of 18.32, while the efficiency range for fixed speed units is 8.69 to 18.08, with an average of 12.85.

4.5 Energy Labeling Practices

Energy performance labeling is voluntary in Thailand. The voluntary label is implemented by the Electricity Generating Authority of Thailand (EGAT), with five levels. Because the label is voluntary, manufacturers only choose to label products achieving the fifth labeling level (EGAT No. 5). However, the vast majority of products in the market are labeled and achieve this fifth labeling level.

Figure 14: Market Share of Labeled ACs (N=2146)



The EGAT No. 5 label has different versions for inverter and fixed speed models, with different requirements for each AC type. The EGAT No. 5 label displays the product's energy rating, estimated electricity bill cost (in THB per year), electricity consumption (in kWh per year), SEER, brand, model, and capacity. In January 2019, EGAT updated the label to include 3 stars that go beyond the level 5. The full details of the labeling requirements and the label update are explained in **Section 7**. The labels as of 2018 appear in **Figures Figure** 15 **and Figure** 16. The new 2019 label with the additional stars appears in **Figure 17**.

Figure 15: EGAT No. 5 label for inverter units as of 2018

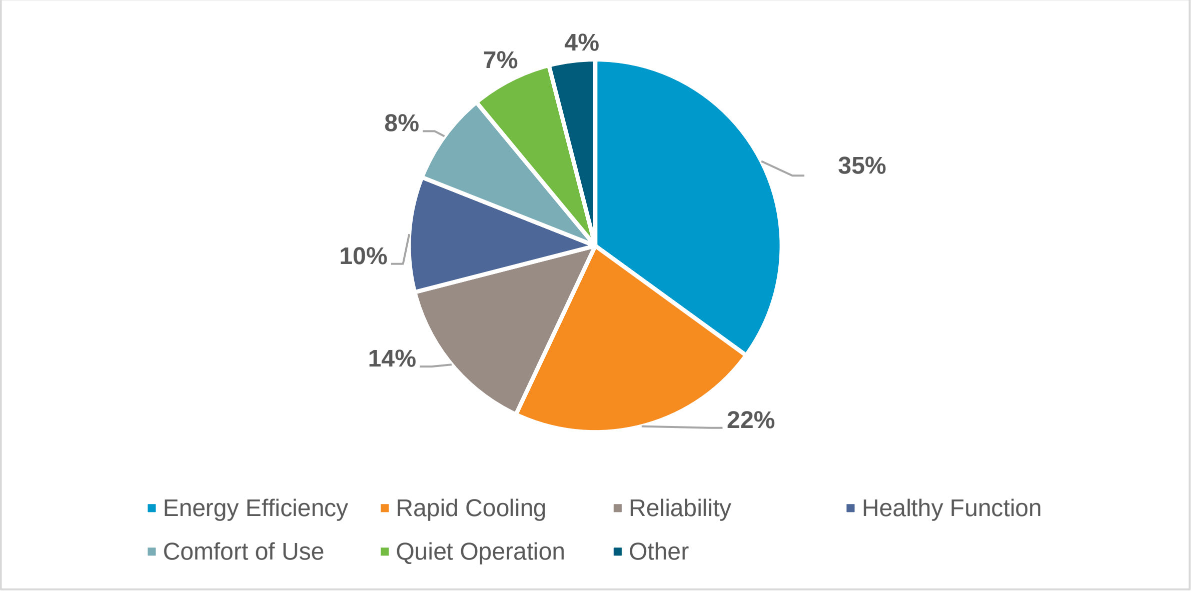
Figure 16: EGAT No. 5 label for fixed speed units as of 2018

Figure 17: 2019 EGAT No. 5 label with stars

4.6 Consumer Practices and Preferences

Energy efficiency is an important factor in consumers' choice of ACs, both for individual consumers as well as for procurement by the government and real estate developers. After energy efficiency, the most commonly cited factor in consumers' purchasing decision is rapid cooling, as can be seen in **Figure 18**.[26]

Figure 18: Top AC selection factors for Thai consumers



Given that AC unit prices are high relative to average Thai incomes, most distributors offer payment plans. At department stores, these payment plans often involve low- or no-interest loans. On the other hand, AC specialty retailers often include free AC servicing for the first year in order to attract customers.

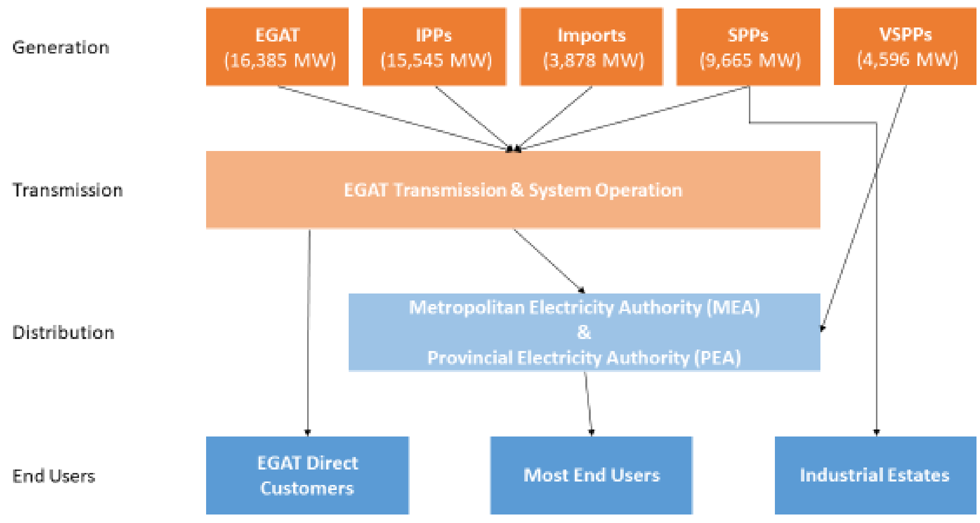
The market for bulk purchases, either by government or by real estate developers, is also significant. These bulk purchases often specify a requirement that the ACs receive the EGAT No. 5 label in order to be considered. Some AC models are even developed specifically for such bids and not released to the retail AC market.

[26] Based on a 2018 Marketeer study conducted for LG Electronics and shared with Niwat Phansilpakom during an interview.

5 Power Sector

Thailand's power sector is organized into an enhanced single buyer model, with the Electricity Generation Authority of Thailand (EGAT) purchasing or producing around 92% of all power generated in Thailand before selling the power on to the distribution utilities or large consumers. The remaining 8% of power generation is from small power producers (SPPs) and very small power producers (VSPPs), who sell their power directly to large customers or to the distribution utilities, without going through EGAT's transmission system. EGAT itself accounts for 36% of installed generation capacity, while independent power producers (IPPs) account for 33%, SPPs and VSPPs account for 22%, and imports (primarily from Laos) account for 9%. This system is diagramed in **Figure 19.**

Figure 19: Thai power sector structure as of 2017[27]



5.1. Utilities

EGAT is the largest state-owned enterprise in the Thai power sector, though its role has decreased since the 1990s. Until 1994, EGAT owned all power generation in the country and EGAT continued to own a majority of power generation until 2006.[28] The key liberalizations that led to this decrease in EGAT's dominant role in power generation were the introduction of IPPs in 1994 and the introduction of SPPs and VSPPs in the 2000s. However, despite these liberalizations, EGAT maintains total control of the transmission system and system operations, which has preserved its role as the central player in the electricity sector and the off-taker of the vast majority of electricity generated.

The electricity distribution utilities are also state-owned. These are the Metropolitan Electricity Authority (MEA), whose service territory consists of Bangkok and its suburbs, and the Provincial Electricity Authority (PEA), who serves the rest of the country. In 2017, MEA had approximately 3.7 million customers who consumed 51 TWh of electricity. By comparison, PEA had 19 million customers who consumed 130 TWh of electricity. [29] MEA and PEA both charge the same electricity rates, which appear in **Table 2.**

[27] DBS Bank. "Thai Power Industry." 2017. Available online at: https://www.dbs.com/aics/pdfController.page?pdfpath=/content/article/pdf/AIO/042017/170426_insights_neutral_on_thai_power_sector.pdf

[28] DBS Bank. "Thai Power Industry." 2017. Available online at: https://www.dbs.com/aics/pdfController.page?pdfpath=/content/article/pdf/AIO/042017/170426_insights_neutral_on_thai_power_sector.pdf

[29] Data provided to Niwat Phansilpakom by MEA and PEA

Table 2: Residential electricity rates in Thailand

Residential Customer Group	Rate (THB)
Electricity use not over than 150 kWh per month:	
First 15 units (Unit 1-15)	2.3488
Next 10 units (Unit 16 -25)	2.9882
Next 10 units (Unit 26 -35)	3.2405
Next 65 units (Unit 36 -100)	3.6237
Next 50 units (Unit 101 -150)	3.7171
Next 250 units (Unit 151 - 400)	4.2218
Over 400 units (Unit 401 ->)	4.4217
Monthly Service Charge	8.19
Electricity use over 150 kWh per month:	
First 150 units (Unit 1-150)	3.2484
Next 250 units (Unit 151- 400)	4.2218
Over 400 units (Unit 401 ->)	4.4217
Monthly Service Charge	38.22

EGAT, MEA, and PEA all have played roles in promoting energy efficiency through their demand side management programs. For the appliance sector, EGAT's role has been the most significant, as they manage the EGAT No. 5 label program. However, MEA and PEA have both also played significant roles in energy efficiency at times. For instance, PEA has led a streetlight replacement program over the past four years.[30] In addition, the 2011 Energy Efficiency Development Plan includes the implementation of an energy efficiency resource standard (EERS) that would require that these utilities invest in specified amounts of energy efficiency measures each year; the EERS has, however, not yet been implemented.[31]

5.2. Power Sector Goals and Challenges

Thailand is seeking to diversify its generation mix away from its longstanding heavy dependence on natural gas-based generation. Specifically, the Thai Power Development Plan (PDP) targets decreasing the share of natural gas generation from 64% in 2014 to 30%-40% in 2036 by increasing the shares of imported hydro power, coal-fired generation, renewable generation, and, potentially, nuclear generation. The increase coal-fired generation is intended to consist of clean coal technologies, though these may prove prohibitively expensive as has been the case with clean coal pilot projects in North America.[32]

[30] LEDInside. "PEA Aims to Complete Thailand LED Streetlight Upgrade Project by 2018." 2014. Available online at: https://www.ledinside.com/news/2014/11/pea_aims_to_complete_thailand_led_streetlight_upgrade_project_by_2018
[31] EPPO. "Thailand 20-Year Energy Efficiency Development Plan (2011-2030)." 2011. Available online at: http://www.eppo.go.th/images/POLICY/ENG/EEDP_Eng.pdf
[32] Kristi E. Swartz. "Southern Co.'s clean coal plant hits a dead end." E&E News. June 22, 2017. Available online at: https://www.eenews.net/stories/1060056418

Table 3: Planned generation mix in Thailand

Fuel	Share in 2014	Share in 2036
Imported Hydro Power	7%	15%-20%
Clean Coal	20%	20%-25%
Renewables, including Hydro	8%	15%-20%
Natural Gas	64%	30%-40%
Nuclear	0%	0%-5%
Petroleum	1%	0%

