# Regulating Horizontal  Refrigerated Units

June 2022

## *Workshop at AVARI- Lahore*

clasp

Efficient Appliances for People & the Planet

HIMA^Verte

NEECA

# Why standards and labelling, and why “add” more refrigerated products to regulations?

*Stuart Jeffcott*

clasp

Efficient Appliances for People & the Planet

HIMA^Verte

NEECA

# A brief introduction to the benefits of Standards and Labels

# “Definition” of MEPS and Labelling

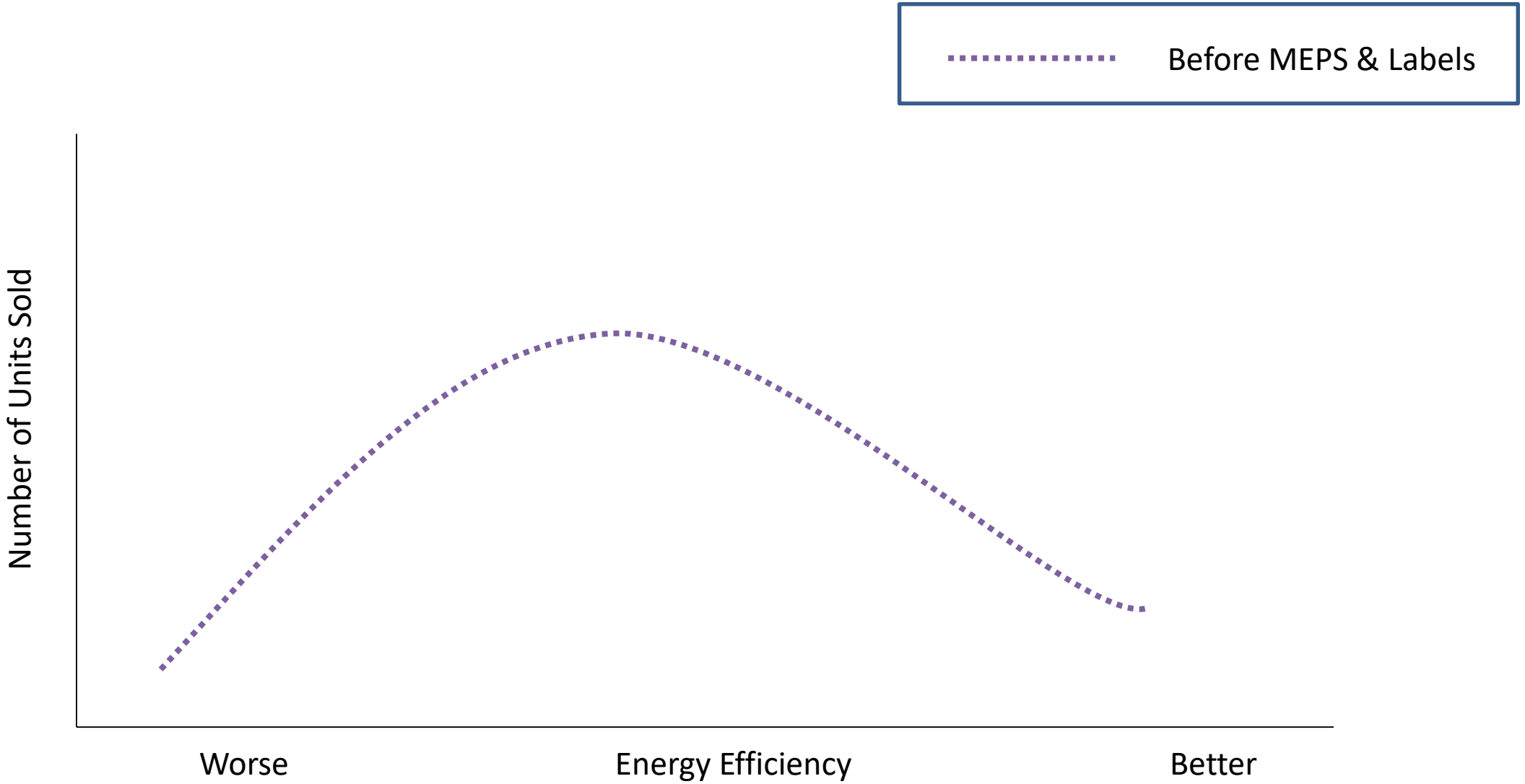
Minimum Energy Performance Standards (MEPS)

- Removal from the market of products that are deemed to have unacceptably low energy performance.

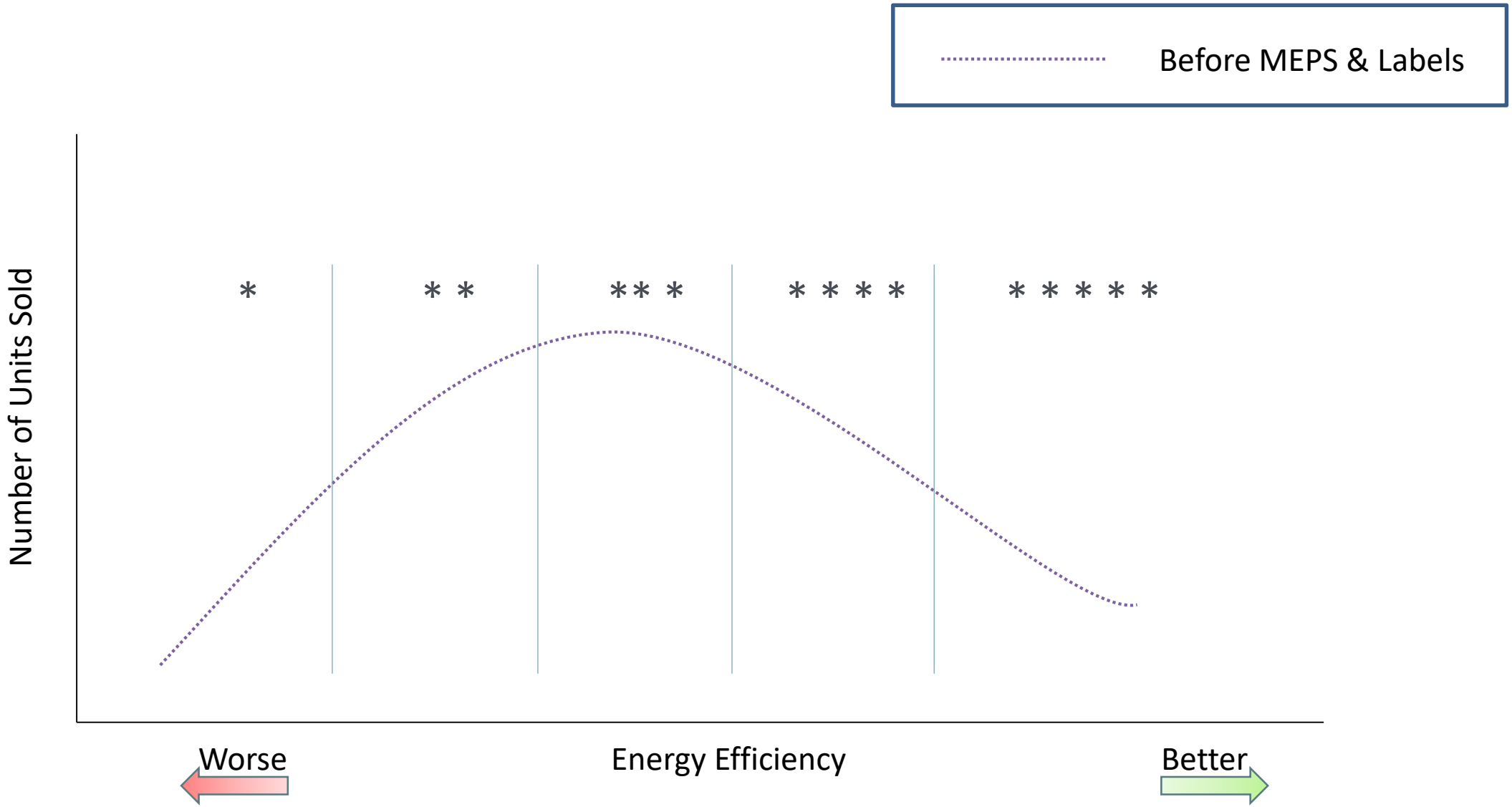
Labelling

- To categorise the energy performance of products to enable differentiation of the “better” products from the “less good” products.
  - *Consumers get more transparency for decision making*
  - *Allows effective implementation of other policy (eg procurement)*

