Recognizing and rewarding higher efficiency: case studies in moving to a single test metric for fixed and variable speed air conditioners

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Abstract
Increasing the market share of inverter air conditioners is a key step towards improving the efficiency of residential cooling. Inverter air conditioners can be as much as 51 % more efficient than fixed speed air conditioners by operating at part load instead of turning on and off. However, because the metrics used in many energy efficiency standards and labelling programs do not convey to users whether the energy efficiency metric is based on full load only or on part loads including full load, the efficiency benefits from inverters are often not captured. Additionally, economies that implement standards based on performance metrics that do capture the gains from inverters often apply these standards to inverter air conditioners only, while continuing to rate fixed speed air conditioners under a different metric. Such policies prevent a fair, technology-neutral comparison between all types of air conditioners and can confuse consumers.

This paper examines the transition to a single test metric for room air conditioners and the resulting market transformation in India and Southeast Asia. In India, the convergence to a single metric and energy efficiency requirement for room air conditioners has accompanied an increase of inverter technologies from 1 % in 2012 to about 30 % in 2018. In Vietnam, the introduction of a performance metric that captures the benefits from part load performance coincided with a near doubling of the penetration of inverter air conditioners in the market from 34 % in 2013 to 65 % in 2018. These case studies focus on the technical and institutional hurdles when shifting to a single test metric, and the impact of the convergence of efficiency requirements on the room air conditioner market. The lessons from these case studies provide valuable insights for policymakers seeking to promote high efficiency cooling products in their markets.

Introduction
The use of variable frequency drives (VFDs) with inverters has long been a well-known energy efficiency measure in industrial and commercial applications, including air compressors, pumps, fans, motors, elevators, and escalators. Similarly, using an inverter to vary the speed of an **air conditioner** (AC) compressor to respond to the cooling demand instead of simply turning the compressor on and off can significantly reduce the AC's energy consumption. While the speed of a non-inverter compressor is fixed so that it operates either at full or minimum speed, a sensor in an inverter AC unit adjusts the compressor power according to the temperature in the room, lowering the electrical consumption and saving energy.[1] In the past decade, AC manufacturers have been increasingly incorporating inverter compressors into their AC units in order to improve efficiency.

Ensuring that the efficiency benefits from inverter ACs are recognized and rewarded requires that they be tested at part-load and that their efficiency be represented by a metric that

1. 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.

reflects the advantages of inverter compressors. Traditionally, ACs have only been tested at full load, with their efficiency measured using the energy efficiency ratio (EER), which is the ratio of cooling output to electric power input. Testing only at full speed fails to capture the benefits of inverter ACs and may even disadvantage ACs with inverter compressors if they are not as efficient at full load as fixed speed compressors at full load.

Several test metrics have been developed to capture the benefits of inverter ACs. The seasonal energy efficiency ratio (SEER) and cooling season performance factor (CSPF) are metrics that represent the ratio of the total cooling output over the year to the total energy consumption for cooling over the year. These can be combined with the heating season performance factor (HSPF), which is the ratio of the total heating output over the course of the year to the total energy consumption for heating, to create the annual performance factor (APF). The APF is, therefore, the ratio of the total heating and cooling output to the total energy input over the course of a year for an AC unit that also functions as a heat pump.

Case studies

Several countries around the world have moved to seasonal AC efficiency metrics that capture the benefits of inverter ACs. Many other countries are in the process of moving to such a metric, or are planning to begin this process soon. Four countries that have moved or are in the process of moving to seasonal AC efficiency metrics are India, China, Vietnam, and Thailand.