One of the major challenges for the Thai electricity grid has been transmission to the South of the country. With the imported hydro power coming across the northern border from Laos and the thermal power plants concentrated in the Central region, most of the South's power must be transmitted to the region through a handful of transmission lines. This transmission bottleneck has led to serious problems, most notably the country's worst ever blackout in 2013.[33] The PDP aims to address this problem through the construction of two new coal-fired power plants in the South.[34]

Another key challenge for the Thai power sector is integrating increasing amounts of variable renewable generation onto the grid. Because technologies such as wind and solar generation may suddenly decrease the amount of electricity they are generating based on weather conditions, the electricity grid must have the flexibility to quickly increase other generation or decrease demand in order to avoid disruptions. With the large share of hydro power and natural gas-fired generation on the Thai grid, this flexibility should not be a major challenge, as these types of generation can ramp up quickly. However, as the share of natural gas-fired generation decreases, additional options for flexibility must be added, including demand side management in general and demand response in particular.[35]

The environmental impacts of electricity generation are yet another main challenge. Although Thailand currently has a relatively low grid-average emissions factor due to the high share of hydro power and natural gas-fired generation, this emissions factor may increase as coal-fired generation increases. This increase in emissions may be avoided if the clean coal technology is successfully implemented, though such technology may prove extremely expensive, as noted above. Thailand's current grid-average emissions factor appears in **Table 4.**

Table 4: Thai grid-average emissions factor[36]

Tool	Weight	Emissions Factor	Unit
Operating Margin	0.5	0.5426	tCO_2/MWh
Build Margin	0.5	0.6367	tCO_2/MWh
Combined Margin		0.5897	tCO_2/MWh

[33] Bangkok Post. "South power restored after Thailand's worst-ever blackout." 22 May 2013. Available online at: https://www.bangkokpost.com/learning/learning-news/351298/south-power-restored-after-thailand-s-worst-ever-blackout
[34] Energy Planning and Policy Office. "Thailand 20-Year Energy Efficiency Development Plan (2011-2030)." 2011. Available online at: http://www.eppo.go.th/images/POLICY/ENG/EEDP_Eng.pdf
[35] IEA. "Thailand Renewable Grid Integration Assessment." 2018. Available online at: https://webstore.iea.org/partner-country-series-thailand-renewable-grid-integration-assessment
[36] Based on data collected by Niwat Phansilpakom from the Thailand Energy Regulatory Commission

Policy Options and Impacts Assessment

6 Legal & Regulatory Framework Overview

Thailand has longstanding energy efficiency policies, including standards and labels for energy consuming products, which were initiated in the early to mid-1990's and have been expanded and strengthened over the years. Additionally, in 1989, Thailand ratified the Montreal Protocol and since then has been steadily working to phase out ozone depleting substances.

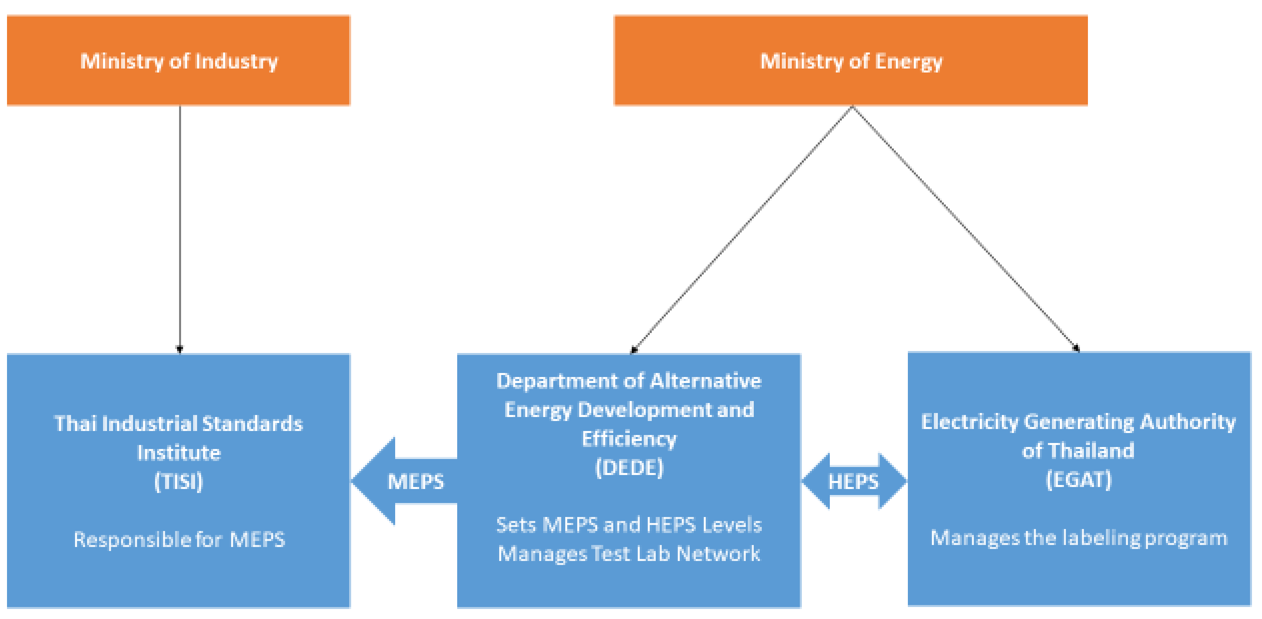
The Thai Energy Conservation Promotion Act, B.E. 2535 (1992) was the cornerstone policy that established energy efficiency as an important means to address future energy challenges. This Act was revised most recently in 2007. The adoption of the Thai Energy Conservation Promotion Act provided the Ministry of Energy with the power to set energy efficiency regulations as well as MEPS and labeling programs.

The Thai Energy Policy and Planning Office under the Ministry of Energy developed a 20-year Energy Efficiency Development Plan (EEDP), approved in 2011, to provide a national policy framework and guidelines on energy conservation in the long term. The EEDP targets a 25% reduction in energy intensity by 2030, over a 2005 baseline. Two of the key strategies identified for meeting this target are MEPS and energy performance labeling.

The Department of Alternative Energy Development and Efficiency (DEDE) under the Ministry of Energy is responsible for the development, implementation and enforcement of national energy efficiency policy. DEDE's duties include energy efficiency promotion and energy conservation regulation. DEDE is responsible for developing MEPS and high efficiency performance standards (HEPS), which designate the top performing products in the market. There is no HEPS for AC units.

Although DEDE develops MEPS, the Thai Industrial Standards Institute (TISI), under the Ministry of Industry, is responsible for regulating MEPS. On the other hand, DEDE is responsible for regulating HEPS. The Electrical and Electronics Institute (EEI), which possesses three AC test chambers, conducts AC testing for the MEPS and labeling program.

Figure 20: Thai standards and labeling institutions



Thailand has a long history of energy labeling. Upon the adoption of the Thai Energy Conservation Promotion Act in 1992, the first voluntary labeling program for refrigerators was launched in 1994. The Electricity Generating Authority of Thailand (EGAT) was the key government organization responsible for regulating the voluntary labeling program: the Label No. 5 program. EGAT's Label No.5 program has expanded steadily over the years, and now covers a wide range of household appliances and energy-using products.

EGAT is also responsible for monitoring and enforcing the voluntary labelling program. EGAT's requirements for the most efficient products (No. 5) are generally in line with HEPS, though there is currently no HEPS for ACs.

Thailand ratified the Montreal Protocol on July 7, 1989.[37] The National Ozone Protection Division of the Department of Industrial Works in the Ministry of Industry is the focal point of Montreal Protocol implementation in Thailand and the World Bank is the Thailand implementing agency for the Multilateral Fund of the Montreal Protocol.[38] Thailand has made significant progress towards meeting its obligations under the Montreal Protocol, having already fully phased out CFCs and having decreased HCFC consumption by approximately 65% since 2012.[39]

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

Table 5: Kigali amendment phase out schedule for Article 5 Group 1 countries

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

[37] UNEP. "Montreal Protocol Ratification Status." 2014. Available online at: http://ozone.unep.org/new_site/en/treaty_ratification_status.php
[38] UNEP. "National Ozone Unit Contacts." 2019. Available online at: https://www.unenvironment.org/ozonaction/national-ozone-unit-contacts
[39] Viraj Vithoontien. "Thailand: HCFC Phase-out Management Plan Stage II." World Bank. 2018. Available online at: https://www.ozonediw.org/attach/159/ThailandStageIIPreparation.pdf

7 Room AC Policy Framework (S&L)

Current Thai Policy

Thailand has mandatory minimum energy performance standard (MEPS) for ACs and refrigerators, and voluntary MEPS for 13 other products. The Thai Industrial Standards Institute (TISI) implements the MEPS program in collaboration with the Department of Alternative Energy Development and Efficiency (DEDE). The certification schemes include mandatory and voluntary certification options for different product classes. Only products meeting the certification requirements are eligible to bear the certification marks as shown below.[40]

Figure 21: Voluntary and mandatory TISI certification marks

voluntary certification mark   mandatory certification mark

The MEPS for ACs was last revised in 2010, and is set out in TIS 2134-2553 (2010). Thailand, 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 a cooling season performance factor (CSPF) of 3.08 W/W (10.51 Btu/hr/W) by 2020. Meeting this target will require that Thailand revise its MEPS to a seasonal metric, which could be SEER in order to align MEPS requirements to the metric used in the labeling program. Thailand will also need to increase the MEPS over the current levels.

Table 6: Thai MEPS levels

Type	Capacity	EER
Window Type	≤8,000W	≥9.6 (Btu/hr/W) ≥2.82 (W/W)
	≥8,000W ≤12,000W	≥8.6 (Btu/hr/W) ≥2.53 (W/W)
Split Type	≤8,000W	≥9.6 (Btu/hr/W) ≥2.82 (W/W)
	≥8,000W ≤12,000W	≥9.6 (Btu/hr/W) ≥2.82 (W/W)

In addition to the MEPS program, Thailand also has a well-recognized labeling program. EGAT is responsible for implementing the voluntary Label No. 5 program for ACs. The No.5 Label is a comparative label with ratings from 1 to 5, with No. 5 being the most efficient and No.1 being the least efficient. However, since the program is voluntary, manufacturers only opt to obtain the EGAT No. 5 label if their products achieve the fifth level. This has meant that the label had no longer been able to differentiate products, as only one labeling level is ever used. In order to address this problem, EGAT introduced three additional stars that products can achieve beyond the fifth level in January 2019.

[40] Asia Pacific Energy Research Center (APERC). 2017. Compendium of Energy Efficiency Policies of APEC Economies

The EGAT No. 5 label measures energy efficiency in SEER and has different requirements based on whether the AC unit is an inverter unit or a fixed speed unit. These levels appear in **Table 7**. In addition, the new star rating levels appear in **Table 8**.