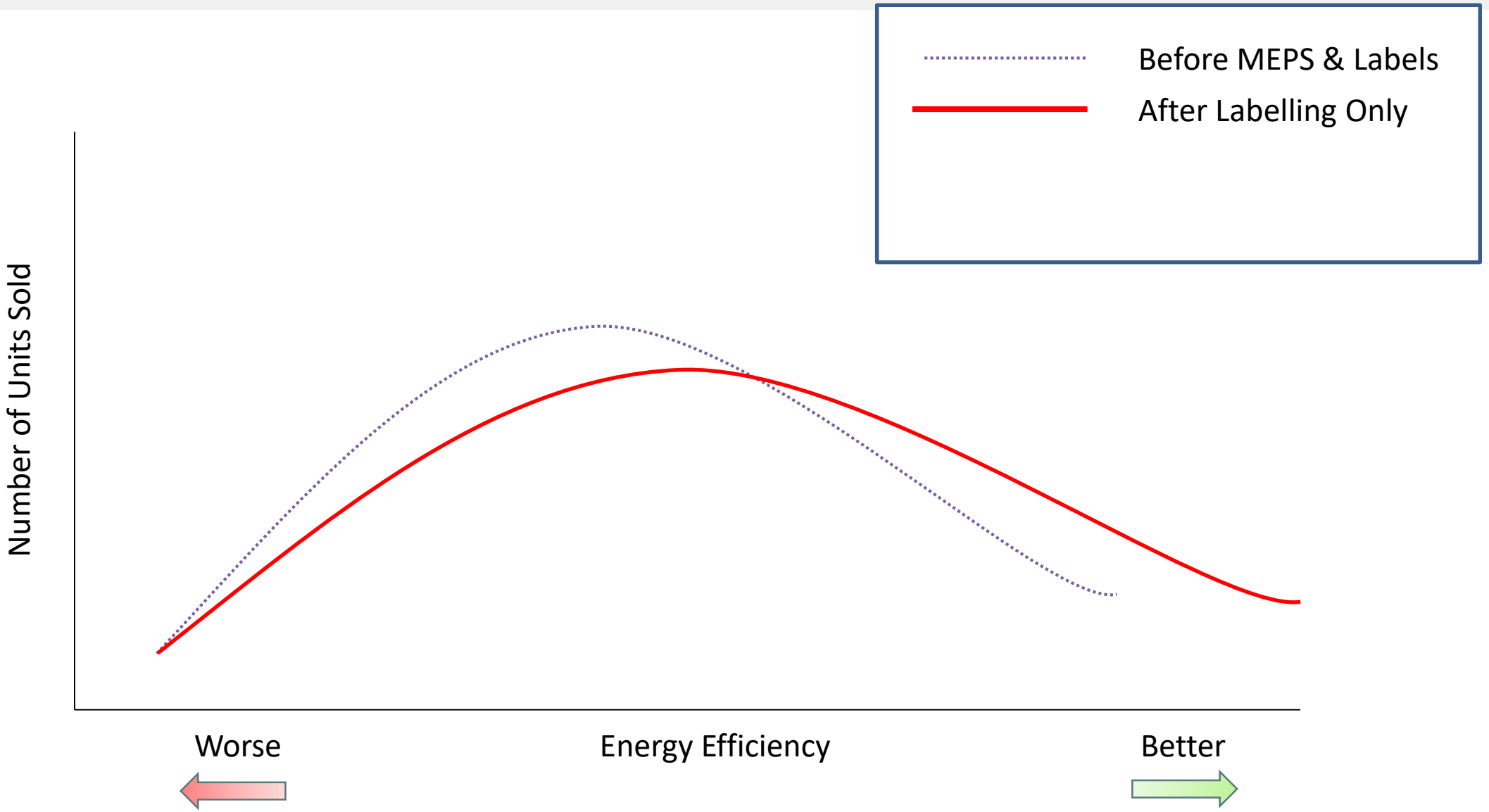
# Distribution of Performance of Products in Market



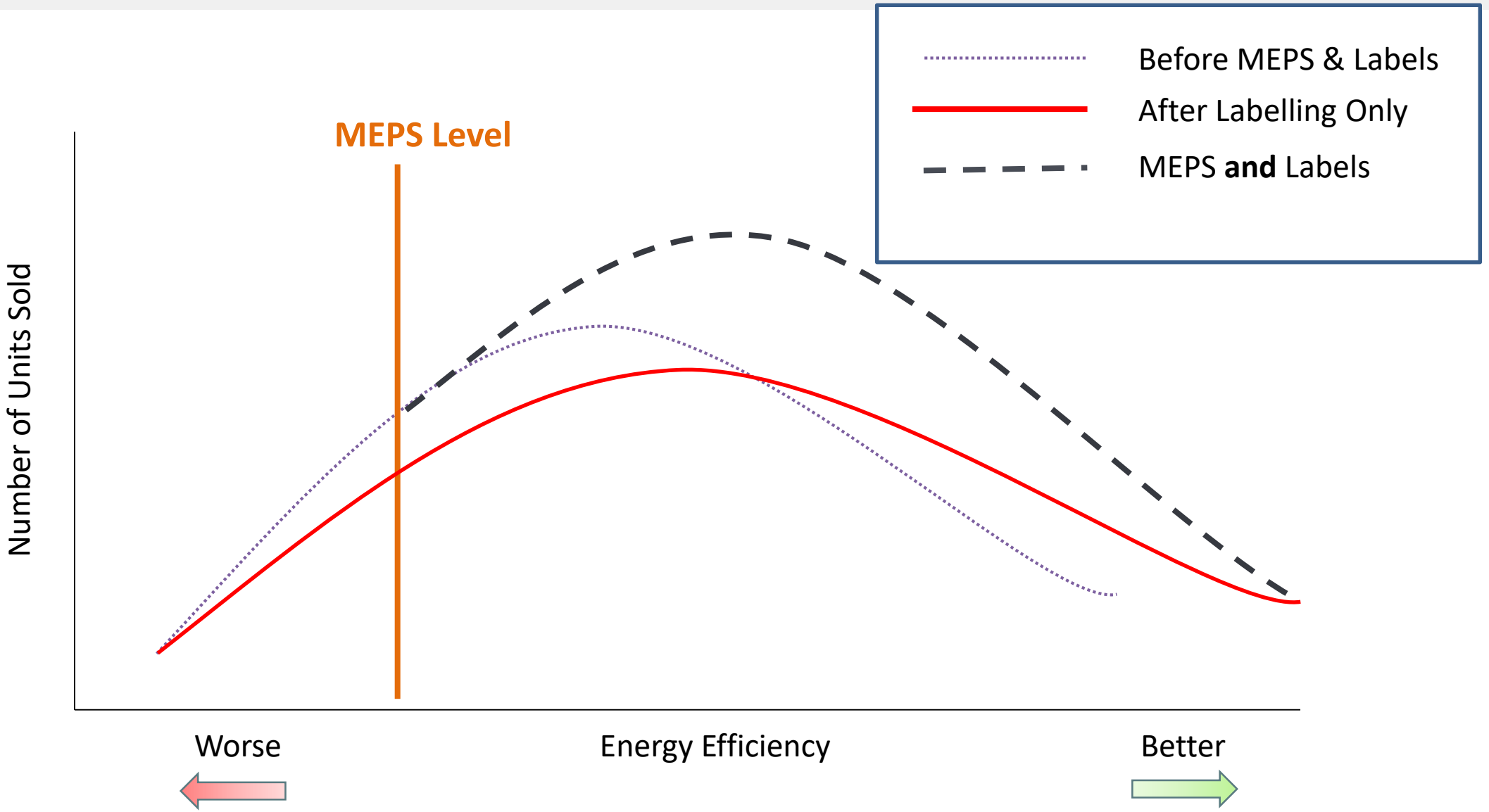
# Effect of Labelling: Transparently "Grading" Product Performance