INDIA

India launched its standards and labelling program for room ACs in 2006, with voluntary labelling. This labelling became mandatory in 2010, with the lower star rating (the label uses 1 to 5 stars, 5 being more efficient) becoming a minimum energy performance standard (MEPS).[2]

The discussion around moving to a test metric that captures the benefits of inverter ACs began when the ISO 16358[3] 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 APF as their energy efficiency metric for ACs. Furthermore, other companies in the industry recognized that inverter technology would be the future of the market and, as they sought to enter the inverter AC market, they wanted to begin preparing the Indian regulatory environment to better accommodate inverter ACs. At the time, the Indian energy efficiency label was still based on EER and Indian consumers were often unable to recognize the difference between inverter and fixed speed units. This was of concern to the AC industry.[4]

The Indian Bureau of Energy Efficiency (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 standards development, BEE reached out to various stakeholders in the AC industry, primarily the manufacturers, and ensured their buy-in to the standards development process. 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 and the potential for scaling up inverter AC production in India.[5]

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. 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.[6]

Based on this study, BEE determined 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 ISO 5151[7] for fixed speed ACs, so it was clear that ISO 16358 would be relatively easy to adopt as it builds on 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 Refrigeration and Air conditioning 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 1,600 hours.[8] The temperature bins and hours can be seen in Table 1.

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 the request of the BEE technical committee. The results of these tests allowed BEE to determine the levels for a new test metric, the India Seasonal Energy Efficiency Ratio (ISEER), which would become a voluntary label beginning in 2015, and then transition to a mandatory phase with a common rating plan for both inverter and fixed speed ACs effective

2. Interview with P.K. Mukherjee. December 2018.

3. ISO. ISO 16358-1:2013. "Air-cooled air conditioners and air-to-air heat pumps – Testing and calculating methods for seasonal performance factors – Part 1: Cooling seasonal performance factor" 2013. Available online at: https://www.iso.org/standard/56467.html.

4. Interview with P.K. Mukherjee. December 2018.

5. Ibid.

6. Developing Standard and Labelling Program for Inverter Air- Conditioners: Market Assessment Report. PricewaterhouseCoopers. 2013.

7. ISO. ISO 5151:2017. Non-ducted air conditioners and heat pumps – Testing and rating for performance. 2017. Available online at: https://www.iso.org/standard/63409.html.

8. Interview with P.K. Mukherjee. December 2018.

January 2018. The MEPS and label levels that went into effect in January 2018 are shown in Table 2, with the minimum for the 1-star label corresponding to the MEPS. 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.[9]

Using ISO 16358, with modifications to the temperature bins and operating hours, proved crucial to implementation of the new test metric. Because ISO 16358 simply builds upon ISO 5151, which the test labs were already using, the labs needed no new equipment and only additional training on the testing and the calculation method. The greatest challenge they faced was calculating the ISEER based on the test results. This was easily solved by building a tool for the labs to use. In addition, the laboratories required that the manufacturers share the manner of setting the frequency to achieve part load conditions for the inverter ACs so that they could be tested properly.[10]

Another key aspect of the implementation of the ISEER was that it was announced 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 labelling 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 evolution of the MEPS (1-star) and the 5-star label can be seen in Figure 1, with the ISEER levels marked in black.[11]

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 2018. This rapid growth in inverter market share was built on the base of the new test metric and supported by government and bulk procurements that specified high ISEER values that only inverter units would be able to attain.[12]

CHINA

China is currently seeking to move to a single test metric and MEPS for both fixed and inverter AC units.[13] As of January 2019, the MEPS and labelling requirements for fixed speed ACs dated from 2010 and were based on EER, while the MEPS and labelling requirements for inverter ACs dated from 2013 and were based on SEER or APF, depending on whether the unit had only cooling or both heating and cooling functions. China uses ISO 5151 and ISO 16358 for testing ACs and heat pumps, with some modifications to the temperature bins as per Table 3.[14]

Table 1. Indian Temperature Bins.

Bin Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Temp in C	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	
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	1,600

Table 2. ISEER levels.

Star Rating	Minimum ISEER	Maximum ISEER
1	3.10	3.29
2	3.30	3.49
3	3.50	3.99
4	4.00	4.49
5	4.50	

9. Ibid.

10. Ibid.

11. Ibid.

12. Ibid.

13. Nearly all AC units sold in China are also heat pumps. Because of this, the AC MEPS is also the heat pump MEPS, as it includes both heating and cooling performance.