Table 7: EGAT No. 5 label levels

Level	Capacity	Inverter SEER (Btu/hr/W)	Fixed Speed SEER (Btu/hr/W)
Level 5	≤8,000W	≥15.00	≥12.85
	≥8,000W ≤12,000W	≥14.00	≥12.40
Level 4	≤8,000W	14.20 – 14.99	12.45 – 12.84
	≥8,000W ≤12,000W	13.20 – 13.99	12.10 – 12.39
Level 3	≤8,000W	13.40 – 14.19	12.00 – 12.44
	≥8,000W ≤12,000W	12.40 – 13.19	11.80 – 12.09
Level 2	≤8,000W	12.60 – 13.39	11.60 – 11.99
	≥8,000W ≤12,000W	11.70 – 12.39	11.45 – 11.79
Level 1	≤8,000W	12.00 – 12.59	11.15 – 11.59
	≥8,000W ≤12,000W	11.00 – 11.69	11.15 – 11.44

Table 8: EGAT No. 5 star requirements

Stars	Capacity	Inverter SEER (Btu/hr/W)	Fixed Speed SEER (Btu/hr/W)
Three Stars	≤8,000W	≥22.50	≥15.85
	≥8,000W ≤12,000W	≥21.50	≥15.40
Two Stars	≤8,000W	20.00 – 22.49	14.85 – 15.84
	≥8,000W ≤12,000W	19.00 – 21.49	14.40 – 15.39
One Star	≤8,000W	17.50 – 19.99	13.85 – 14.84
	≥8,000W ≤12,000W	16.50 – 18.99	13.40 – 14.39
No Stars	≤8,000W	15.00 – 17.49	12.85 – 13.84
	≥8,000W ≤12,000W	14.00 – 16.49	12.40 – 13.39

EGAT has a compliance framework in place for its Label No.5 program and has continuously implemented compliance activities since 2005. A compliance unit within EGAT is responsible for the program, and routinely carries out random sampling and verification testing. EGAT assigned the Electrical and Electronics Institute

(EEI), an accredited laboratory, as the program's testing laboratory. EGAT's annual budget for carrying out the random spot-check and verification testing is approximately 5 million Baht (~166,000 $US).

However, since the EGAT No. 5 label is a voluntary labeling scheme, there is no law and regulation to support strict penalties. The penalties begin with a verbal warning, then a written warning, then a requirement to remove the No. 5 label, and then finally EGAT publishes the name of the non-compliant model on the program's website.

Lessons from the European Union

In the European Union, policymakers also faced the challenge posed by products accumulating in the top labeling tier, which similarly prevented consumers from effectively differentiating products. Also like Thailand, the European Union sought to address this problem by adding additional efficiency tiers beyond the top category.

The European Union introduced categorical labeling for household appliances in 1992 with the *Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances*. This directive established the A to G scale and the general design of the EU Energy Label as is still used today. After a few years of enforcement of the label, it became obvious that the highest efficiency classes for some products were already overpopulated whereas the lower classes were empty. The clustering of models in the top classes meant that the label no longer allowed for visible differentiation between products on the market. The EU therefore needed to revise the scale of the label in order to restore its ability to help consumers make well-informed purchasing choices. The discussion preceding the adoption of a new Directive in 2010 centred on the question of the rescaling. However, in view of the industry resistance to proceed to a complete rescale of the label, EU Member States decided to maintain the existing classes and add higher efficiency classes (A+, A++, and A+++). The 2010 Directive therefore did not trigger a rescale of the energy labels but rather an extension of the scale to those 3 additional classes.

In 2013, CLASP published a consumer research study[41] to examine the effectiveness of the new label design in supporting consumers in making informed choices about the energy efficiency of appliances during purchase. The study assessed how consumers use, understand, and are motivated by the new and revised labels. This was achieved by holding 10 consumer focus groups and 30 in-depth interviews across ten cities in the EU.

Evidence from this study demonstrated that consumers understand both versions of the label and that both positively influence purchase decisions. It also showed some differences in appeal and understanding between the two versions. The new design was deemed more attractive and clearer, but the appeal of the best class compared to the rest of the scale appeared higher in the A to G scale than in the A+++ to D scale. Consumers were less likely to choose an A+++ model over an A model under the new regulation than they were to choose an A model over a D model under the previous regulation.

In 2017, the European Commission adopted a revised legal framework for the energy efficiency label.[42] This revised framework included a return to the original A to G scale, along with clear criteria on when to re-scale the label based on the share of products in the top classes.

Much like in the European Union, EGAT's introduction of star ratings beyond level five of the EGAT No. 5 label allows consumers to differentiate between products where such differentiation was previously impossible. EGAT should consider evaluating the effectiveness of the new label design to identify if the new ratings compel consumers to purchase ACs with an EGAT No. 5 label and three stars over a unit with an EGAT No. 5 label and no stars.

[41] CLASP. "Assessing Consumer Comprehension of the EU Energy Label.":2013. Available online at: https://clasp.ngo/publications/assessing-consumer-comprehension-of-the-eu-energy-label

[42] Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU. Available online at: https://eur-lex.europa.eu/eli/reg/2017/1369/oj

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.[43]

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 Thailand, 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 ACs. 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 SEER, cooling capacity, and price. The regression model uses data from 1,806 observations of ACs, with cooling capacities ranging from 8,500 to 60,000 Btu/hr and SEERs ranging from 8.69 to 27.33 Btu/hr/W, to approximate a linear relationship between the dependent variable, Price, and two independent variables, SEER and Cooling Capacity. The output of the regression analysis can be found in **Appendix B**. The R Square value of the regression model was 0.688, indicating that the linear model using cooling capacity and efficiency explains approximately 69% of the variation in price. Additionally, the p-values for both variables (i.e. SEER 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:

$$Price = -23560.60 + 1{,}694.92(SEER) + 1.297(Cooling\ Capacity)$$

Where: Price is in THB/unit, SEER is in Btu/hr/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 four cooling capacities that best represent the range of products found in the Thai market – 12,000 Btu/hr, 24,000 Btu/hr, 36,000 Btu/hr, and 48,000 Btu/hr.

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

These four representative cooling capacities were analysed separately for both MEPS and labelling policy revisions. Baseline SEERs were obtained for each capacity for both labelled and unlabelled AC by identifying the most common SEER in each category (i.e. labelled 12,000 Btu/hr units, unlabelled 12,000 Btu/hr units, labelled 24,000 Btu/hr units, etc.). Baseline prices were then calculated based on the average prices of models with the baseline SEERs and cooling capacities. The same baseline model was used for both categories of 48,000 Btu/hr units as there currently is no labelling policy for units with a capacity above 40,944 Btu/hr.

Table 9: Baseline models for PAMS analysis

Cooling Capacity	EGAT No. 5 Label?	Most Popular SEER on the Market	Average Price (THB)	Average Price (USD)
12,000 Btu/hr	No	12.1 (Btu/hr/W)	12,557	389
12,000 Btu/hr	Yes	13.0 (Btu/hr/W)	14,039	435
24,000 Btu/hr	No	12.1 (Btu/hr/W)	28,123	872
24,000 Btu/hr	Yes	13.2 (Btu/hr/W)	29,944	928
36,000 Btu/hr	No	12.1 (Btu/hr/W)	43,689	1,354
36,000 Btu/hr	Yes	12.5 (Btu/hr/W)	44,239	1,371
48,000 Btu/hr	No	11.1 (Btu/hr/W)	57,454	1,781

The cost curve for smaller capacity models is steeper indicating that increases in efficiency are costlier as compared to larger capacity models. The starting efficiencies for each of the eight base cases corresponds to the most common SEER for labeled or unlabeled units in each capacity, as shown in **Table 9**. The cost-efficiency curves for unlabeled models appear in **Figure 22**, while the cost-efficiency curves for labeled models appear in **Figure 23**.

Figure 22: Cost-efficiency curves for MEPS analysis

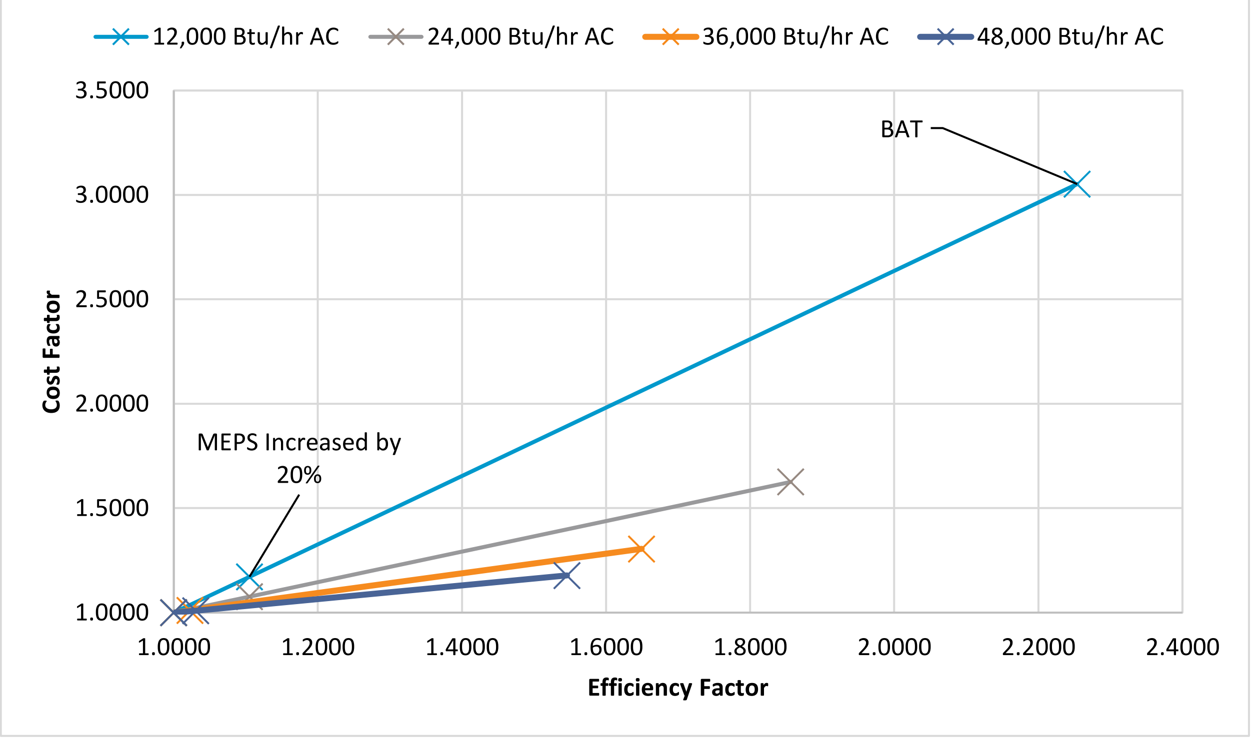
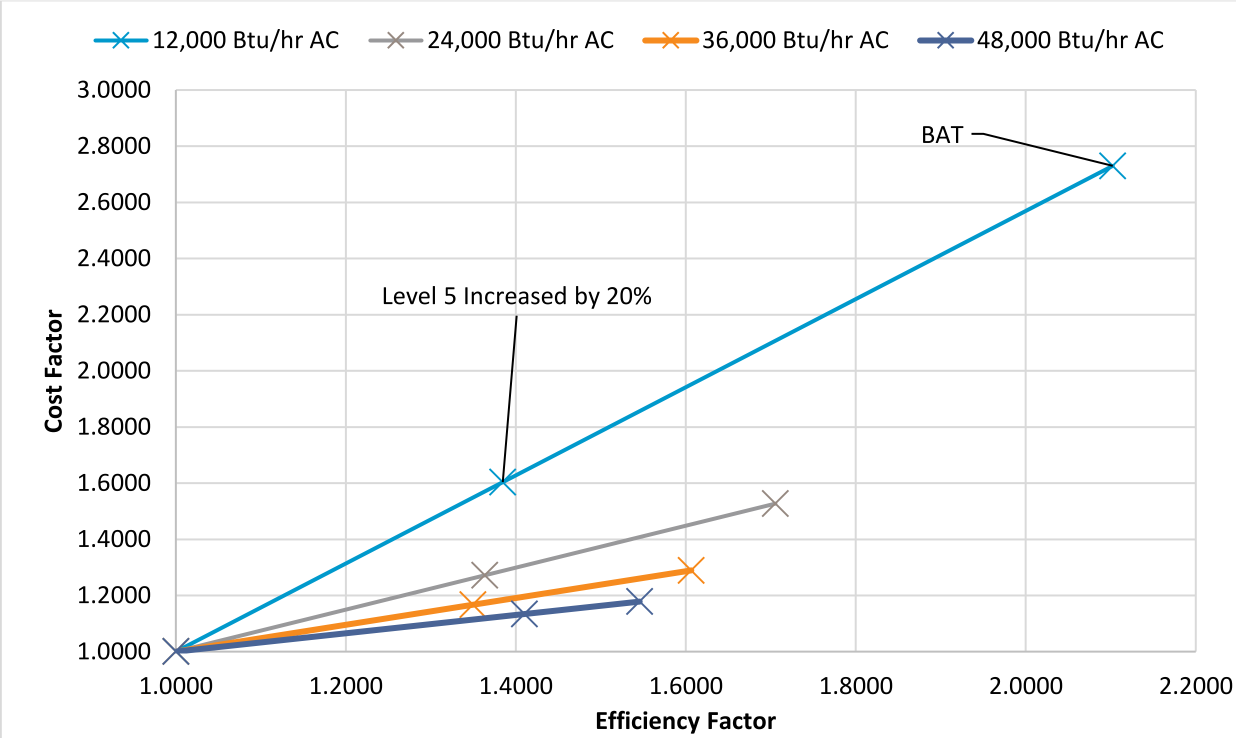


