Background document to PEET 2021 discussion of room air conditioners

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PEET efficiency trends analysis 2021

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Glossary

AC	Air conditioner
APF	annual performance factor
COP	coefficient of performance
CSPF	cooling seasonal performance factor
EER	energy efficiency ratio
HSPF	heating seasonal performance factor
IEA	International Energy Agency
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
MEPS	minimum energy performance standard
NA	not available (or applicable)
PEET	Product Energy Efficiency Trends project
Rating	the set of rated values and operating conditions
Rated value	a quantity value assigned, generally by a manufacturer, for a specified operating condition
SCOP	seasonal coefficient of performance
TR	Top Runner
UEC	unit energy consumption

1. Introduction

This report presents 2021 findings of the IEA 4E Product Energy Efficiency Trends (PEET) project. This work follows upon previous PEET projects but applies a different methodological approach as follows. For the PEET 2021 work a survey was sent to each 4E member economy to request information on:

- changes made to product energy efficiency regulations and test procedures in the period of July 2020 to June 2021
- pending changes to product energy efficiency regulations and test procedures in the period of July 2021 and beyond.

In order to ensure a consistent approach when discussing application of policy measures and test/methodological standards the convention applied in this report is to reference them based on when they enter into effect and not when they are first issued.

Based on the findings received and processed in July 2021 it was decided to conduct in-depth investigations into the developments in energy efficiency regulations and test procedures applicable to the following four product groups:

- Electric motors
- Televisions (and when relevant) electronic displays
- room air conditioners
- Room air conditioners

which constituted the set of products where the greatest changes in 4E economy regulations had occurred or were pending within the periods in question.

The analysis presented in this report addresses each of these products in turn and is being developed according to the following indicative timetable.

Proposed Date (webinar)	Topic/scope	Draft Report	Final Report
4-8 October	Electric Motors	09-Sep	30-Sep
18-22 October	Televisions	17-Sep	04-Oct
15-19 November	ExCo week		
29 Nov-3 Dec	Domestic refrigeration appliances	08-Nov	22-Nov
13-17 Dec	RAC	22-Nov	06-Dec

For each product the analysis presents:

- A summary of the of the existing regulations in place per 4E economy and the recent or pending changes
- A comparison of the scope of the regulations in 4E economies
- A comparison of the efficiency levels applied in the 4E economies.

For the comparison of efficiency levels normalisation methods are applied (either as per previous PEET work or amended/updated as explained in each case).

Whenever relevant a synthesis of necessary information on test procedures and/or product types is provided but only to the extent that it facilitates the above analyses and their communication.

The intention of this work is not to produce a definitive account or public facing report but to foster and facilitate a common basis for discussion of the issues addressed among 4E members. This report will not be published and is solely for 4E member's use. It is also a living document being added to per the schedule outlined above.

This specific report presents background information to inform the discussion on room air conditioners.

2. Findings for room air conditioners

This report discusses the status of policy measures (MEPS/Top Runner/labelling) in 4E countries for room air conditioners including recent or pending changes. In doing so it considers and compares the policy measures in terms of:

- the type of regulation (MEPS/Top Runner, Energy Labels)
- the principal type of room air conditioners addressed
- the characteristics of the principal room air conditioners which are within or without of scope
- the level of stringency of the policy requirements.

In the case of comparisons of policy stringency, the following principal types of room air conditioners are considered:

- split room air conditioners in the cooling mode
- single-package[1] room air conditioners in the cooling mode.

These product categories are chosen because they correspond to the most important types of room air conditioner found in the market; and, consequently, that have the greatest energy savings potential from the adoption of energy saving regulations. The choice of product categories for policy stringency comparison is also affected by the existence of proven normalisation methods.

In addition, there have been important developments in testing and standardisation methods that have a major bearing on the extent to which room air conditioner performance is accurately captured by regulations and on the comparison of regulatory stringency. Thus, the discussion considers test procedure and standardisation developments when relevant to the policy development and comparison discussion. The remainder of the report is structured as follows:

- Section 3 provides a summary of room air conditioner types and major standards
- Section 4 summarises the status of the regulations in the 4E economies
- Section 5 compares the scope of the room air conditioner regulations in place for each of the principal types
- Section 6 reports findings on the comparison of the stringency of the room air conditioner regulations in force (or that are pending)
- Section 7 proposes potential topics for discussion among 4E policymakers.

[1] Also known as unitary, integrated or just “room air conditioners” depending on the jurisdiction – these are packaged AC units that are mounted through the wall or through the window.

3. Summary of room air conditioner types and major standards

Before exploring the developments in room air conditioner energy efficiency regulations its useful to consider the major types of room air conditioner and how they can be grouped for comparison of regulatory measures.

Room air conditioners (i.e. air conditioners designed to provide comfort cooling to one or more rooms, but not a whole building) cover a variety of products and technologies of which the main types are:

- split room air conditioners (also known as single split-packaged or mini-splits)
- multi-split air conditioners (a split AC type with a single outdoor unit and multiple in-door units)
- single packaged (unitary) air conditioners (sometimes referred to as “through the window”, or “through the wall” air conditioners and in North America are simply called “room air conditioners”; Korea uses the term “integrated” to refer to this type)
- single-duct air conditioners (a type of portable AC unit)
- double-duct air conditioners (a type of portable AC unit).

The term room air conditioner is applied somewhat differently in different jurisdictions and it’s important to clarify what is meant by it when used in this report.

The PEET scope is residential air-conditioners, with an upper cooling capacity limit of 14 kW. In principle such air conditioners can be:

- ducted or non-ducted
- air to air, air to water or water to water
- cooling only or reversible i.e. can provide heating – reversible air conditioners are also referred to as heat pumps
- single-packaged (unitary) or split-packaged
- portable or fixed in place
- use the vapor compression cooling cycle or another type
- can be fixed capacity or variable capacity – note, in practice variable capacity units use variable speed compressors and fixed capacity units use single (or fixed) speed compressors.

Under the ISO standards system, that is used entirely or to some extent in all 4E economies, the principal distinction between air conditioners is whether they are ducted or non-ducted. The use of ducting allows the air conditioner unit to be linked to a ducted distribution system that can cool a whole building, and thus makes an air conditioner a central air conditioner, whereas non-ducted types can only cool an individual space or a few individual spaces i.e. rooms; thus, room air conditioners are considered to be non-ducted air conditioners.

Most 4E economies issue separate energy efficiency regulations for ducted and non-ducted air conditioners, but Australia and New Zealand cover them within the same regulation albeit within different product classes. Similarly, among non-ducted types of air conditioners 4E economies differ in how they draw regulatory boundaries around them. For this reason, the summary of 4E regulations for room air conditioners given in section 4 includes some information about regulations applicable to portable air conditioners, such as single or double duct types, even though these are either:

- not regulated (Japan and Korea)

- are treated under a different regulation (Canada/USA, and China)
- or treated within the same regulation but a different product group to fixed room air conditioners (Australia and New Zealand and European economies).

For the comparison of policy thresholds presented in section 6:

- only electrically driven vapour compression cycle units are considered
- only air-cooled air conditioners are considered
- only units that cool air directly are considered (this excludes units that chill water for the cooling medium)
- ducted central air conditioners, portable (single and double duct) air conditioners are excluded
- unitary (e.g. window/wall) packaged units and split-packaged are included
- only the cooling mode of reverse cycle units is assessed in the PEET analysis.

Table 1: AC Types and characteristics included in the section 6 policy stringency comparison

	Included	Excluded
AC type	• Split • Multi-split • Unitary i.e. window/wall types	• Ducted i.e. central • Portable i.e. single and double duct types
Refrigeration cycle	Electric vapour compression	Others e.g. gas absorption or evaporative cooling
Heat transfer media	• Air-to-Air	• Air-to-Water • Water-to-Air • Water-to-Water
Operating mode	• Cooling	• Heating

Single and double-duct air conditioners (i.e. portable AC units) are excluded as they are only sold in modest numbers internationally, have specific (non-negligible) comparability issues and low energy consumption (due to low hours of use and small numbers).

The large bulk of the product that remain in scope are split room air conditioners which dominate all the international markets (see Table 1) except North America (and to a much lesser extent Australia), where central ducted air conditioners (i.e. with ducting integrated into the building fabric) are most common. Despite the importance within North America of ducted air conditioners, they are excluded from the current PEET analysis because they are a very different product group to non-ducted packaged air conditioners (such as split units). In particular, the PEET study team are unaware of any prior benchmarking work to compare ducted and non-ducted units performance. Furthermore, given the difference in their respective test methods plus the need to factor in the influence of the building

integrated ducting system for a comparison to be meaningful it seems premature to attempt such a comparison without much more foundational work being conducted[2].

Table 2: Estimated global air conditioner market, 2018[3]

Type	Global sales in 2018 (millions)
Window type	12.6
Single-split	79.3
Multi-split	4.2
Commercial air conditioners	14.9
Total	110

Although the focus of the present PEET analysis is on the cooling mode performance, most air conditioners sold can deliver both heating and cooling; and the heating mode performance is also important. Technically, the provision of reversible (i.e. cooling and heating = heat pump) functionality makes negligible difference to the performance in the cooling mode and, furthermore, performance in the cooling mode and the heating mode is strongly correlated, i.e. products with relatively good cooling mode efficiency also tend to have relatively good heating mode efficiency.

In general, heating mode performance is not analysed in PEET, although it is taken into account when it is part of an overall seasonal energy performance metric such as an Annual Performance Factor (APF) to the extent that it affects the cooling performance. Its exclusion is for pragmatic reasons, namely that no prior benchmarking work has been done that considers the heating mode in isolation while some has been done that considers conversions between cooling mode only performance metrics and annual performance factors.

Summary of developments in test and energy performance metric rating standards relevant to room air conditioners

For over a decade all 4E economies have been using essentially the same method to test non-ducted air conditioners at full load (a method aligned with the ISO 5151 test method). This includes alignment on the method of conducting the test and the test conditions applied (indoor side and outdoor side ambient temperatures, both wet and dry bulb). The methods also essentially align with how to test at part-load conditions except that the set of part-load conditions and the related ambient temperatures at these part-loads can vary (the method of testing at any given part-load condition are essentially aligned). Early MEPS and labelling criteria for room air conditioners were always set in terms of full load performance expressed by the Energy Efficiency Ratio (EER = Cooling power output/electrical power input) in the cooling mode and Coefficient of Performance (COP = heating power output/electrical power input) in the heating mode.