# Effect of MEPS and Labelling



# Effect of MEPS and Labelling



# MEPS and Labelling around the world (2014)

| | Minimum Standards | Comparative Labels |
|---|---|---|
| Europe | 939 | 652 |
| Asia Pacific | 243 | 228 |
| North America | 92 | 44 |
| Central America | 43 | 88 |
| Middle East | 79 | 78 |
| Africa | 57 | 59 |
| **Total** | **1453** | **1149** |

**1,900+**

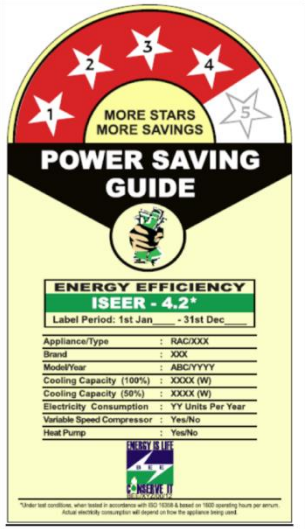
**2009 - 60 countries with performance requirements for refrigerators.**

**Currently ~ 75 countries**

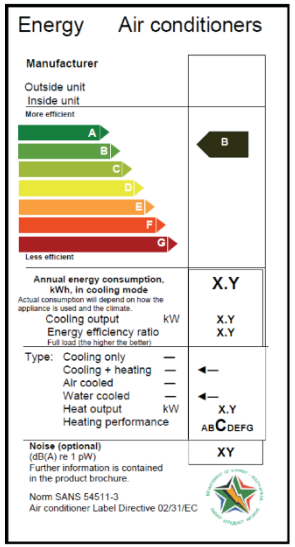
Source: Energy Standards and Labelling Programmes Around the World: in 2013, Department of Industry, Australia (2014)

# Label Examples

*Australia*




*Europe*




*China*


*USA*

*Korea*

# Standards and Labelling in Pakistan


Currently Voluntary for Fans

Soon to be Mandatory

- **Fans**
- Air Conditioners
- Refrigerators (side-by-side FF)
- LED Lights
- **Electric Motors**
- **Water Heaters**
- **Commercial Refrigeration**

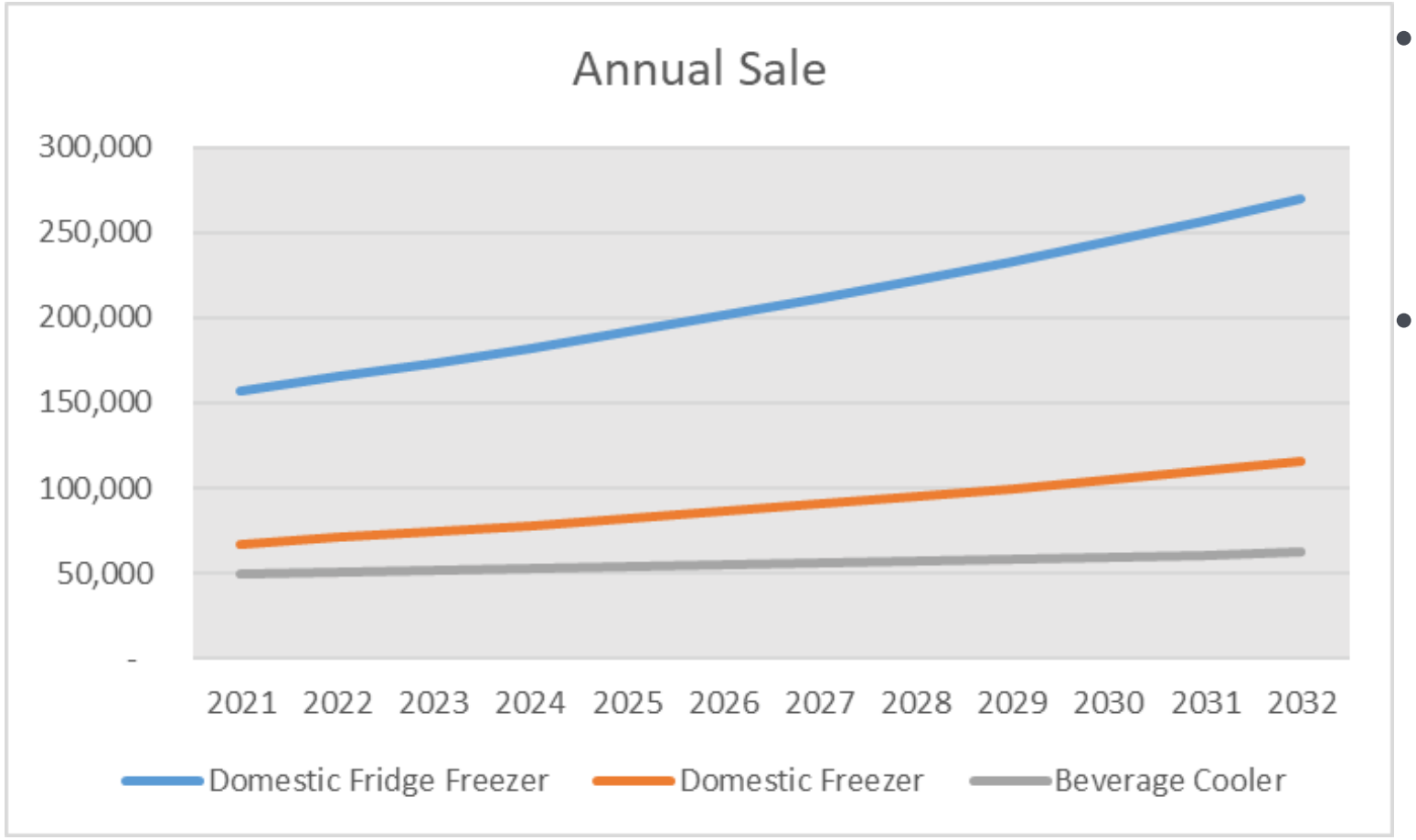
# Market Summary

# Sales, Stock & Lifetime

Approximately **300,000** horizontal chest cooling cabinets are manufactured each year in Pakistan.