Figure 23: Cost-efficiency curves for labeling analysis



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[44] and urbanization[45] in Thailand are from UN Population.
- A deposit interest rate of 1.29% (as the consumer discount rate) and a real interest rate of 2.06% are used to estimate cost savings at the consumer and national level. [46]
- A real income growth rate of 3.64% is used.[47]

[44] UN, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects: The 2017 Revision
[45] UN Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization Prospects: The 2018 Revision. https://population.un.org/wup/Country-Profiles/
[46] World Bank. 2017. Deposit interest rate (%), Real Interest rate (%) available at: https://data.worldbank.org/
[47] World Bank. 2017. GDP per capita growth (%) is available at: https://data.worldbank.org/

Underlying power sector data:

- Transmission and distribution (T&D) Loss Factor is 6.07%.[48]
- The most recent grid emissions factor of 0.5897 kg CO_2/kWh is used.
- The 2018 marginal residential electricity rate for consumption above 400 kWh of 4.4217 THB/kWh is used. This is equivalent to approximately 0.137 USD/kWh.[49]

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 and kept constant to 2030: 75% for 12,000 Btu/hr ACs, 13% for 24,000 Btu/hr ACs, and 6% for 36,000 Btu/hr and 48,000 Btu/hr ACs.
- The market share of labeled ACs was assumed to be 71.5%, based on the market data collected by Niwat Phansilpakom.
- Based on average estimates given by manufacturers, importers, and exporters, the average AC lifetime is 10.5 years with 2,920 operating hours per year.
- Unit energy consumption was calculated based on the baseline values in Error! Reference source not f ound. using the formula.[50]

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

- The exchange rate used for conversion to and from THB and USD was 0.031 THB/USD.[51]

Market Composition Assumptions

- Given Thai consumers' strong preference for products bearing the EGAT No. 5 label, we assumed that the market share of labeled products would remain fixed, at 71.5%, following labeling policy revisions
- We therefore modeled labeling and MEPS policies separately, applying the labeling policy to the labeled share of the market (71.5%) and the MEPS policy to the unlabeled share of the market (28.5%)

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

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[48] World Bank. 2014. Electric power transmission and distribution losses (% of output). https://data.worldbank.org/indicator/EG.ELC.LOSS.ZS?locations=TH

[49] This rate is used because, at the baseline efficiency of 12.1 SEER (Btu/hr/W) and a capacity of 12,000 Btu/hr, the AC unit alone would consume approximately 240 kWh. If we assume that consumers have several other appliances, it is quite likely that they would exceed 400 kWh per month. At higher capacities, the AC unit alone will exceed 400 kWh per month.

[50] The formula for unit energy consumption is taken from the EGAT No. 5 label handbook

[51] Exchange rate taken on December 18, 2018.

9 Policy Options & Results

9.1 Policy Options

CLASP evaluated three policy options in the impacts analysis: increasing MEPS by approximately 20% over the current EGAT No. 5 label's level one threshold for fixed speed unit, increasing the EGAT No. 5 label's level five threshold by 20% over the current level five threshold for inverter units, and increasing both MEPS and the EGAT No. 5 label's level five threshold to the best currently available technology. For each policy option, CLASP also included expanding the scope of the policies to include all AC units under 60,000 Btu/hr. CLASP's policy options analysis adopts a technology neutral approach, wherein increased MEPS and label levels are applied equally to both fixed speed and inverter ACs.

Increasing MEPS Levels by 20% over Current Fixed Speed Level 1

The first policy scenario CLASP considered was an increase in the MEPS levels by approximately 20% over the current fixed speed level one threshold for the EGAT No. 5 label. Given that all AC units found on the Thai market exceed the MEPS for their capacity and the vast majority significantly exceed the EGAT No. 5 label's level one threshold, it is clear that technological progress on the Thai market has rendered these policies essentially irrelevant to the current market situation. Furthermore, the EGAT No. 5 label has already transitioned to SEER as the efficiency metric, in line with the ASEAN SHINE agreement. Therefore, this scenario proposes MEPS set at 20% above the current SEER for the level one EGAT No. 5 threshold for fixed speed units, with varying (lower) efficiency requirements for higher capacities, as in the inverter labeling requirements. In addition, this scenario includes expanding the scope of the MEPS to all products under 60,000 Btu/hr, with an additional step-down in stringency for the MEPS for the newly regulated higher capacities, in order to examine the impacts of expanding policies to include higher capacity units.

These MEPS levels can be found in **Table 10**, below, and compared to **Table 6 in Section 7**. Window units were not evaluated in this analysis as they are no longer found in the Thai market.

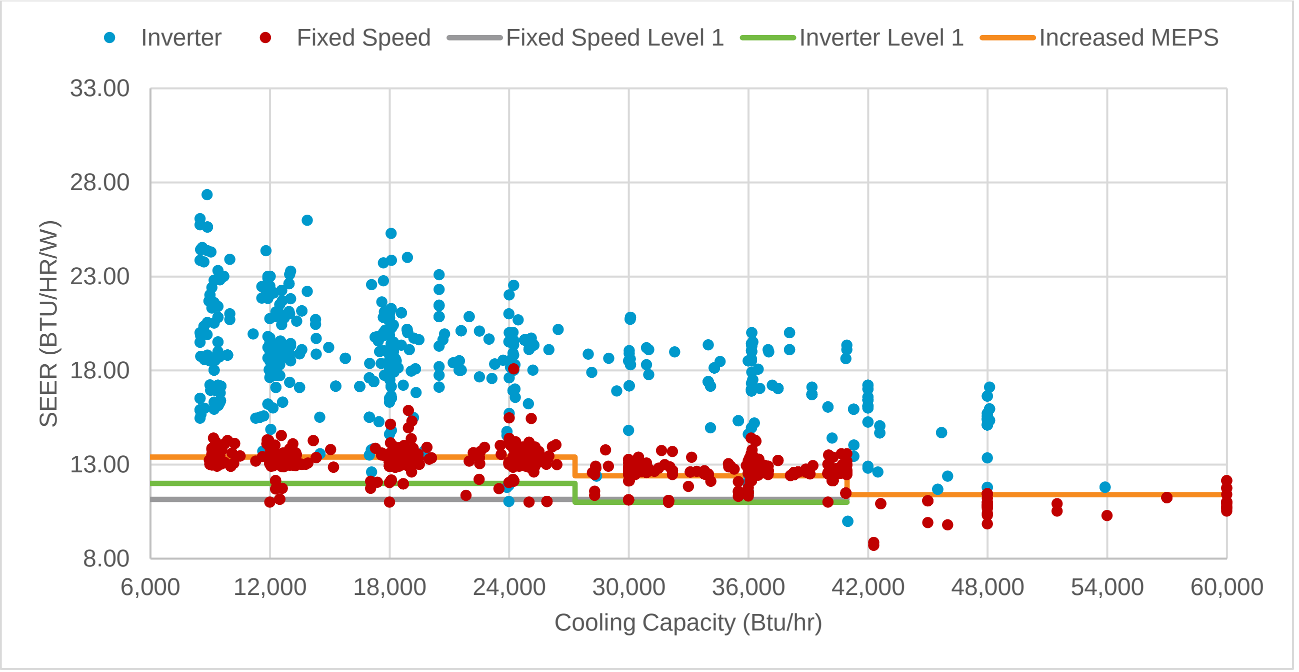
Table 10: Scenario 1 MEPS levels

Capacity	Policy Scenario SEER	Current SEER[52]
≤27,296 Btu/hr/W	≥13.40 (Btu/hr/W) ≥3.93 (W/W)	≥10.97 (Btu/hr/W) ≥3.22 (W/W)
≥27,296 Btu/hr/W ≤40,944 Btu/hr/W	≥12.40 (Btu/hr/W) ≥3.63 (W/W)	≥10.97 (Btu/hr/W) ≥3.22 (W/W)
≥40,944 Btu/hr/W ≤60,000 Btu/hr/W	≥11.40 (Btu/hr/W) ≥3.34 (W/W)	N/A

Increasing the MEPS by 20% over the current EGAT No. 5 label's first level would remove the least efficient ACs, most of which are fixed speed units, from the market, as is illustrated in **Figure 24**.

[52] Converted from EER based on the conversion function EER = SEER x 0.875.

Figure 24: MEPS at 20% above EGAT No. 5 label level one (N=1804)



Increasing EGAT No. 5 Label Level by 20% over Current Inverter Level 5

The second policy scenario CLASP considered was an increase in the EGAT No. 5 level 5 by 20% over the current threshold. This scenario would provide a technology-neutral labeling scheme, without setting lower labeling requirements for fixed speed units. Thus, all products receiving the EGAT No. 5 label would have to comply with the same requirements, and consumers would no longer be faced with fixed speed EGAT No. 5 labeled units that are less efficient than some unlabeled inverter units. In addition, this scenario includes expanding the scope of the EGAT No. 5 label to all products under 60,000 Btu/hr, with a step-down in stringency for the level five tier for the newly regulated higher capacities, in order to examine the impacts of expanding policies to include higher capacity units.

