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Assessment of Brazil's Labeling Program for Air Conditioners

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Energy labeling is a critical component of effective appliance energy efficiency policy.

While minimum energy performance standards (MEPS) remove the least-efficient products from the market, energy labels drive product markets to higher efficiency in three ways by:

- Allowing consumers to make informed purchasing decisions by differentiating high efficiency products from average and low efficiency products;
- Incentivizing manufacturers to produce more efficient products by helping them to market their high efficiency products, as the label provides unbiased evidence that their products are more efficient; and
- Providing the foundation for market transformation programs by allowing policymakers to easily identify high efficiency products to target for bulk purchasing, financing, and incentives.

KEY FINDINGS

Brazil has well-developed and well-known energy labels for electricity-consuming products.

There are two energy labels for electricity-consuming products in Brazil:

1. The mandatory Brazilian Labeling Program (PBE, for its initials in Portuguese) comparative label with categories from 'A' to 'C' or 'G,' depending on the product and
2. The voluntary Selo PROCEL endorsement label. The PBE is managed by the Brazilian National Metrology, Quality, and Technology Institute (INMETRO), who began the discussion around energy labeling in Brazil in 1984. The Selo PROCEL, which was first launched for window air conditioners (ACs) in 1996, is managed by the Electricity Conservation Program (PROCEL) of the state-owned electricity generation and transmission company, Eletrobras. These two labels are closely interconnected; for example, any room AC that achieves the 'A' class on the PBE can also receive the Selo PROCEL.

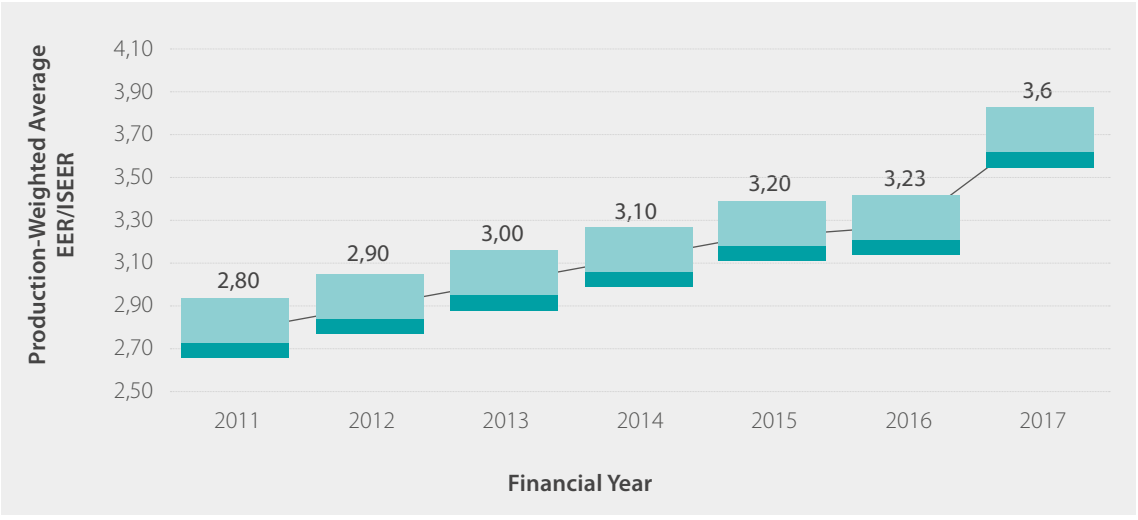
The labels have been effective at reducing energy demand and have a strong influence on the mini-split room air conditioner market.

Consumers in Brazil respond to the labels, and manufacturers, importers, and retailers all recognize that products that do not attain an 'A' rating and the Selo PROCEL do not sell well. A 2015 study conducted by INMETRO found that 91% of consumers recognized the comparative label, 79.9% said they understood the label, and 68.3% said that they would pay 10% more for a product bearing the Selo PROCEL[1]. Because of the preference for 'A' rated products that bear the Selo PROCEL, many manufacturers seek to primarily or exclusively produce 'A' rated products, and some retailers only carry 'A' rated products.[2] The influence of the labeling program on manufacturers' production decisions is evident in the products available on the market; the most common efficiency level for a split AC is an energy efficiency ratio (EER) of 3.24 W/W, which is just above the 'A' class and Selo PROCEL threshold of 3.23 W/W.[3] The two AC labels combined have had a significant impact in reducing energy demand in Brazil, saving an estimated 2 TWh of electricity in 2009 alone.[4]

The Brazilian Labeling Program and Selo PROCEL are not currently promoting high efficiency split air conditioners.

The criteria for the 'A' class label and Selo PROCEL for split ACs have been virtually unchanged over the past 10 years. As of 2019, only categories 'A' and 'B' may be sold in the market, as 'C' and below do not meet the current MEPS.[5] In addition, all 'A' class products are eligible for the voluntary Selo PROCEL endorsement label. This means that 77% of split ACs being sold in the market are now 'A' class and eligible for the Selo PROCEL. This has greatly reduced the value of both the PBE and Selo PROCEL, because neither clearly differentiates highly efficient products from average efficiency or even below average efficiency products. This lack of differentiation has slowed the improvement of energy efficiency for split ACs, with the median efficiency only increasing 10.2% over 8 years, since 2010.[6]

Figure 1: Production-weighted average EER/ISEER of ACs sold in India, 2011-2017



[1] BRACIER. "USO DE ETIQUETAS DE CONSUMO DE ENERGIA GERÁ ECONOMIA DE R$ 2,9 BI EM DEZ ANOS." 2015. Available online at: http://bracier.org.br/noticias/brasil/5288-uso-de-etiquetas-de-consumo-de-energia-gera-economia-de-r-2-9-bi-em-dez-anos

[2] Based on interviews with manufacturers and retailers, conducted in August 2018.

[3] Based on data from the PBE product database (from 2004 to 2018)

[4] Balbino Cardoso, Rafael. "Estudo dos impactos energéticos dos Programas Brasileiros de Etiquetagem Energética: Estudo de caso em refrigeradores de uma porta, condicionadores de ar e motores elétricos." UNIVERSIDADE FEDERAL DE ITAJUBÁ. 2012.

[5] Diário Oficial da União. "PORTARIA INTERMINISTERIAL Nº 2, DE 31 DE JULHO DE 2018."

[6] Based on data from the PBE product database (from 2004 to 2018)

By comparison, the average efficiency of ACs sold in India improved 29% over 6 years, from 2011 to 2017, as can be seen in Figure 1.[7] Similarly, the efficiency improvement of ACs in Vietnam was 30.8% over 5 years from 2013-2018.[8] These differences in efficiency improvements can be explained, at least in part, by the fact that labeling programs in both of these countries have increased the stringency of their top category by at least 9% since 2010.

KEY RECOMMENDATIONS

The Brazilian Labeling Program and Selo PROCEL are well placed to move the Brazilian split AC market to high efficiency products, as they are well-understood and recognized by consumers, and they clearly affect the behavior of AC manufacturers. Realizing this potential and meaningfully improving the efficiency of split ACs sold in Brazil will require revisions to these programs. Based on lessons learned and best practices from a review of international labeling programs for ACs, CLASP recommends the following:

The PBE and Selo PROCEL should transition to a seasonal performance metric to rate the efficiency of both fixed speed and inverter ACs.

Inverter ACs are as much as 51.7% more efficient than fixed speed ACs.[9] However, the EER test metric currently used by the Brazilian Labeling Program and the Selo PROCEL, does not capture the efficiency benefits of inverter units.[10] This means that a substantially more efficient inverter AC is presented as having the same efficiency as a much less efficient fixed speed unit.[11] To ensure that the highest efficiency products are being appropriately promoted by the Brazilian Labeling Program and the Selo PROCEL, these programs should move to a seasonal performance metric, such as the seasonal energy efficiency ratio (SEER), as soon as possible.

In countries such as India, Thailand, and Vietnam, the transition to seasonal performance metrics has led to a doubling or more of the market share of inverter ACs. [12] In India, this increase in inverter market share accounts for nearly half of the total improvement in the average efficiency of AC units sold.[13] As in these countries, a transition to a seasonal performance metric in Brazil should not be overly burdensome, since Brazil already uses the ISO 5151 test method.[14] The ISO 16358 evaluation method that allows for fixed speed and inverter ACs to be rated under the same metric simply builds on the ISO 5151 test method by calling for the same efficiency test to be conducted at part load in addition to full load, and does not require any additional test laboratory equipment.[15]

The labeling tiers for the Brazilian energy label for split ACs should be re-scaled as soon as possible.

In order for the label to clearly differentiate high efficiency products, the label must be re-scaled with products represented in at least four categories from most efficient

[7] Based on data collected by the CLASP India team from the BEE AC database.
[8] Based on data collected by CLASP in 2013 and 2018 in these markets. The 2013 data was reported in EER and converted to SEER based on the conversion equation for fixed speed units. As such, it does not account for the efficiency benefits of inverter units in these markets in 2013.
[9] Yoon, M.S., J. H. Lim, T. S. M. Al Qahtani, Y.J. Nam. "Experimental Study on Comparison of Energy Consumption between Constant and Variable Speed Air-Conditioners in Two Different Climates." Proceedings of the 9th Asian Conference on Refrigeration and Air-conditioning. June 2018.
[10] The energy efficiency ratio (EER) is the ratio of the cooling capacity (in Watts) to the total power consumption (in Watts) at standard rating conditions. This means the higher the EER, the more efficient the air conditioner.
[11] Various manufacturers estimated that the inverter market share in Brazil is between 30% and 45%.
[12] CLASP. "Cooling in a Warmer World." January 2019. Available online here: https://issuu.com/claspngo/docs/clasp_-_cooling_in_warming_world?e=0
[13] Based on data collected by CLASP from the Bureau of Energy Efficiency product database.
[14] Diário Oficial da União "Portaria Interministerial MME/MCT/MDIC nº 364 de 24/12/2007"
[15] United for Efficiency (U4E). "Accelerating the Global Adoption of Energy-efficient and climate-friendly air conditioners". 2017.

('A') to least efficient ('D'). This revision should be based on the new, seasonal performance metric. The revision should ensure that there are products actively being sold that fall into at least four categories (A to D) so that consumers can identify a variety of different efficiencies in the market. In addition, the 'A' class and Selo PROCEL criteria should be sufficiently stringent so that only high efficiency, inverter AC units can achieve these designations.

Such a requirement to have at least four categories, with the highest category reserved for highly efficient products, is in line with international best practice.

- In the European Union labeling program, on which the PBE is based, the 'A' class must contain no products at the time of re-scaling and the label must be re-scaled any time that 'A' class products account for 30% or more of the market, or 'A' and 'B' class products together account for more than 50% of the market.
- In China, there must be at least three and no more than five labeling tiers, with products in each tier being actively produced. This requirement for multiple tiers, where each account for some market share, allows Chinese policymakers to make market transformation targets based on the tiers; for instance, the Central Government requires that products in the top tier or top two tiers achieve certain market shares.

The PBE should publish a multi-year split AC policy revision roadmap

This roadmap should cover at least the coming six years, with 5% to 10% increases to each labeling tier every two years. Such increases will ensure that the labeling tiers keep pace with the products available in the market, continue to differentiate high efficiency products, and encourage consumers to purchase more efficient products. Announcing these increases well in advance, with a roadmap, will give the AC industry certainty as to the policy direction and allow them the necessary time to plan investments to produce ACs in the desired tiers. Multiple AC manufacturers operating in Brazil have requested such a roadmap for this reason.[16]

The effectiveness of such an AC policy roadmap can be observed in India, where a roadmap was implemented from 2010 to 2016, driving the 29% improvement in efficiency while also securing the AC industry's support for energy efficiency policies. This roadmap included increasing the stringency of the labeling tiers every two years over the six-year period, which ensured that the label kept pace with energy efficiency improvements in the market. Similarly, the announcement of the move to a seasonal metric led to an increase in the market share of inverter ACs even before the seasonal metric became mandatory, as manufacturers shifted their production plans to take advantage of the new metric.