Since the US and Canada first introduced a seasonal energy efficiency rating (SEER) to express the cooling mode efficiency across a set of part-load conditions the other 4E economies have all

[2] For comparisons to be made between the efficiency of ducted AC systems and those of non-ducted packaged AC systems used in residential applications the losses in the ducting used for the indoor side of ducted AC systems would need to be accounted for. While being able to include ducted systems with adjustment for duct losses in the analysis would be useful, because this equipment represents the majority of the market in the US and Canada and an important part of the Australian market, no prior work has been done to the study team's knowledge that would allow comparisons to be made on an equitable basis and much fresh work would be needed to derive a normalisation methodology and determine its robustness. For this reason, ducted systems are not included in the present PEET analysis.

[3] The Japan Refrigerator and Air Conditioning Industry Association, World Air Conditioner Demand by Region, June 2019

introduced equivalent energy performance metrics. Some, as in the USA and Canada were expressed in terms of a SEER or Cooling Seasonal Performance Factor (CSPF) (essentially the same concept as a SEER metric) while others have gone beyond this and incorporated the part-load performance in the heating mode (expressed via a Heating Seasonal Performance Factor (HSPF) or a seasonal coefficient of performance (SCOP)) into a combined cooling and heating part-load performance indicator called an Annual Performance Factor (APF).

Thus, while the means of measuring performance at any specified full or part-load test condition are essentially aligned, the specific part-load performance metrics used and the testing load conditions they require are not.

From a standardisation perspective the following rating standards are used:

> 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*
>
> ISO 16358-1:2013 specifies the testing and calculating methods for seasonal performance factor of equipment covered by ISO 5151, ISO 13253 and ISO 15042.
>
> ISO 16358-1:2013 also specifies the seasonal performance test conditions and the corresponding test procedures for determining the seasonal performance factor of equipment, as specified above, under mandatory test conditions and is intended for use only in marking, comparison, and certification purposes. For the purposes of ISO 16358-1:2013, the rating conditions are those specified under T1 in the reference standards above. The procedures in ISO 16358-1:2013 may be used for other temperature conditions.

This standard was amended in 2019 (ISO 16358-1:2013/AMD 1:2019).

> ISO 16358-2:2013 *Air-cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors — Part 2: Heating seasonal performance factor*
>
> ISO 16358-2:2013 specifies the testing and calculating methods for seasonal performance factor of equipment covered by ISO 5151, ISO 13253 and ISO 15042. For the purposes of ISO 16358-2:2013, it is assumed that any make-up heating will be provided by electric heaters running concurrently with the heat pump.
>
> ISO 16358-2:2013 also specifies the seasonal performance test conditions and the corresponding test procedures for determining the seasonal performance factor of equipment, as specified above, under mandatory test conditions and is intended for use only in marking, comparison, and certification purposes.
>
> ISO 16358-3:2013 *Air-cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors — Part 3: Annual performance factor*
>
> ISO 16358-3:2013 specifies the testing and calculating methods for seasonal performance factor of equipment covered by ISO 5151, ISO 13253 and ISO 15042.
>
> ISO 16358-3:2013 also specifies the seasonal performance test conditions and the corresponding test procedures for determining the seasonal performance factor of equipment, as specified above, under mandatory test conditions and is intended for use only in marking, comparison, and certification purposes.

None of the ISO 16358:2013 standards apply to the testing and rating of:

- water-source heat pumps or water-cooled air conditioners
- portable units having a condenser exhaust duct
- individual assemblies not constituting a complete refrigeration system; or

- equipment using the absorption refrigeration cycle.

The ISO 16358 series originally took its inspiration from the approach used in Japan (the first economy to develop an APF) which in turn elaborated further on the US/Canadian approach of using a SEER.

Currently the test methods used in China's (standard GB/T 7725) and Japan (standard JSA – JIS C 9612 and JSA - JIS B 8615-1) fully align to the ISO 16358 method. In particular, they both entail derivation and measurement of a CSPF and HSPF and produce an overall APF value for reversible non-ducted air conditioners.

The Korean standard (KS C 9306) is also aligned to the ISO 16358-1 method to determine a CSPF but the MEPS and labelling regulations are only specified in terms of the CSPF and not an overall APF. In contrast, Japan's regulations are set exclusively in terms of the APF, while China's use the APF for reversible air conditioners but a SEER for cooling only units. This probably reflects that practically only reversible units are sold in Japan whereas in southern China some cooling only units are sold.

The metric used in European regulations predates the ISO 16358 standard and constitutes a European version of the SEER metric first developed in North America (for the cooling mode). Europe also applies a seasonal heating performance metric (a seasonal coefficient of performance, SCOP) for energy labelling purposes but does not combine it with the SEER into an overall APF metric.

Key distinctions

All of the part-load energy performance metrics test at full-load and one or more part-load test conditions before applying a set of weightings (that are designed to reflect local climate conditions and usage preferences) to determine an overall part-load efficiency metric.

In the cooling mode that metric is either called a SEER or a CSPF; however, in practice the economies that use an SEER test at four conditions (e.g. 100%, 75%, 50% and 25%) and then weight these to derive the overall SEER value, whereas those that use a CSPF (per the ISO 16358:1 method) only test at three conditions (full load, 25% of full load and an intermediate part-load condition) and use interpolation to determine the performance at other part-load conditions to derive the overall CSPF.

The European SEER further includes the energy used in the standby and low-power modes as well as crankcase heaters – a duty cycle approach is applied to factor these loads into the overall metric.

Australia and New Zealand apply a SEER for energy labelling purposes but not for MEPS – for the latter they use full load metrics (akin to the EER and COP) but have adapted these to include low power mode consumption and a hybrid method to treat a single part-load performance value if an AC unit is of a variable capacity type.

Canada and the USA use a SEER for MEPS and labelling for split room air conditioners but a full-load EER for MEPS and labelling of single packaged units (called "room air conditioners" in both economies). This full load EER is adapted to also factor in low power mode consumption.

A summary of the metrics used per 4E economy is shown in Table 3.

Table 3: Summary of air conditioner performance metrics by 4E economy

Metric	Australia/New Zealand	Canada/USA	China	European economies	Japan	Korea
EER/COP	for MEPS	for single-packaged				
SEER	for labelling	✓	✓	✓		
CSPF					✓	✓
HSPF	for labelling	✓	✓		✓	
SCOP				✓		
APF			✓		✓	
Part-load test conditions in cooling mode						
No of load points	3	4	3	4	3	3
Share of full load:	100%	100%	100%	100%	100%	100%
	25%	75%	25%	74%	25%	25%
	Intermediate	50%	Intermediate	47%	Intermediate	Intermediate
		25%		21%		

Notes:

a) where it says "for MEPS" or "for labelling" it indicates the metric is only used for that purpose

b) where it says "single-packaged" indicates the metric is only used for that product type

c) in practice the EER/COP metrics that are used are indicators of full-load performance amended to include low power mode energy consumption

d) for China the part-load loading points are indicated for the SEER which is used as input to the APF, which is applied to the dominant reversible AC types – for cooling only units China simply uses an SEER metric

e) for the economies that use the ISO method of determining an APF, a CSPF (or SEER) and HSPF are calculated first – the CSPF (or SEER) has a 25% load point, a 100% load point and one other that is selected by the supplier; Korea follows the same approach for its CSPF

f) a blue tick indicates the metric is used as a component within an APF and is not reported separately (except for China's SEER which is for cooling only units).

4. Summary of room air conditioner regulations in 4E economies

Due to regional regulatory harmonisation for the purposes of comparison the following groupings of economies can be applied:

- Australia and New Zealand
- Canada and the USA
- The EU, Switzerland and the UK.

Thus, these economies are grouped under the same colour coding and are believed to have directly aligned policies in place.

The status of MEPS/TR requirements is summarised in Table 4. The full list of regulations and related links can be found in the Appendix.

Table 4: MEPS/Top Runner and label requirements currently in place for room air conditioners

	MEPS or TR				Mandatory energy labels			
	Split	Single packaged	Double & single duct (portable)	Multi-split	Split AC	Single packaged AC	Double & single duct (portable)	Multi-split
Australia/ New Zealand	✓	✓	✓	✓	✓	✓	✓	✓
Canada/ USA	✓	✓	✓	✓	✓	✓	✓	✓
China	✓	✓			✓	✓		
EU/ Switzerland/ UK	✓	✓	✓	✓	✓	✓	✓	✓
Japan	✓				✓			
Korea	✓	✓		✓	✓	✓		✓

Key: Black tick indicates that all sub-types are included, Green tick indicates that not all sub-types are included (for Split units in Japan cooling-only types are not included)

From this table it can be seen that:

- all 4E economies have MEPS/TR and energy labelling requirements in place for reversible split AC units (heat-pumps = HP) and all but Japan do for cooling only split room air conditioners
- all 4E economies except Japan have MEPS/TR and energy labelling requirements in place for single-packaged (window/wall) room air conditioners
- all 4E economies except China, Japan and Korea have MEPS/TR and energy labelling requirements in place for double- and single-duct (i.e. portable) room air conditioners
- all 4E economies except China and Japan have MEPS/TR and energy labelling requirements in place for multi-split room air conditioners.

Changes in these regulations have either recently occurred or are due to occur in most 4E economies as set out in sections 4.1 and 4.2.

4.1 Changes in the period of July 2020-June 2021

Table 5 shows for which 4E economies changes in room air conditioner MEPS/TR, energy label, test procedure, policy scope, product categorisation and energy efficiency metric came into effect in the period from July 2020 to June 2021.