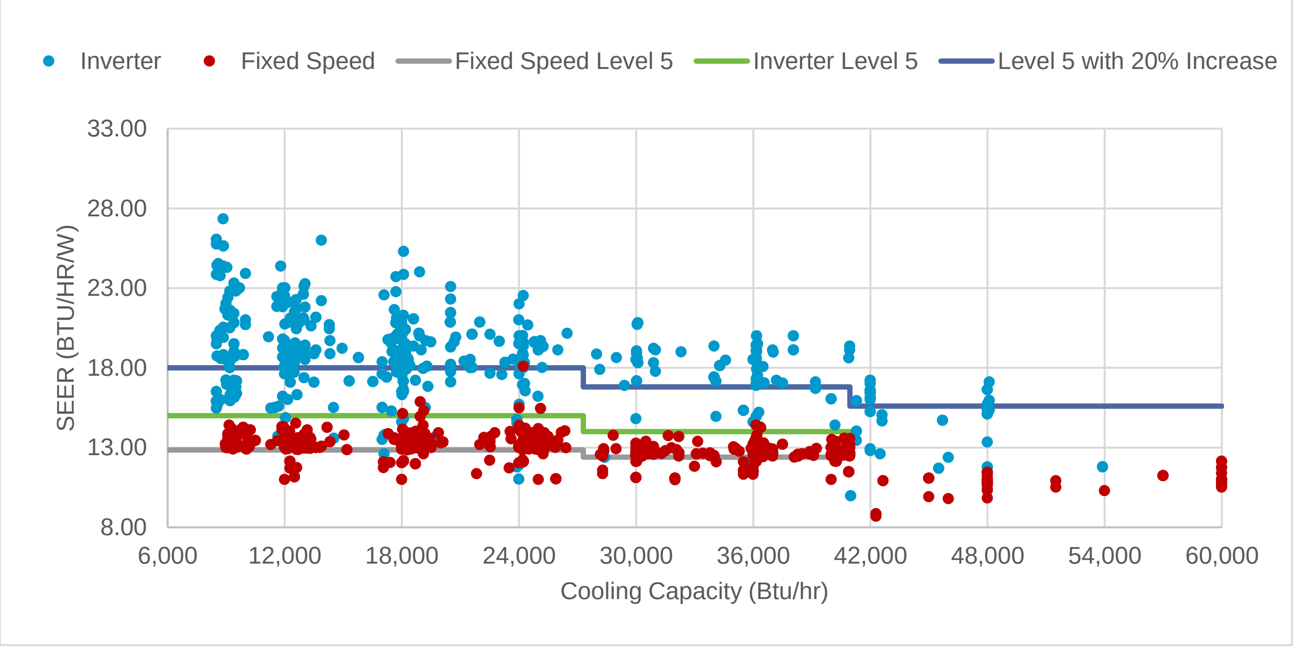
These label levels can be found in **Table 11**, below, and compared to **Table 7 in Section 7**.

Table 11: Scenario 2 EGAT No. 5 level 5

Capacity	Policy Scenario SEER	Current Inverter SEER	Current Fixed Speed SEER
≤27,296 Btu/hr/W	≥18.00 (Btu/hr/W) ≥5.28 (W/W)	≥15.00 (Btu/hr/W) ≥4.40 (W/W)	≥12.85 (Btu/hr/W) ≥3.77 (W/W)
≥27,296 Btu/hr/W ≤40,944 Btu/hr/W	≥16.80 (Btu/hr/W) ≥4.92 (W/W)	≥14.00 (Btu/hr/W) ≥4.11 (W/W)	≥12.40 (Btu/hr/W) ≥3.64 (W/W)
≥40,944 Btu/hr/W ≤60,000 Btu/hr/W	≥15.60 (Btu/hr/W) ≥4.57 (W/W)	N/A	N/A

Increasing the EGAT No. 5 label level by 20% over the current inverter level would result in only high-efficiency, inverter ACs receiving the EGAT No. 5 label, as illustrated in **Figure 25**.

Figure 25: 20% Increase to EGAT No. 5 label threshold over current inverter level 5 (N=1804)



Best Available Technology (BAT)

The final 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 Thai market. **Table 12** summarizes the SEERs and average prices for the BAT for the representative cooling capacities in Thailand.

Table 12: Best available technology for four representative cooling capacities

Cooling Capacity	Highest SEER on the Market in Range	Average Price (THB)	Average Price (USD)
12,000	27.33 Btu/hr/W	38,328	1,188
24,000	22.51 Btu/hr/W	45,724	1,417
36,000	20.00 Btu/hr/W	57,036	1,768
48,000	17.10 Btu/hr/W	89,059	2,761

9.2 Outputs

The following eight tables below show the summary outputs of the PAMS analysis for the four representative models under the three scenarios. Under all scenarios, consumers benefit from lifecycle cost savings, showing that increases in the stringency of energy efficiency policy are highly cost-effective for Thai consumers. However, the benefit/cost ratios of the BAT scenarios are all lower than the benefit/cost ratios for the 20% increase scenarios, which shows that moving to the BAT, while cost-effective, is not the optimal policy for consumers.

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

Metric	20% Increase to MEPS SEER 13.40	BAT SEER 27.33
Consumer Benefits		
Payback Period (years)[53]	1.78	3.63
LCC savings (THB)	9,172	405,240
National Benefits		
Total Electricity Cost Savings through 2030 (millions of THB)	30,117	174,689
Benefit/Cost Ratio	4.39	2.17
Site Energy Savings in 2030 (GWh)[54]	900	5,193
Site Energy Savings through 2030 (GWh)	4,851	28,239
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	3.05	17.73

Table 14: PAMS output summary for labeled 12,000 Btu/hr room ACs

Metric	20% Increase to Level 5 SEER 18.00	BAT SEER 27.33
Consumer Benefits		
Payback Period (years)	2.56	3.89
LCC savings (THB)	22,401	339,916
National Benefits		
Total Electricity Cost Savings through 2030 (millions of THB)	204,108	385,274
Benefit/Cost Ratio	3.08	2.03
Site Energy Savings in 2030 (GWh)	6,068	11,454
Site Energy Savings through 2030 (GWh)	32,995	62,281
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	20.72	39.10

Table 15: PAMS output summary for unlabeled 24,000 Btu/hr room ACs

Metric	20% Increase to MEPS SEER 13.40	BAT SEER 22.51
Consumer Benefits		
Payback Period (years)	0.89	1.49
LCC savings (THB)	20,504	923,454
National Benefits		
Total Electricity Cost Savings through 2030 (millions of THB)	10,675	50,217
Benefit/Cost Ratio	8.70	5.28
Site Energy Savings in 2030 (GWh)	321	1,493
Site Energy Savings through 2030 (GWh)	1,712	8,118
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	1.07	5.10

[53] 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.
[54] Site energy savings refers solely to on-site energy savings from using ACs.

Table 16: PAMS output summary for labeled 24,000 Btu/hr room ACs

Metric	20% Increase to Level 5 SEER 18.00	BAT SEER 22.51
Consumer Benefits		
Payback Period (years)	1.30	1.63
LCC savings (THB)	50,247	747,697
National Benefits		
Total Electricity Cost Savings through 2030 (millions of THB)	66,938	103,757
Benefit/Cost Ratio	6.05	4.85
Site Energy Savings in 2030 (GWh)	1,991	3,085
Site Energy Savings through 2030 (GWh)	10,817	16,773
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	6.79	10.53

Table 17: PAMS output summary for unlabeled 36,000 Btu/hr room ACs

Metric	20% Increase to MEPS SEER 12.40	BAT SEER 20.00
Consumer Benefits		
Payback Period (years)	0.55	0.88
LCC savings (THB)	7,443	1,274,044
National Benefits		
Total Electricity Cost Savings through 2030 (millions of THB)	1,770	29,671
Benefit/Cost Ratio	14.03	8.91
Site Energy Savings in 2030 (GWh)	53	882
Site Energy Savings through 2030 (GWh)	283	4,796
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	0.18	3.01

Table 18: PAMS output summary for labeled 36,000 Btu/hr room ACs

Metric	20% Increase to Level 5 SEER 16.80	BAT SEER 20.00
Consumer Benefits		
Payback Period (years)	0.76	0.91
LCC savings (THB)	82,782	1,186,424
National Benefits		
Total Electricity Cost Savings through 2030 (millions of THB)	48,125	69,525
Benefit/Cost Ratio	10.22	8.67
Site Energy Savings in 2030 (GWh)	1,439	2,067
Site Energy Savings through 2030 (GWh)	7,749	11,238
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	4.87	7.06

Table 19: PAMS output summary for unlabeled 48,000 Btu/hr room ACs

Metric	MEPS SEER 11.40	BAT SEER 17.10
Consumer Benefits		
Payback Period (years)	0.34	0.52
LCC savings (THB)	14,880	1,742,196
National Benefits		
Total Electricity Cost Savings through 2030 (millions of THB)	3,460	39,184
Benefit/Cost Ratio	22.31	15.09
Site Energy Savings in 2030 (GWh)	105	1,171
Site Energy Savings through 2030 (GWh)	554	6,313
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	0.35	3.96

Table 20: PAMS output summary for labeled 48,000 Btu/hr room ACs

Metric	Level 5 SEER 15.60	BAT SEER 17.10
Consumer Benefits		
Payback Period (years)	0.47	0.52
LCC savings (THB)	144,262	1,742,196
National Benefits		
Total Electricity Cost Savings through 2030 (millions of THB)	81,590	98,303
Benefit/Cost Ratio	16.47	15.09
Site Energy Savings in 2030 (GWh)	2,447	2,938
Site Energy Savings through 2030 (GWh)	13,117	15,837
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	8.24	9.94

10 Impacts Assessment Results

10.1 Impacts to Consumers

We assessed the impacts to consumers under three policy scenarios:

- **MEPS increase by 20% over current EGAT No. 5 label fixed speed level one:** savings are substantial for consumers of all AC capacities. The payback periods for these MEPS are all between 0.34 years and 1.78 years, with the larger capacities having faster payback periods. Similarly, the lifecycle cost savings range from 7,443 THB to 20,504 THB.
- **EGAT No. 5 label increase by 20% over current inverter level five:** savings are also substantial for consumers of all AC capacities. The payback periods for the increase in the labeling threshold are all between 0.47 years and 2.56 years, with the larger capacities having faster payback periods. Similarly, the lifecycle cost savings range from 22,410 THB to 144,262 THB, with the larger capacities also having the larger lifecycle cost savings.
- **BAT scenario** showed payback periods between 0.52 years and 3.89 years. The lifecycle cost savings range from 339,916 to 1,742,196. The payback periods were shorter and the lifecycle cost savings were higher for larger, unlabeled units than for smaller, labeled units.