The PBE should require manufacturers and importers to report sales per model.

The PBE's current database of AC models on the market does not track sales per model. Several AC companies noted that the database includes models that are no longer sold or that were never sold in significant quantities to begin with. Requiring that manufacturers and importers report sales per model will allow policymakers to

[16] Based on interviews with Brazilian AC companies, conducted in August 2018.

track the market closely, especially what products are actually being sold, which will better inform labeling tier revisions going forward.

Such a requirement is a key component of the Bureau of Energy Efficiency (BEE)'s labeling program in India, where manufacturers and importers are required to report the sales per model each quarter. A well maintained database is a necessary tool for the implementation of other recommendations, as it allows for market monitoring and facilitates timely revisions of the labels. It can also support market surveillance and verification efforts by gathering much of the necessary information to provide a low--cost compliance check for products entering the market and to identify high-risk or regularly non-compliant applicants, which can then be targeted for checks and testing.

The Selo PROCEL should only be applied to the best performing products.

Only the top 10%-25% of products available on the market should be able to achieve the 'A' class efficiency criteria and therefore the Selo PROCEL. In addition, PROCEL should consider additional requirements that would maximize the climate benefits of the labeling program and encourage the adoption of new technologies:

- PROCEL should consider requiring that AC units use non-ozone-depleting, low global warming potential refrigerants in order to receive the Selo PROCEL, as it has done for refrigerators.[17]
- In order to better manage electricity demand from cooling, the Selo PROCEL could include a requirement that ACs be demand response ready, so that the AC units could be automatically cycled or turned down during peak demand. While demand response readiness has not been included in any criteria for the Selo PROCEL, there is an increasing need for grid flexibility as the share of thermal and variable renewable generation on the Brazilian grid grows.[18] ACs are a key driver of peak demand and controlling such demand could significantly improve grid flexibility.

The value of these additional requirements should be weighed against the additional cost and complexity of certifying compliance; implementing an overly complex certification process may lead to too few products receiving the designation and therefore have limited impact, as was the case of Top Runner in China. In Brazil, the efficiency requirements for the Selo PROCEL should continue to be based on the efficiency testing conducted for the PBE, with any additional criteria heavily considering requirements for any additional testing. For example, the efficiency requirement for the Selo PROCEL could continue to correspond to the 'A' labeling tier, but with additional requirements related to the refrigerant or demand response being easily verified from the product specifications.

[17] For refrigerators, the Selo PROCEL requires that the refrigerant used must have zero ozone depleting potential and a global warming potential of less than 150 times that of CO2.

[18] IEEE. "Challenges for Demand Response in Brazil." 2015. Available online at: https://www.ieee-pes.org/presentations/gm2015/PESGM2015P-001977.pdf

1. Introduction: The Purpose of Energy Efficiency Labeling

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1. Introduction: The Purpose of Energy Efficiency Labeling

This study was carried out to evaluate the evolution and impacts of the Brazilian Labeling Program and the PROCEL Seal endorsement label for air conditioners (ACs), and to assess opportunities to advance energy efficiency in Brazil by identifying international best practice in appliance and product labeling programs and their relevance to the Brazilian context. This assessment was funded by the Instituto Clima e Sociedade as part of the Kigali Cooling Efficiency Program (K-CEP), which aims to improve energy efficiency in cooling products to increase and accelerate the climate and development benefits of the Kigali Amendment to phase down high global warming potential (GWP) refrigerants.

Labeling programs that promote highly efficient products are a critical element of energy efficiency policy. They are a valuable tool for different stakeholders, including consumers, industry, government energy agencies, and other institutions interested in market transformation. Frequent revisions to the label criteria, in order to keep up with market and technology trends, is essential to maintaining the value and integrity of the program.

Value to consumers

Informing purchasing decisions and differentiating products

Labels inform consumers as to which products are more or less efficient, allowing them to make an educated decision about the trade-off between up-front cost and operating cost, as well as the environmental benefits of more efficient products. They can inform consumers by categorizing products into different efficiency tiers, identifying a product's efficiency relative to a continuous spectrum representing the range of efficiencies available in the market, or by endorsing the highest efficiency products.

In order to inform consumers effectively, labels must be updated frequently and ratcheted up as technology improves. Without such changes, technological improvements will lead all products to be categorized as highly efficient, and the label will no longer serve its purpose of differentiating products.

Value to industry

Incentives to market more efficient products

Labels also help manufacturers who produce highly efficient products to market their products. An official label can be viewed as an impartial signal that the product is highly efficient, and can therefore help to justify what may be a higher up-front cost. In this way, energy efficiency labeling can help appliance manufacturers increase their revenues by marketing products with higher upfront costs.

The labels also encourage manufacturers to improve efficiency of their products, as these highly efficient products will be differentiated in the market; often times, labels from the top rated products are used as a marketing tool. This, in turn, encourages investments in research and development in order to improve product technology. Technological advancements that allow for greater output from less input, such as improvements in energy efficiency, have been demonstrated to be the key driver of long-run economic growth.[19]

Value to market transformation program

Providing easy to use categorization for informing program design

By differentiating products, labels provide the foundation for market transformation programs such as incentive schemes, government procurement rules, and bulk buys. Energy labels allow the administrators of such programs to easily identify the more efficient products and target those products for purchase or for incentives.

With frequent updates to the label categories, labels can continuously serve this function, as the highest category signals a high-efficiency product relative to the average efficiency in the market. In such a case, basing a market transformation program on the highest labeling category can lead to noticeable improvement in the average efficiency in the market.

[19] FPress release. NobelPrize.org. Nobel Media AB 2019. Thu. 7 Feb 2019. https://www.nobelprize.org/prizes/economic-sciences/1987/press-release/

2. Energy Efficiency Labeling for Room ACs in Brazil

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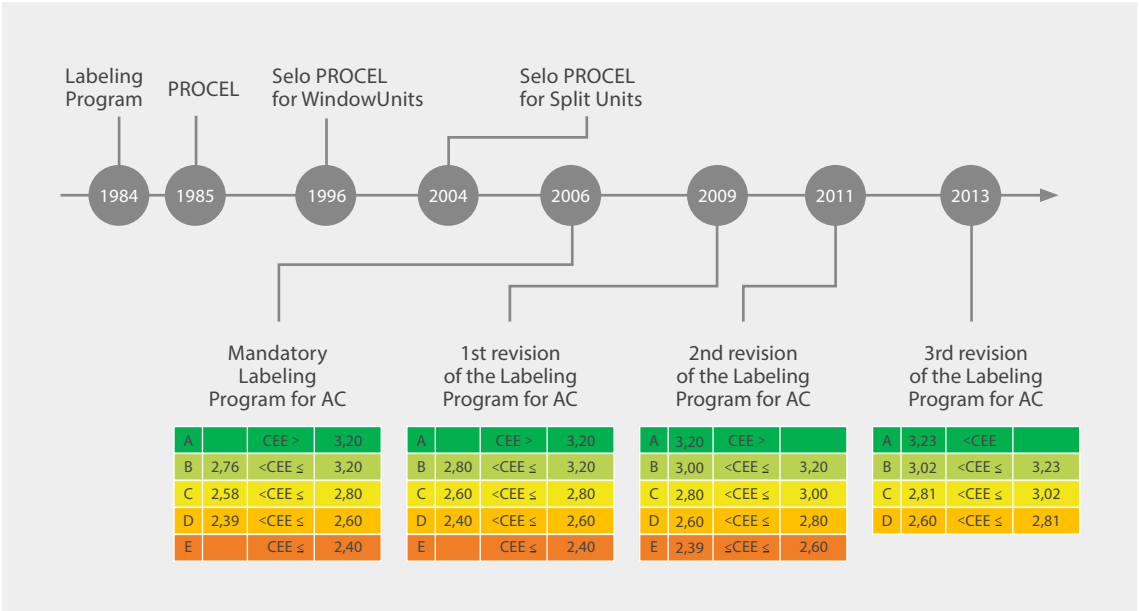
2. Energy Efficiency Labeling for Room ACs in Brazil

Brazil began exploring a labeling program for energy-consuming products in 1984, though ACs were not included in the labeling program for another decade.[20] The first label for ACs was the voluntary Selo PROCEL endorsement label for window units, launched in 1996. This was then followed by a Selo PROCEL for split units in 2004 and then mandatory comparative labeling under the Brazilian Labeling Program (PBE, for its initials in Portuguese) in 2006. The criteria for the Selo PROCEL and the comparative label have both been revised since their introductions, though there have been no major revisions in the past decade.

Figure 2: Timeline of the Brazilian Labeling Program for ACs



BRAZILIAN LABELING PROGRAM

The PBE is a well-known energy efficiency labeling program, covering a wide variety of products.[21] According to Law 10.295, also known as the Energy Efficiency Law of 2001, the Brazilian National Metrology, Quality, and Technology Institute (INMETRO) manages the PBE. In addition, according to the accompanying Decree 4059, INMETRO is responsible for assessing conformity with PBE regulations and enforcing compliance with those regulations. The minimum energy performance standard (MEPS) regulation for ACs also states that INMETRO is responsible for assessing conformity with the MEPS and enforcing compliance.[22] The test methods for assessing conformity with both regulations are the national standards NBR-5858 jun/1983 and NBR-5882 out/1983, which is equivalent to ISO 5151.[23]

[20] INMETRO. "Histórico do Programa Brasileiro de Etiquetagem." 2019. Available online at: https://www2.inmetro.gov.br/pbe/historico.php

[21] The PBE currently has 38 programs covering products ranging from refrigerators to light duty vehicles. For more information on the products covered, visit http://www2.inmetro.gov.br/pbe/

[22] Diário Oficial da União. "PORTARIA INTERMINISTERIAL Nº 2, DE 31 DE JULHO DE 2018."

[23] Diário Oficial da União "Portaria Interministerial MME/MCT/MDIC nº 364 de 24/12/2007"

The PBE label itself is based on the European Union's label, with products categorized from 'A' to 'C' or 'G,' depending on the product, with 'A' being the highest efficiency rating.[24] Consumers respond to the label, and manufacturers, importers, and retailers all recognize that products that do not attain an 'A' rating do not sell well. Because of this preference for 'A' rated products, many manufacturers seek to primarily or exclusively produce 'A' rated products, and some retailers only carry 'A' rated products.[25] A 2015 study conducted by INMETRO found that 91% of consumers recognized the comparative label, 79.9% said they understood the label, and 68.3% said that they would pay 10% more for a product bearing the Selo PROCEL.[26]

Figure 3: PBE Comparative Label for ACs

As part of its administration of the PBE, INMETRO maintains a database of all ACs authorized for sale on the Brazilian market, with specific information on their efficiency and capacity, among other criteria. However, this database does not contain sales figures for each product, and several stakeholders have stated that it contains many models that are not currently available in the market.[27] Because of the lack of sales information, it is not possible to use the database to identify the sales-weighted average AC efficiency in the market.

The PBE does not have a clearly defined system for determining when and how to revise labeling criteria. Typically, the labeling tiers have been revised whenever INMETRO has come to an agreement with local industry on a label revision. In recent years, INMETRO, like much of the Brazilian Government, has faced declining budgets. At the same time, the agreements on label revisions have become less frequent.[28] As a result, the criteria for the 'A' level for ACs has not been meaningfully revised in the past decade.