Table 5: Changes in MEPS or Top Runner for room air conditioners in the period July 2020-June 2021

	MEPS/TR	Mandatory label	Test procedure	Scope	Product categorisation	EE metric
Australia/ New Zealand						
Canada/ USA	✓	✓	✓			
China	✓	✓				
EU/ Switzerland/ UK						
Japan						
Korea						

Key: Black tick indicates that a significant change has occurred, Blue tick indicates that a negligible change has occurred

ANZ – a 2019 GEMS (Greenhouse and Energy Minimum Standards) determination setting new MEPS and labelling requirements came into effect in April 2020 (i.e. just before the period in Table 3)[4].

Canada/US – The US published a new test procedure for room air conditioners and heat pumps on 29/03/2021 – this is described as having negligible impact thus the impact on the MEPS and label is also negligible (which is why the tick is blue).

China – China's MEPS and energy labels (GB 21455-2019) were adopted on 31st December 2019 and entered into effect on 1st July 2020. Test standard GB/T 7725-2004 and JB/T 13573-2018.

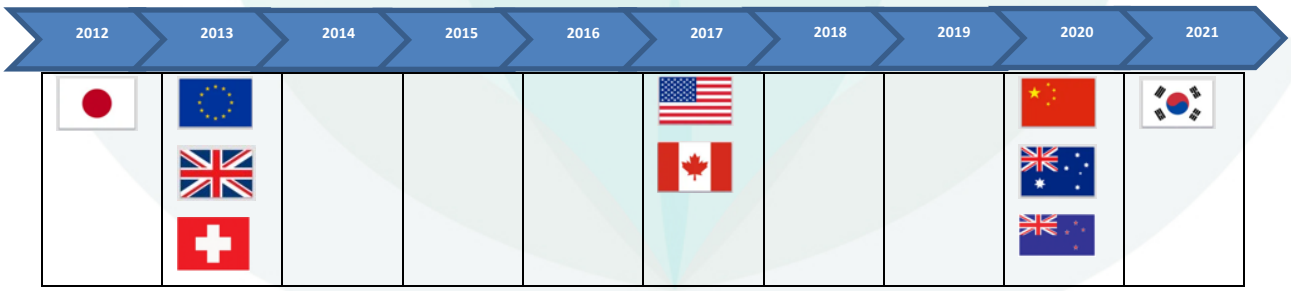
Table 6 shows the dates that the current MEPS and Top Runner requirements came into effect for different types of non-ducted air conditioner used for comfort cooling. Figure 1 shows the timeline of when the current MEPS/TR regulations came into effect for split AC units.

[4] see: https://www.energyrating.gov.au/suppliers/registration/regulated-products
https://www.legislation.gov.au/Details/F2019L00490

Table 6: Date that current MEPS or Top Runner requirements came into effect for various types of non-ducted air conditioner

	MEPS or TR				Mandatory energy labels			
	Split	Single packaged	Double & single duct	Multi-split	Split	Single packaged	Double & single duct	Multi-split
Australia/ New Zealand	01/04/2020 (AU)	01/04/2020 (AU)	01/04/2020 (AU)	01/04/2020 (AU)	01/04/2020 (AU)	01/04/2020 (AU)	01/04/2020 (AU)	01/04/2020 (AU)
Canada/ USA	01/01/2017	01/06/2014	01/07/2020	01/01/2017	01/01/2017	01/06/2014	01/07/2020	01/01/2017
China	01/07/2020	01/07/2020			01/07/2020	01/07/2020		
EU/ Switzerland/ UK	01/01/2014	01/012014	01/012014	01/012014	01/01/2013	01/01/2013	01/01/2013	01/01/2013
Japan	01/04/2012			01/04/2012	01/04/2012			01/04/2012
Korea	01/10/2021			01/10/2021	01/10/2021	01/10/2021		01/10/2021

Figure 1: Timeline of when MEPS/TR requirements came into effect for split AC units



4.2 Pending changes after June 2021

Table 7 shows for which 4E economies changes in room air conditioner MEPS/TR, energy label, test procedure, policy scope, product categorisation and energy efficiency metric are set to occur in the period post June 2021.

Table 7: Pending changes in MEPS or Top Runner for room air conditioners in the period post June 2021

	MEPS/TR	Mandatory label	Test procedure	Scope	Product categorisation	EE metric
Australia/ New Zealand	✓	✓	✓	✓	✓	✓
Canada/ USA	✓	✓				
China						
EU/ Switzerland/ UK						
Japan						
Korea	✓	✓				

Key: Black tick indicates that all sub-types are included, Blue tick indicates that not all countries in the country grouping are concerned as explained below

Australia/New Zealand – the change in MEPS/labelling and energy performance test previously adopted in Australian regulations was adopted in NZ regulations from 1st July 2021.

Canada/US – no changes are pending for single-packaged "room" air conditioners. New portable AC MEPS will come into force in 1/10/2025. Also, in June 2017 the US DOE published new MEPS for central AC and heat pumps which take effect from 1/1/2023 – this product group includes split AC room air conditioners.

China – no pending changes.

Europe – no pending changes have been announced but a major review process of Ecodesign and labelling requirements is ongoing and at an advanced stage.

Japan – no changes pending.

Korea – updated MEPS and labelling requirements were published in the Regulations on Equipment and Materials/Machinery for Management of Efficiency on 30th December 2020 and took effect from 1st October 2021. No other changes pending.

5. Comparison of scope of room air conditioner policies in 4E economies

This section reviews the scope of room air conditioner MEPS/TR and labelling efficiency regulations in place in 4E economies (section 5.1). Section 5.2 comments on the significance of differences in regulatory scope or product categorisation.

5.1 Scope of room air conditioner policies in 4E economies

In this section for each 4E economy grouping details are presented on the overall regulatory scope, the primary product group categorisation, the use of additional product feature weighting factors when calculating the energy efficiency (EE) metric, and some relevant aspects of the energy performance test procedure and how it is applied to calculate the energy performance metrics used in the MEPS/TR and labelling regulations.

Australia and New Zealand

The Australian and New Zealand requirements apply to single-phase and three-phase:

- air conditioners; and
- multi-split outdoor units (whether or not supplied or offered for supply as part of a multi-split system); and
- single-split outdoor units

that have a rated standard cooling full capacity, or for heating only products, a rated standard heating full capacity, of 65kW or less.

Air conditioners that have a rated standard cooling full capacity, or for heating only products, a rated standard heating full capacity, of greater than 65kW are expected to be covered by another regulation.

The products covered by this regulation are ones that are designed primarily for human comfort. However, this regulation covers such products irrespective of the context in which they are used. For example, this regulation applies to products designed primarily for human comfort even if they are used in a close control context (i.e. computer rooms).

Provisions do not apply to:

(a) close control air conditioners

(b) liquid-chilling packages

(c) evaporative coolers or any other cooling systems that are not of the vapour compression type

(d) ground-water air conditioners or ground-loop air conditioners

(e) spot coolers

(f) dehumidifiers

(g) air conditioners powered by mains electricity specifically designed and sold only for installation in end-use mobile applications, such as caravans, mobile homes, camper vans, boats and rail cars

(h) air conditioners powered by mains electricity specifically designed and sold only for installation in specialised high temperature industrial applications, such as crane cabins used over blast furnaces

(i) air conditioners that do not condition air sourced from within the conditioned space, but instead condition air sourced from outside the conditioned space, and deliver that air to the conditioned space.

Australia and New Zealand differentiate 23 primary categories of room air conditioner as follows:

Table 8: Product categorisation (and MEPS levels) for air conditioners in Australia and New Zealand

Kind of product	Product class	Characteristics	Value of *R*	MEPS value
Air-to-air unitary air conditioners	1	Wall mounted unitary double duct air conditioners	R ≤ 65kW	3.10
	2	Portable unitary double duct air conditioners	R ≤ 65kW	2.50
	3	Wall mounted unitary single duct air conditioners	R ≤ 65kW	3.10
	4	Portable unitary single duct air conditioners	R ≤ 65kW	2.50
	5	Ducted or non-ducted, excluding product classes 1 to 4	R < 10kW	3.10
	6	Ducted or non-ducted, excluding product classes 1 to 4	10kW ≤ R ≤ 39kW	3.10
	7	Ducted or non-ducted, excluding product classes 1 to 4	39kW < R ≤ 65kW	2.90
Air-to-air single-split systems	8	Non-ducted	R < 4kW	3.66
	9	Non-ducted	4kW ≤ R < 10kW	3.22
	10	Ducted	R < 10kW	3.10
	11	Ducted or non-ducted	10kW ≤ R ≤ 39kW	3.10
	12	Ducted or non-ducted	39kW < R ≤ 65kW	2.90
Air-to-air single-split outdoor units (not supplied or offered for supply as part of a single-split system)	13	Supplied or offered for supply to create a non-ducted system	R < 4kW	3.66
	14	Supplied or offered for supply to create a non-ducted system	4kW ≤ R < 10kW	3.22
	15	Supplied or offered for supply to create a ducted system	R < 10kW	3.10
	16	Whether supplied or offered for supply to create a ducted or a non-ducted system	10kW ≤ R ≤ 39kW	3.10
	17	Whether supplied or offered for supply to create a ducted or a non-ducted system	39kW < R ≤ 65kW	2.90
Air-to-air multi-split outdoor units (whether or not supplied or offered for supply as part of a multi-split system)	18		R < 4kW	3.66
	19		4kW ≤ R < 10kW	3.22
	20		10kW ≤ R < 39kW	3.10
	21		39kW ≤ R ≤ 65kW	2.90
Water-to-air air conditioners	22		R < 39kW	3.50
	23		39kW ≤ R ≤ 65kW	3.20

Thus overall, Australia and New Zealand:

- differentiate MEPS and labelling requirements by cooling capacity
- do not differentiate MEPS and labelling requirements by whether the product is cooling only or reversible
- do not differentiate MEPS and labelling requirements by whether the product is variable or fixed capacity but do allow a different rating process for variable capacity units to comply with MEPS
- differentiate MEPS requirements by whether the product is single-packaged (unitary) or split but do not for labelling requirements

- technically differentiate MEPS requirements by whether the product is single split or multi-split but in practice the same thresholds are set – there is no differentiation for labelling requirements.

EE metrics

For product classes 2, 3 & 4 MEPS are set for full load EER and COP limits in (W/W).