Table 21: Consumer benefits of a MEPS and EGAT No. 5 label increase

Market Segment	Cooling Capacity	Most Popular SEER on the Market	LCC Savings (THB)	LCC Savings (USD)	Payback Time	Benefit/Cost Ratio
Unlabeled	12,000 Btu/hr	12.1 Btu/hr/W	9,172	284	1.78 years	4.39
	24,000 Btu/hr	12.1 Btu/hr/W	20,504	636	0.89 years	8.70
	36,000 Btu/hr	12.1 Btu/hr/W	7,442	231	0.55 years	14.03
	48,000 Btu/hr	11.1 Btu/hr/W	14,880	461	0.34 years	22.31
Labeled	12,000 Btu/hr	13.0 Btu/hr/W	22,401	694	2.56 years	3.08
	24,000 Btu/hr	13.2 Btu/hr/W	50,247	1,558	1.30 years	6.05
	36,000 Btu/hr	12.5 Btu/hr/W	82,782	2,566	0.76 years	10.22
	48,000 Btu/hr	11.1 Btu/hr/W	144,262	4,472	0.47 years	16.47

10.2 Impacts to Manufacturers

According to the data collected, all of the 1,806 models for which energy efficiency information was reported using SEER or EER 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 increased MEPS scenario, 31% of models on the market (32% of Thai-made models and 22% of imported models) would be removed from the market. Of the models that would be removed from the market, 2% are inverter units and 98% are fixed speed units.

Another component of the policy scenario is the increase in the stringency of the EGAT No.5 label level five by approximately 20%. Under this scenario, only 26% of the models on the market would achieve the EGAT No.5 label, and virtually all of these models would be inverter units.

To understand the impact this policy would have on Thai companies, CLASP analyzed the data to determine which companies producing and/or marketing Thai brands would potentially see a significant number of their lower efficiency, fixed speed ACs removed from the market and what share of their models would achieve the revised EGAT No.5 label threshold. All of the Thai companies' models that would be eliminated are fixed speed units. Companies that manufacture some or all of the products they market are marked in bold.

Table 22: Share of Thai companies' products achieving the EGAT No. 5 label

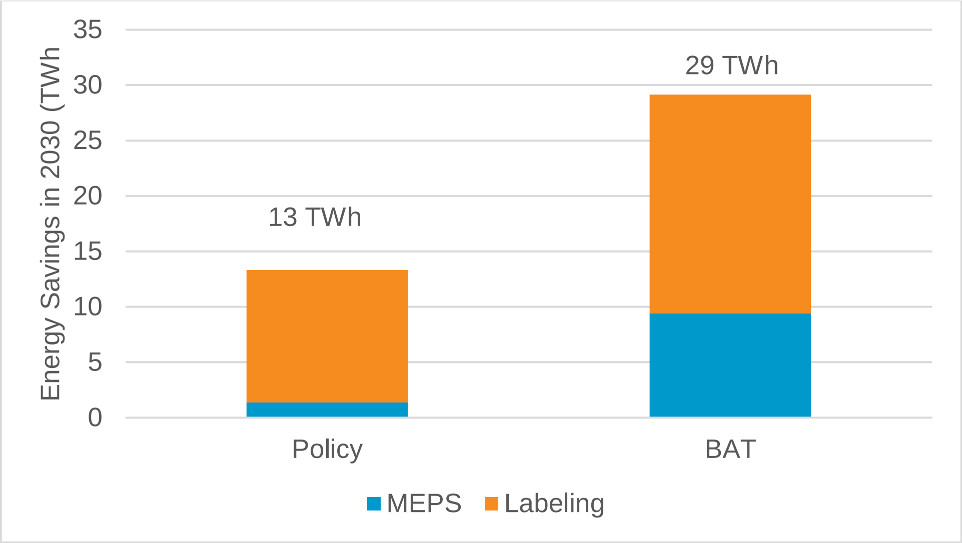
Company	% of models eliminated	% of models achieving EGAT No. 5 label
Air Image Group	**35%**	**0%**
Bacchus and Hanjo	40%	0%
Casper Electric	13%	50%
Energy World Corporation	**30%**	**40%**
Furano Air	**6%**	**0%**
Kent United	**71%**	**0%**
Panabishi	**31%**	**0%**
PSI Corporation	17%	63%
Rangsiya Cooling Ltd.	32%	0%
Sapsuksiri	**17%**	**0%**
Sapthonghor	**46%**	**0%**
Siam Products Air conditioning	**29%**	**0%**
Sic Cooling Service Co.	0%	0%
Vekin	19%	76%
Vertex Supply	44%	0%
Weather Cool	33%	0%
Total	**32%**	**7%**

10.3 Impacts at the National Level

Energy Savings

- Under a business as usual scenario, in which no changes are made to Thailand's policies for ACs, CLASP projects that by 2030 Thai AC users will consume 72.5 TWh of energy annually.
- Under the policy scenarios, including both the MEPS and labeling requirement increases, significant energy savings of just over 13.3 TWh of electricity in 2030 are possible. AC use-driven energy consumption in 2030 can be reduced by 18.4%. Over a ten-year period, the cumulative site energy savings could reach nearly 72.1 TWh of electricity.
- Under the BAT scenario in which Thailand adopts MEPS and EGAT No. 5 labeling requirements equivalent to the SEER of the best available AC on the market, an estimated 40% reduction in 2030 energy use is possible, relative to business-as-usual. Essentially, the technology to reduce room AC-related energy consumption by a 40% is already market-ready and cost-effective.

Figure 26: Energy savings in 2030 under different scenarios

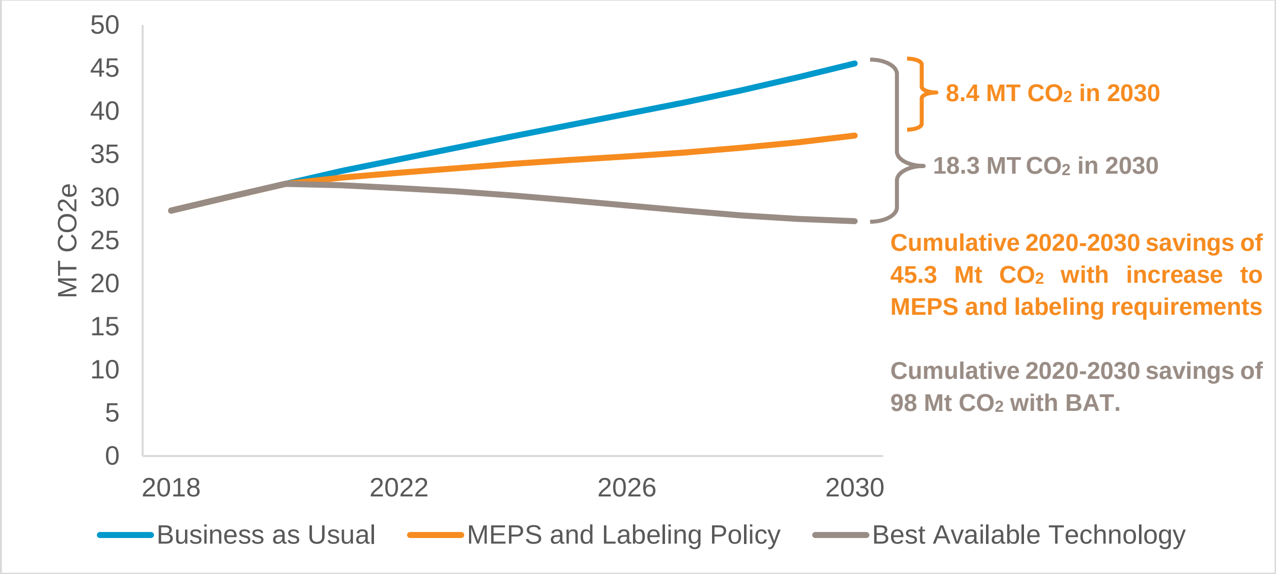


Emissions reductions

In 2030, with no policy changes, Thai AC users will consume 72.5 TWh of energy annually, resulting in up to 46 MT of CO_2 emissions.

- **The policy scenarios, including both the MEPS and labeling requirement increases** can deliver a significant emissions reduction of 8.4 MT CO_2 in 2030 (the cumulative reductions through 2030 is equal to 45.3 MT CO_2).[55]
- **Under the BAT scenario**, the CO_2 from operating ACs in households can be reduced by about 18.3 MT CO_2 in 2030. Market-ready and cost-effective technology exists to reduce domestic space cooling related emissions in Thailand by a cumulative 98 MT CO_2 through 2030.

Figure 27: Avoided CO_2 emissions over time and in 2030



55 Emissions from refrigerants are not considered for this analysis.

11 Conclusions and Recommendations

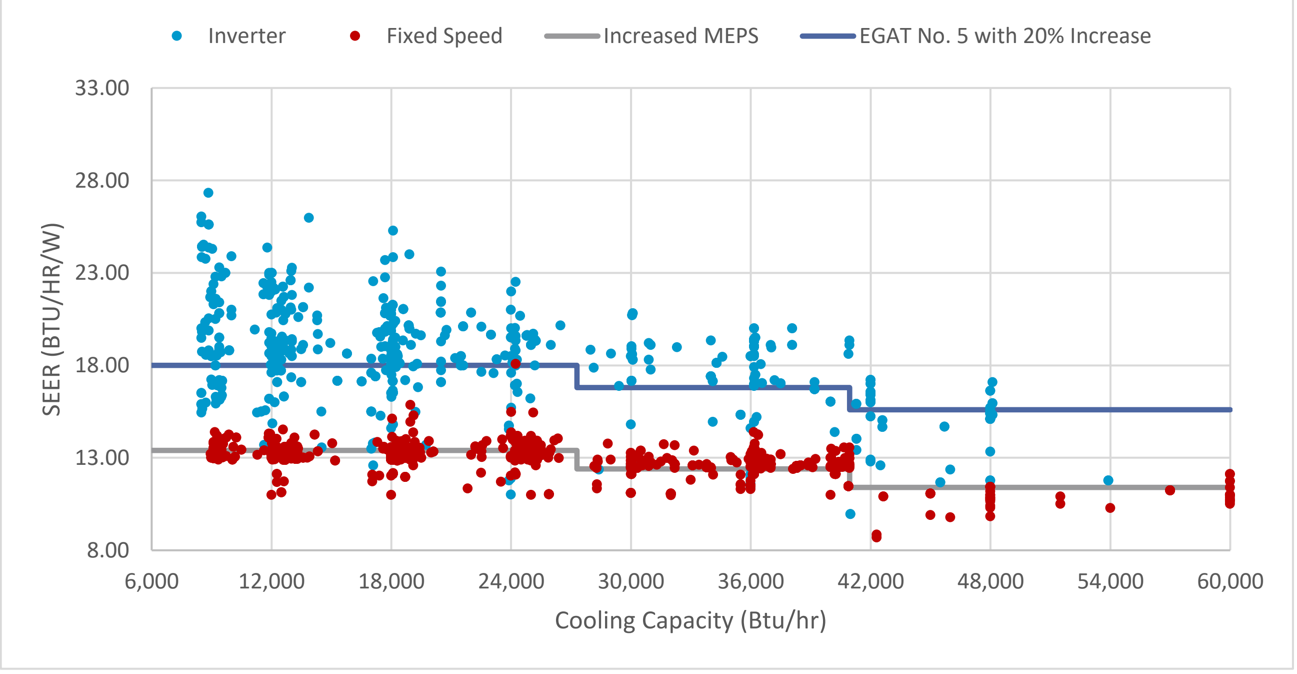
The Thailand Room Air Conditioner Market Assessment and Policy Options Analysis provides the technical evidence to support a revision of MEPS as well as the requirements for the EGAT No. 5 label. The Thai AC market is ready for an increase in MEPS and revisions to the EGAT No. 5 label requirements. Government 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 2,146 AC models, obtained from store visits, manufacturer interviews, online retailers, and EEI. This assessment of the room AC market in Thailand provides evidence for the development and implementation of more stringent energy performance standards and labeling in Thailand.