14. Interview with CNIS Staff. November 2018.

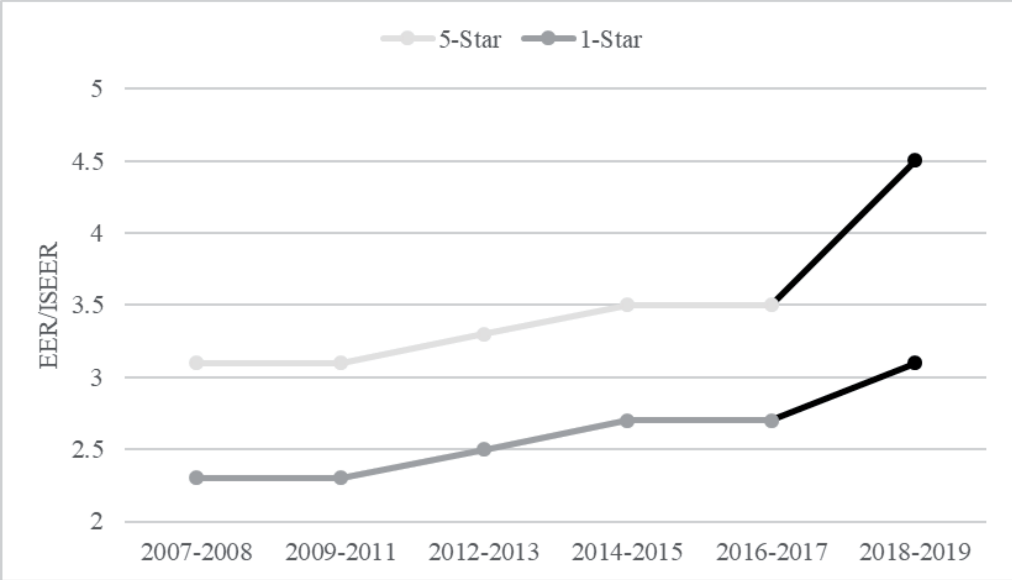

Figure 1. Evolution of the Indian Standards and Labelling Program for ACs.

Table 3. Chinese cooling temperature bins.

Bin Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Temp in °C	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	–
Fraction	4.7	8.4	8.5	9.9	8.6	8.5	9.7	9.4	9.2	8.3	6.7	5.4	1.9	0.4	0.2	100
Bin Hours	54	96	97	113	98	96	110	107	105	94	76	61	22	5	2	1,136

The process of moving to a single standard and test metric has been a complex process involving several complex discussions. There were concerns from academia on collapsing the fixed speed and inverter AC MEPS into a single regulation using a seasonal test metric, because fixed speed units might be more cost-effective for certain usage patterns. For instance, this could be the case for consumers who only turn on their AC unit for an hour or so at full speed each day. These concerns have been alleviated and the standards committee has agreed on collapsing the two technologies into a single MEPS. However, the level of the new MEPS is still under discussion, particularly around what share of existing fixed speed models should be eliminated from the market.[15]

The second discussion has surrounded the inclusion of refrigerant type into the MEPS. The Ministry of Environment and Ecology has sought for the new MEPS to incentivize the transition to low global warming potential refrigerants, particularly R-290, while the National Development and Reform Commission has sought for prioritizing energy efficiency above other concerns. The compromise reached is that there will be different energy efficiency requirements for ACs using different refrigerants according to an equation. The coefficient that determines the trade-off between the energy efficiency of the unit and the global warming potential of the refrigerant is still being debated.[16]

15. Ibid.

16. Ibid.

China National Institute of Standardization staff anticipate that the new AC MEPS will be ready by June of 2019, as they believe that all remaining aspects of the complex discussions surrounding the new MEPS should be resolved by then.[17]

VIETNAM

Vietnam first implemented mandatory MEPS for ACs in 2007 under TCVN 7830:2007, revised the AC MEPS in 2012 and then again in 2015. 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 already had been using ISO 5151, so, as in the Indian case, the transition to using the ISO 16358 evaluation method was relatively simple. [18]