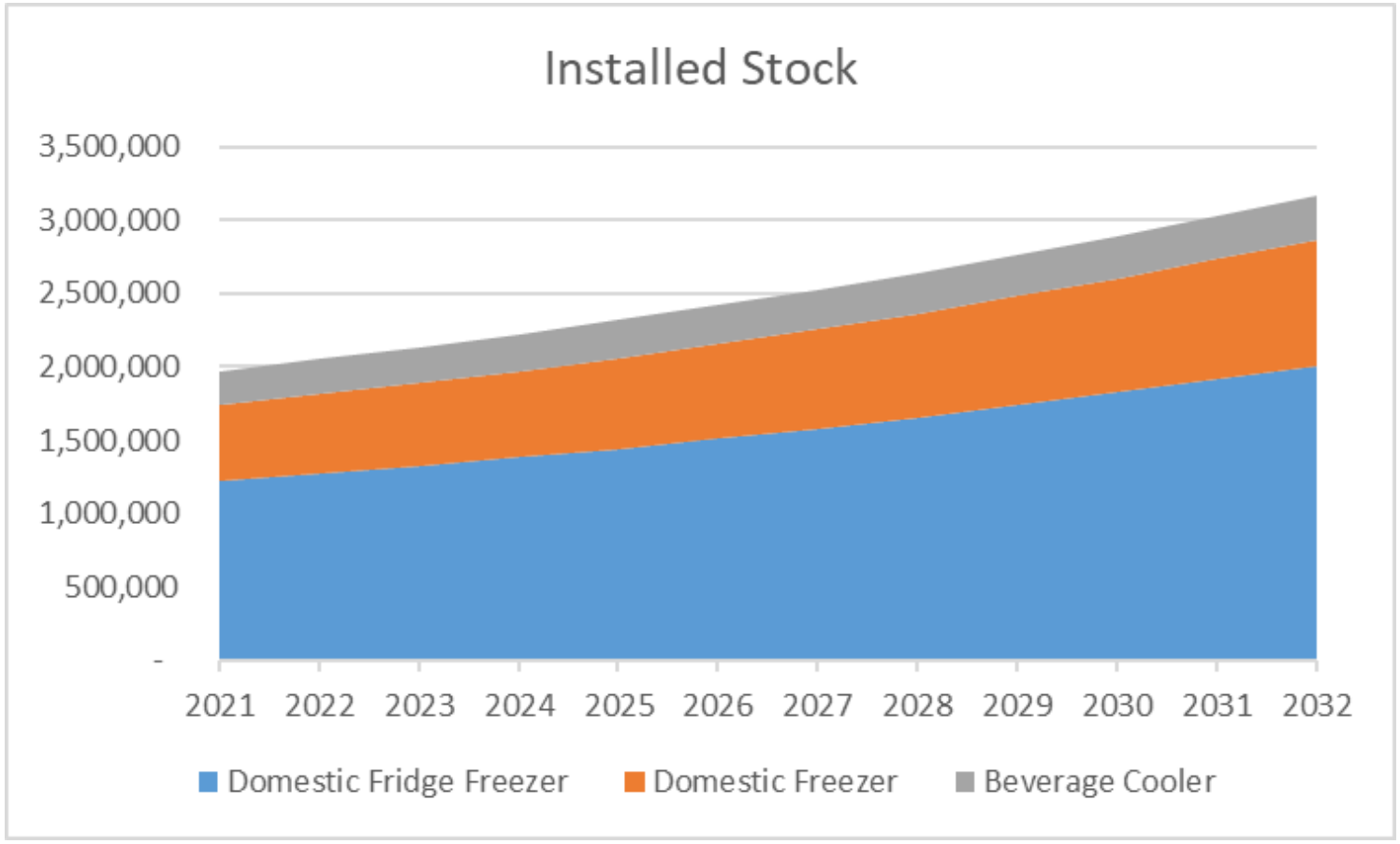
- Domestic Use ~ 225k (160k Horizontal Fridge/Freezer , 65k Horizontal Freezer)
- Beverage Coolers – 50k
- Ice Cream – 20k
- Food and others – 5k

# Sales




- Average annual Sales
  - Fridge/Freezer: 160k
  - Freezer: 65k
  - Beverage Cooler: 50k
- Annual Growth rate
  - Fridge/Freezer: 5%
  - Freezer: 5%
  - Beverage Cooler: 2%

# Stock




- Installed Stock 2021
  - Fridge/Freezer: 1.3m
  - Freezer: 0.55m
  - Beverage Cooler: 0.22m
- Life time
  - Freezer: 9 year
  - Beverage:  4-5 Year

# Supply and Demand Sides of the market

| Type | Supply Side | Demand Side |
|---|---|---|
| Horizontal (side-by-side) Fridge-Freezers | Waves, Dawlance, Haier, PEL | Domestic Users |
| Horizontal Freezers | Waves, Dawlance, Haier, PEL | Domestic Users<br>Shop keepers |
| Horizontal Beverage Coolers | Waves, Varioline | Beverage Companies |

# Scope

# Primary standalone refrigerated appliances in Pakistan

## Domestic

- Upright refrigerators (with and without ice box)
- Upright (refrigerator above freezer) fridge-freezers
- Upright (side-by-side) fridge-freezers
- Horizontal (side-by-side) fridge-freezers
- Horizontal Freezers

## Commercial cabinets (stand-alone)

- Open-fronted display (horizontal and vertical)
- Vertical beverage (vizis)
- Horizontal beverage
- Frozen food/other
- Icecream

# Current (and expected) future sales justifying regulation

## Domestic

- ~~**Upright refrigerators (with and without ice box)**~~
- Upright (refrigerator above freezer) fridge-freezers
- ~~**Upright (side-by-side) fridge-freezers**~~
- Horizontal (side-by-side) fridge-freezers
- Horizontal Freezers

## Commercial cabinets (stand-alone)

- ~~**Open-fronted display (horizontal and vertical)**~~
- Vertical beverage (vizis)
- Horizontal beverage
- ~~**Frozen food/other**~~
- ~~**Icecream**~~

# MEPS and labelling regulation already drafted

## Domestic

- ~~Upright refrigerators (with and without ice box)~~
- **Upright (refrigerator above freezer) fridge-freezers (JICA 2020)**
- ~~Upright (side-by-side) fridge-freezers~~
- Horizontal (side-by-side) fridge-freezers
- Horizontal Freezers

## Commercial cabinets (stand-alone)

- ~~Open-fronted display (horizontal and vertical)~~
- **Vertical beverage (vizis) CLASP (2021/2)**
- Horizontal beverage
- ~~Frozen food/other~~
- ~~Icecream~~

# Outstanding refrigerated products requiring regulation

## Domestic

- ~~Upright refrigerators (with and without ice box)~~
- ~~Upright (refrigerator above freezer) fridge-freezers (JICA 2020)~~
- ~~Upright (side-by-side) fridge-freezers~~
- Horizontal (side-by-side) fridge-freezers
- Horizontal Freezers

## Commercial cabinets (stand-alone)

- ~~Open-fronted display (horizontal and vertical)~~
- ~~Vertical beverage (vizis) CLASP (2021/2)~~
- Horizontal beverage
- ~~Frozen food/other~~
- ~~Icecream~~

# Thank you

# Questions?

# Testing Standards for horizontal refrigerated cabinets

*Abdul Rehman*

clasp

Efficient Appliances for People & the Planet

HIMA^Verte

NEECA

# Testing Standards:
# Domestic horizontal freezers and fridge-freezers

# Domestic Refrigeration Testing “Options”

Traditionally a significant number of domestic refrigerator test methods used internationally in regulations (20+ in 2005). Variations in:

- Ambient temperatures: 20$^{o}$C, 25$^{o}$C, 30$^{o}$C, 32$^{o}$C, 35$^{o}$C, 40$^{o}$C, …
- Compartment temperatures: Varied by mandatory and cultural requirements
- Loading: Empty, test package, warm loaded of varying sizes,…
- Door openings: Never, once per hour, once per 24 hours, ….

More recent migration to a single, internationally recognised suite of standards: IEC62552-x

- Method provides routes to test *all* types of domestic refrigerators and/or freezers at ambient and compartment temperatures to suit local conditions.
- Method adopted by PSQCA (PS IEC62552-x), and used by JICA in proposals for regulation of upright refrigerator-freezers.

# Domestic Refrigeration: Testing proposal

To allow alignment with international trend, AND allow direct relationship with developed JICA fridge-freezer regulations, adopt the PS IEC62552-x suite of standards for the regulation of chest fridge-freezer combination and freezer only units.