The Thai AC market has evolved rapidly over the past six years. The market share of inverter units has at least doubled since 2013, from 16% to 32% of available models, with manufacturers stating that inverter units now make up a majority of sales for products under 25,000 btu/hr. At the same time, AC manufacturers have transitioned away from R-22, a high GWP, ozone-depleting substance, which was used in 79% of products on the market in 2013. R-410A, which is used in 62% of available models, and R-32, which is used in 34% of available models, now dominate the market.

Highly efficient products are cost-effective in Thailand. Moving to the best available technology is cost-effective for consumers for all AC unit capacities. The lifecycle energy performance benefits outweigh the increased costs of these high-efficiency units by at least 2:1, with even higher benefit-to-cost ratios at the higher capacities. Similarly, the payback period for purchasing the most efficient 48,000 btu/hr AC unit is just over six months, though the payback periods for the most efficient 12,000 btu/hr AC units are closer to four years.

Figure 28: Policy scenario for MEPS and EGAT No. 5 label



Increasing MEPS and the EGAT No. 5 label requirements and expanding product coverage to all products under 60,000 Btu/hr 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% over the current EGAT No. 5 label's level one for fixed speed units. Similarly, consumers who prioritize purchasing products with the EGAT No. 5 label would receive lifecycle benefits and rapid payback periods from a 20% increase in the label requirements over the current requirements for inverter units. These lifecycle benefits from both MEPS and labeling are particularly large for consumers of currently unregulated products with capacities between 40,944 Btu/hr and 60,000 Btu/hr. At the national level, by revising AC MEPS and EGAT No. 5 label requirements, Thailand can reduce annual energy consumption from ACs and make progress towards the NDC target of 25% emissions reduction in 2030 compared to business-as-usual. A 25% reduction would be equivalent to 138.8 MT CO_2, of which AC MEPS and labeling revisions alone can provide 8.4 MT CO_2 or 6% of the intended reduction.

Some locally manufactured products would be eliminated by increasing MEPS and others will no longer be eligible for the EGAT No. 5 label: 32% of all Thai-produced AC units on the market would be eliminated by the increase in MEPS and only 26% of the models on the market, nearly all of which are inverter units, would still be eligible for the EGAT No. 5 label. Given the strong preference for the EGAT No. 5 label, this means that local manufacturers would need to upgrade their production lines to produce high efficiency inverter units in order to remain competitive. A World Bank project is currently underway to support this upgrade for several local manufacturers.

Recommendation 1: Increase MEPS for ACs by 20% above the current EGAT No. 5 label level one requirement for fixed speed units. The vast majority of products on the Thai market already significantly exceed the MEPS, which shows that the market has evolved rapidly since the last MEPS revision in 2010. The MEPS increase would yield significant lifecycle cost savings for consumers, with the consumer benefits outweighing costs by more than 4:1 for lower capacity units and more than 14:1 for higher capacity units. Furthermore, the MEPS increase would reduce CO_2 emissions by 4.3 MT through 2030. Although the increased MEPS would remove 31% of products from the market, including 32% of Thai-made products, all Thai manufacturers currently make several models that would be able to comply with the new MEPS, indicating that the necessary technology and production lines already exist.

Recommendation 2: Increase the EGAT No. 5 label requirement by 20% over the current requirement for inverter units and apply this requirement to both fixed speed and inverter units. Under the current system with different labeling requirements for inverter and fixed speed units, a fixed speed unit with the EGAT No. 5 label and one star might be less efficient than an inverter unit that cannot achieve the EGAT No. 5 label at all. This system can lead consumers to purchase less efficient fixed speed units, as the label can cause them to believe such units to be more efficient than inverter units. Moving to a technology-neutral approach with a single set of requirements for all types of AC units would allow consumers to make better-informed purchasing decisions and would cost-effectively reduce CO_2 emissions by 32.4 MT through 2030.

However, given the challenges that some Thai manufacturers have faced in producing high efficiency inverter units, only 26% of models on the market would be able to achieve the EGAT No.5 label, including relatively few units made by Thai companies. Therefore, it may be best to implement the EGAT No. 5 labeling requirement revisions after the World Bank technology transfer program is complete, as it will support Thai manufacturers in building their capacity to produce such high efficiency inverter units.

Recommendation 3: Expand MEPS and EGAT No. 5 label coverage to all products under 60,000 Btu/hr. Expanding policy coverage to these products provides substantial consumer benefits, as the MEPS would provide consumers with a payback period of under 4 months and the EGAT No. 5 label would provide consumers with a payback period of under 6 months. In addition, expanding these policies to higher capacity products would yield substantial national benefits of approximately 13.7 TWh of electricity savings and 8.6 MT of CO_2 emissions reductions through 2030.

Appendix A: EGAT No. 5 Labeling Impacts

A.1: Policy Options

CLASP considered two labeling policy options in the impacts analysis: increasing the EGAT No. 5 label's level 5 threshold by 20% over the current level 5 threshold for inverter units within the current scope of the program, and increasing the EGAT No. 5 label's level 5 threshold by 20% over the current level 5 threshold for inverter units while also expanding the scope of the program to include all AC units under 60,000 Btu/h. Both labeling policy scenarios use a technology neutral approach, wherein the new label levels are applied equally to both fixed speed and inverter ACs.

Policy Scenario 1: Increasing EGAT No. 5 Label Level by 20% over Current Inverter Level 5

The first labeling policy scenario CLASP considered was an increase in the EGAT No. 5 level 5 by 20% over the current threshold. This scenario would provide a technology-neutral labeling scheme, without setting lower labeling requirements for fixed speed units. Thus, all products receiving the EGAT No. 5 label would have to comply with the same requirements, and consumers would no longer be faced with fixed speed EGAT No. 5 labeled units that are less efficient than some unlabeled inverter units.

Policy Scenario 2: Increasing EGAT No. 5 Label Level by 20% over Current Inverter Level 5 and Expanding the Scope to 60,000 Btu/h

The second labeling policy scenario CLASP was identical to the first scenario for units under 40,944 Btu/h. In addition, this scenario includes expanding the scope of the EGAT No. 5 label to all products under 60,000 Btu/h, with a step-down in stringency for the level five tier for the newly-regulated higher capacities, in order to examine the impacts of expanding policies to include higher capacity units.

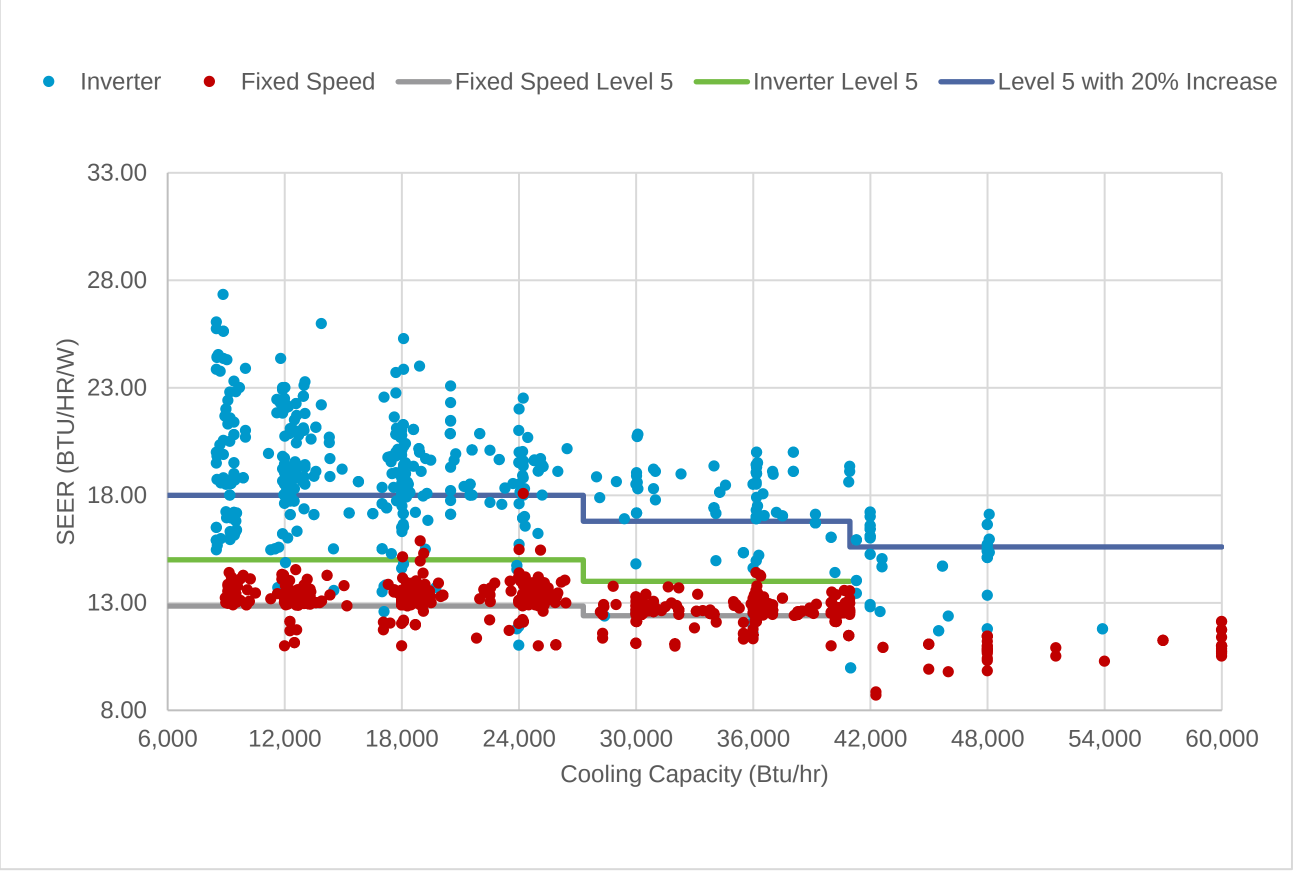
These label levels can be found in **Table 23**.

Table 23: Scenarios for EGAT No. 5 label

Capacity	Policy Scenario 1 SEER	Policy Scenario 2 SEER	Current Inverter SEER	Current Fixed Speed SEER
≤27,296 Btu/hr/W	≥18.00 (Btu/hr/W) ≥5.28 (W/W)	≥18.00 (Btu/hr/W) ≥5.28 (W/W)	≥15.00 (Btu/hr/W) ≥4.40 (W/W)	≥12.85 (Btu/hr/W) ≥3.77 (W/W)
≥27,296 Btu/hr/W ≤40,944 Btu/hr/W	≥16.80 (Btu/hr/W) ≥4.92 (W/W)	≥16.80 (Btu/hr/W) ≥4.92 (W/W)	≥14.00 (Btu/hr/W) ≥4.11 (W/W)	≥12.40 (Btu/hr/W) ≥3.64 (W/W)
≥40,944 Btu/hr/W ≤60,000 Btu/hr/W	N/A	≥15.60 (Btu/hr/W) ≥4.57 (W/W)	N/A	N/A

Increasing the EGAT No. 5 label level by 20% over the current inverter level would result in only high-efficiency, inverter ACs receiving the EGAT No. 5 label, as illustrated in **Figure 29**. In addition, expanding the scope to include all units under 60,000 Btu/hr would identify the higher efficiency high-capacity units and differentiate them in the market.