SELO PROCEL

The Selo PROCEL is an endorsement labeling program managed by the Electricity Conservation Program (PROCEL) of the state-owned electricity generation and transmission company, Eletrobras. The Selo PROCEL currently covers 41 product categories, having started with refrigerators in 1995 and having most recently added LCD TVs and LED luminaires in 2017. PROCEL faced declining budgets over the past few years, with the budget decreasing by 64% from 2013 to 2016. However, in 2016, Law 13.280 was passed, specifying that 0.4% of electricity revenues will now go to PROCEL. As a result PROCEL's funding in 2017 was five times larger than the budget in 2016. With this new funding, PROCEL is seeking to update and expand the Selo PROCEL and to support the PBE, among other activities.[29]

24 INMETRO. " Histórico do Programa Brasileiro de Etiquetagem." 2019. Available online at: http://www2.inmetro.gov.br/pbe/historico.php

25 Based on interviews with manufacturers and retail store workers, conducted in August 2018.

26 BRACIER. "USO DE ETIQUETAS DE CONSUMO DE ENERGIA GERÁ ECONOMIA DE R$ 2,9 BI EM DEZ ANOS." 2015. Available online at: http://bracier.org.br/noticias/brasil/5288-uso-de-etiquetas-de-consumo-de-energia-gera-economia-de-r-2-9-bi-em-dez-anos

27 Based on interviews with manufacturers operating in Brazil, conducted in August 2018.

28 Correspondence with INMETRO Staff. January 2019

29 PROCEL. "Resultados PROCEL 2018." 2018. Available online at: http://www.procelinfo.com.br/resultadosprocel2018/docs/Procel_rel_2018_web.pdf

Figure 4: Selo PROCEL for ACs

The criteria for the Selo PROCEL for ACs is based on the 2004 agreement between PROCEL and INMETRO that accompanied the launch of the Selo PROCEL for split ACs.[30] This agreement stipulates that any product that receives an 'A' rating may also receive the Selo PROCEL; however, it notes that the 'A' rating should only apply to approximately 25% of the market. As detailed below, the 'A' rating now applies to most split ACs currently available on the Brazilian market, which has led PROCEL to begin discussion with INMETRO on re-evaluating the criteria for both labels.

The Selo PROCEL for some other products includes criteria beyond energy efficiency. For refrigerators, the refrigerant used must have zero ozone depleting potential and a global warming potential of less than 150 times that of CO2.[31] PROCEL is currently considering whether the requirements for the Selo PROCEL for ACs should include criteria beyond energy efficiency, such as the refrigerant or the materials in the AC unit. While demand response readiness has not been included in any criteria for the Selo PROCEL, controlling electricity demand from ACs via demand response may prove to be a valuable method of adding grid flexibility.

The Potential for AC Demand Response in Brazil [32, 33]

The large share of hydroelectric dams in Brazil's electricity generation mix has historically guaranteed adequate grid flexibility to meet variations in demand. However, there is an increasing need for grid flexibility as the share of thermal and variable renewable generation on the Brazilian grid increases. Demand response and time of use rates, wherein the price of electricity depends on the time of day when the electricity is consumed, have been identified as one way of providing this flexibility. Eletropaulo has begun implementing time of use rates and smart metering with support from the National Electric Energy Agency (ANEEL).

ACs are a key driver of peak demand and controlling such demand could significantly improve grid flexibility. WiFi compatibility coupled devices that allow for customers to program their ACs to respond to time of use rates could provide additional grid flexibility. Additionally, utilities could pay consumers to turn down or cycle their ACs during peak demand.

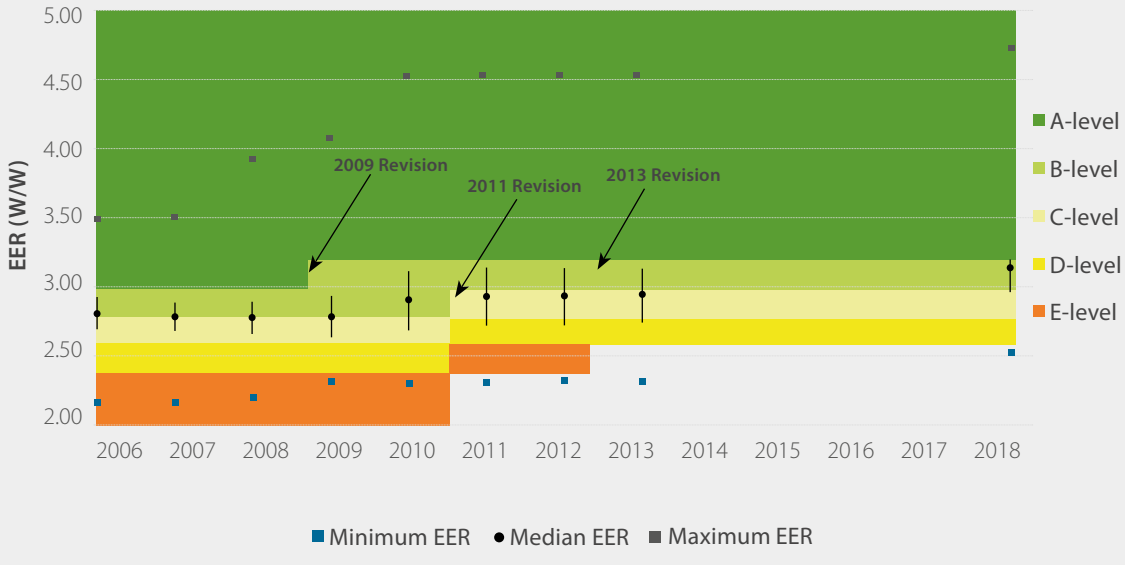
[30] Correspondence with PROCEL Staff. January 2019.
[31] PROCEL. "CRITÉRIOS PARA A CONCESSÃO DO SELO PROCEL DE ECONOMIA DE ENERGIA A REFRIGERADORES E ASSEMELHADOS" 2015. Available online at: http://www.procelinfo.com.br/services/DocumentManagement/FileDownload.EZTSvc.asp?DocumentID=%7BE298D619-FE84-42CE-A8EC-31A1BB5E38E7%7D&ServiceInstUID=%7B46764F02-4164-4748-9A41-C8E7309F80E1%7D
[32] IEEE. "Challenges for Demand Response in Brazil." 2015. Available online at: https://www.ieee-pes.org/presentations/gm2015/PESGM2015P-001977.pdf
[33] Smart Energy International. "Smart grid development in Brazil and South American counterparts." September 2018. Available online at: https://www.smart-energy.com/industry-sectors/business-finance-regulation/smart-grid-brazil-south-america-frost-sullivan/

BRAZILIAN AC MARKET EVOLUTION, DRIVERS, AND TRENDS

The Brazilian Labeling Program and Selo PROCEL have noticeably shaped the efficiency levels of split ACs sold in Brazil. These effects can be seen in the models registered for sale in Brazil, even though the database does not include sales figures for each model. For example, the last major revisions to the 'A' class and Selo PROCEL criteria in 2009 led to a 3% increase in the median split AC efficiency in two years, following 3 years of no improvement in split AC efficiency. The influence of the PBE and Selo PROCEL is even more evident in 2018, as the median and most common efficiency available in the split AC market is an energy efficiency ratio (EER) of 3.24 W/W, just above the 'A' class and Selo PROCEL threshold of 3.23 W/W, with 25% of split ACs in the market having EERs between 3.24 W/W and 3.26 W/W. This large percentage of split ACs just above the 'A' class and Selo PROCEL threshold indicates that manufacturers design their products to achieve these labels (see Figure 5).

The impacts of the Brazilian Labeling Program and Selo PROCEL on electricity consumption have also been significant. For example, a 2012 study found that the labeling programs for ACs had saved over 2 TWh in 2009. Similarly, the labeling programs for refrigerators had saved approximately 3.5 TWh in 2009.[34] In addition, a 2015 study conducted by INMETRO found that the labeling program had saved consumers 2.9 billion reals in the ten years from 2006-2015.[35]

Figure 5: Evolution of the Brazilian Split AC Market

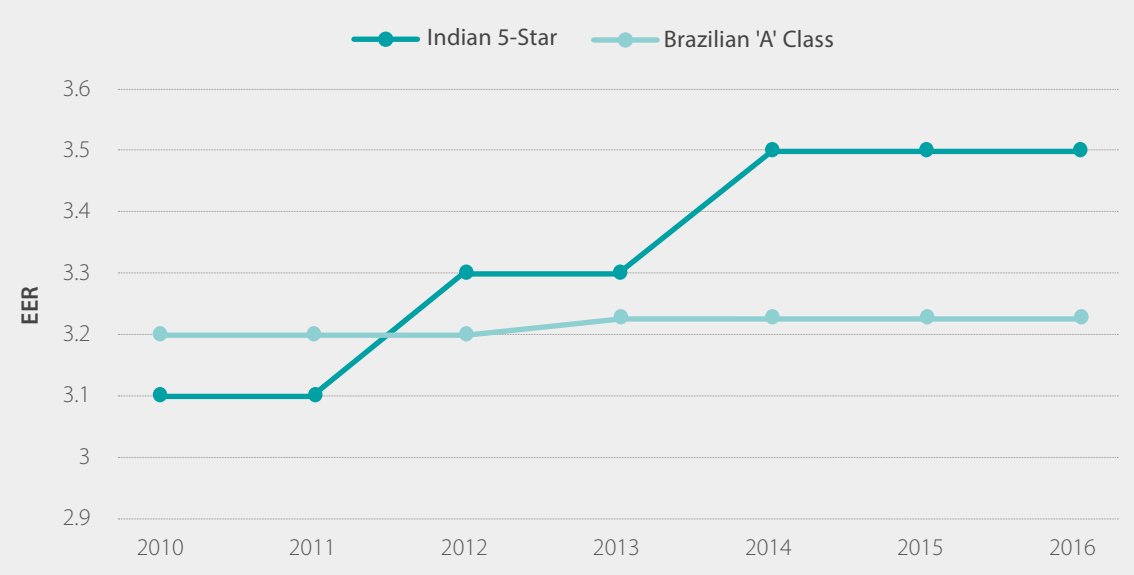


[34] Balbino Cardoso, Rafael. "Estudo dos impactos energéticos dos Programas Brasileiros de Etiquetagem Energética: estudo de caso em refrigeradores de uma porta, condicionadores de ar e motores elétricos." UNIVERSIDADE FEDERAL DE ITAJUBÁ. 2012.

[35] BRACIER. "USO DE ETIQUETAS DE CONSUMO DE ENERGIA GERÁ ECONOMIA DE R$ 2,9 BI EM DEZ ANOS." 2015. Available online at: http://bracier.org.br/noticias/brasil/5288-uso-de-etiquetas-de-consumo-de-energia-gera-economia-de-r-2-9-bi-em-dez-anos

Despite the ability of the Selo PROCEL and PBE to shape the Brazilian split AC market, these labels have not driven significant efficiency improvements in recent years, because the labeling criteria for the 'A' class has not been meaningfully revised in a decade. As a result, efficiency improvements in Brazil significantly lag behind other markets. From 2010 to 2018, the median efficiency of split ACs available on the Brazilian market increased 10.2%, based on EER. By comparison, the market-weighted average efficiency of ACs sold on the Indian market has increased 29% from 2011-2017, if the benefits from the shift to inverter units are included. Based purely on EER, the efficiency improvement in India from 2011-2016 was 15.4%. A comparison of the evolution of the top label classes in Brazil and India is shown in Figure 6.[36] Similarly, the efficiency improvement in Vietnam was 30.8% over 5 years from 2013-2018.[37]

Figure 6: Evolution of Indian and Brazilian Top Labeling Tiers for Split ACs 2010-2016



The pace of energy efficiency improvement over the past decade in Brazil is influenced by a variety of factors, such as the AC components available locally, consumer price sensitivity, and the spillover effects of efficiency improvements in other markets. On one hand, the availability of AC components in Brazil and consumer sensitivity to higher prices for more efficient equipment have been identified as challenges for improving the efficiency of ACs made and sold in Brazil.[38] On the other hand, the spillover effects of efficiency improvements in other markets have likely increased the efficiency of ACs assembled and sold in Brazil, as many of these ACs use the same designs and components used in other markets. However, the lack of labeling revisions has been determinant in the slow improvements in energy efficiency. The pace of labeling revisions in Brazil has lagged the pace in India, as can be seen the figure above. The 1% increase in the stringency in the highest efficiency category since 2010 has also lagged the 9.5% increase in the stringency of the highest category in Vietnam and the 10.8% increase in Thailand over the same period.[39, 40] This has meant that Brazilian AC manufacturers have had little incentive to improve the efficiency of their products, as the improved efficiency would not be demonstrated to consumers on the label.