The use of TCVN 10273-1:2013 was voluntary for the first two years. However, the 2015 MEPS and labelling 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 applied to all ACs with capacities under 48,000 Btu/hr; however, the 2015 standard only covers ACs up to 41,000 Btu/hr.[19]

Vietnam, as a member of the Association of Southeast Asian Nations (ASEAN),[20] is part of the 2015 ASEAN SHINE agreement to harmonize MEPS for ACs below 3.52 kW (12,032 Btu/

17. Ibid.

18. Vietnam Room Air Conditioner Market Assessment and Policy Options Analysis. CLASP. (Forthcoming.)

19. Ibid.

20. ASEAN member states are Indonesia, Thailand, Malaysia, Singapore, Philippines, Vietnam, Cambodia, Myanmar (Burma), Brunei, and Laos.

Table 4. T1 Temperature bins.

Bin Number	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	–
Bin Hours	100	139	165	196	210	215	210	181	150	120	75	35	11	6	4	1,817

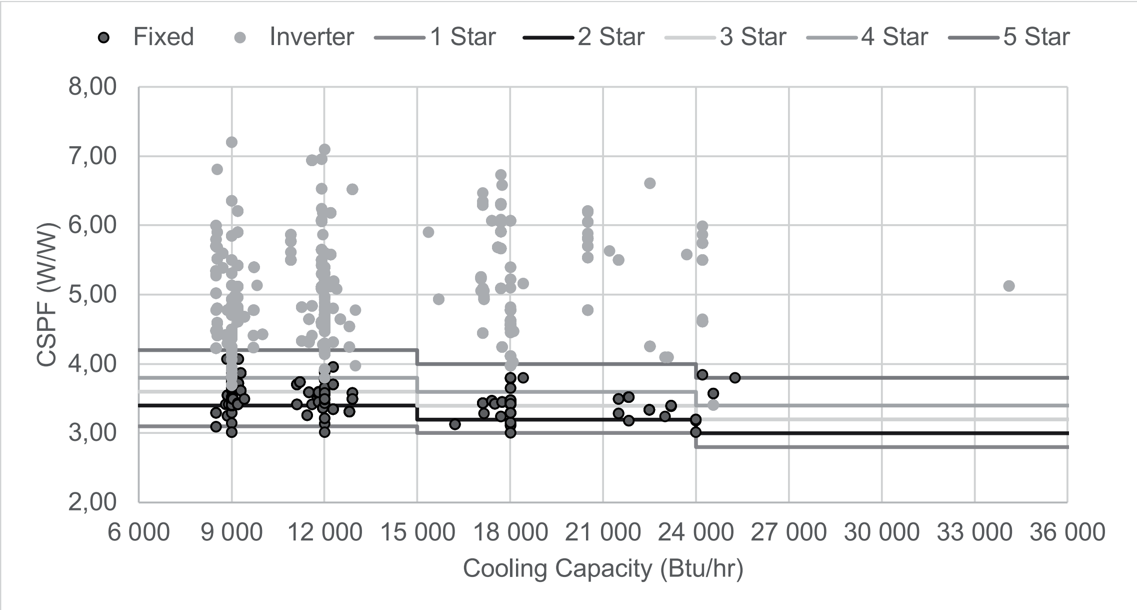

Figure 2. 2018 Status of AC efficiency in Vietnam.

hr) cooling capacity to a CSPF of at least 3.08 W/W by 2020. This agreement to harmonize test metrics to CSPF across ASEAN has provided the impetus for many ASEAN countries to begin moving to this metric that accounts for the benefits of inverter ACs. However, the ASEAN MEPS level itself is not particularly relevant for the Vietnamese market, since the current MEPS already stands at a CSPF of 3.10 W/W for split ACs under 12,032 Btu/hr. ACs in this category represent 59 % of the market.[21]

Vietnam uses the T1 test conditions and temperature bins (see Table 4), 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.[22]

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 percentage points, 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 technology is 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 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.[23]

Figure 2[24] shows the current status of the Vietnamese AC market, including the labelling tiers and the products available on the market. By using CSPF as the efficiency metric, inverter units are clearly more efficient than fixed speed units, and only inverter units are able to achieve the 5-star label.