Primary testing requirements:

- Stable state test
- Ambient temperature: 32°C – aligns with JICA requirement
- Compartment temperatures: As declared by manufacturer (this will be a regulatory requirement)
- Minimum test period: 24 hours (varies depending on defrost cycle)
- Door openings: None for energy test, one plus load addition for “load processing” tests
- Careful volume measurement required

# Testing Standards: Horizontal beverage coolers

# Horizontal Beverage Coolers: Testing proposal

Already agreed use of ISO 22044 for Visi's *(pending adoption by PSQCA).*

Scope of test method includes both vertical AND horizontal beverage cabinets:

- Logical extension to use in horizontal regulation

Primary testing requirements:

- Ambient temperature: 32°C (CC2)
- Stable state test (M-can loaded), door closed, average M-can temperature 3.5°C (K1)
  - Max M-can: 7°C, Min M-can: 0°C, Tolerance: 0.5°C
  - Adjustments for Energy Management Devices
- Half reload of warm cans, must recover <20 hrs at 32ºC ambient)

# Proposed performance requirements

*M. Salman Zaffar*

clasp

Efficient Appliances for People & the Planet

HIMA^Verte

NEECA

# A few words about horizontal cabinets (all types)

**Basis of the proposals:**

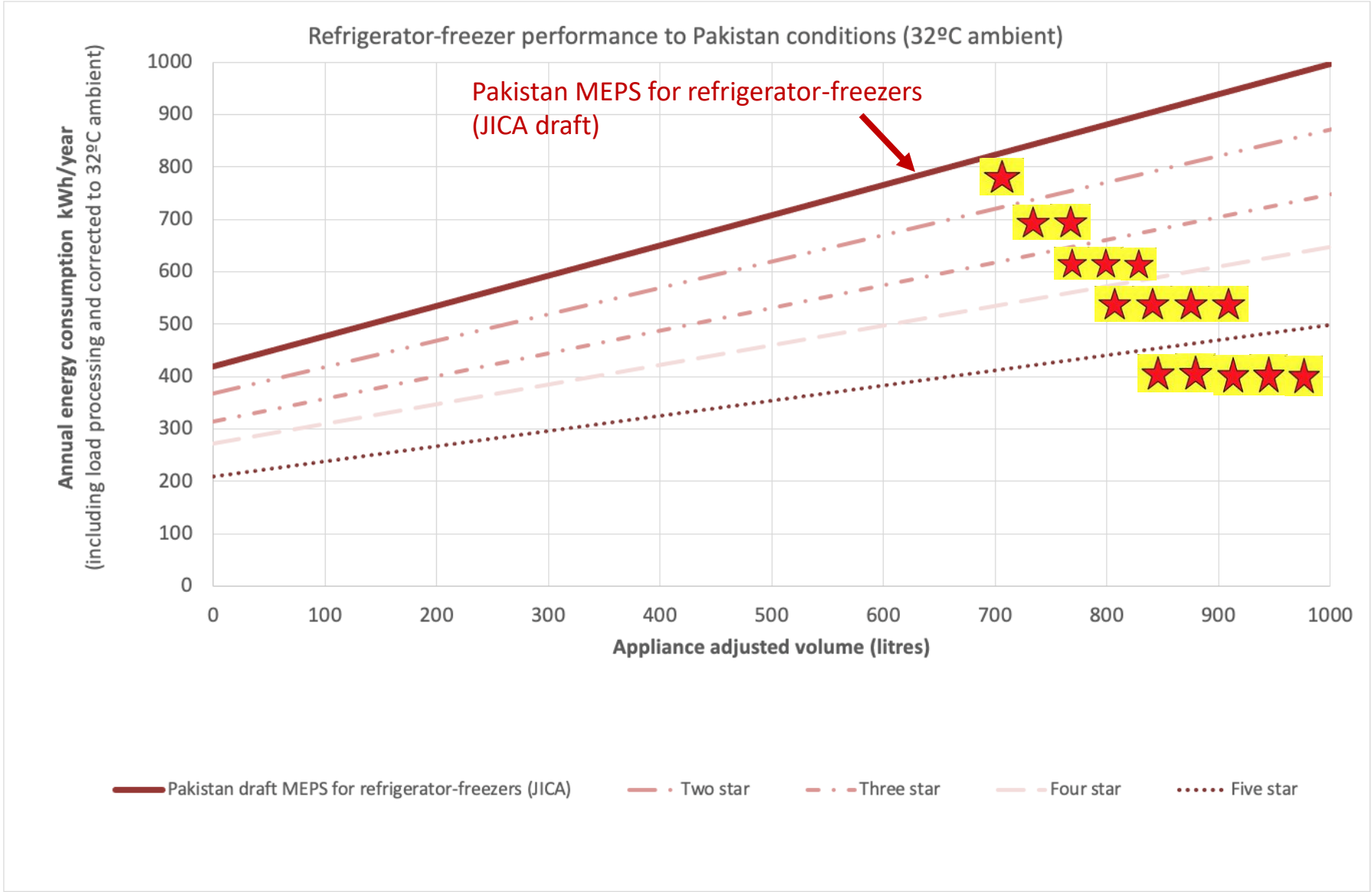
1. Horizontal (‘chest’ format) cabinets perform the same cooling function as their vertical equivalent, but have a different format / shape.
2. To give fair information to consumers / buyers, the energy label grades should be directly comparable between horizontal cabinets and vertical cabinets.
3. This means that they should share:
   - The same energy efficiency test method
   - The same energy label thresholds
   - Directly comparable annual energy consumption

# Horizontal Refrigerator – Freezers

# MEPS and labels for horizontal refrigerator-freezers

**NEECA / JICA draft regulation for refrigerator freezers:**

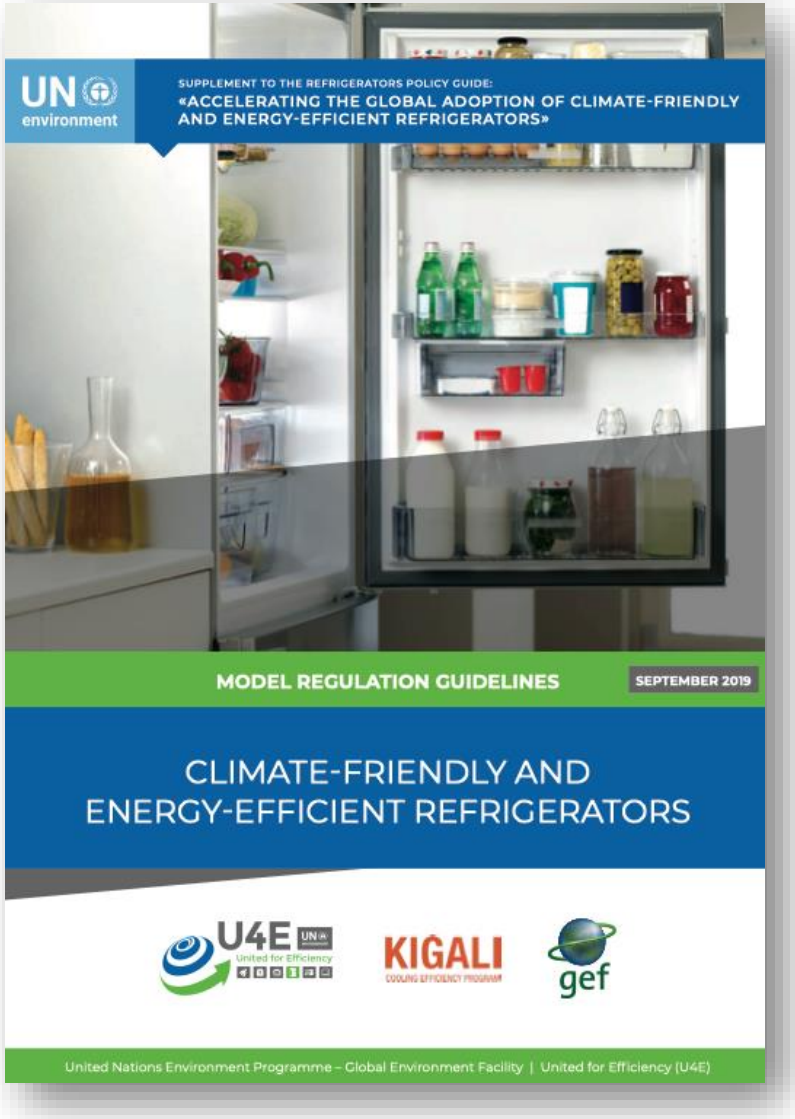
Excludes “French door / Side by side door”



# MEPS and labels for horizontal **freezers**

The Pakistan MEPS level for **refrigerator-freezers** was derived from the UNEP United for Efficiency recommendations, to make the JICA draft.