[36] Note that both the Brazilian Labeling Program and the Indian program used the same metric (EER) and same test standard (ISO 5151) through 2016. Thus, the labeling tiers shown in this figure are directly comparable.

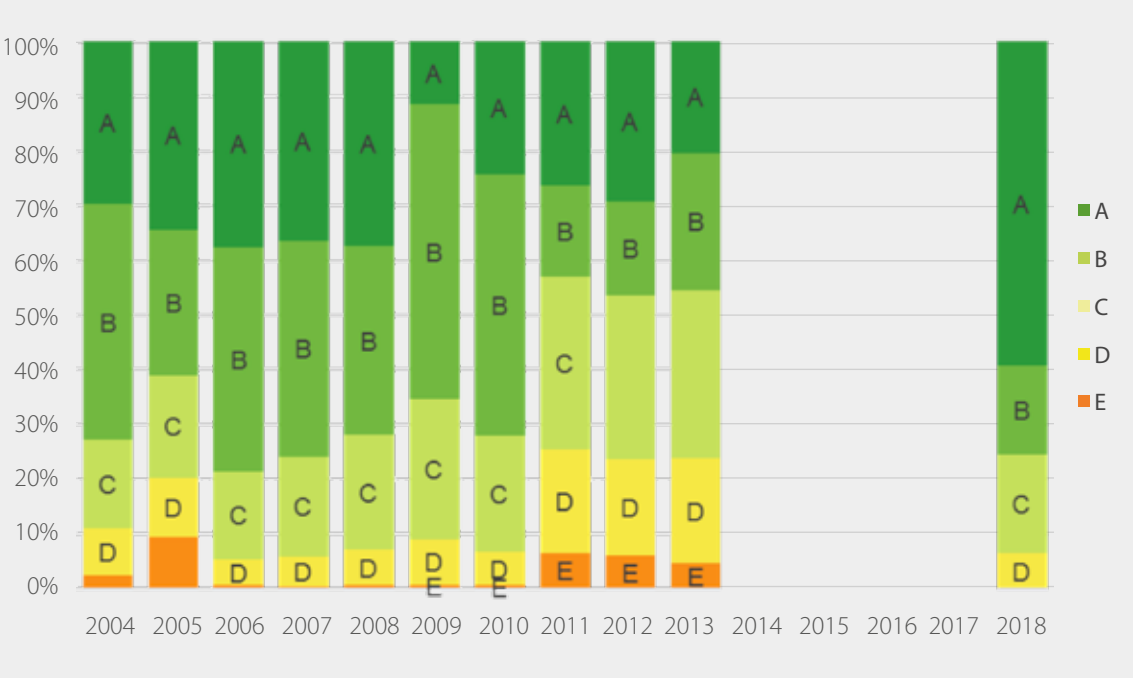
[37] Based on data collected by CLASP in 2013 and 2018 in these markets. The 2013 data was reported in EER and converted to SEER based on the conversion equation for fixed speed units. As such, it does not account for the efficiency benefits of inverter units in these markets in 2013.

[38] CLASP "Estudo de Viabilidade Técnica e Econômica para um Mercado de Compressores de Alta Eficiência no Brasil". November 2018. Available online at: http://kigali.org.br/wp-content/uploads/2019/01/iCS-compressores.pdf

[39] CLASP. Vietnam Room Air Conditioner Market Assessment and Policy Options Analysis. Forthcoming.

[40] CLASP. Thailand Room Air Conditioner Market Assessment and Policy Options Analysis. Forthcoming.

Figure 7: Proportion of Split AC Models per Efficiency Class (2006-2018) in Brazil [41]



Another key way in which the lack of labeling revisions has slowed the pace of efficiency improvements is that, with most products now in the 'A' class, the labels no longer differentiate the high efficiency products from the average products. As can be seen in Figure 7, 77% of all split AC models are now 'A' class, following the 2019 MEPS revision, as 'C' and 'D' class products are below the MEPS and cannot be sold in the market.

This inability to differentiate products means that consumers seeking to purchase higher efficiency split ACs cannot easily determine which products have above-average efficiency. Manufacturers seeking to market high efficiency products have no credible, third-party label to refer to in order to show that their products are higher efficiency than the market average. Policymakers seeking to shift the market through government purchasing requirements or subsidies cannot specify above-average efficiency, as the only ready-made specification is the 'A' class label and Selo PROCEL, which are applied to average efficiency products.

41 No data was available for 2014-2017.

3. International Labeling Programs for Room Air Conditioners

PROJETO
KIGALI

3. International Labeling Programs for Room Air Conditioners

As of 2019, approximately 90 economies around the world have some form of energy labeling policy for ACs, showcasing a wide array of experiences and best practices for AC energy labeling policy design and revision. The case studies below are relevant for Brazil in particular as they reflect the experiences of other relatively large AC markets with local AC industries.

Table 1: Overview of Case Study Economies

Economy	GDP Per Capita (2017)[42]	AC Market Size (2017)[43]	AC Production Volume (2017)[44]
Brazil	$9,821	3.8M	3.1M
European Union	$33,715	4.2M	1.2M
India	$1,940	4.3M	2.6M
China	$8,827	91.7M	144.4M
Vietnan	$2,343	2.4M	0.6M
Thailand	$6,594	1.6M	12.4M

THE EUROPEAN UNION

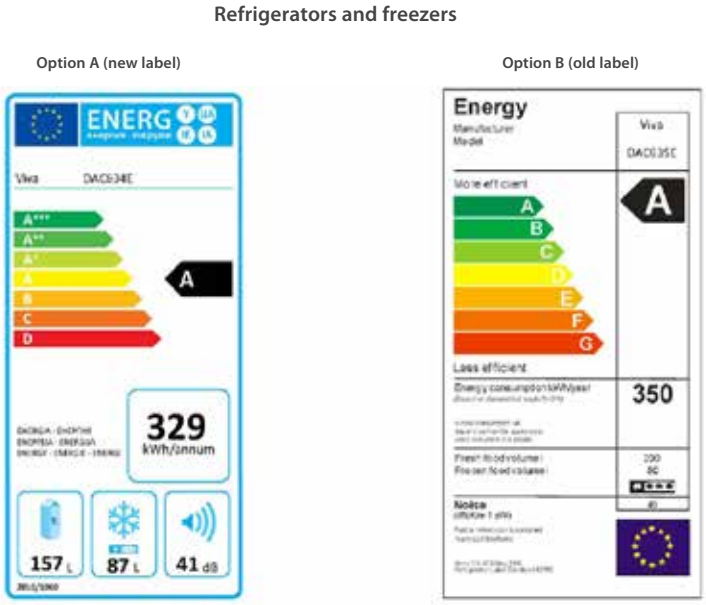
The European Union introduced categorical labeling for household appliances in 1992 with the *Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances.* This directive established 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 scale of the label therefore needed to be revised 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.

[42] World Bank
[43] Euromonitor
[44] Euromonitor

In 2013, CLASP published a consumer research study[45] 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 was designed to assess how consumers use, understand, and are motivated by the new and revised labels. This was achieved by holding ten 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 impact 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. See Figure 8.

Figure 8: 2010 (left) and 1992 (right) versions of the EU energy label for refrigerators



The 2010 label was considered 'clearer' by 50% of focus groups, and 'less cluttered' and 'better designed' by 60%. The CLASP study found that more consumers would consider the middle class acceptable in an A+++ to D label scale than in an A to G scale. When selecting products from an A+++ to D scale, consumers declared that they would be willing to pay 44% more for the highest energy efficiency class as opposed to middle-range products, compared to 50% more for an A to G class. Other studies found a larger difference between the motivational power of the two scales (see for example Heinzle & Wüstenhagen, 2010, in which researchers dissociated the effect of the A+++ to D scale from the rest of the design changes).[46]

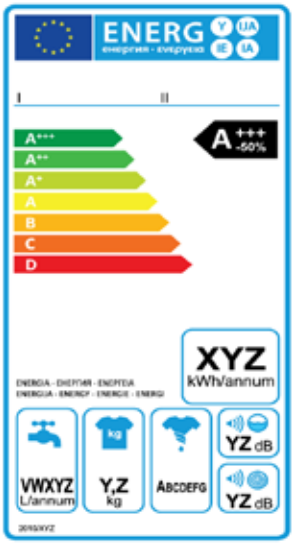
The study also investigated other parts of the label, such as energy consumption per year, water consumption, icons and others. Detailed feedback from consumers was extremely useful to justify shifting back to the original A to G scale in the 2017 revision of the legal framework, as well as to improve the presentation of certain elements and identify what may have to be further investigated for each product group. The survey also highlighted the importance of improving communication around the energy label.

[45] 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

[46] Heinzle S. and Wüstenhagen R., 2010. Disimproving the European energy label's value for consumers? Results from a consumer survey, University of St. Gallen, February 2010

After the A+++ to D scale was put in place, it rapidly became obvious that product efficiency was improving beyond what the 3 additional classes were able to discriminate and that a new rescaling would be necessary. In 2015, less than 4 years after the entry into force of the revised energy label for washing machines, Electrolux was putting a machine on the market that claimed to "surpass the EU top energy rating A+++ by a whole 50%" (see Figure 5).

Figure 9: Electrolux illustration of the efficiency class of 2015 machine on the December 2015 energy label



The company was concerned that the EU label would not do justice to the efficiency of their product and called for a revision, declaring: "It is time for a major revision of the energy labeling system in the EU", and "The current system where manufacturers have to add more and more plus-signs to the labels will be increasingly confusing for consumers."[47] In fact, just 3 years after the revisions to the EU Energy Label in 2010, there was already a consensus that a new rescale was needed and that adding plus-signs was not a long term solution. The European Environmental Bureau (EEB), the European Environmental Citizens Organisation for Standardisation (ECOS) and the European Committee of Domestic Equipment Manufacturers (CECED) co-authored a paper on this issue in 2013: Revising EU energy label: evolution or revolution?, confirming that even for industry, the 2010 revision with its scale extension only "provided a short term solution to the issue of saturation of the top classes."[48] This paper also lays out a few suggested principles for the revision of the label, some of which were respected by the European Commission.

