4EPEET

PEET Efficiency Trends Analysis

Status of Domestic Refrigerator Regulations

JULY 2022

Product Energy Efficiency Trends -
A project of the Energy Efficient End-use Equipment TCP

About 4E

The Technology Collaboration Programme on Energy Efficient End-Use Equipment (4E TCP), has been supporting governments to co-ordinate effective energy efficiency policies since 2008.

Fourteen countries and one region have joined together under the 4E TCP platform to exchange technical and policy information focused on increasing the production and trade in efficient end-use equipment. However, the 4E TCP is more than a forum for sharing information: it pools resources and expertise on a wide a range of projects designed to meet the policy needs of participating governments. Members of 4E find this an efficient use of scarce funds, which results in outcomes that are far more comprehensive and authoritative than can be achieved by individual jurisdictions.

The 4E TCP is established under the auspices of the International Energy Agency (IEA) as a functionally and legally autonomous body.

Current Members of 4E TCP are: Australia, Austria, Canada, China, Denmark, European Commission, France, Japan, Korea, Netherlands, New Zealand, Switzerland, Sweden, UK and USA.

Further information on the 4E TCP is available from: www.iea-4e.org

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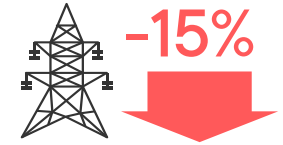
Context

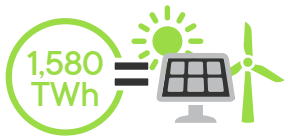
Since 2008, the Energy Efficient End-Use Equipment TCP (4E) has tracked the efficiency trends of major globally traded products and corresponding energy efficiency regulations. This enables 4E Members to identify whether their current policies are being effective, how these policies and the performance of products compares across different regions and opportunities for closer alignment.

This process forms a multi-lateral exchange between regulators within 4E Member countries that accelerates the development of product policies and increases the level of energy savings, while also reducing regulatory and cost burdens on industry and consumers.

Joint analysis by the IEA and 4E into the global impacts of energy efficiency regulations[1] has shown that:

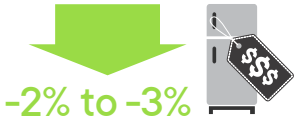


The longest running energy efficiency (EES&L) programmes are estimated to deliver annual reductions of around 15% of total current electricity consumption.



In the nine countries/regions for which data were available, these programmes reduced annual electricity consumption by a total of around 1,580 terawatt-hours in 2018 – similar to the total electricity generation of wind and solar energy in those countries.

On average, the energy efficiency of new major appliances in countries with EES&L programmes has increased two to three times the underlying rate of technology improvement.



The average purchase price of appliances covered by EES&L programmes declined at a rate of 2–3% per year.

Within 4E economies, energy efficiency regulations, taken to include minimum energy performance standards (MEPS), mandatory and voluntary energy labelling in this report, are a key driver for product efficiency. Core elements of these regulations include:

- **The methods used to test and measure product performance**
- **The metrics used to define energy performance or efficiency**
- **The performance thresholds required by regulations**

Since 2020, the 4E Product Energy Efficiency Trends (PEET) project has been monitoring the status of these elements across regulations for major appliance and equipment types across 4E Member countries.

1 IEA/4E TCP (2021), Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programmes, IEA, Paris (2021). https://www.iea.org/reports/achievements-of-energy-efficiency-appliance-and-equipment-standards-and-labelling-programmes

Domestic Refrigerators

This latest PEET report summarises the status of energy efficiency policy measures for **domestic refrigeration appliances** within 4E economies.

Domestic refrigeration appliances have been amongst the first products covered by most energy efficiency regulations. The relevant test methods and performance requirements for MEPS and energy labelling have been updated several times by most 4E economies to keep pace with the evolution in products and their improved energy efficiency. It is noteworthy that domestic refrigeration appliances consume considerably less electricity than they did two decades ago, while also becoming larger and cheaper in real terms[1]. Despite these considerable achievements, further improvements are still being made, as highlighted in the workshops, papers and discussions held between 4E Members, which are summarised here.

This summary condenses many highly technical regulatory documents. However, to gain a thorough understanding, it should not replace consideration of these regulations.

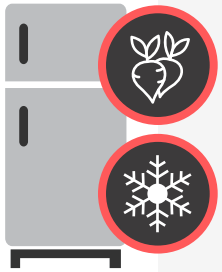
This report describes the main types of domestic refrigeration appliances and explains the coverage of relevant energy efficiency regulations within 4E economies. It concludes with a brief summary of the major trends observed by 4E in the evolution of policies for these products.