THAILAND

Thailand has maintained an energy efficiency standards and labelling program for ACs since 1995. Under this program, there is a mandatory MEPS for all ACs with a capacity under 40,944 Btu/hr. In addition, there is a voluntary label, 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 label-

21. Vietnam Room Air Conditioner Market Assessment and Policy Options Analysis. CLASP. (Forthcoming.)

22. Ibid.

23. Ibid.

24. Ibid.

Table 5. Thai SEER levels for ACs.

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

ling 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 labelled EGAT No. 5.[25]

The MEPS levels have been revised several times since the program was launched. The current MEPS came into force in 2010 and continues to use EER, specifying that all units under 40,944 Btu/hr must exceed a 2.82 W/W EER. However, in 2015, Thailand, like Vietnam, began the move to harmonize its policies to the ASEAN metric by introducing new labelling levels for inverter AC units, based on SEER. This was followed by the 2017 revision of the labelling levels for fixed speed units, also based on SEER. As in Vietnam, the test method and evaluation method follow ISO 5151 and ISO 16358, using T1 testing conditions shown in Table 4, as per the ASEAN SHINE agreement. The label levels for both types of ACs can be seen in Tables 5.[26]

This movement to a single test metric, SEER, for the EGAT No. 5 label 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 labelling tiers for fixed speed and inverter ACs, and has maintained MEPS in EER, while Vietnam has moved to one set of MEPS and labels for all AC technologies, based on a seasonal metric.[27]

Maintaining different labelling tiers for fixed speed and inverter ACs has likely slowed the market transformation towards higher efficiency, inverter AC units. The maintenance of different labelling requirements for the different technologies is particularly important in Thailand. Thai consumers have a strong preference for EGAT No. 5 labelled products and the EGAT No. 5 label is often required for government procurement and bulk purchases by real estate developers. However, maintaining different labelling 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 labelled products continues.[28]

Figure 3[29] shows the current status of the Thai AC market, including the labelling tiers and the products available on the market. The Thai SEER has been converted to watts per watt in order to allow for a direct comparison with the Vietnamese market. The large number of fixed speed units that are able to meet the fixed speed EGAT No. 5 label requirement but which could not meet the inverter requirement show how having these differential requirements allows less efficient, fixed speed units to be continue to receive the EGAT No. 5 label.

Lessons learned

From these four experiences of moving to a single test metric for all ACs of both technology types, we can identify some key lessons learned on how to overcome the major technical and institutional challenges associated with moving to a single test metric and how best to design policy around a new test metric in order to reap the greatest efficiency benefits.

TECHNICAL CHALLENGES

It is important to balance the need for the test method and metric to suit local weather conditions and usage patterns with the value of using international standards. In India, setting different temperature bins from those specified in international standards made sense, but this is not the case in many countries. In much of India, the climate is particularly hot, and so AC units made for other, cooler climates may not be well-suited to India. In addition, India has several local AC test laboratories and one of the world's largest AC markets, with most of the Indian market being supplied by local production.[30] This means that there is local capacity to test according to an India-specific metric and manufacturers are willing to have their products tested in these local laboratories because the value of sales in the Indian market greatly outweigh the cost of testing, with