In 2014, the European Commission published a report on the evaluation of the Energy Labelling Directive (initiated in 2012).[49] The first priority identified by this study was to revise the energy label:

> *A key priority is the revision of the present energy label so that higher efficiency levels can be communicated in the future. This will help to ensure future relevance and effectiveness of the energy label. While a new label design will inevitably require a rebasing of the efficiency classes currently applied, consumer understanding should be the chief concern for future label revisions (…). It is also becoming increasingly clear that the A+ categories are less effective at attracting consumers to the higher classes than the A class on an A-G scale. The evolution of energy labels to the A+++ categories is one that has little support among stakeholders, and where there is an overwhelming recognition of the need for change. In addition, labels should also not show empty classes at the lower end of the scale without in some way indicating that they are no longer active. The possibility to display environmental information on the label should be maintained. Future options to explore in greater depth are the opportunities offered by ICT to convey additional information or provide electronic labels, display of lifecycle cost information, the development of guidelines for how to revise existing labels, an in-depth assessment of transition issues, as well as a number of advanced label design options.*

[47] Electrolux "New washer breaks all limits: Time to revise energy label system." 2015. Available online at: https://www.electroluxgroup.com/en/new-washer-breaks-all-limits-time-to-revise-energy-label-system-21050/

[48] Arditi, S., Toulouse, E., and Meli, L., "Revising EU energy label: evolution or revolution?" 2013. Available online at: http://www.ecostandard.org/wp-content/uploads/Revising-EU-energy-label-evolution-or-revolution.pdf

[49] ECOFYS. "Final Technical Report: Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive" 2014. Available online at: http://www.energylabelevaluation.eu/tmce/Final_technical_report-Evaluation_ELD_ED_June_2014.pdf

In 2017 the European Commission adopted a revised legal framework for the energy efficiency label.[50] Not only does this new framework restore the original A to G scale, but it also institutes rules about how efficiency classes shall be defined and revised in the future:

Leaving top of the scale empty:

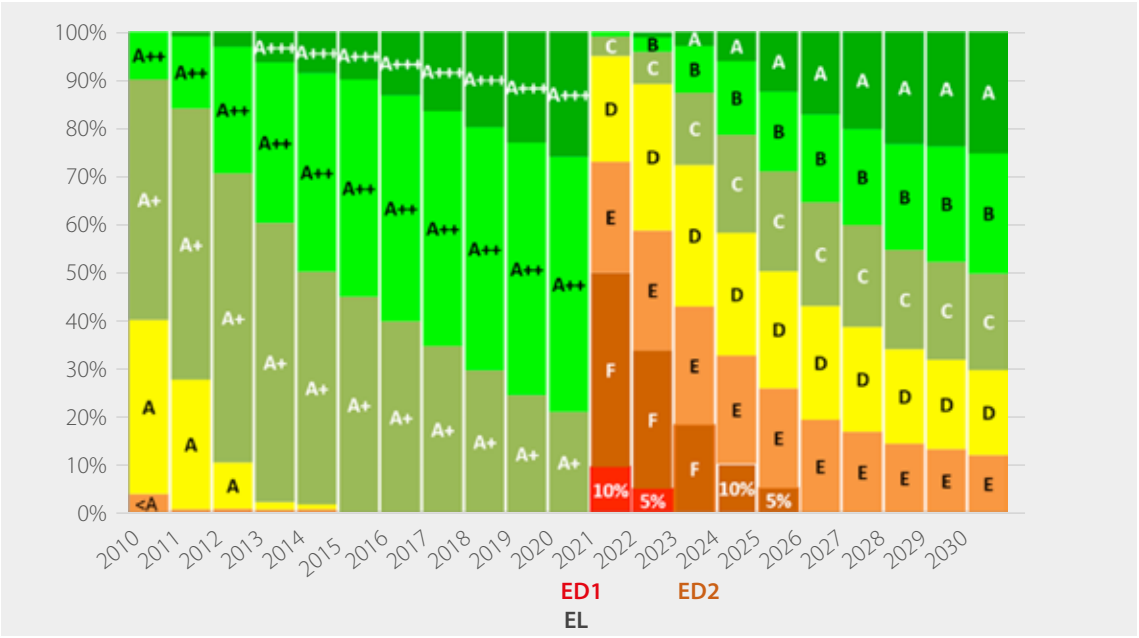
- "Where a label is introduced or rescaled, the commission shall ensure that no products are expected to fall into energy class A at the moment of the introduction of the label and the estimated time within which a majority of models falls into that class is at least 10 years later.
- By way of derogation […], where technology is expected to develop more rapidly, requirements shall be laid down so that no products are expected to fall into energy classes A and B at the moment of the introduction of the label."

Rescale trigger: "the commission shall review the label with a view to rescaling if it estimates that:

- 30 % of the units of models belonging to a product group sold within the union market fall into the top energy efficiency class A and further technological development can be expected, or
- 50 % of the units of models belonging to a product group sold within the union market fall into the top two energy efficiency classes A and B and further technological development can be expected."

These new rules have led to dramatic changes in how products are categorized. For example, the refrigerator market went from only including products that were 'A+' or higher, to having no 'A' class products at all, as the previous 'A+' became an 'F.' The figure below shows the evolution of the classes in the past 9 years, and how they are projected to evolve through 2030.[51]

Figure 10: Refrigerator Market Share by Label Level in the European Union



[50] 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

[51] COMMISSION DELEGATED REGULATION (EU) supplementing Regulation (EU) 2017/1369 of the European Parliament and of the Council with regard to energy labelling of refrigerating appliances and repealing Commission Delegated Regulation (EU) No 1060/2010 Available online at: https://ec.europa.eu/info/law/better-regulation/initiative/1553/publication/311969/attachment/090166e5be38dcdc_en

For ACs, the revisions to the labeling levels will also be dramatic. According to the labeling tiers proposed by the EU Commission in May of 2018, the current 'A' class will become an 'F' class. The full revisions can be seen below, in Table 2.[52]

Table 2: Existing and Proposed EU AC Labeling Tiers

Existing Label Tiers		Proposed Label Tiers	
Tier	**SEER**	**Tier**	**SEER**
A+++	SEER ≥ 8.50	A	SEER ≥ 11.5
A++	6.10 ≤ SEER < 8.50	B	9.7 ≤ SEER < 11.5
A+	5.60 ≤ SEER < 6.10	C	8.1 ≤ SEER < 9.7
A	5.10 ≤ SEER < 5.60	B	6.8 ≤ SEER < 8.1
B	4.60 ≤ SEER < 5.10	E	5.7 ≤ SEER < 6.8
C	4.10 ≤ SEER < 4.60	F	4.8 ≤ SEER < 5.7
D	3.60 ≤ SEER < 4.10	G	SEER < 4.8
E	3.10 ≤ SEER < 3.60		
F	2.60 ≤ SEER < 3.10		
G	SEER < 2.60		

Beyond highlighting the need for a dramatic re-scaling of the EU energy labels, the evaluation of the EU labeling program noted the need for up-to-date information on the types of products on the market and their sales totals. The long rulemaking process and low level of ambition in energy labeling were viewed as direct results of the lack of up-to-date market data. In order to address this problem, the evaluation recommended that the EU create a database of all models allowed to be sold in the EU market. This database would then simplify rulemaking by giving policymakers the necessary data to inform label re-scaling and would also improve market surveillance by providing compliance authorities with an accurate database of all products allowed to be sold in the market.

Key takeaways from the EU labeling program

- It is essential to frequently revise the energy efficiency label tiers and/or to leave the top categories empty at the time of re-scaling, so that the market can evolve to fill all label categories.
- The system of creating A+, A++, and A+++ categories was less effective at influencing consumer behavior than a full re-scaling, as consumers did not find these categories compelling.
- A well-maintained central database of models for sale in the market simplifies policymaking and compliance efforts.

[52] Baijia Huang, Philippe Riviere, Peter Martin Skov Hansen, Jan Viegand, Hassane Asloune, Florian Dittmann. Air conditioners and comfort fans, Review of Regulation 206/2012 and 626/2011 Final report. [Research Report] European Commission, DG Energy. 2018.

INDIA

The Indian Bureau of Energy Efficiency (BEE) launched the labeling program for fixed-speed ACs in 2006 as a voluntary initiative, and the program became mandatory in 2009. BEE revised the energy performance thresholds for ACs covered under the program on a biennial basis from 2010 - 2016. In 2015, BEE launched a voluntary labeling program for inverter ACs, and made the program mandatory in January 2018. The labeling program for ACs now covers both fixed and inverter units under a common rating plan. The increases in stringency have resulted in substantial efficiency improvement of 35% to the MEPS for split units, which are the most popular type of AC. Since the inception of the AC labeling program, 46 TWh of electricity have been saved and 38 million tons of carbon emissions have been avoided.[53]

THE EVOLUTION OF THE INDIAN AC LABELING PROGRAM

Figure 11: Indian Energy Efficiency Label for Split ACs

BEE developed distinct star rating plans for split and window/unitary type ACs. The split AC rating plan covers wall, ceiling, and floor-mounted ACs. AC efficiency was originally measured in terms of the EER. Starting on a voluntary basis in 2016, BEE adopted an improved rating methodology that factors in variance in temperature across the various climatic zones in India and operating hours. The new metric is called the Indian Seasonal Energy Efficiency Ratio (ISEER), which is the ratio of the total annual amount of heat that the equipment may remove from the indoor air when operated for cooling in active mode to the total annual amount of energy consumed by the equipment during the same period.

BEE has been revising the star rating plans for window and split ACs since the program was launched to increase the stringency of the energy performance thresholds, as shown in Table 3 and Table 4 respectively. These revisions to the star ratings have been conducted based on analysis of the registered labeled products in BEE's database, with a view to ensuring that each star rating contains a meaningful share of the products available on the market. Such a distribution of products across all rating tiers allows consumers to clearly distinguish between the efficiency levels of the various available products.

Table 3: Revisions in Star Rating Levels for Window ACs

Star level	1st January 2009 to 31st December 2011	1st January 2012 to 31st December 2013	1st January 2014 to 31st December 2015	1st January 2016 to 31st December 2017	1st January 2018 to 31st December 2019
	EER	EER	EER	EER	ISEER
1 Star	2.3	2.3	2.5	2.5	2.5
2 Star	2.5	2.5	2.7	2.7	2.7
3 Star	2.7	2.7	2.9	2.9	2.9
4 Star	2.9	2.9	3.1	3.1	3.1
5 Star	3.1	3.1	3.3	3.3	3.3

[53] The data and qualitative information contained in this case study has been gathered by the CLASP India office with support from BEE.

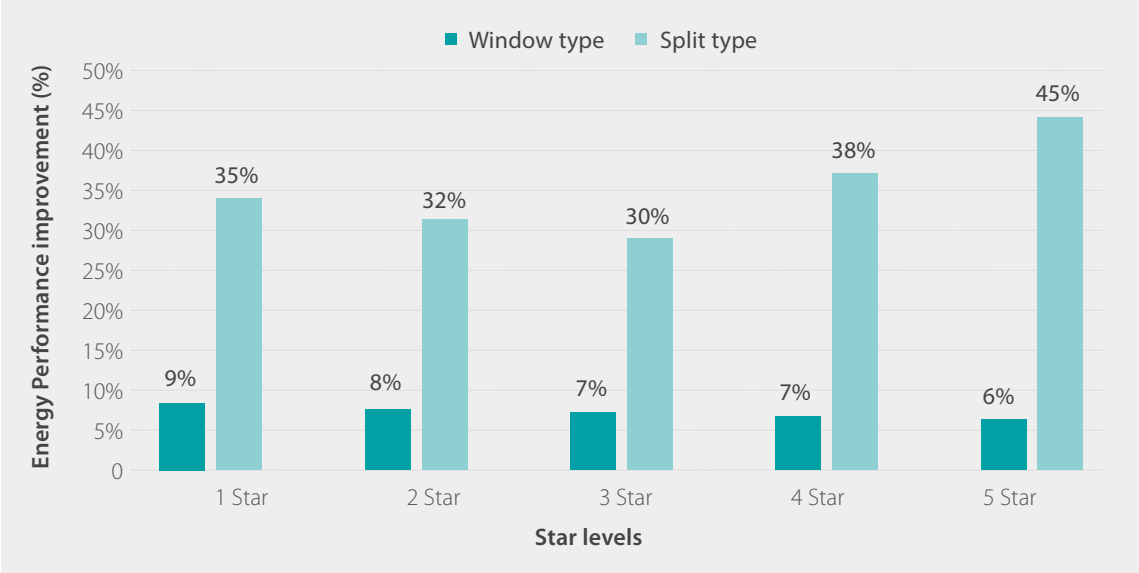
Table 4: Revisions in Star Rating Levels for Split ACs

Star level	1st January 2009 to 31st December 2011	1st January 2012 to 31st December 2013	1st January 2014 to 31st December 2015	1st January 2016 to 31st December 2017	1st January 2018 to 31st December 2019
	EER	EER	EER	EER	ISEER
1 Star	2.3	2.5	2.7	2.7	3.1
2 Star	2.5	2.7	2.9	2.9	3.3
3 Star	2.7	2.9	3.1	3.1	3.5
4 Star	2.9	3.1	3.3	3.3	4.0
5 Star	3.1	3.3	3.5	3.5	4.5

As per Table 3, the extent of efficiency improvements for window ACs has been limited. This is due to the technological and size constraints inherent in window ACs. As per the last revision in 2018, BEE does not allow the registration of those models which would have been rated 1-Star.