1 IEA/4E TCP (2021), Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programmes, IEA, Paris (2021). https://www.iea.org/reports/achievements-of-energy-efficiency-appliance-and-equipment-standards-and-labelling-programmes

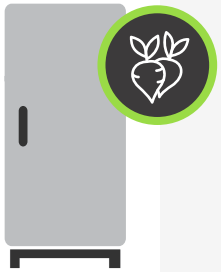
Domestic Refrigerator Types

In this report, we focus on the following groups of domestic refrigeration appliances based on AC electric vapour-compression technology that are the most prevalent within 4E economies.

Refrigerator-freezers: appliances that are designed to store fresh food but also be capable of freezing food and storing it. These are the most common type



Refrigerators: appliances to store fresh food



Freezers: appliances to freeze food and/or store frozen food of which the dominant types are upright or chest freezers

Among the broad groupings there are many variants with regard to:

- The inclusion/use of compartments with different operating temperatures
- The configurations of the compartments and the number of external doors
- The choice of defrost method
- Whether the appliance is freestanding or built-in
- The ambient temperatures the appliance is designed to operate under
- Opaque or transparent doors
- The noise level

A glossary is provided at the end of this report to explain the terminology used.

Coverage of Regulations

Table 1 shows the coverage of MEPS and mandatory labelling for the types of domestic refrigerators in 4E economies.

- All 4E economies have MEPS requirements for domestic refrigeration appliances
- All 4E economies have energy label requirements for domestic refrigeration appliances
- Some also have MEPS and labelling in place for wine storage and other specialised refrigeration appliances

Table 1: Coverage of EES&L programmes for domestic refrigeration

	MEPS				Mandatory Energy Labels			
Rated Power (kW)	Refrigerators	Refrigerator -freezers	Freezers	Specialised types	Refrigerators	Refrigerator -freezers	Freezers	Specialised types
Australia	✔[1]	✔[1]	✔[1]		✔[1]	✔[1]	✔[1]	
New Zealand	✔[1]	✔[1]	✔[1]		✔[1]	✔[1]	✔[1]	
Canada	✔	✔	✔		✔	✔	✔	
USA	✔	✔	✔		✔	✔	✔	
China	✔	✔	✔	✔[2]	✔	✔	✔	✔[2]
EU	✔	✔	✔	✔[3]	✔	✔	✔	✔[3]
Switzerland	✔	✔	✔	✔[3]	✔	✔	✔	✔[3]
UK	✔	✔	✔	✔[3]	✔	✔	✔	✔[3]
Japan	✔	✔	✔		✔	✔	✔	
Korea	✔	✔	✔	✔[4]	✔	✔	✔	✔[4]

Notes

1 Includes wine storage compartments within a refrigerator with other compartments

2 Includes specific requirements for wine storage appliances and a correction factor for appliances with transparent doors

3 Includes:

- Low noise refrigerating appliances including those with fresh food compartment(s) and those with transparent doors but excepting of low noise combi appliances with a frozen compartment
- Wine storage appliances including those with transparent doors

4 Includes kimchi refrigerators, although these are a managed under a different section of the regulations than the provisions which apply to all other domestic refrigeration appliances

Test Methods

In 4E economies, energy performance tests are conducted according to one of the two following procedures, which differ significantly

The US DOE/CSA-C300-15 test method:
used in USA and Canada

- tests energy consumption at a single steady-state ambient temperature of 32.2°C
- tests at an internal chilled food compartment temperature of 3.3°C
- tests at an internal frozen food compartment temperature of –15°C

The IEC 62552 test method:
used in Australia[2], China, European Economies, Japan and Korea

- tests energy consumption at two steady-state ambient temperatures of 32°C and 16°C with a weighting applied to the two values to produce a single overall energy consumption value. The weighting is chosen to produce an interpolated energy consumption value that corresponds to the most representative local ambient temperature, which are shown below
- tests at an internal chilled food compartment temperature of 4°C[3]
- tests at an internal frozen food compartment temperature of –18°C[4]
- tests auxiliary loads independently
- allows for the energy used to process loads[5] to be tested independently

Similarities between the methods include:

- the means of measuring volume and compartment temperature
- the means of testing the impact of auto-defrost on the appliance's energy consumption.

Even amongst those economies that base their test on the IEC method, there are differences in the representative test temperature adopted and in the treatment of processing loads.