The Pakistan MEPS level for Fridge Freezers and **freezers** could be derived in the same way.



# MEPS and labels for horizontal Fridge Freezers

The JICA MEPS for refrigerator-freezers allow twice the annual energy consumption of the MEPS proposed in U4E.

There is a reason for this….

United for Efficiency (U4E) recommendations:

**Table 4. Maximum Annual Energy Consumption ($AEC_{Max}$) for Optional Reference Temperatures**

| Reference Temperature | Product Category | $AEC_{Max}$ (kWh/year) |
|---|---|---|
| 20°C | Refrigerators | 0.134×AV+84 |
| | Refrigerator-Freezers | 0.188×AV+137 |
| | Freezers | 0.175×AV+161 |
| 32°C | Refrigerators | 0.220×AV+137 |
| | Refrigerator-Freezers | 0.288×AV+210 |
| | Freezers | 0.268×AV+247 |

JICA draft requirements for Pakistan:

**x 2**

MEPS cut-off level = 0.576×Vadj + 420

# How ambitious are the U4E requirements?

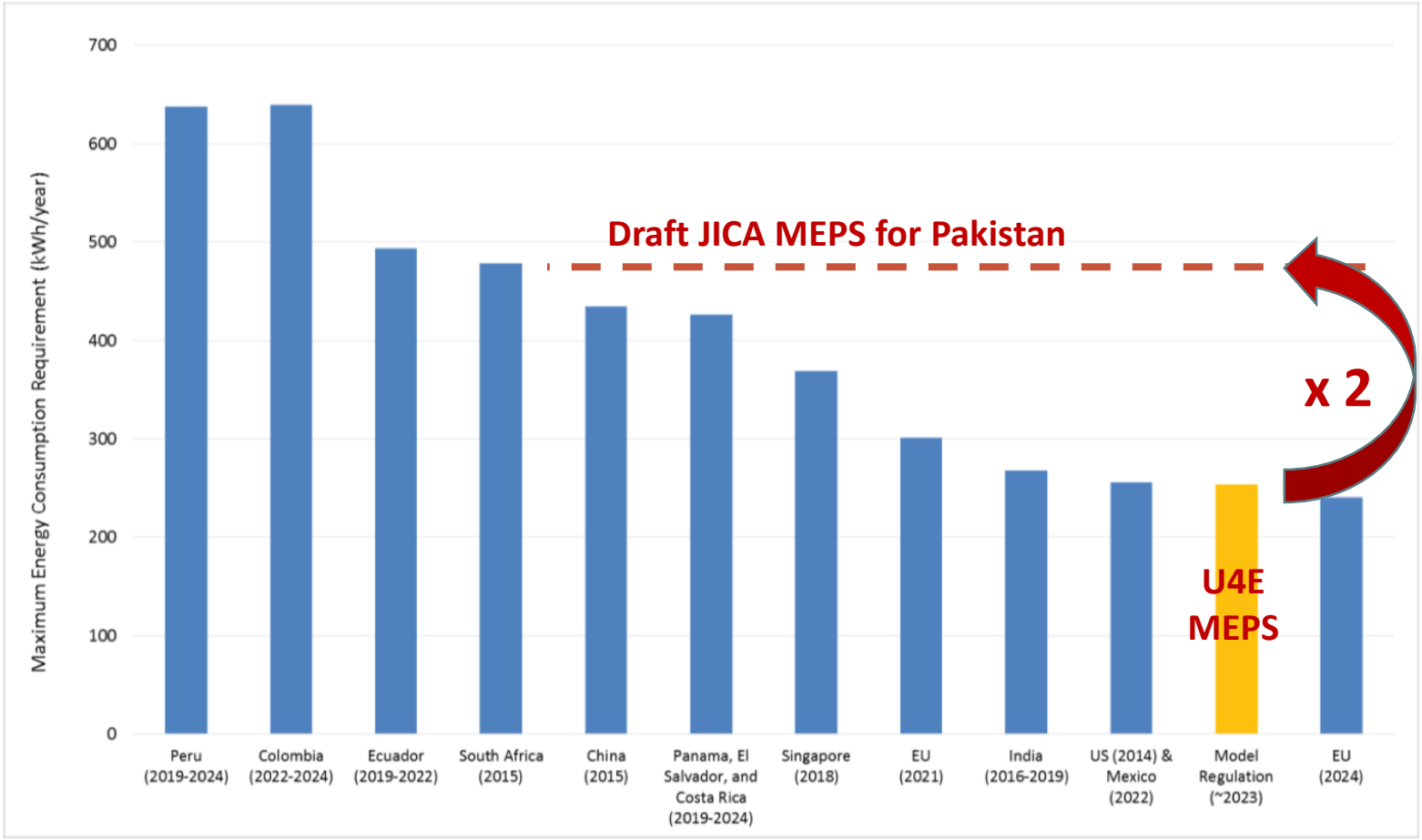



**Figure 3: Comparison of maximum energy use requirements for refrigerator-freezers (25°C)**

Source: Lawrence Berkeley National Laboratory [LBNL] analysis

The **U4E** MEPS for refrigerator-freezers are:

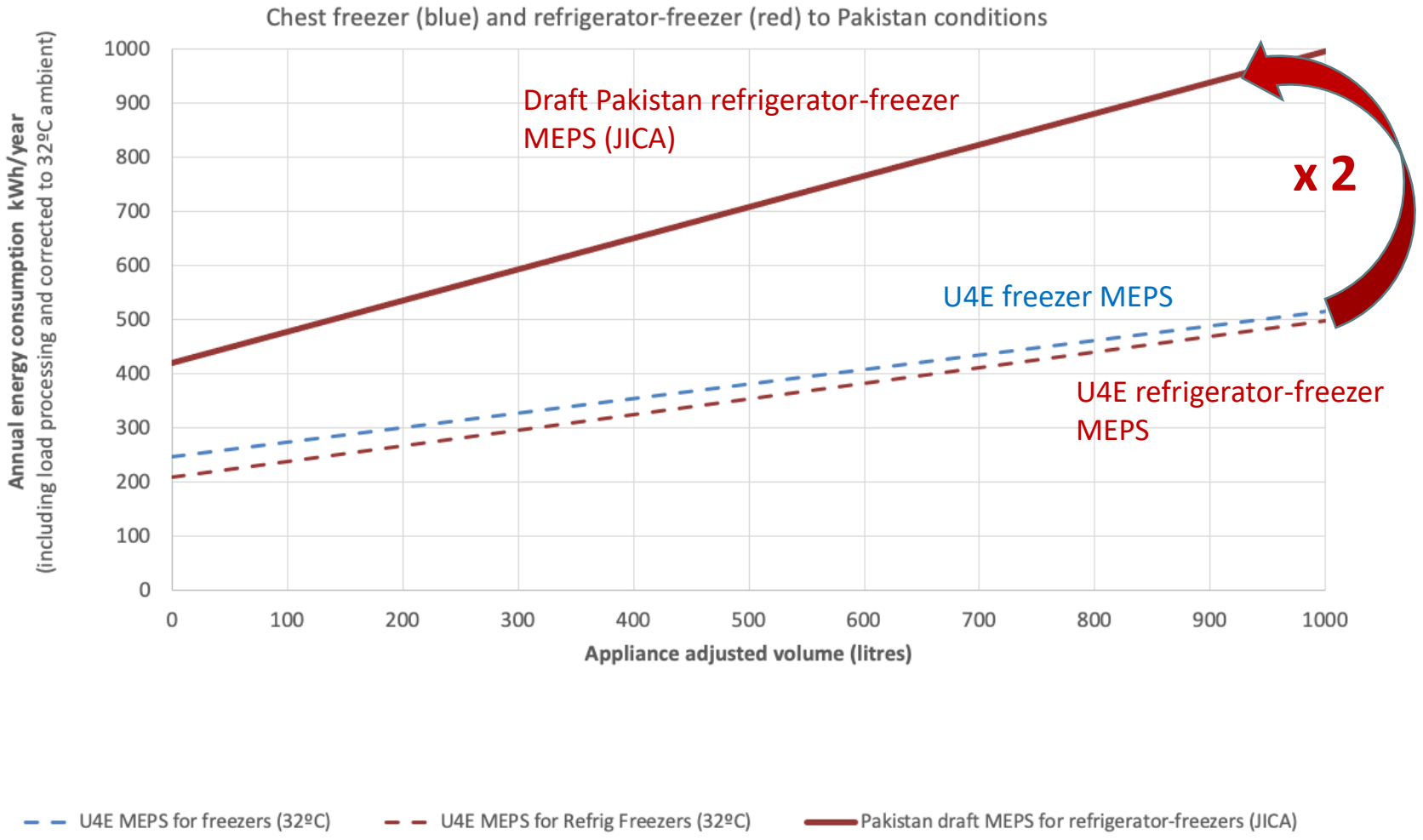
- Close to the future EU MEPS in 2024.

The **draft JICA (Pakistan)** MEPS for refrigerator-freezers are:

- Close to the 2015 MEPS in South Africa
- 10% less ambitious than those for China in 2015

# MEPS for horizontal freezers - transposed from U4E

Draft JICA MEPS for refrigerator-freezers are twice the U4E MEPS (as already explained).

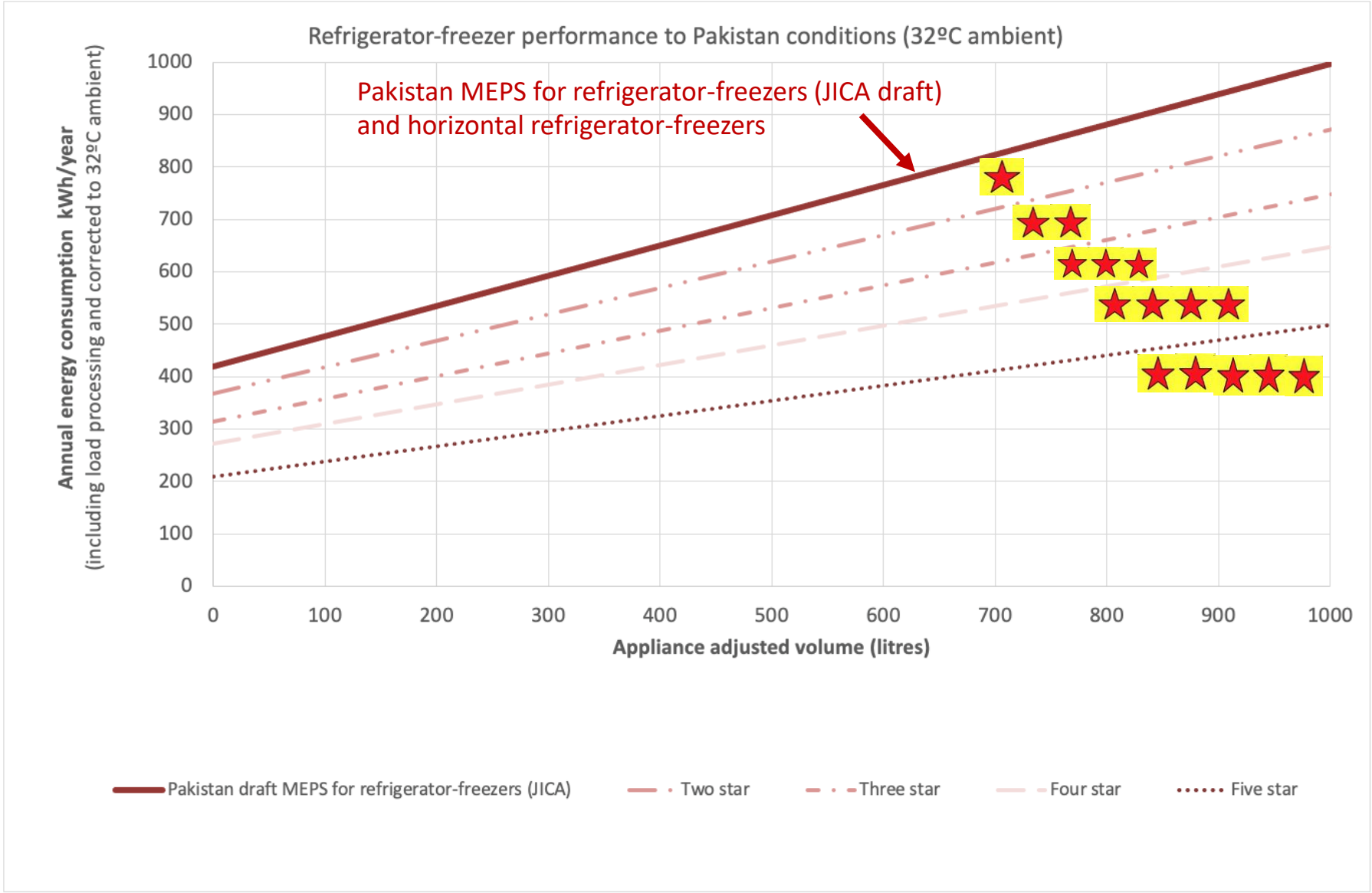


# **Proposed** MEPS and labels for horizontal refrigerator-freezers

**Proposal:**

The same test method, energy label criteria and MEPS apply to horizontal 2-door refrigerator-freezers as apply to vertical 2-door.

(= JICA draft regulation)