In comparison, the split type ACs have periodically seen more substantial revisions (see Table 4). For example, the existing 5-Star level in 2009 became 3-Star in 2015 and 1-Star in 2018 as per new star levels and ISEER methodology.

Figure 12: Star Level Improvement for Window and Split ACs, 2009- 2018



As shown in the figure above, the increases in the energy efficiency requirements for window ACs resulted in marginal efficiency improvements of 9% to the MEPS (1-Star) and 6% for the 5-Star threshold. For split RACs, increases in the energy efficiency requirements resulted in an overall improvement of 35% to the MEPS (1-Star) and 45% for the 5-Star threshold.

Notably, dramatic changes to the labeling program, such as the shift to the ISEER, have first been implemented on a voluntary basis before being made mandatory. This transitional voluntary phase in making these large shifts has allowed manufacturers to adapt to policy changes over time and to understand how they can benefit from these programs before being required to participate.

THE DEVELOPMENT AND IMPLEMENTATION OF THE ISEER

The discussion around moving to a test metric that captures the benefits of inverter ACs began when the ISO 16358 series of standards were published in 2013. Many of the major AC manufacturers in India are Japanese companies, such as Daikin, Toshiba, Hitachi, Mitsubishi, Sharp, and Panasonic. These companies were well aware of Japan's shift to using a seasonal energy efficiency metric for ACs. Furthermore, other companies in the industry recognized that inverter technology would be the future of the market and they wanted to begin preparing themselves for the Indian regulatory environment as they sought to enter the inverter AC market. At the time of initiating dialogue with the stakeholders, particularly the manufacturers, the energy efficiency label was based on EER. Manufacturers were concerned that consumers were not able to differentiate between a fixed speed and variable speed AC.

BEE understood that it would be necessary to implement new policies based on a test metric that reflected the benefits of inverter ACs. Before beginning the process of developing the energy efficiency matrix based on a seasonal metric, BEE initiated dialogue with the manufacturers and their associations to understand their preparedness and support. After achieving industry buy-in, BEE commissioned a study on the inverter AC market in order to understand the incremental cost associated with moving to inverter ACs, the status of the technology, the market growth, the component supply chain, the availability of standards, and the potential for scaling up inverter AC production in India.

The study found that there was significant potential for scaling up inverter AC production in India and that manufacturers were already planning to build facilities to produce inverter ACs.[54] The study projected that the share of inverter ACs would rise to 5.7% of the total AC market in India by 2018, compared to a 2012 baseline of 1.9% of the market. The study also found that inverter units cost more than fixed speed units, in part due to the fact that all inverter units were imported during that period. It was, however, unclear if the increased cost was adequately offset by electricity cost savings from improved efficiency, as there was no set way to test AC units according to Indian temperature conditions at that point in time. In addition, many of the imported inverter units were designed for more temperate climates than what is found in parts of India, and it was unclear if these units were truly suitable to Indian weather conditions.

Based on this study, BEE decided that the logical next step would be to develop a test standard for inverter ACs based on Indian climate conditions. Indian test labs were already using the national standard IS 1391 test method, which corresponds to ISO 5151, for fixed speed ACs. This made it clear that the ISO 16358 series of standards would be relatively easy to adopt as they prescribe the methodology to determine the seasonal energy efficiency using the same test protocol defined in ISO 5151. However, BEE recognized that the temperature bins proposed in ISO 16358 did not match India's weather conditions, which include five distinct climatic zones. Therefore, BEE collected weather data for 57 Indian cities and cross-checked this data with information from the Indian Metrological Department (IMD) and the AC manufacturers association, RAMA. This data allowed BEE to determine the relevant ambient temperature bins ranging from 24 ° C to 43 ° C. In addition, consultations with stakeholders allowed BEE to determine that average annual AC usage in India was 1600 hours.

[54] Developing Standard and Labeling Program for Inverter Air- Conditioners: Market Assessment Report. PricewaterhouseCoopers. 2013.

Table 5: ISEER Temperature Bins

Temp in C	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	Total
Average Annual Hours	527	590	639	660	603	543	451	377	309	240	196	165	130	101	79	59	44	31	20	10	5774
Fraction	9.1	10.2	11.1	11.4	10.4	9.4	7.8	6.5	5.4	4.2	3.4	2.9	2.3	1.7	1.4	1.0	0.8	0.5	0.3	0.2	100
Bin Hours	146	163	177	183	167	150	125	104	86	67	54	46	36	28	22	16	12	9	6	3	1600

With the test method and temperature bins decided, four samples each from four manufacturers were tested in three different test labs. These four manufacturers volunteered their samples based on a request from the BEE technical committee. The results of these tests were considered by BEE when determining the levels for a new test metric, the ISEER. The label for inverter ACs, based on the ISEER, became voluntary beginning in 2015, and then transitioned to a mandatory phase with a common rating plan for both inverter and fixed speed ACs effective January 2018. Unlike in some other countries, such as Japan and China, India opted to develop a seasonal metric for cooling only, as heating is not a relevant function in most of India.

Using ISO 16358-1, with modifications to the temperature bins and operating hours, proved crucial to implementation of the new test metric. Because the ISO 16358 series of standards specifies the testing and calculation methods for the seasonal performance factor of equipment covered by ISO 5151 or the national standards on ACs, there was no need for the laboratories to set up any additional test facilities or equipment to test inverter ACs. The labs only needed to understand the calculation methodology to determine the seasonal energy efficiency ratio and to get themselves trained, primarily to set the various levels of frequency. The greatest challenge they faced was calculating the ISEER based on the test results at each outdoor temperature conditions and the corresponding operating hours. This was easily solved by building a tool to help the manufacturers and the test labs conduct testing and report the test results. In addition, the laboratories required that the manufacturers share the manner of setting the frequency to achieve the required part load conditions for the inverter ACs as defined in ISO 16358.

Another key aspect of the implementation of the ISEER was that it was announced two years in advance of its mandatory implementation phase. This followed the precedent of announcing a roadmap for label revisions every two years, as had been practiced since the beginning of the standards and labeling program for ACs in India. The announcement of a policy roadmap and of the transition to the ISEER with years of advance notice gave the AC industry time to plan for the policy changes and also helped the policies to begin transforming the market even before they were made mandatory.

THE INDIAN COMPLIANCE FRAMEWORK

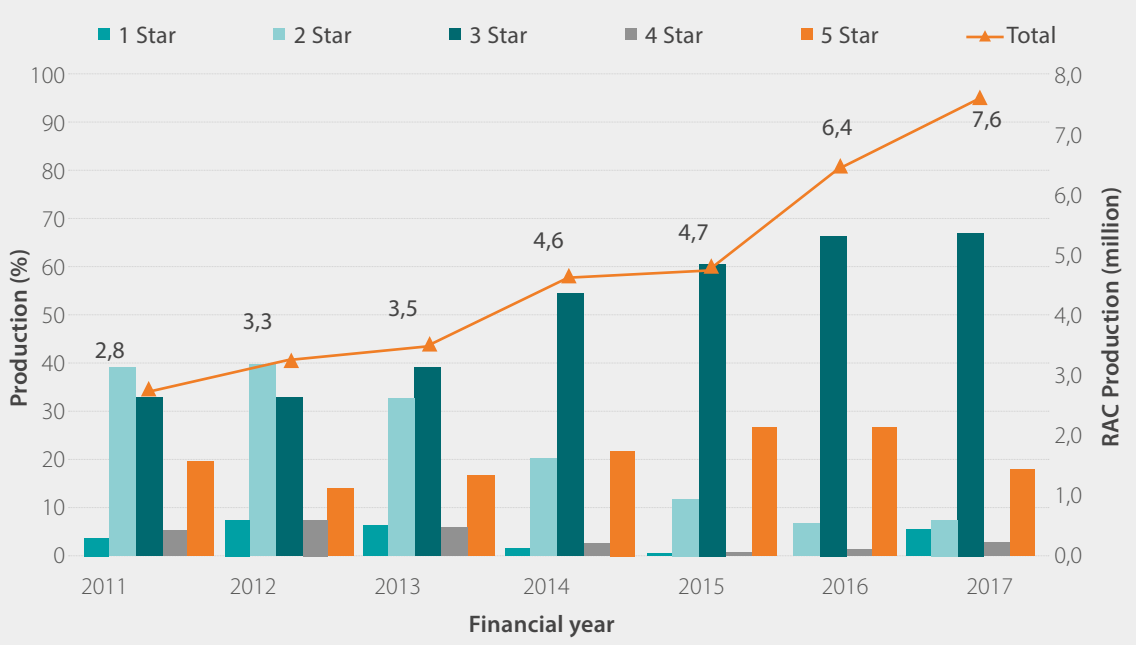
A robust compliance program safeguards the energy savings and consumer benefits from the Indian AC labeling program. This compliance program begins with product registration. In order to receive a label, a manufacturer or importer shall first submit an application along with all the relevant documents on the BEE S&L web portal for company registration. Subsequently, the manufacturer should submit their application for model registration, which shall be supported by a test report from a laboratory accredited by the national accreditation body. Subject to the approval of the application for registration, the manufacturers or importers are authorized to use the BEE label on their product. Once approved and registered, the supplier must submit a sales report and pay a labeling fee to BEE every quarter. This system allows BEE to maintain a database of all AC models approved for sale on the Indian market, as well as their sales volumes, which facilitates policymaking by providing up-to-date information on the status of the market.

Beyond registration, BEE ensures compliance through market surveillance, check testing, and challenge testing. Market surveillance is conducted by officials who inspect retail outlets to verify that labels are authentic, displayed correctly, and attached to the correct product. Check testing is conducted through random sampling on the open market, while challenge testing is conducted when BEE receives a formal complaint about a non-compliant product. If a product fails two tests under check or challenge testing, the manufacturer loses labeling permission and must withdraw the product from the market. For the benefit of the consumers, the name of any manufacturer, brand, model, or model number that has failed testing is published in national and regional newspapers.

IMPACTS OF THE INDIAN LABELING PROGRAM

The Indian labeling program has driven a dramatic transformation of the Indian AC market over the last decade, as can be seen in Figure 13. In 2011-2012, the market share of 2-Star ACs was the highest at 39% followed by 3-star ACs at 33%. However, in 2017-18, 3-Star ACs dominated the market with 66% followed by 5-Star ACs with 18% market share. The majority of AC sales over the last four years were of 3-Star and 5-Star models, with average market shares of 61% and 23% respectively. This trend points to a consumer preference for 3-Star ACs, possibly due to lower, more affordable upfront purchase costs.

Figure 13: Indian AC Market by Star Level 2011-2017



The production-weighted average EER/ISEER of ACs has increased from 2.8 W/W in 2011-12 to 3.6 W/W in 2017-18, which represents a 29% increase in efficiency due to the tightening of standards and the introduction of a labeling program for variable speed ACs in 2015.

The effect of the move to the ISEER in the Indian market has been tremendous. While inverter units only made up 1.9% of the market in 2012 and were only projected to make up 5.7% of the market by 2018, they came to make up 11% of the market in 2016 and around 30% of the market in 2017. This rapid growth in inverter market share was built on the foundation of the new test metric and supported by government and bulk procurements that specified high ISEER values only attainable by inverter units.[55]

[55] Based on Interview with P.K. Mukherjee, December 2018.