Table 2: Representative local ambient temperature used by 4E economies using the IEC test method

	Representative ambient test temperature	
Australia & New Zealand	MEPS	32°C
	Labelling	22°C
China		23.7°C
EU, Switzerland & UK		25°C
Japan		25°C
Korea		25°C

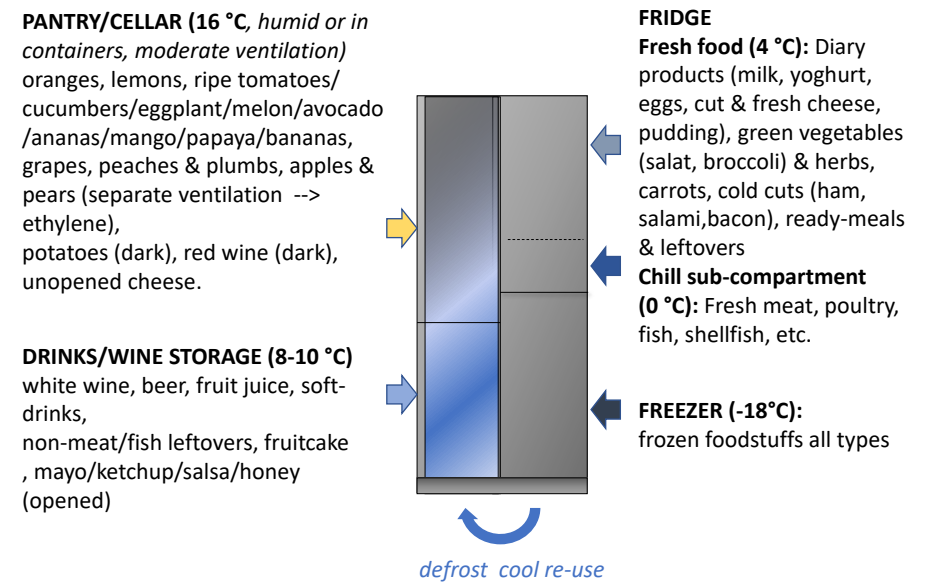
2 New Zealand is expected to align to this method soon
3 Other compartment types (and design temperatures) are also recognised under the IEC method.
4 For 3 and 4 star frozen food compartments
5 i.e. the appliance energy consumption effect of thermal loads such as ambient/warm food or humid air ingress from door openings

Product Categories, Energy Efficiency Metrics and Performance Requirements

Variations in the design of domestic refrigeration appliances are treated very differently across 4E economies for the purpose of setting performance requirements. For example, Canada and the US defines 42 distinct product categories, each of which have their own performance requirement. In Europe, these are all covered within a single product category and performance requirement formula, with adjustment factors applied to recognise the presence of specified features. These include frost-free, built-in design, the number of doors and load losses.

Conceptually, the European approach recognises that the performance of a domestic refrigeration appliance is dependent on the efficiency of the refrigeration system and the thermal loads it has to process, which are a function of the internal design temperatures and ambient temperature. These factors can be expressed and treated consistently for all vapour-compression cycle refrigeration devices while the impact of additional features can then be addressed by feature factors.

A further interesting development within the European regulation is the treatment of each compartment type as a separate entity, to cope with the development of new refrigeration products that may have several compartments operating at different temperatures (see following section and Box 1).



Box 1: Illustration of domestic refrigerator with compartments designed to store different foodstuffs

Image source: VHK for European Commission 2016

Trends

A number of 4E economies have updated their test methods and/or regulations recently, or are in the process of doing so. These include:

Europe have introduced major changes to all aspects of their regulation that have applied since March 2021

Korea have changed the energy performance formula within regulations for domestic refrigeration appliances with effect from October 2021

The US has adopted changes in the energy performance test procedure that will take effect from April 11th 2022, although this is being applied in a manner that does not affect the ambition of the MEPS

New Zealand are moving to align with Australia, which should be finalized in June 2022

Changes to test methods amongst 4E economies based on the IEC method over recent years have produced greater alignment.

It is interesting to note that the thinking behind the new European regulations for refrigeration products takes into account a concern to reduce food waste, since there is evidence that around 11% of refrigerated food in the EU ends up as avoidable waste (a total of 156 Mt including waste in the supply chain). Since this may be reduced by the storage of food at more appropriate temperatures, the new regulation allows for products with multiple compartments with different temperature settings, and is designed so that it does not inhibit such innovation in product design. Further measures, such as encouraging the avoidance of food waste through the energy label may be considered in the future.

Glossary

The following terminology is used in this report.

AV	Adjusted volume
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 under the 4E TCP
Rating	The set of rated values and operating conditions
Rated value	A quantity value assigned, generally by a manufacturer, for a specified operating condition
TR	Top Runner Programme in Japan
UEC	Unit energy consumption