For air conditioners without variable capacity belonging to any of the other product classes the MEPS limits are set in terms of the AEER and/or ACOP, where:

(1) In this Determination:

Annual Coefficient of Performance or ***ACOP*** means the measure of the energy efficiency of the heating function of air conditioners and incorporates Weighted Average Inactive Power Consumption (P_{ia}).

Annual Energy Efficiency Ratio or ***AEER*** means the measure of the energy efficiency of the cooling function of air conditioners and incorporates Weighted Average Inactive Power Consumption (P_{ia}).

Coefficient of Performance or ***COP*** means a ratio of the standard heating full capacity to the power input to the product (watts/watts).

Energy Efficiency Ratio or ***EER*** means the ratio of the standard cooling full capacity to the power input to the product (watts/watts).

Calculation of ACOP and AEER

(2) For this Determination, a product's ACOP and AEER are calculated in accordance with the following formula:

$$ACOP \text{ or } AEER = \frac{\text{capacity} \times 2000}{(\text{power input} \times 2000) + (P_{ia} \times 6.76)}$$

where:

capacity is:

(a) in relation to the product's ACOP—the product's standard heating full capacity or standard heating part-load capacity, as appropriate, in kW; and

(b) in relation to the product's AEER—the product's standard cooling full capacity or standard cooling part-load capacity, as appropriate, in kW.

power input is the product's power input, in kW, when determining the relevant capacity.

P_{ia} is the Weighted Average Inactive Power Consumption, in watts, as defined in Annex B of AS/NZS 3823.4.1:2014 and AS/NZS 3823.4.2:2014.

Note 1: P_{ia} represents a single, weighted, average, inactive power consumption figure that applies equally to both cooling and heating cycles. It can be measured/calculated once using Annex B of either AS/NZS 3823.4.1:2014 or AS/NZS 3823.4.2:2014. The product of the amount P_{ia} and the number of hours of inactive mode, H_{ia}, as given by AS/NZS 3823.4.1:2014 or AS/NZS 3823.4.2:2014, is equal to the annual inactive energy consumption C_{IAE}, as used in subsections 30(1) and (2).

Note 2: The number 2000 represents the assumed hours of operation per year in cooling or heating mode.

Note 3: The number 6.76 is a factor that converts power (watts) to energy (kWh) for 6760 (that is, 8760 – 2000) hours per year.

For air conditioners with variable capacity belonging to any of the other product classes the MEPS limits are also set in terms of the AEER and/or ACOP but suppliers have an option to apply a formula that accounts for a part-load condition per the specifications below:

Cooling requirement

(2) If the product is capable of cooling, then either:

(a) the product's rated and tested AEER at full load must be greater than or equal to the relevant MEPS level; or

(b) both of the following must be satisfied:

(i) the product's rated and tested AEER at full load must be greater than or equal to 95 per cent of the relevant MEPS level;

(ii) when operating at a part-load point nominated by the manufacturer—either:

(A) for a part-load point between 83.3 per cent and 100 per cent of full load —the tested AEER at that part-load point must be greater than or equal to the relevant MEPS level; or

(B) for a part-load point between 50 per cent and 83.3 per cent of full load —the tested AEER at that part-load point must be greater than or equal to the amount $AEER_{\text{part-load}}$ as calculated in accordance with subsection (4).

Where:

(4) For this section, the amounts $AEER_{\text{part-load}}$ and $ACOP_{\text{part-load}}$, at a particular part-load point, are calculated in accordance with the following formula:

$$AEER_{\text{partload}} \text{ or } ACOP_{\text{partload}} = \left[1.25 - 0.3 \times \frac{capacity_{\text{partload}}}{capacity_{\text{fullload}}}\right] \times MEPS$$

where:

***capacity*$_{\text{part-load}}$** is:

(a) in relation to the product's $AEER_{\text{part-load}}$—the product's standard cooling part-load capacity, in kW, at that part-load point; and

(b) in relation to the product's $ACOP_{\text{part-load}}$—the product's standard heating part-load capacity, in kW, at that part-load point.

***capacity*$_{\text{full-load}}$** is:

(a) in relation to the product's $AEER_{\text{part-load}}$—the product's standard cooling full capacity, in kW; and

(b) in relation to the product's $ACOP_{\text{part-load}}$—the product's standard heating full capacity, in kW.

MEPS is the relevant MEPS level.

When it comes to energy labelling Australia/New Zealand apply a SEER metric where:

Meaning of *SEER rating*

In this Determination:

commercial SEER rating means a SEER rating calculated:

(a) using the commercial-based temperature bins set out in section 1 of Schedule 6; and

(b) according to subclause 6.2 of AS/NZS 3823.4.1:2014 and AS/NZS 3823.4.2:2014, using the t_0 and t_{100} values set out in section 2 of Schedule 6 for the purposes of Formula 2.

residential SEER rating means a SEER rating calculated in accordance with Division 2 of this Part.

SEER rating (short for Seasonal Energy Efficiency Ratio rating) means any of the following:

(a) the Total Cooling Seasonal Performance Factor (TCSPF);

(b) the Heating Seasonal Performance Factor (HSPF);

(c) the Cooling Season Total Energy Consumption;

(d) the Heating Season Total Energy Consumption.

Note: For each SEER rating, there will be 6 values, one for each temperature zone (hot, average and cold) relating to residential use of the product, and one value for each temperature zone relating to commercial use of the product.

Test procedure characteristics

Australia/New Zealand's energy performance test and rating method for non-ducted AC units are:

AS/NZS 3823.1.1:2012 *Performance of electrical appliances – Air conditioners and heat pumps - Part 1.1: Non-ducted air conditioners and heat pumps - Testing and rating for performance*

AS/NZS 3823.1.4:2012 *Performance of electrical appliances – Air conditioners and heat pumps - Part 1.4: Multiple split-system air conditioners and air-to-air heat pumps - Testing and rating for performance*

The test method is aligned with ISO 5151.

For ducted systems it is:

AS/NZS 3823.1.2:2012 *Performance of electrical appliances – Air conditioners and heat pumps - Part 1.2: Ducted air conditioners and air-to-air heat pumps - Testing and rating for performance*

Canada and the USA

In Canada and the USA specific MEPS and labelling regulations are set for each of the following types of air conditioners used for residential comfort cooling:

- Portable air conditioners
- Room air conditioners
- Split-system central air conditioners and heat pumps
- Single package central air conditioners and heat pumps
- Single package vertical air conditioners and heat pumps.

The single package central air conditioners and heat pumps and the single package vertical air conditioners and heat pumps are ducted AC systems and hence fall outside the definition of room air conditioner used in this report.

By contrast, the "room air conditioner" product grouping includes through the window and through the wall types of non-ducted AC units (known as single package room air conditioners under ISO standards) and hence fall within this report's definition of "room air conditioner", but so does the "Split-system central air conditioners and heat pumps" grouping as this pertains to non-ducted single and multi-split types.

The scope of the Canadian and US regulations that match the definition of room air conditioner used in this report are as follows:

Split-system central air conditioners and heat pumps

Split-system central air conditioner, a single-phase or three-phase central air conditioner that is a split-system with a cooling capacity of less than 19 kW (65,000 Btu/h).

Split-system heat pump, a single-phase or three-phase air-to-air heat pump that is a centrally ducted split-system and that has a cooling or heating capacity of less than 19 kW (65,000 Btu/h).

"Room air conditioners"

Room air conditioner, a single-phase electric air conditioner that has a cooling capacity of 10.55 kilowatts (36,000 Btu/h) or less. It does not include a packaged terminal air conditioner, a portable air conditioner or a single package vertical air conditioner.

Portable air conditioners

Portable air conditioner, a single package air conditioner, other than a packaged terminal air conditioner, room air conditioner or dehumidifier, with or without mounted wheels, that is portable and that is designed to deliver cooled and conditioned air to an enclosed space is powered by single-phase electric current, and has a cooling capacity of less than 19 kW (65,000 Btu/h).

Dual-duct portable air conditioner, a portable air conditioner that draws some or all of the condenser inlet air from outside the conditioned space through a duct attached to an adjustable window bracket and discharges the condenser outlet air outside the conditioned space by means of a separate duct attached to an adjustable window bracket.

Single-duct portable air conditioner, a portable air conditioner that draws all of the condenser inlet air from the conditioned space without the means of a duct and discharges the condenser outlet air outside the conditioned space through a single duct attached to an adjustable window bracket.

Thus, regulations in Canada and the USA differentiate 18 distinct categories of room air conditioners as follows:

Table 9: Product categorisation for single-packaged room air conditioners in Canada and the USA

Product class
1. Without reverse cycle, with louvered sides, and less than 6,000 Btu/h
2. Without reverse cycle, with louvered sides, and 6,000 to 7,999 Btu/h
3. Without reverse cycle, with louvered sides, and 8,000 to 13,999 Btu/h
4. Without reverse cycle, with louvered sides, and 14,000 to 19,999 Btu/h
5a. Without reverse cycle, with louvered sides, and 20,000 to 24,999 Btu/h
5b. Without reverse cycle, with louvered sides, and 25,000 Btu/h or more
6. Without reverse cycle, without louvered sides, and less than 6,000 Btu/h
7. Without reverse cycle, without louvered sides, and 6,000 to 7,999 Btu/h
8a. Without reverse cycle, without louvered sides, and 8,000 to 10,999 Btu/h
8b. Without reverse cycle, without louvered sides, and 11,000 to 13,999 Btu/h
9. Without reverse cycle, without louvered sides, and 14,000 to 19,999 Btu/h
10. Without reverse cycle, without louvered sides, and 20,000 Btu/h or more
11. With reverse cycle, with louvered sides, and less than 20,000 Btu/h
12. With reverse cycle, without louvered sides, and less than 14,000 Btu/h
13. With reverse cycle, with louvered sides, and 20,000 Btu/h or more
14. With reverse cycle, without louvered sides, and 14,000 Btu/h or more
15. Casement-Only
16. Casement-Slider

Split air conditioners fall into the central air conditioner group in the USA and two product categories are applied (in both Canada and the USA):

- split system air conditioners
- split system heat pumps.