Figure 29: 20% increase to EGAT No. 5 label threshold over current inverter level 5 (N=1804)



A.2: Outputs

The following four tables show the summary outputs of the PAMS analysis for the four representative models under the labeling scenarios. For all capacities, consumers benefit from lifecycle cost savings, showing that increases in the stringency and scope of the EGAT No. 5 label are highly cost-effective for Thai consumers.

Table 24: PAMS output summary for labeled 12,000 Btu/hr room ACs

Metric	20% Increase to Level 5 SEER 18.00
Payback Period (years)	2.56
LCC savings (THB)	22,401
Total Electricity Cost Savings through 2030 (millions of THB)	204,108
Benefit/Cost Ratio	3.08
Site Energy Savings in 2030 (GWh)	6,068
Site Energy Savings through 2030 (GWh)	32,995
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	20.72

Table 25: PAMS output summary for labeled 24,000 Btu/hr room ACs

Metric	20% Increase to Level 5 SEER 18.00
Payback Period (years)	1.30
LCC savings (THB)	50,247
Total Electricity Cost Savings through 2030 (millions of THB)	66,938
Benefit/Cost Ratio	6.05
Site Energy Savings in 2030 (GWh)	1,991
Site Energy Savings through 2030 (GWh)	10,817
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	6.79

Table 26: PAMS output summary for labeled 36,000 Btu/hr room ACs

Metric	20% Increase to Level 5 SEER 16.80
Payback Period (years)	0.76
LCC savings (THB)	82,782
Total Electricity Cost Savings through 2030 (millions of THB)	48,125
Benefit/Cost Ratio	10.22
Site Energy Savings in 2030 (GWh)	1,439
Site Energy Savings through 2030 (GWh)	7,749
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	4.87

Table 27: PAMS output summary for labeled 48,000 Btu/hr room ACs

Metric	Level 5 SEER 15.60
Payback Period (years)	0.47
LCC savings (THB)	144,262
Total Electricity Cost Savings through 2030 (millions of THB)	81,590
Benefit/Cost Ratio	16.47
Site Energy Savings in 2030 (GWh)	2,447
Site Energy Savings through 2030 (GWh)	13,117
CO_2 Emissions Mitigation through 2030 (MT CO_2e)	8.24

A.3: Impacts to Consumers

We assessed the impacts to consumers under two policy scenarios:

- **EGAT No. 5 label increase by 20% over current inverter level five:** savings are substantial for consumers of all AC capacities. The payback periods for the increase in the labeling threshold are all between 0.76 years and 2.56 years, with the larger capacities having faster payback periods. Similarly, the lifecycle cost savings range from 22,410 THB to 82,782 THB, with the larger capacities also having the larger lifecycle cost savings.
- **EGAT No. 5 label increase by 20% over current inverter level five with a scope expansion up to 60,000 Btu/h:** savings are also substantial for consumers of all AC capacities. The payback period for the ACs covered by the scope expansion is 0.47 years, or less than six months. In addition, the lifecycle cost savings from the ACs covered by the scope expansion is 144,262 THB.

Table 28: Consumer benefits of an EGAT No. 5 label Increase

Cooling Capacity	Most Popular SEER on the Market	LCC Savings (THB)	LCC Savings (USD)	Payback Time	Benefit/Cost Ratio
12,000 Btu/h	13.0 Btu/h/W	22,401	694	2.56 years	3.08
24,000 Btu/h	13.2 Btu/h/W	50,247	1,558	1.30 years	6.05
36,000 Btu/h	12.5 Btu/h/W	82,782	2,566	0.76 years	10.22
48,000 Btu/h	11.1 Btu/h/W	144,262	4,472	0.47 years	16.47

A.4: Impacts to Manufacturers

Increasing the stringency of the EGAT No. 5 label would impact manufacturers. Under both labeling scenarios, only approximately 26% of the models included in the scope of the EGAT No. 5 labeling program would achieve the EGAT No. 5 label, and virtually all of these models would be inverter units. Under the scope expansion, 21% of models between 40,944 Btu/hr and 60,000 Btu/hr would achieve the EGAT No. 5 label.

To understand the impact this policy would have on Thai companies, CLASP analyzed the data for companies producing and/or marketing Thai brands to determine what share of their models would achieve the revised EGAT No. 5 label threshold. None of these companies reported any models above the 40,944 Btu/hr threshold, so there is no information on how the scope expansion would affected them, or if they would be affected at all.

Table 29: Share of Thai companies' products achieving the EGAT No. 5 label

Company	% of models achieving EGAT No. 5 label
Air Image Group	**0%**
Bacchus and Hanjo	0%
Casper Electric	50%
Energy World Corporation	**40%**
Furano Air	**0%**
Kent United	**0%**
Panabishi	**0%**
PSI Corporation	63%
Rangsiya Cooling Ltd.	0%
Sapsuksiri	**0%**
Sapthonghor	**0%**
Siam Products Air conditioning	**0%**
Sic Cooling Service Co.	0%
Vekin	76%
Vertex Supply	0%
Weather Cool	0%
Total	**7%**

A.5: Impacts at the National Level

Energy Savings

- Under a business as usual scenario, in which no changes are made to Thailand's policies for ACs, CLASP projects that by 2030 Thai AC users will consume 72.5 TWh of energy annually.
- Under the first labeling policy scenario, where the EGAT No. 5 label threshold is increased by 20% within the current scope, significant energy savings of just under 9.5 TWh of electricity in 2030 are possible. AC use-driven energy consumption in 2030 can be reduced by 13.1%. Over a ten-year period, the cumulative site energy savings could reach nearly 51.6 TWh of electricity.
- Under the second labeling policy scenario, where the EGAT No. 5 label threshold is increased by 20% and the scope of the program is expanded to include all AC units under 60,000 btu/hr, significant energy savings of just over 11.9 TWh of electricity in 2030 are possible. AC use-driven energy consumption in 2030 can be reduced by 16.4%. Over a ten-year period, the cumulative site energy savings could reach nearly 64.7 TWh of electricity.

Figure 30: Energy savings in 2030 under different labeling scenarios

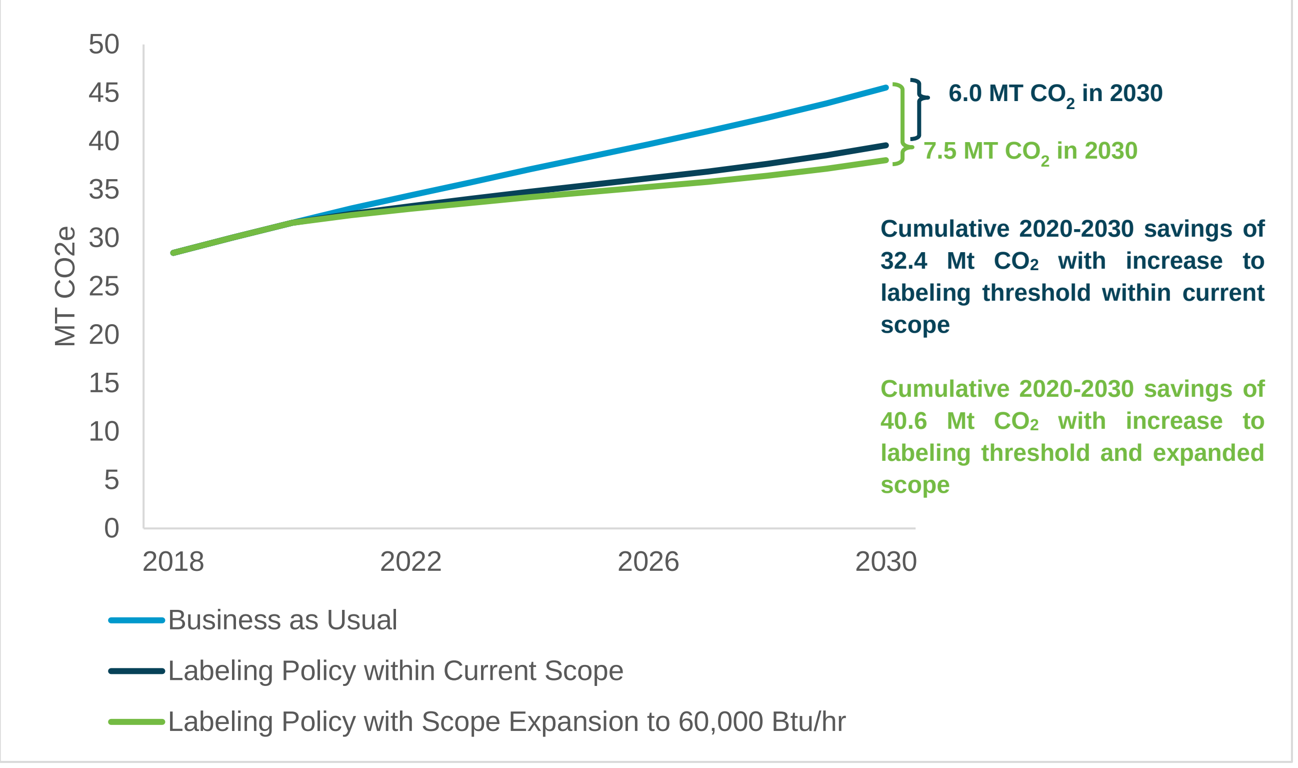
Emissions reductions

In 2030, with no policy changes, Thai AC users will consume 72.5 TWh of energy annually, resulting in up to 46 MT of CO_2 emissions.

- **The first labeling policy scenario, where the EGAT No. 5 label threshold is increased by 20% within the current scope,** can deliver a significant emissions reduction of 6.0 MT CO_2 in 2030 (the cumulative reductions through 2030 is equal to 32.4 MT CO_2).[56]
- **The second labeling policy scenario, where the EGAT No. 5 label threshold is increased by 20% and the scope of the program is expanded to include all AC units under 60,000 btu/hr,** can deliver a significant emissions reduction of 7.5 MT CO_2 in 2030 (the cumulative reductions through 2030 is equal to 40.6 MT CO_2).

56 Emissions from refrigerants are not considered for this analysis.

Figure 31: Avoided CO_2 emissions over time and in 2030 under different labeling scenarios



Appendix B: Regression Analysis Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.829378
R Square	0.687868
Adjusted R Square	0.687522
Standard Error	9630.398
Observations	1806

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	3.69E+11	1.84E+11	1986.701	0
Residual	1803	1.67E+11	92744571		
Total	1805	5.36E+11			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-23560.6	1433.946	-16.4306	1.22E-56	-26372.9	-20748.2	-26372.9	-20748.2
Energy Rating (SEER)	1694.923	77.68804	21.81704	7.75E-94	1542.555	1847.291	1542.555	1847.291
Cooling Capacity	1.297158	0.020581	63.02586	0	1.256792	1.337524	1.256792	1.337524