25. Thailand Room Air Conditioner Market Assessment and Policy Options Analysis. CLASP. (Forthcoming.)

26. Ibid.

27. Ibid.

28. Ibid.

29. Thailand Room Air Conditioner Market Assessment and Policy Options Analysis. CLASP. (Forthcoming.)

30. AC Production by Country. Euromonitor. 2018.

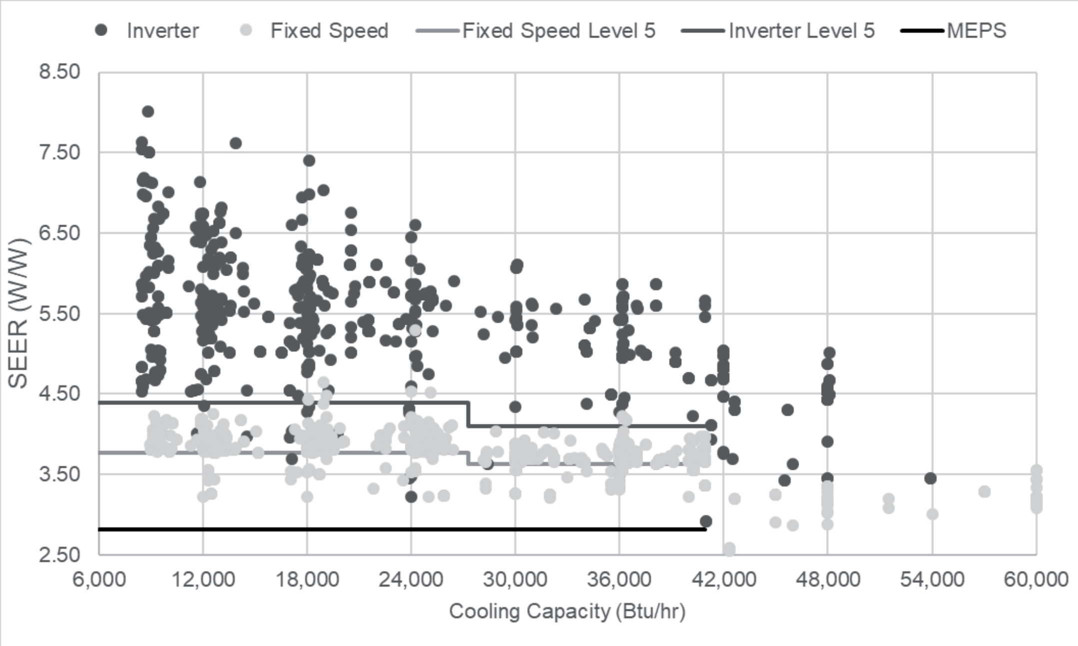

Figure 3. 2018 status of AC efficiency in Thailand.

many manufacturers specifically designing AC units for the Indian market. This situation is similar to China, which is the world's largest AC producer and consumer.

In contrast, Vietnam and Thailand both chose to follow the T1 testing conditions contained in ISO 16358, as was decided as part of the ASEAN SHINE agreement. Although these testing conditions may not be perfectly suited to the climates of these countries, using an international standard and the most commonly-accepted testing conditions facilitates trade for these countries. Thailand is the second largest AC exporter, after China, and 68 % of all ACs imported by ASEAN countries are produced in other ASEAN countries.[31] Aligning testing conditions enables the test reports from any laboratory in ASEAN to be accepted in any other ASEAN country, greatly simplifying compliance for manufacturers by providing flexibility as to where they can have their products tested.

Developing lab capacity need not be a major challenge. For countries already using the ISO 5151 test method, adopting the ISO 16358 evaluation method simply requires testing again at part load and at standby. No new equipment is required. The greatest challenges typically faced are calculating the CSPF or SEER based on the test results and applying the proper frequency to the inverter compressor to achieve part load. The first challenge can be readily addressed by developing a tool and sharing it with the test laboratories, as has been done in India. The second challenge is similarly simple to address by requiring that manufacturers provide the relevant frequency settings.

INSTITUTIONAL CHALLENGES

Stakeholder opposition can pose a major threat to moving to a single test metric, and so it is crucial to involve major stakeholders from the beginning of the process. This includes not only the AC industry, but also relevant government entities, civil society groups, and academic institutions. As can be seen from the Chinese case, some of the most important disputes surrounding the move to a single test metric can come from academia or even from within the government. Involving all of these stakeholders in the process from the beginning can help ensure that their concerns are addressed early in the process, without causing major delays in standards and labelling development.