Overall, Canada and the USA:

- differentiate MEPS and labelling requirements by cooling capacity
- differentiate MEPS and labelling requirements by whether the product is cooling only or reversible
- differentiate MEPS and labelling requirements by whether the product is single-packaged (unitary) or split-packaged
- differentiate single-packaged room AC by the type of sides and casement type
- do not differentiate MEPS requirements by whether the product is variable or fixed capacity
- do not differentiate MEPS and labelling requirements by whether the product is single split or multi-split.

EE metrics

Canada and the USA apply a seasonal energy efficiency rating (SEER) in the cooling mode and a heating seasonal performance factor (HSPF) in the heating mode, but only for split units (actually the same metric is applied for split and central (ducted) AC units). The energy performance of single packaged (i.e. window/wall) AC units are only rated at full capacity albeit via a method that also takes into account the average low-power mode consumption. The SEER and HSPF are reported separately - MEPS and labelling criteria are applied separately to each of these indicators.

Test procedure characteristics

The SEER metric used in Canada and the USA rates performance at 4 testing load conditions (100%, 75%, 50% and 25% of full load) and applies a climate-specific weighting to each of these points to determine an overall SEER value. The HSPF applies 3 test conditions.

The test method used in Canada and the USA is aligned with ISO 5151.

China

China's regulations are applicable to

- room air conditioners using air-cooled condensers and hermetic motor compressors with the rated cooling capacity no greater than 14 000 W and under working condition T1
- low ambient temperature air source heat pump air heaters with nominal heating capacity no greater than 14 000 W.

They are not applicable to mobile (i.e. portable) air conditioners, multi-connected air conditioning (heat pump) units and ducted air conditioners.

China differentiates three categories of room air conditioners as follows:

Table 10: Product categorisation for room air conditioners in China

Product category
Cooling-only type room air conditioners
Heat pump type room air conditioners
Low ambient temperature air source heat pump air heaters

China sets slightly more stringent energy efficiency requirements and grades for units with lower cooling/heating capacity.

China's requirements are (at least superficially) differentiated by whether the product is cooling only or reversible as they use APF limits for reversible units and SEER for cooling-only units (it is not immediately clear if the thresholds applied are consistent i.e. equate to a comparable performance level).

China differentiates its MEPS thresholds for fixed speed and variable speed units such that variable speed units have to attain a more stringent MEPS level.

Thus overall, China:

- differentiates MEPS and labelling requirements by cooling capacity
- differentiates MEPS and labelling requirements by whether the product is cooling only or reversible
- differentiates MEPS requirements by whether the product is variable or fixed capacity
- does not differentiate MEPS and labelling requirements by whether the product is single-packaged (unitary) or split
- does not differentiate MEPS and labelling requirements by whether the product is single split or multi-split.

EE metrics

China's energy performance rating method is aligned to ISO 16358 and uses an APF for reversible units and a SEER for cooling-only units for MEPS and labelling purposes.

Test procedure characteristics

Per the ISO 16358 method China requires testing at 25% of full load conditions or at a lower load level specified by the manufacturer. Testing is also required at another intermediate point between the lowest load point (25% of full capacity or lower) and the full load condition. A formula is then applied to determine the performance at intermediate test points. The test method is aligned with ISO 5151.

European Economies

The regulations in European economies apply to electric mains-operated air conditioners with a rated capacity of ≤ 12 kW for cooling or heating if the product has no cooling function.

They do not apply to:

(a) appliances that use non-electric energy sources

(b) air conditioners of which the condenser-side or evaporator-side, or both, do not use air for heat transfer medium.

Within this, the European economies differentiate three categories of air conditioner as follows:

Table 11: Product categorisation for room air conditioners in European economies

Product categories
Air conditioners except double and single duct air conditioners
Double duct air conditioners
Single duct air conditioners

All types of split (i.e. single and multi-split) and single packaged air conditioners (i.e. through the window or through the wall units) are treated in the same category.

The European economies link their MEPS energy efficiency requirements to the global warming potential (GWP) of the refrigerant used such that products using lower GWP refrigerants (below 150 GWP) have to meet less stringent MEPS requirements.

The European MEPS or labelling requirements are differentiated into two cooling capacity groups (below 6kW, and above 6kW) for products within the overall scope.

The European MEPS requirements are not differentiated by whether the product is cooling only or reversible.

Thus overall, European economies:

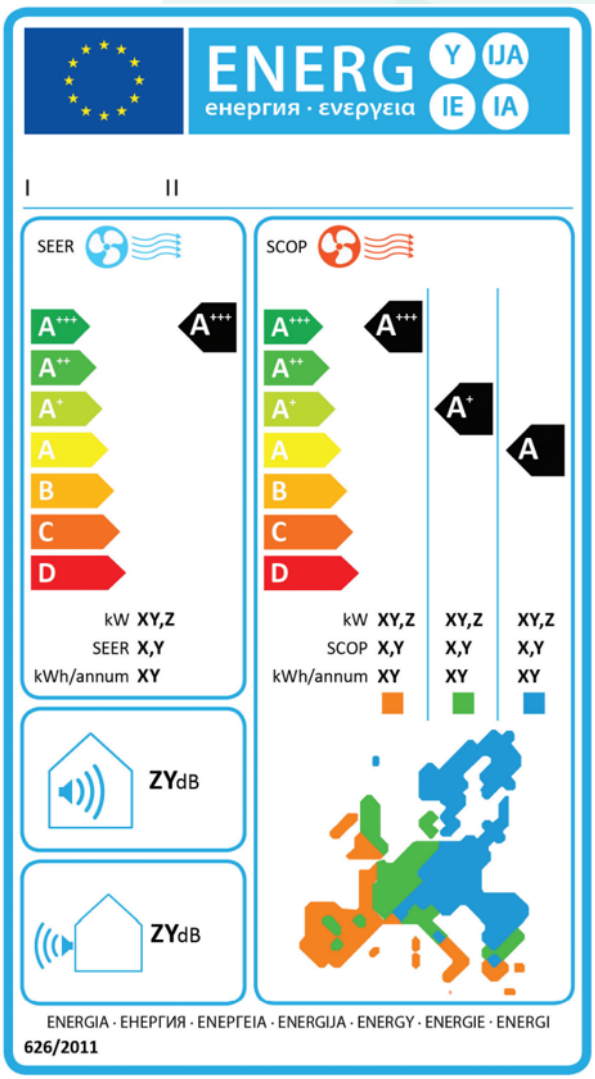
- differentiate MEPS requirements depending on the GWP of the products refrigerant but not for labelling requirements
- differentiate MEPS requirements by cooling capacity but not labelling requirements
- do not differentiate MEPS and labelling requirements by whether the product is cooling only or reversible

- do not differentiate MEPS and labelling requirements by whether the product is variable or fixed capacity
- do not differentiate MEPS and labelling requirements by whether the product is single-packaged (unitary) or split
- do not differentiate MEPS and labelling requirements by whether the product is single split or multi-split.

EE metric

European economies use a SEER as the indicator of the cooling mode performance and a SCOP as the indicators of the heating mode performance. MEPS are set separately for the SEER and the SCOP. Labelling thresholds are also specified separately for SEER and SCOP and shown via a dual A-G rating system on the energy label. The SEER label thresholds are common across all of Europe, but the SCOP thresholds are differentiated depending on the climate with three climatic zones applied, each with their own set of label thresholds. The label format is common across Europe but shows a map with climatic zones to indicate which of the heating-mode labelling scales is applicable (see below).

Figure 2: Europe's energy label for reversible room air conditioners



Test procedure characteristics

In determining the SEER rating the European economies specify 4 test conditions for the cooling load which correspond to full load (100%), 74%, 47% and 21% of full load. For the heating mode SCOP rating 3 test conditions are specified.

The test measurement standard used in the European regulations for split room air conditioners is EN14511:2013 which defines the rated performance and measurement methods to be used for all air conditioners in cooling and in heating mode. The standard EN14825:2016 defines the calculation and testing points to calculate the seasonal energy efficiency (SEER) and seasonal coefficient of performance (SCOP) and completes where required measurement methods defined in standard EN14511.

The test method is aligned with ISO 5151.

Japan

Japan's Top Runner regulations apply to air conditioners, except the following:

1) ones with cooling capacity of over 50.4 kW

2) ones of water-cooling type

3) ones so structured as to have no motor for compression

4) ones so structured as to use any energy other than electricity as a heat source for space heating

5) ones so structured as to have temperature control function or dust control function intended for air conditioning to maintain machine or appliance performance or beverage or food hygiene

6) ones so structured as to solely cool outside air and send it into indoors

7) spot air conditioners

8) ones designed for vehicles and other means of transport

9) ones so structured as to have a duct at suction/exhaust outlet of a heat-exchanger of the outdoor unit

10) ones so structured as to have a thermal storage tank dedicated for cooling (including a thermal storage tank for cooling-cum-heating)

11) ones designed for highly gas-tight/heat-insulating housing, and so structured as to send air to multiple rooms through a branched duct and operate interlocked with ventilation devices

12) ones so structured as to have compressors, air blowers and other main components powered by electricity generated from a dedicated solar cell module

13) ones having floor heating function or hot-water supply function

14) among separate type air conditioners so structured as to connect two or more indoor units to one outdoor unit, ones using heat absorbed by space cooling for space heating

15) ones dedicated to space cooling use

16) ones structured for installation in the window frame

17) ones structured for installation penetrating a wall, or

18) among air conditioners with cooling capacity of over 28 kW, ones other than those of separate type structured to connect two or more indoor units to one outdoor unit (applicable only to ones each of whose indoor units is separately controlled).