Figure 14: Production-weighted average EER/ISEER of ACs, 2011-2017

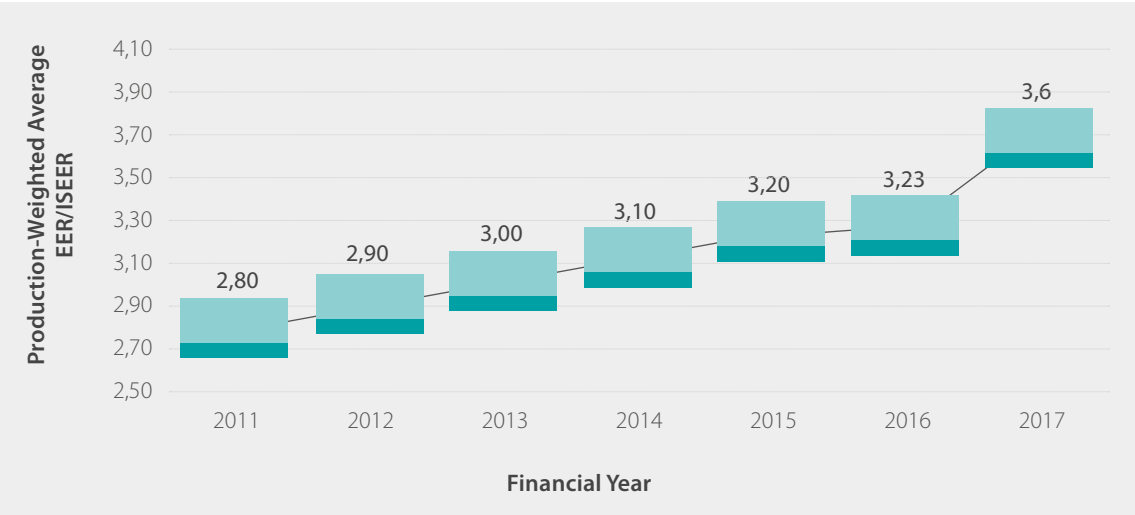
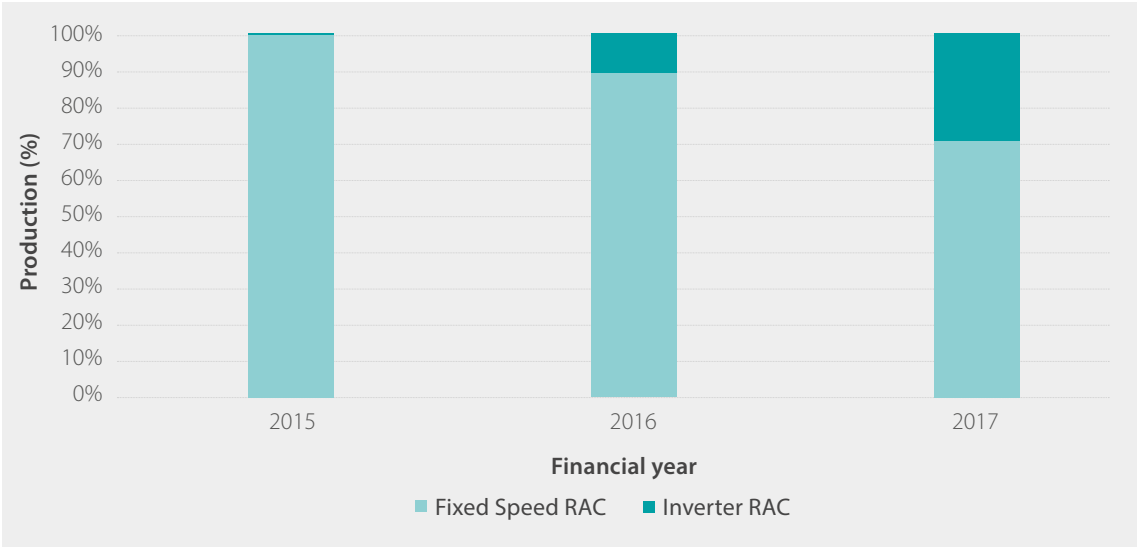


Figure 15: Market Share of Fixed Speed and Inverter ACs



Key Takeaways from the Indian Labeling Program

- Announcing policy changes years in advance and increasing label stringency every two years drives increases in product efficiency while also giving manufacturers sufficient advance notice to adapt to policy changes
- Moving to a seasonal energy efficiency metric promotes the rapid growth of inverter AC market share
- Creating a database of approved models and requiring manufacturers and importers to report the sales of each model facilitates policymaking by giving a clear picture of the status of the market

CHINA

China's energy labeling program demonstrates the value of labels that differentiate products for promoting market transformation. At the same time, China's extensive experience with a wide variety of endorsement labels provides key lessons for such programs and shows some key pitfalls in endorsement label design.

China Energy Label

The China National Institute of Standardization (CNIS) has led an energy labeling program for more than 15 years. The China Energy Label has three to five levels, with level 1 being the most efficient and levels 3 or 5 being the MEPS, depending on the product. The label levels are specified in the same document as the MEPS, and label rescaling occurs as part of the MEPS revision process. Chinese regulations require that each MEPS include at least three label levels, with at least some products in each of the labeling categories. The label also now includes a QR code that allows customers to access additional information on the product's energy performance. Some manufacturers have included the electricity bill cost for appliances in the QR code, though this cost information is not verified by third-parties and CNIS is not currently interested in playing a role in developing or certifying this information. Additionally, some retailers have been known to remove the QR codes, as they believe the QR codes provide consumers with too much information and can be confusing.

There is also an energy efficiency endorsement label for level one and two products, though this label is not often observed in the market, as it can be regarded as duplicative of the China Energy Label. An example of the China Energy Label with the QR code appears in Figure 16 and the endorsement label appears in Figure 17.

Figure 16: China Energy Label

Figure 17: China Energy Conservation Certification Label

These labels provide the basis for China's market transformation targets contained within the Five-Year Plans. In the current Five-Year Plan, which runs from 2016 to 2020, the target for ACs is to increase market share of level 1 and 2 products from 22.6% in 2015 to 50% in 2020.[56] These targets are currently evaluated against the registry of products available for sale in the market. However,

[56] State Council of the People's Republic of China. "13th Five Year Plan for Energy Conservation and Emission Reduction Programme" Available online at: http://www.gov.cn/zhengce/content/2017-01/05/content_5156789.htm

the Chinese Central Government is also now improving its data collection efforts in order to ensure that these targets are evaluated against robust, sales-weighted data that accurately reflects the status of the market. This effort is beginning by requiring that manufacturers provide sales data, though it is possible that retailers will be required to provide sales data per model as well.

Top Runner

The Top Runner policy was published at the end of 2014. This program is intended to identify and recognize the appliances, equipment, enterprises, and buildings with the best energy performance. Top Runner appliances receive a special Top Runner mark on the China Energy Label. So far, the Top Runner program has not yet met its objectives and is being evaluated for reforms. The main challenge with the Top Runner policy for appliances is that the criteria for the Top Runner label is very strict and not directly related to the criteria for the China Energy Label. The result is that very few products have received the Top Runner designation and these products are very expensive. The small market share of the Top Runner products has then led to low consumer awareness about the program and a lack of interest from certification bodies – the small volume of certification business for Top Runner products is not worth learning the certification method.[57]

The National Development and Reform Commission (NDRC), which is the entity in charge of Chinese Central Government energy policy, has tasked the Energy Research Institute (ERI) with evaluating the Top Runner program and proposing improvements. ERI staff believe that the program could be made more effective if it were more like the Japanese Top Runner program where the Top Runner category is made the target for the average efficiency of products in the future. Other potential improvements that ERI has identified are to create an incentive program for Top Runner products or a publicity campaign.[58]

Green Product Label and Standard

The State Council, which is the highest-ranking entity in Chinese government, has identified the proliferation of labels as a problem and has directed the various agencies responsible for labeling to work on consolidating the labels into a single green product label. The development of the green product label is under the State Council's high control, with NDRC, the Ministry of Industry and Information Technology, the Ministry of Environment and Ecology, CNIS, and China Standard Certification Co. (CSC) all having roles in the development of the labels. The State Council aims to see what agencies make the most progress on label development and to use the best practices developed by each. The first 13 green product labels have been announced, though they mostly cover building materials and furniture, with solar water heaters being the only appliance covered. There will be another batch of green product labels announced soon and it will include several appliances.

CSC is the secretary of the green product label technical committee and has been developing the certification methods. They have proposed that the green product label have two levels: 'full green' and 'partial green,' with 'partial green' labels highlighting what aspects of the green product label the product meets. As part of this proposal, CSC suggested that the energy conservation mark be incorporated into the 'partial green' label and this suggestion was accepted. In addition,

[57] According to interviews with CNIS and ERI Staff. November 2018.
[58] According to interviews with ERI Staff, November 2018

CSC is proposing that the green product label requirements be loose enough to allow 20% of the market to meet the requirements in order to avoid the problems that Top Runner is facing from low recognition and lack of interest from certification bodies. However, other policymakers disagree with this proposition and would prefer that the green product label only apply to the very best performing products.

Key Takeaways from the Chinese Labeling Program

- Energy labels that clearly differentiate highly efficient products can form the basis for effective market transformation programs
- Very strict criteria for endorsement labels may result in few products receiving the designation, low consumer awareness, and lack of interest from certification bodies given the small volume of certification business.

SOUTHEAST ASIA

In 2015, members of the Association of Southeast Asian Nations (ASEAN)[59] agreed to harmonize their standards for ACs to a single, seasonal test metric. This agreement has led to ASEAN countries moving from EER to seasonal test metrics that capture the efficiency benefits from inverter ACs. Two countries that have already made the shift to seasonal test metrics for their labeling programs are Vietnam and Thailand. The experiences of these two countries show how shifting to a seasonal test metric promotes a market shift to inverter technology. However, the differences in the two experiences show that the test metric must be applied to all products in the same way in order to have maximum effect on the market.

VIETNAM

Energy performance labeling is mandatory in Vietnam. Vietnam's Ministry of Industry and Trade (MOIT) oversees the energy labeling program. The Vietnamese energy label is a comparative label that provides star ratings from 1-5 (Figure 18). The more stars an AC receives, the more efficient the model is. A certified energy label provides the following information: manufacturer's name, product origin, model number, rated power, energy efficiency, the relevant regulation, and certification number.

Figure 18: Vietnam endorsement label (left) and energy label (right)

[59] ASEAN member states are Indonesia, Thailand, Malaysia, Singapore, Philippines, Vietnam, Cambodia, Myanmar (Burma), Brunei, and Laos

In 2013, Vietnam began the process of moving to a seasonal test metric by adopting TCVN 10273-1:2013, which is equivalent to ISO 16358-1:2013. Vietnam had already been using ISO 5151, so, as in the Indian case, the transition to using the ISO 16358 evaluation method was relatively simple.[60]

The use of TCVN 10273-1:2013 was voluntary for the first two years. However, the 2015 MEPS and labeling revision mandated the use of the CSPF energy performance metric and extended the regulation to cover inverter ACs. Notably, under the previous 2012 standard, MEPS and labels applied to all ACs with capacities under 48,000 Btu/hr; however, the 2015 standard only covers ACs up to 41,000 Btu/hr.[61]

Vietnam uses the T1 test conditions and temperature bins, which are the most commonly used temperature bins internationally. This use of ISO 5151 and ISO 16358 with T1 conditions allows Vietnam to accept test reports from labs in many different countries, since these test standards and conditions are widely used throughout much of the world. Furthermore, these standards and conditions are the basis of the ASEAN SHINE agreement and are used throughout the region.[62]

Table 6: T1 Temperature Bins

Bin No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Temp in °C	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	-
Fraction	0,055	0,076	0,091	0,108	0,116	0,118	0,116	0,100	0,083	0,066	0,041	0,019	0,006	0,003	0,002	-
Annual Hours	100	139	165	196	210	215	210	181	150	120	75	35	11	6	4	1817

The effect of moving to a single, seasonal test metric is clear. Compared to market data from 2013, inverter penetration has increased by approximately 31%, from 34% of the market to 65% of the market in 2018. Despite inverter technology now having a larger overall market share than fixed speed technology, fixed speed ACs are still more prevalent at cooling capacities above 36,000 Btu/hr. The higher market share of fixed speed units at these higher capacities is likely because units over 41,000 Btu/hr are not labeled and consumers, therefore, cannot readily identify the efficiency benefits of the inverter models. Without a label, manufacturers have no incentive to develop high-capacity inverter models for the Vietnamese market. The consumer preference for ACs with energy labels indicating higher efficiency is also clear, as high efficiency 5-star labeled products account for 54% of the market. This preference can also be seen in the fact that inverter ACs are more popular despite slightly higher average prices for inverter ACs.[63]

THAILAND

Thailand has maintained an energy efficiency labeling program for ACs since 1995. The label is voluntary, 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). The label is well-recognized by Thai consumers and the vast majority of AC units sold on the Thai market are labeled EGAT No. 5.[64] Notably, government procurement often requires that products have the EGAT No. 5 label.