One way of addressing stakeholder concerns is by phasing in the shift to a single, seasonal test metric over a number of years. From these case studies, we can see two main ways of implementing such a phase-in. The first is to implement the seasonal test metric on a voluntary basis during a transitional period before making its use mandatory. This was the implementation path chosen in both India and Vietnam, and the result of the transitional period in both countries was a significant shift towards inverter units before the seasonal test metric became mandatory. The second path for phasing in the seasonal test metrics is to make it mandatory for all ACs, but to implement different requirements for fixed speed units as opposed to inverter units. This is the path that Thailand has chosen, though it has not led to as rapid a transformation of the market.

Beyond implementing a transitional period for the seasonal test metrics, the transition for industry can be eased by publishing a multi-year roadmap that allows the industry to have certainty and time to plan. This was particularly valuable in the Indian case, where the move to a seasonal test metric and the MEPS and label levels were announced three years in advance of the regulation becoming mandatory. This announcement, combined with dissemination of the plan to increase the regulation stringency every two years, gave the industry certainty about the policy direction as well as time to plan for the changes in policy.

POLICY DESIGN

The move to a single, seasonal test metric simply provides the basis for moving the AC market to more efficient inverter units. Policies built upon a single test metric must be designed to lev-

31. The role of Trade Policy and Energy Efficiency Policy to promote highly efficient air conditioner markets. CLASP. (Forthcoming.)

erage the test metric to remove inefficient fixed speed ACs from the market and to encourage consumers to buy highly efficient inverter ACs. This means, first, that the MEPS for both types of ACs must be set at the same level and according to the same, seasonal metric. Maintaining separate MEPS for fixed speed ACs as opposed to inverter ACs allows retailers to continue selling inefficient fixed speed units and slows the shift to higher efficiency inverter units.

The second key component of effective policy built upon the foundation of a seasonal test metric is a labelling policy that clearly differentiates high efficiency units from low efficiency units on a technology-neutral basis. Simply displaying the seasonal test metric value is insufficient, as consumers often do not understand the meaning of this information. Instead, the label levels must clearly communicate which AC is more or less efficient by applying to both technologies in the same way. From the Vietnamese and Thai cases, we can see the importance of such labelling policy. In Thailand, the different labelling requirements for fixed speed versus inverter ACs means that a level 5 fixed speed unit is only as efficient a level 3 inverter unit, even though their efficiencies are communicated to the consumer as being the same. On the other hand, in Vietnam, all AC units have the same labelling requirements. The comparative effect of these labelling policies is clear: whereas inverter AC market share has increased from 34 % to 65 % in Vietnam from 2013 to 2018, the market share in Thailand has only increased from 16 % in 2013 to 32 % in 2018.

Conclusion and recommendations

Moving to a single, seasonal test metric for both fixed speed and inverter ACs is an important step for moving the AC market to more efficient technology. For many countries, it makes the most sense to directly adopt international standards for these test metrics, though countries with large AC markets and industries and extensive testing capacity may find it worthwhile to adapt the international standards to local conditions. In countries with existing testing capacity, there is no reason to assume that adopting the seasonal test metrics should pose a significant technical challenge so long as the laboratories are provided with sufficient training and tools to calculate the new seasonal test metric.

Addressing institutional challenges for moving to a single, seasonal test metric requires involving the relevant stakeholders in the process from the beginning and giving them certainty as to the policy direction well in advance of any policy shifts. This allows stakeholders to have their concerns heard and addressed while also giving manufacturers time to adapt to the new policies.

Finally, reaping the benefits of the move to a seasonal test metric requires building effective policies on top of the test metric foundation. In particular, policies must apply the seasonal test metric to all ACs, regardless of the technology they use. This also requires clearly and effectively communicating the seasonal test metric to consumers so that they can easily identify the more efficient units based on the label. As can be seen from the Indian and Vietnamese cases, once the efficiency information is clearly communicated to consumers on a technology-neutral basis, consumers react by rapidly shifting the market to more efficient inverter AC units.

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