Japan differentiates 10 categories of air conditioner where there is an initial distinction made between home-use and business-use air conditioners as follows:

Table 12: Product categorisation for room air conditioners in Japan

Product type	Unit form/function	Cooling capacity
Home-use air conditioners	The wall-hung types among the non-ducted types (excluding the multi-types that control operation of indoor units individually)	4.0kW or less
		Over 4.0kW
	Others	Those applicable
Business-use air conditioners	Those applicable	Those applicable

For home-use air conditioners the following categories are used:

Table 13: Product categorisation for "home use" air conditioners in Japan

Category		
Cooling capacity	Dimension type of indoor units	Category name
Up to 3.2kW	Dimension-defined type	A
	Free-dimension type	B
Over 3.2kW up to 4.0kW	Dimension-defined type	C
	Free-dimension type	D

Where: "Dimension Type of Indoor Unit" means that air conditioner models whose indoor unit has horizontal width of 800 mm or less and height of 295 mm or less shall be defined as a dimension-defined type. Air conditioners other than those of dimension-defined type shall be free-dimension type.

For business-use air conditioners the following categories are used:

Table 24: Product categorisation for "business use" air conditioners in Japan

Category		
Unit form	Cooling capacity	Category name
Non-ducted wall-hung type (except multi-type controlling operation of indoor units individually)	Over 4.0kW up to 5.0kW	E
	Over 5.0kW up to 6.3kW	F
	Over 6.3kW up to 28.0kW	G
Other non-ducted type (except multi-type controlling operation of indoor units individually)	Up to 3.2 kW	H
	Over 3.2 kW up to 4.0 kW	I
	Over 4.0 kW up to 28.0 kW	J

Thus overall, Japan:

- differentiates Top Runner and labelling requirements depending on whether the product is designated for home use or business use
- differentiates Top Runner and labelling requirements by cooling capacity
- does not differentiate Top Runner and labelling requirements by whether the product is cooling only or reversible

- does not differentiate Top Runner and labelling requirements by whether the product is variable or fixed capacity
- does not differentiate Top Runner and labelling requirements by whether the product is single-packaged (unitary) or split
- does not differentiate Top Runner and labelling requirements by whether the product is single split or multi-split.

EE metric

Japan's energy performance rating method is aligned to ISO 16358 and uses an APF for Top Runner and labelling.

Test procedure characteristics

Japan's energy performance rating method is aligned to ISO 16358 and uses an APF for Top Runner and labelling. This requires testing at 25% of full load conditions or at a lower load level specified by the manufacturer. Testing is also required at another intermediate point between the lowest load point (25% of full capacity or lower) and the full load condition. A formula is then applied to determine the performance at intermediate test points. The test method is aligned with ISO 5151.

South Korea

The scope of South Korea's regulations are:

- Air conditioners with a rated cooling capacity less than 23 kW and the sum of motors' rated power consumption at 7.5 kW or below as per KS C 9306, exclusive of water-cooling, portable and duct-based air conditioning systems. However, household split-type air conditioners that connect a single outdoor unit with two or three indoor units shall be included only if at least one of those two or three indoor units is stand-type. In the case of household split-type air conditioners, the energy efficiency grading standard is determined based on the indoor unit with the highest rated cooling capacity. However, the rated cooling capacity of stand-type indoor units shall be less than 10 kW.

South Korea differentiates room air conditioners as integrated (i.e. single packaged/unitary) or split. Korea also differentiates MEPS and label thresholds as a function of cooling capacity (see below).

Table 35: Product categorisation for room air conditioners in Korea

Product categories	Cooling capacity distinctions
Integrated	None
Split	< 4 kW
	4 kW ≤ CC < 10kW
	10 kW ≤ CC < 17.5 kW
	17.5 kW ≤ CC < 23 kW

Thus overall, Korea:

- differentiates MEPS and labelling requirements by whether the product is single-packaged (unitary) or split
- differentiates MEPS and labelling requirements by cooling capacity

- does not differentiate MEPS and labelling requirements by whether the product is cooling only or reversible
- does not differentiate MEPS and labelling requirements by whether the product is variable or fixed capacity
- does not differentiate MEPS and labelling requirements by whether the product is single split or multi-split.

EE metric

Korea's energy performance rating method is aligned to ISO 16358 and uses a CSPF for MEPS and labelling. Heating mode performance is not subject to MEPS or labelling.

Test procedure characteristics

Korea's energy performance test rating method is aligned to ISO 16358 but reports the CSPF rather than an APF for MEPS and labelling. This requires testing at 25% of full load conditions or at a lower load level specified by the manufacturer. Testing is also required at another intermediate point between the lowest load point (25% of full capacity or lower) and the full load condition. A formula is then applied to determine the performance at intermediate test points. The test method is aligned with ISO 5151.

5.2 Significance of differences in regulatory scope or product categorisation

There are only minor differences in overall scope of what falls under the 4E economy MEPS and labelling regulations for room air conditioners. All include:

- single-packaged (window/wall) types and split packaged types (except Japan)
- cooling only (except Japan) and reversible types
- fixed and variable capacity types.

All 4E economies except Japan and China have MEPS/TR and labelling requirements for multi-split AC units.

Not all have measures for portable (single or double duct) AC types (only partly in the scope of this report) and only economies where use of ducted residential air conditioners are common (Australia/New Zealand, Canada/USA) have measures for ducted residential AC types (not in scope of this report).

Within the non-ducted, non-portable AC types the main differences are in how the products are categorised for MEPS/Top Runner and labelling purposes. The table below summarises these differences where an empty cell indicates that there is no differentiation by the parameter in question, a tick indicates there is differentiation and a "–" indicates there is a partial differentiation.

From this it can be remarked that:

- all 4E economies differentiate MEPS thresholds by cooling capacity but many do not for energy labels
- some 4E economies differentiate MEPS and labelling thresholds for cooling only or reversible units but most do not
- only China distinguishes MEPS and label thresholds between fixed and variable capacity units
- some 4E economies differentiate MEPS requirements between single-packaged and split AC units but some don't; even less do so for energy labelling

- only Canada and the USA distinguish single-packaged AC (window/wall) by the nature of louvers or casements
- only Europe distinguishes MEPS thresholds as a function of refrigerant GWP
- only Japan distinguishes Top Runner and labelling thresholds as a function of the user (Home or Business).

In addition, the following remarks can be made about the energy performance metrics:

- all 4E economies use weighted part load energy performance metrics for split air conditioners and most do regardless of the AC type, but Australia/New Zealand/Canada/USA do not for MEPS for single-packaged (window/wall) AC types. For energy labels only Canada/USA do not use such metrics for single-packaged units but instead rate performance at full load
- for reversible AC units some 4E economies use an aggregate APF metric for MEPS/TR and labelling while others set MEPS & labelling requirements separately for the cooling and heating modes and hence rate and report their performance separately.

Table 4: Summary of product categorisation differentiation for room air conditioners across 4E economies

Parameter	ANZ		Canada/USA		China		Europe		Japan		Korea	
	MEPS	Labels	MEPS	Labels	MEPS	Labels	MEPS	Labels	Top Runner	Labels	MEPS	Labels
Cooling capacity	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓
Cooling-only or reversible			✓	✓	✓	✓						
Variable or fixed capacity	-				✓	✓						
Single-packaged or split	✓		✓	✓			✓				✓	✓
Single-split or multi-split	-											
Other			Louvers/Casements				refrigerant GWP		Home or business use	Home or business use		

6. Comparison of room air conditioner policy efficiency thresholds in 4E economies

This section presents the findings of policy benchmarking analysis for split room air conditioners in the cooling mode. This exercise has not been attempted for room air conditioners operating in the heating mode, nor for other types of air conditioner in the cooling mode due to resource constraints and because split room air conditioners dominate most 4E markets.

6.1 Benchmarking approach

As cooling loads and power demand at any specific test condition are measured in the same way across 4E economies normalisation doesn't need to adjust for any differences in measurement method. Rather, it needs to adjust for which part-load conditions are assessed and how all test rating points are weighted within an overall part-load performance metric, such as a SEER, CSPF or APF.

The method applied here is the same benchmarking method used in the previous PEET studies, which is based on a combined theoretical normalisation method whose accuracy has been confirmed through measurement in test labs. Specifically, it is the approach first developed by Econoler et al, then updated by LBNL as defined in the PEET Methodology report.

This method is suitable for normalisation between the following metrics:

- China's APF
- Canada/USA's SEER
- Europe's SEER
- Japan's APF
- Korea's CSPF

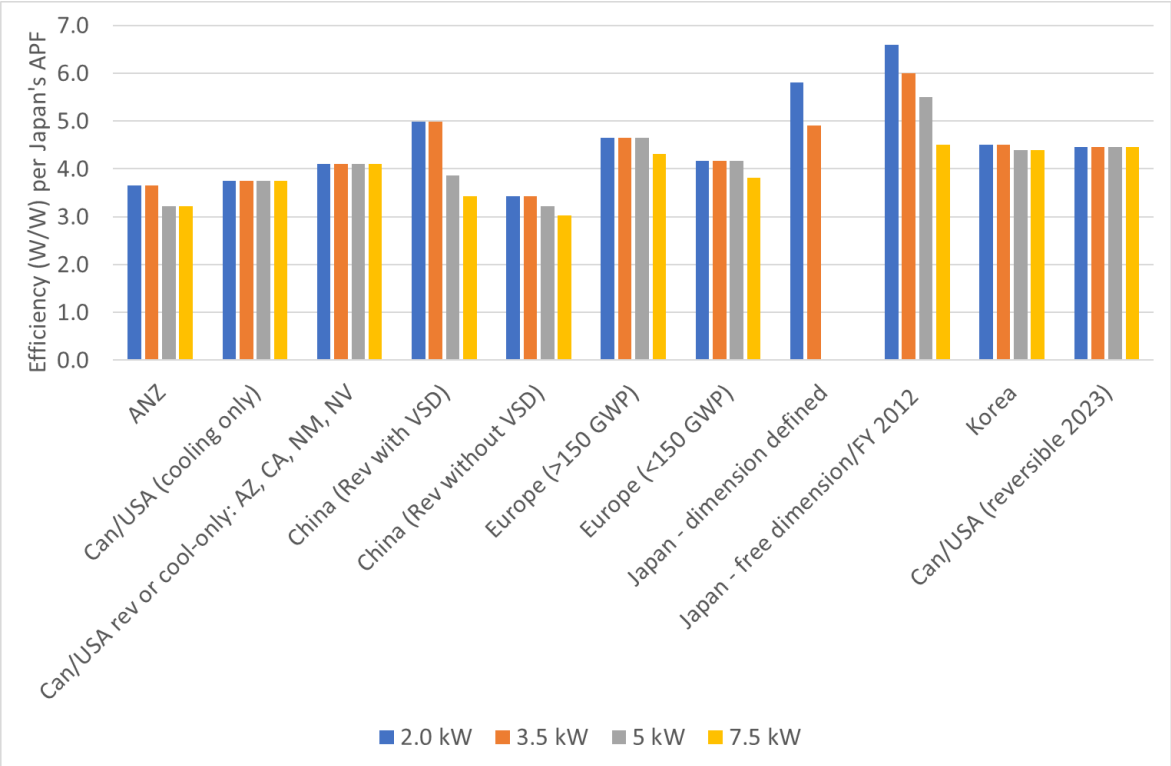
and has been shown to produce very consistent results (i.e. with R^2 fits of > 0.98) when normalising results across these metrics to the extent that cross test data has been available.