The label levels have been revised several times since the program was launched. Until 2015, all AC units had their efficiency measured by EER. However, in 2015, Thailand began the move to harmonize its labeling tiers to the ASEAN metric by introducing new label levels for inverter AC units, based on seasonal energy efficiency ratio (SEER). This was followed by the 2017 revision of the label levels for

60 Vietnam Room Air Conditioner Market Assessment and Policy Options Analysis. CLASP. (Forthcoming).
61 Ibid.
62 Ibid.
63 Ibid.
64 Thailand Room Air Conditioner Market Assessment and Policy Options Analysis. CLASP. (Forthcoming).

fixed speed units, also based on SEER. The test method and evaluation method follow ISO 5151 and ISO 16358, using T1 testing conditions, as per the ASEAN SHINE agreement. The label levels for both types of ACs can be seen in Table 7.[65]

Table 7: SEER Levels for Thai EGAT No. 5 Label

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

This movement to a single test metric, SEER, has accompanied a significant increase in the market share of inverter ACs in Thailand. In 2013, inverter ACs accounted for 16% of the Thai AC market - this figure had increased to 32% by 2018. However, this increase is less dramatic than in Vietnam, despite both countries being part of the ASEAN free trade area and both countries participating in the ASEAN SHINE energy efficiency standards harmonization initiative. A likely reason for the different results in the two countries is that Thailand has maintained different labeling tiers for fixed speed and inverter ACs, while Vietnam has moved to one set of labels for all AC technologies. [66]

Maintaining different labeling requirements for fixed speed and inverter ACs has likely slowed the market transformation towards higher efficiency, inverter AC units. Thai consumers have a strong preference for EGAT No. 5 labeled products and the EGAT No. 5 label is often required for government procurement and bulk purchases by real estate developers. However, maintaining different labeling requirements levels for different technologies allows less efficient fixed speed ACs to continue to receive a No. 5 label. Eliminating this difference would result in few, if any, fixed speed ACs meeting the No. 5 label and would therefore lead the Thai market to rapidly move to inverter ACs if the strong preference for EGAT No. 5 labeled products continues.[67]

Key Takeaways from Southeast Asian Labeling Programs

- Moving to a seasonal energy efficiency metric promotes a rapid increase in the market share of inverter AC units.
- However, maintaining separate requirements for inverter vs. fixed speed ACs slows the pace of inverter market share growth by preventing a clear comparison between the two technologies.

[65] Ibid.
[66] Ibid.
[67] Ibid.

SUMMARY

The case studies in this report provide a variety of experiences with managing AC labeling programs in different markets, with different outcomes. The table below provides a summary of these labeling programs.

Table 8: Summary of AC Labeling Programs

Economy	Performance Rating Approach	Voluntary or Mandatory	Test Method and Metric	Compliance Overview
European Union	Single requirement for inverter and fixed speed units	Mandatory	SEER, based on the ISO 5151 test method and the EN 14825 evaluation method	Manufacturers, importers, and dealers are responsible for appropriate labeling. Member states conduct market surveillance, which may include check testing
India	Single requirement for inverter and fixed speed units	Mandatory	ISEER, based on an adaptation of the ISO 5151 test method with the ISO 16358 evaluation method	Manufacturers and importers are responsible for appropriate labeling. BEE conducts market surveillance, including check testing.
China	Separate requirements for inverter and fixed speed units	Mandatory	Annual Performance Factor (APF) or SEER for inverter units, based on an adaptation of the ISO 5151 test method with the ISO 16358 evaluation method. EER and ISO 5151 for fixed speed units	Only manufacturers are responsible for appropriate labeling. Provincial authorities conduct market surveillance.
Vietnam	Single requirement for inverter and fixed speed units	Mandatory	CSPF, based on the ISO 5151 test method with the ISO 16358 evaluation method	Manufacturers and retailers are responsible for appropriate labeling. Vietnam Society of Refrigeration and Air Conditioning Engineers (VISRAE) and Provincial Governments conduct market surveillance.
Thailand	Separate requirements for inverter and fixed speed units	Voluntary	SEER, based on an adaptation of the ISO 5151 test method with the ISO 16358 evaluation method	Manufacturers, importers, and retailers are responsible for appropriate labeling. EGAT conducts market surveillance.

4. Conclusions and Recommendations

PROJETO
KIGALI

4. Conclusions and Recommendations

The Brazilian Labeling Program and Selo PROCEL are well placed to move the Brazilian split AC market to high efficiency products; they are well-understood and recognized by consumers and they clearly influence AC manufacturers' product design. However, realizing this potential and meaningfully improving the efficiency of split ACs sold in Brazil will require changes to both programs. Based on lessons learned and best practices from a review of international labeling programs for ACs discussed in this report, CLASP recommends the following:

Update the test metric to a seasonal performance metric as soon as possible

The current metric, EER, does not capture the efficiency benefits of inverter ACs, which are up to 51.7% more efficient than fixed speed ACs.[68] This means that a substantially more efficient inverter AC is presented as having the same efficiency as a much less efficient fixed speed unit. Brazil should follow the lead of countries such as India, China, Thailand, Vietnam, and the European Union in adopting a seasonal metric, such as the SEER, which captures the increased efficiency from inverter ACs.

In countries such as India, Thailand, and Vietnam, the transition to seasonal performance metrics has led to a doubling or more of the market share of inverter ACs.[70] In India, this increase in inverter market share accounts for nearly half of the total improvement in the average efficiency of AC units sold.[71] As in these countries, a transition to a seasonal performance metric in Brazil should not be overly burdensome, since Brazil also already uses ISO 5151 as its test standard.[72] The ISO 16358 evaluation method that allows for fixed speed and inverter ACs to be rated under the same metric simply builds on the ISO 5151 test method by calling for the same efficiency test to be conducted at part load in addition to full load, and does not require any additional test laboratory equipment. [73]

Rescale the PBE comparative label for split ACs

In order for the labels to clearly differentiate high efficiency products, their efficiency criteria must by revised. The 'A' class and Selo PROCEL criteria should be set sufficiently high that only highly efficient inverter ACs can achieve these designations. Such a revision will rapidly move the market to highly efficient inverter ACs, as has been the experience in Vietnam, Thailand, and India. Brazilian consumers' label recognition and preference for 'A' class products will facilitate the transition.

In addition, the revision should ensure that there are products falling into at least four categories, 'A' to 'D,' so that consumers can identify a variety

[68] Yoon, M.S., J. H. Lim, T. S. M. Al Qahtani, Y.J. Nam. "Experimental Study on Comparison of Energy Consumption between Constant and Variable Speed Air-Conditioners in Two Different Climates." Proceedings of the 9th Asian Conference on Refrigeration and Air-conditioning. June 2018.
[69] Various manufacturers estimated that the inverter market share in Brazil is between 30% and 45%.
[70] CLASP. "Cooling in a Warmer World." January 2019. Available online here: https://issuu.com/claspngo/docs/clasp_-_cooling_in_warming_world?e=0
[71] Based on data collected by CLASP from the Bureau of Energy Efficiency product database.
[72] Diário Oficial da União "Portaria Interministerial MME/MCT/MDIC nº 364 de 24/12/2007"
[73] United for Efficiency (U4E). "Accelerating the Global Adoption of Energy-efficient and climate-friendly air conditioners". 2017.

of different efficiencies in the market. A requirement to have at least four categories is in line with international best practices. For example, in the European Union labeling program, on which the PBE is based, the 'A' class must contain no products at the time of re-scaling and the label must be re-scaled any time that 'A' class products account for 30% or more of the market or when 'A' and 'B' class products account for more than 50% of the market. In China, there must be at least three and no more than five labeling tiers, with products in each tier being actively produced. Requiring multiple tiers that each account for some market share allows Chinese policymakers to set market transformation targets based on the tiers – the Central Government sets goals that products in the top tier or top two tiers achieve certain market shares.

Develop and implement a policy roadmap for split ACs

INMETRO and PROCEL should announce, along with the re-scaling and test metric update, a roadmap for labeling criteria over the coming six years. This roadmap should include labeling tier increases of 5%-10% every two years. The roadmap will provide policy certainty so that AC manufacturers can plan their investments around the future labeling tiers and ensure that they are able to produce products that meet the requirements of the desired label. At the same time, such a roadmap will ensure that split AC energy efficiency is improving and that the label is keeping up with and even driving technological improvements. Several AC manufacturers operating in Brazil have specifically asked for such a roadmap, as they agreed that a roadmap would help them plan their investments.

The effectiveness of a roadmap can be observed in India, where a roadmap was implemented from 2010 to 2016, driving the 29% improvement in efficiency while also securing the AC industry's support for these policies. This roadmap included increasing the stringency of the labeling tiers every two years over that period, which ensured that the label kept pace with improvements in energy efficiency in the market.

Require manufacturers and importers to report sales per model

The PBE's current database of AC models on the market does not include sales figures for these models. Several AC companies noted that the database includes models that are no longer sold or that were never sold in significant quantities to begin with. Requiring that manufacturers and importers report sales per model will allow policymakers to get a clearer picture of the market and what products are actually being sold, which will better inform re-scaling going forward. Such a requirement is official policy in India, where manufacturers and importers are required to report their sales per model each quarter. A well maintained and well-informed database is a necessary tool for the implementation of the other recommendations, allowing fine monitoring of the market and timely revisions of the labels. It can also support market surveillance and verification efforts by gathering much of the necessary information to provide a low-cost compliance check for products entering the market and to identify high-risk or regularly non-compliant applicants, which can then be targeted for checks and testing.

Apply the Selo PROCEL to only the best performing products

To maximize climate benefits and encourage adoption of new technologies, only the top 10%-25% of products available on the market should be able to achieve the Selo PROCEL. The move to a seasonal test metric and the rescaling of the Brazilian energy label should lead to the 'A' class of the comparative label only applying to 25% or less of the market. In that case, PROCEL could keep the current arrangement where the Selo PROCEL maintains its efficiency criteria as the 'A' class criteria.

In addition, PROCEL should consider including additional criteria for the Selo PROCEL. In order to maximize the climate benefits of the labeling program and encourage new technologies, PROCEL could require that AC units use non-ozone-depleting, low global warming potential refrigerants in order to receive the Selo PROCEL. In addition, in order to better manage electricity demand from cooling, the Selo PROCEL could include a requirement that ACs be demand response ready so that the distribution utility can dispatch AC units during peak demand or so that consumers could set their AC units to use less electricity when time of use rates are highest.

The value of these additional criteria should be weighed against the additional cost and complexity of certifying compliance; implementing an overly complex certification process may lead to too few products receiving the designation and therefore have limited impact, as was the case of Top Runner in China. In Brazil, the efficiency requirements for the Selo PROCEL should continue to be based on the efficiency testing conducted for the PBE, with any additional criteria heavily considering requirements for any additional testing. For example, the efficiency requirement for the Selo PROCEL could continue to correspond to the 'A' labeling tier, but with additional requirements related to the refrigerant or demand response being easily verified from the product specifications.

Assessment of Brazil's Labeling Program for Air Conditioners

PROJETO KIGALI

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