The method has not yet been developed or proven for Australia/New Zealand's SEER or MEPS performance metrics, or for China's SEER (used for cooling-only AC units). In principle, it would be possible to adapt it to address both of these metrics at a future stage.

6.2 Comparison of efficiency thresholds

Figure 3 shows a comparison of the normalised MEPS/TR thresholds applicable to split room air conditioners in the cooling mode, with rated capacities of 2, 3.5, 5, 7.5 or 10 kW, converted to Japan's APF using the normalisation methodology for economies other than Japan (whose Top Runner requirements are already expressed in their APF). Note, normalisation has been applied for all other 4E economies except Australia and New Zealand as there is no demonstrated normalisation methodology yet available for their metric. In any case, as previously mentioned, the Australian and New Zealand efficiency metric for MEPS is either a full-load EER adapted to take account of low-power modes, or the same with an option to use a modified part-load rating point for variable capacity units (see section 5.1) and thus is only partially comparable to the other metrics.

Figure 3: Comparison of normalised split room air conditioner MEPS/TR thresholds for the cooling mode



From this the following observations can be made:

- the most stringent requirements are Japan's Top Runner thresholds
- the only exception to this is China's MEPS for 3.5kW units with VSDs which are slightly more stringent than Japan's if applied to dimension defined units (this distinction only exists in Japan's regulations)
- China's MEPS at 2kW (for reversible units with VSDs) and Europe's MEPS for units with refrigerants having a GWP > 150 are the next most ambitious although Europe's MEPS and Korea's are at a similar level (with Canada/USA's from 2023)
- the MEPS applied in Canada/USA are slightly less stringent than those in Europe and Korea but are more stringent than China's reversible units with VSDs at 5kW or above and across the whole capacity range for China's reversible units without VSDs
- it is difficult to compare the Australia/New Zealand MEPS to the others due to the lack of a proven normalisation method, but they would appear to be of a similar level to the Canada/US MEPs at low cooling capacities.

It is also worth reflecting on the ambition of these regulations when considering the date when they came into effect. The years the regulations came into effect ranked from oldest to newest are:

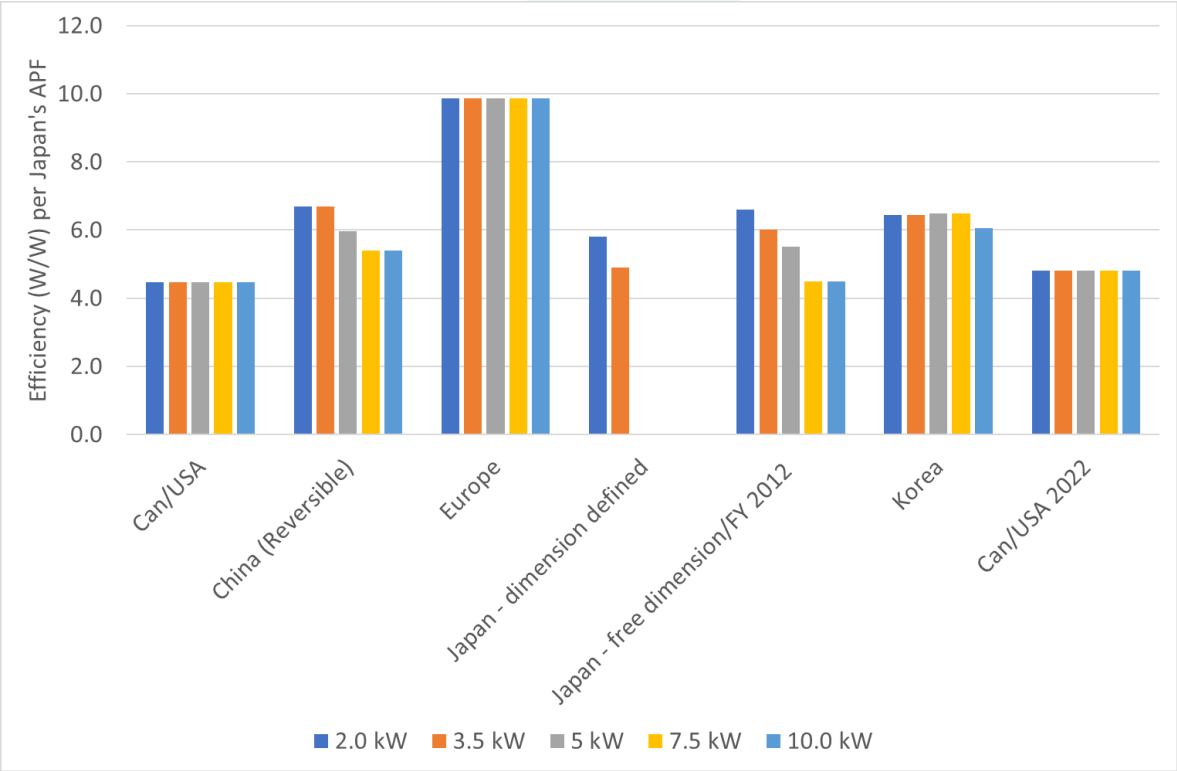
- Japan (FY 2010 or 2012 – depending on the AC type)
- Europe (2014)
- Canada/USA (2017)
- Australia (April 2020) /New Zealand (July 2021)
- China (July 2020)

- Korea (October 2021)

Yet with the exception of some of the specific cases under China's regulations it is the generally the older regulations that are more stringent.

Figure 4 shows a comparison of the top normalised energy label thresholds for split room air conditioners (also shown are the top threshold which will apply in Canada/USA from 1st January 2022). Note – this figure does not include the Australian/New Zealand label as no proven normalisation formula is yet available for the metric used in this label (albeit the principle underpinning the label efficiency metric is akin to that used elsewhere such as in Europe or North America).

Figure 4: Comparison of normalised top energy label thresholds for split room air conditioners



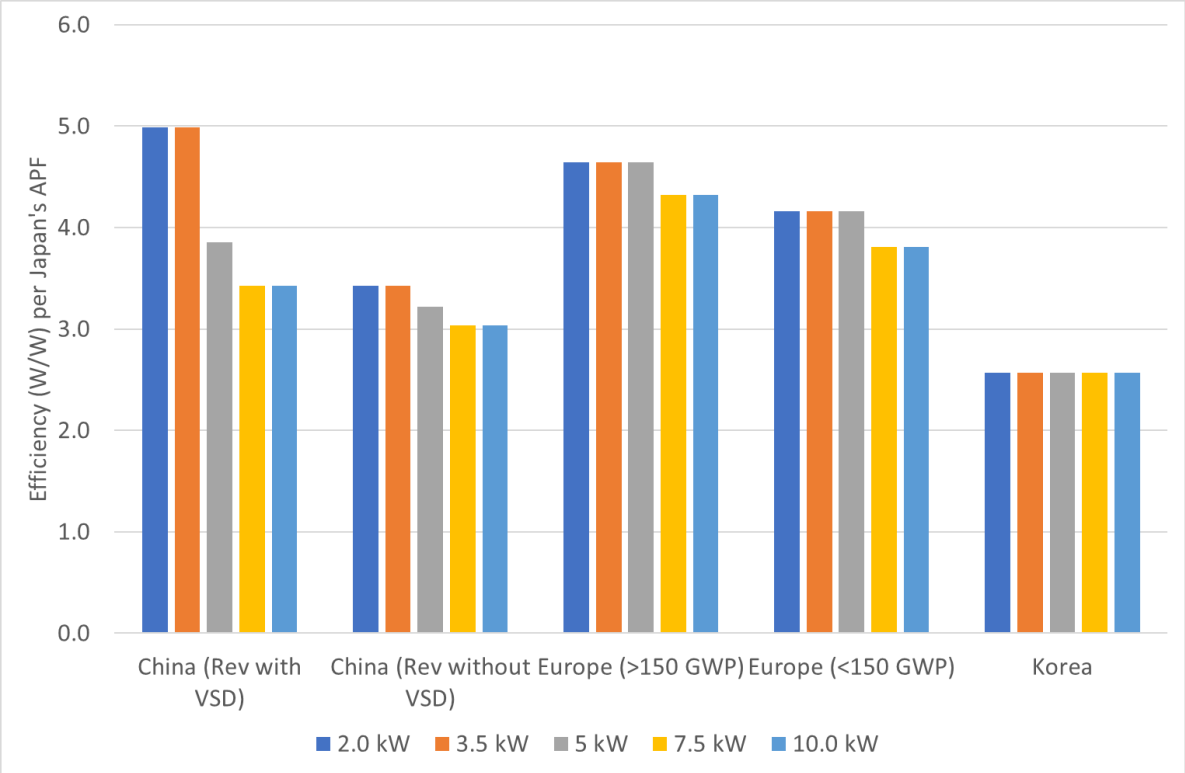
From this the following observations can be made:

- Europe's class A+++ is by the highest efficiency label threshold of those for which normalisation is currently possible even though it is the 2nd oldest (coming into force in 2013)
- some 4E economies differentiate their highest efficiency threshold by cooling capacity but others do not
- Japan's top label threshold (5 star) is simply the current Top Runner attainment requirement; however, the label design indicates products which exceed this, but there is no higher class i.e. no more stars are awarded.

Figure 5 shows a comparison of the normalised MEPS/TR thresholds for single-package (unitary) room air conditioners. It should be noted that proven part-load normalisation formulae are only available for: China, European economies, Japan, Korea for this product group. The metrics used in Australia/New Zealand and Canada/USA for this product group are at full-load only. Note, Japan does

not set Top Runner requirements for this product group presumably as they are not commonly sold on the Japanese market.

Figure 5: Comparison of normalised single-package (unitary) room air conditioner MEPS/TR thresholds



From this the following observations can be made:

- the MEPS applied in China and the European economies are the same for single package products as they are for split-packaged products, whereas those in Korea are differentiated
- China's MEPS for reversible AC with VSDs are the most stringent at cooling capacities of 2 and 3.5 kW although how many single package units have a VSD is unclear
- Europe's MEPS are the most stringent in the 5-10kW cooling capacity range
- MEPS are applied with full load EER metrics to this product group in Australia/New Zealand and Canada/USA but are not shown in this figure.

Appendix

A1. List of regulations and test standards

Australia	Greenhouse and Energy Minimum Standards (Air Conditioners up to 65 kW) Determination 2019 Test and rating methods: AS/NZS 3823.1.1:2012, AS/NZS 3823.1.2:2012, AS/NZS 3823.1.4:2012 (commercial link not added)
New Zealand	EECA MEPS and labelling (Air Conditioners 65kW and under) Test and rating method: AS/NZS 3823.1.1:2012, AS/NZS 3823.1.2:2012, AS/NZS 3823.1.4:2012 (commercial link not added)
Canada	Room air conditioner MEPS and labelling requirements Split-system central air conditioners and heat pumps MEPS and labelling requirements Portable air conditioners MEPS and labelling requirements Single package central air conditioners and heat pumps MEPS and labelling requirements Single package vertical air conditioners and heat pumps MEPS and labelling requirements Room air conditioners test procedure CAN/CSA-C368.1-14 Split-system central air conditioners and heat pumps test procedure CAN/CSA-C656-14 Portable air conditioners test procedure: 10 C.F.R. Appendix CC [Appendix CC to Subpart B, Part 430 of Title 10 to the United States Code of Federal Regulations] Single package central air conditioners and heat pumps test procedure CAN/CSA-C656-05 Single package central air conditioners and heat pumps test procedure CAN/CSA-C656-14 Single package vertical air conditioners and heat pumps test procedure CAN/CSA-746-17
USA	Residential room air conditioners MEPS requirements Residential room air conditioners definition 42 U.S.C. 6291(16) Residential room air conditioners test procedure 10 CFR 430 Subpart B, Appendix F Consumer central air conditioners and heat pumps MEPS requirements Consumer central air conditioners and heat pumps 2023 MEPS requirements Consumer central air conditioners and heat pumps definition 42 U.S.C. 6291(16) Consumer central air conditioners and heat pumps test procedure 10 CFR 430.23(m) and 430 subpart B Appendix M Energy Star for room air conditioners EStar V4.2 Energy Star for central air conditioners EStar V5.0 Energy Star for central air conditioners (Effective January 1, 2023) EStar V6.0
China	Room air conditioners MEPS and energy efficiency grades: GB 12021-2015 Room air conditioners test standard GB/T 7725 Low ambient temperature air source heat pump air heaters test standard JB/T 13573-2018

European economies	Energy labelling regulation for air conditioners and comfort fans: EU 626/2011
	Ecodesign regulation for air conditioners and comfort fans (Ecodesign inc. MEPS): EU 206/2010 Harmonised standards for air conditioners and comfort fans: 2018/C 092/03 Harmonised standards for air conditioners and comfort fans: 2014/C 110/01 Harmonised standards for air conditioners and comfort fans: 2012/C 172/01 Test and rating methods: EN14511:2013 and EN14825:2016 (commercial link not added)
Japan	Room air conditioners Top Runner: https://www.enecho.meti.go.jp/category/saving_and_new/saving/enterprise/equipment/toprunner/en/02_aircon.html Room air conditioners test standard: JSA - JIS C 9612 Non-ducted air conditioners and heat pumps - Testing and rating for performance: JSA - JIS B 8615-1
Korea	Equipment efficiency regulations: 효율관리기자재_운용규정(산업통상자원부고시_제2020-225호) Air conditioners test standard KS C 9306

A2. Test standards

Test standards are used to measure air conditioner performance at specified test conditions and rating standards are applied to present aggregate energy performance metrics. All 4E economies use a test method that is aligned with the ISO standard:

ISO 5151:2017 *Non-ducted air conditioners and heat pumps — Testing and rating for performance*

This means that the manner in which the full-load energy performance of non-ducted AC units is measured in the cooling or heating mode is the same in all 4E economies with the same measurement method and the same rating conditions.

A3. Part-load rating standards

While the full load rating points used in both the cooling and heating modes are the same in all the 4E economies and align with the ISO 16358 method, differences occur in the test points and rating metrics used at part-load.

Essentially, China, Japan and Korea align to the ISO 16358 method and require testing at 100% i.e. full load and at 25% of full load conditions. They also require testing at another intermediate point between the lowest load point (25% of full capacity or lower) and the full load condition. A formula is then applied to determine the performance at intermediate test points.

By contrast the other 4E economies apply a SEER with 4 rating points. This is either at 100%, 75%, 50% and 25% of full load (per the North American economies) or at 100%, 74%, 47% and 21% of full load for the European economies. In the heating mode 3 precise test conditions are specified.

Aside from these differences there may be differences in how inverter AC units are set-up for testing under part-load operating conditions, but this would need to be checked were a fuller investigation to be conducted. Note, the manner in which inverter units are set-up for part-load testing is a topic that is currently under consideration in the on-going review of the EU's regulatory requirements.

A4. Standards used in each 4E economy

Australia and New Zealand

Australia and New Zealand use the following standards:

(a) for non-ducted air conditioners—AS/NZS 3823.1.1:2012; and

(b) for ducted air conditioners—AS/NZS 3823.1.2:2012; and

(c) for multi-split systems—AS/NZS 3823.1.4:2012.

These are described as follows:

AS/NZS 3823.1.1:2012 *Performance of electrical appliances – Air conditioners and heat pumps - Part 1.1: Non-ducted air conditioners and heat pumps - Testing and rating for performance*

Specifies the standard conditions for capacity and efficiency ratings of non-ducted air-cooled air conditioners and non-ducted air to air heat pumps. This Standard is applicable to ducted units rated at less than 8 kW and intended to operate at an external static pressure of less than 25 Pa. This International Standard also specifies the test methods for determining the capacity and efficiency ratings. It is adopted with national modifications from ISO 5151:2010.

AS/NZS 3823.1.2:2012 *Performance of electrical appliances – Air conditioners and heat pumps - Part 1.2: Ducted air conditioners and air-to-air heat pumps - Testing and rating for performance*

Specifies the standard conditions for capacity and efficiency ratings of ducted, air-cooled air-conditioners and ducted air-to-air heat pumps. This Standard is applicable to the test methods for determining the capacity and efficiency ratings. Residential, commercial, and industrial single-package and split-system air-conditioners and heat pumps are included. The equipment (taken to mean ducted air-conditioners and/or ducted heat pumps) shall be factory-made and electrically driven, and shall use mechanical compression. Adopted with national modifications from ISO 13253:2011.

AS/NZS 3823.1.4:2012 *Performance of electrical appliances – Air conditioners and heat pumps - Part 1.4: Multiple split-system air conditioners and air-to-air heat pumps - Testing and rating for performance*

Establishes performance testing and rating criteria for factory-made residential, commercial and industrial, electrically driven, mechanical-compression, air-cooled air-conditioners and air-to-air heat pumps, described as basic multi-split systems, modular multi-split systems and modular heat recovery multi-split systems. These multi-split systems include air-to-air systems with non-ducted and/or ducted indoor units with integral fans and indoor units supplied without fans. Adopted with national modifications from ISO 15042:2011.

Canada and the USA

The USA and Canada used aligned energy performance test standards. The US standard is published by the DOE whereas the Canadian standard is published by Canada Standards. The test methods used are aligned with ISO 5151 but the part-load performance rating is not aligned with ISO 16358, albeit it has many similarities.

China

China specifies MEPS and labelling requirements in terms of a seasonal energy efficiency ratio (SEER) for cooling only air conditioners and in terms of an annual performance factor (APF) for reversible units i.e. those capable of both heating and cooling. The APF is an aggregate indicator of the performance in the cooling mode (expressed in terms of a SEER) and of the performance in the heating mode (expressed in terms of a heating seasonal performance factor (HSPF)). Both the SEER and HSPF

metrics (and hence also the APF) express the performance of the air conditioner at full load and at part-load operating conditions.

Regardless of whether a SEER or APF metric is used they are all expressed in terms of the ratio of the delivered useful thermal energy (cooling, heating or both) per unit of electricity consumer i.e. in units of Watts (thermal) per Watt (electric).

China's method to produce the APF aligns with that used in the ISO standards:

- 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*
- ISO 16358-2:2013 *Air-cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors — Part 2: Heating seasonal performance factor*
- ISO 16358-3:2013 *Air-cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors — Part 3: Annual performance factor*

European economies

The test measurement standard used in the European regulations for split room air conditioners is EN14511:2013 which defines the rated performance and measurement methods to be used for all air conditioners in cooling and in heating mode. The standard EN14825:2016 defines the calculation and testing points to calculate the seasonal energy efficiency (SEER) and seasonal coefficient of performance (SCOP) and completes where required measurement methods defined in standard EN14511.

Japan

Japan's test standard for air conditioners is JSA - JIS C 9612 which is aligned with ISO 5151.

Japan's standard to rate the energy performance or air conditioners is JSA - JIS B 8615-1 *Non-ducted air conditioners and heat pumps - Testing and rating for performance* – this is aligned with ISO 16358.

Korea

Korea's standard to test and rate the energy performance or air conditioners is KS C 9306 – this is aligned with ISO 51515 and ISO 16358.

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