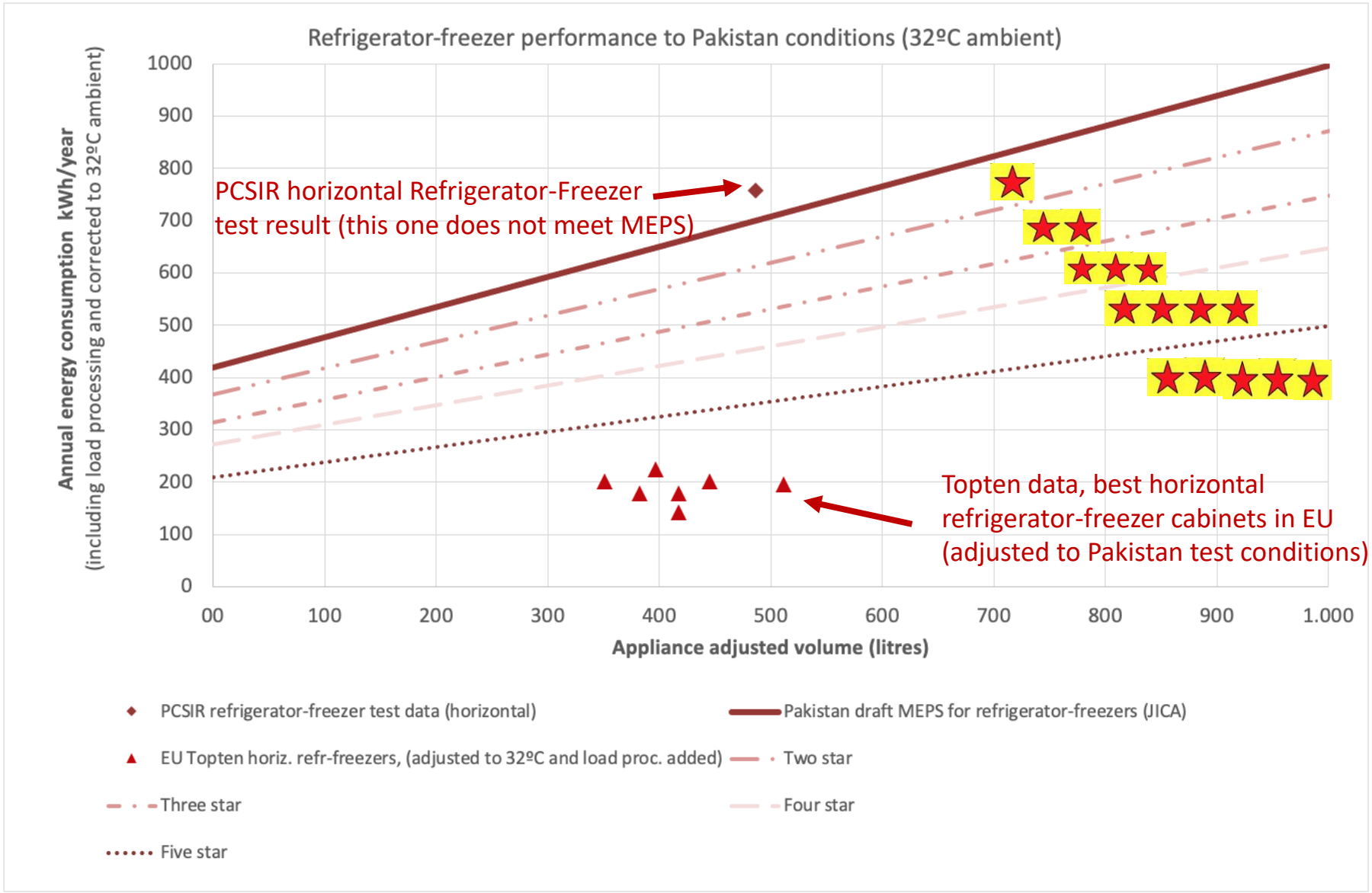


# MEPS and labels for horizontal refrigerator-freezers

**Proposal:**

The same test method, energy label criteria and MEPS apply to horizontal 2-door refrigerator-freezers as apply to vertical 2-door.

(= JICA draft regulation)



# Horizontal Freezers

# MEPS and labels for horizontal **freezers**

The JICA MEPS for refrigerator-freezers allow twice the annual energy consumption of the MEPS proposed in U4E.

There is a reason for this….

United for Efficiency (U4E) recommendations:

**Table 4. Maximum Annual Energy Consumption ($AEC_{Max}$) for Optional Reference Temperatures**

| Reference Temperature | Product Category | $AEC_{Max}$ (kWh/year) |
|---|---|---|
| 20°C | Refrigerators | 0.134×AV+84 |
| | Refrigerator-Freezers | 0.188×AV+137 |
| | Freezers | 0.175×AV+161 |
| 32°C | Refrigerators | 0.220×AV+137 |
| | Refrigerator-Freezers | 0.288×AV+210 |
| | Freezers | 0.268×AV+247 |

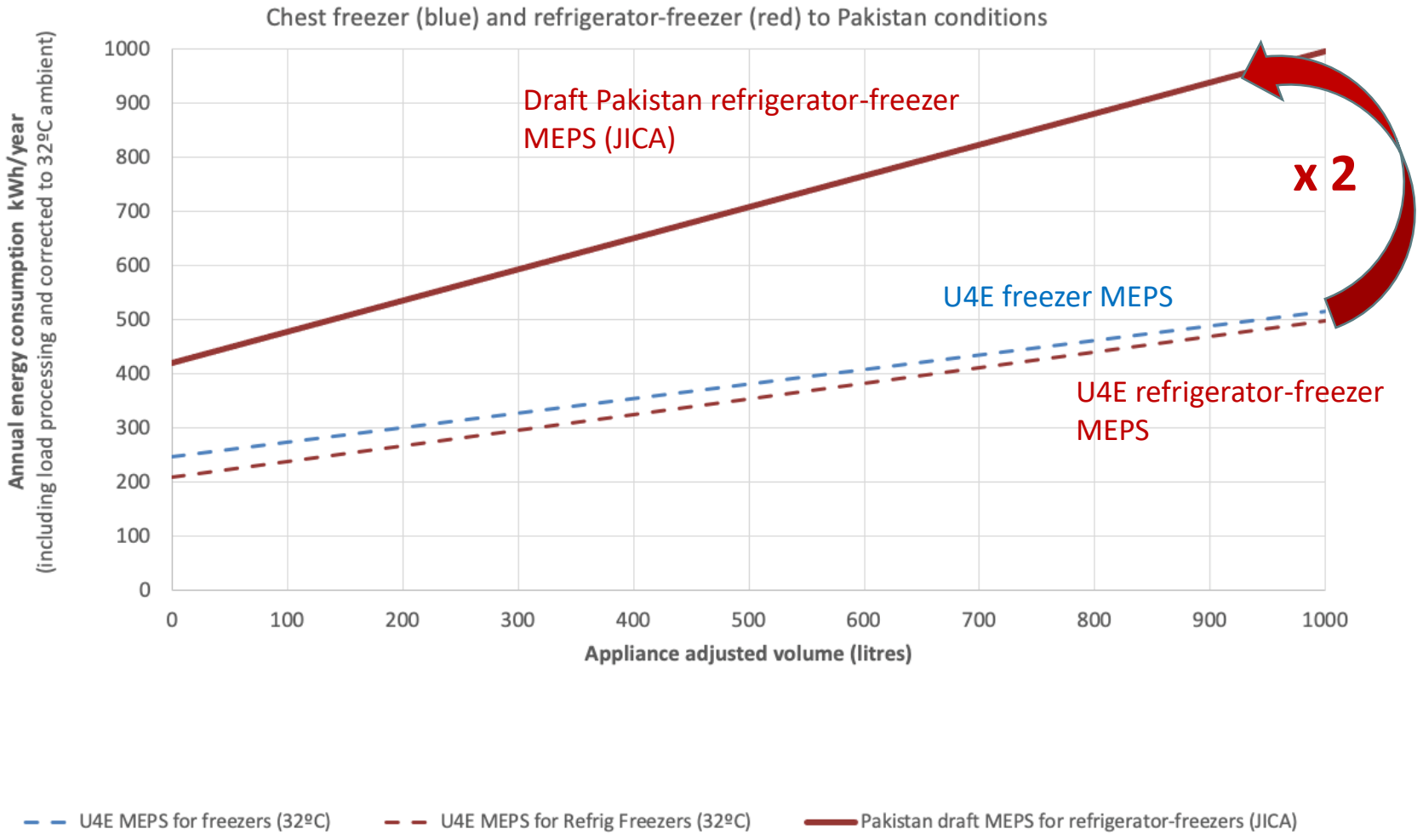
JICA draft requirements for Pakistan:

**x 2**

MEPS cut-off level = 0.576×Vadj + 420

# MEPS for horizontal freezers - transposed from U4E

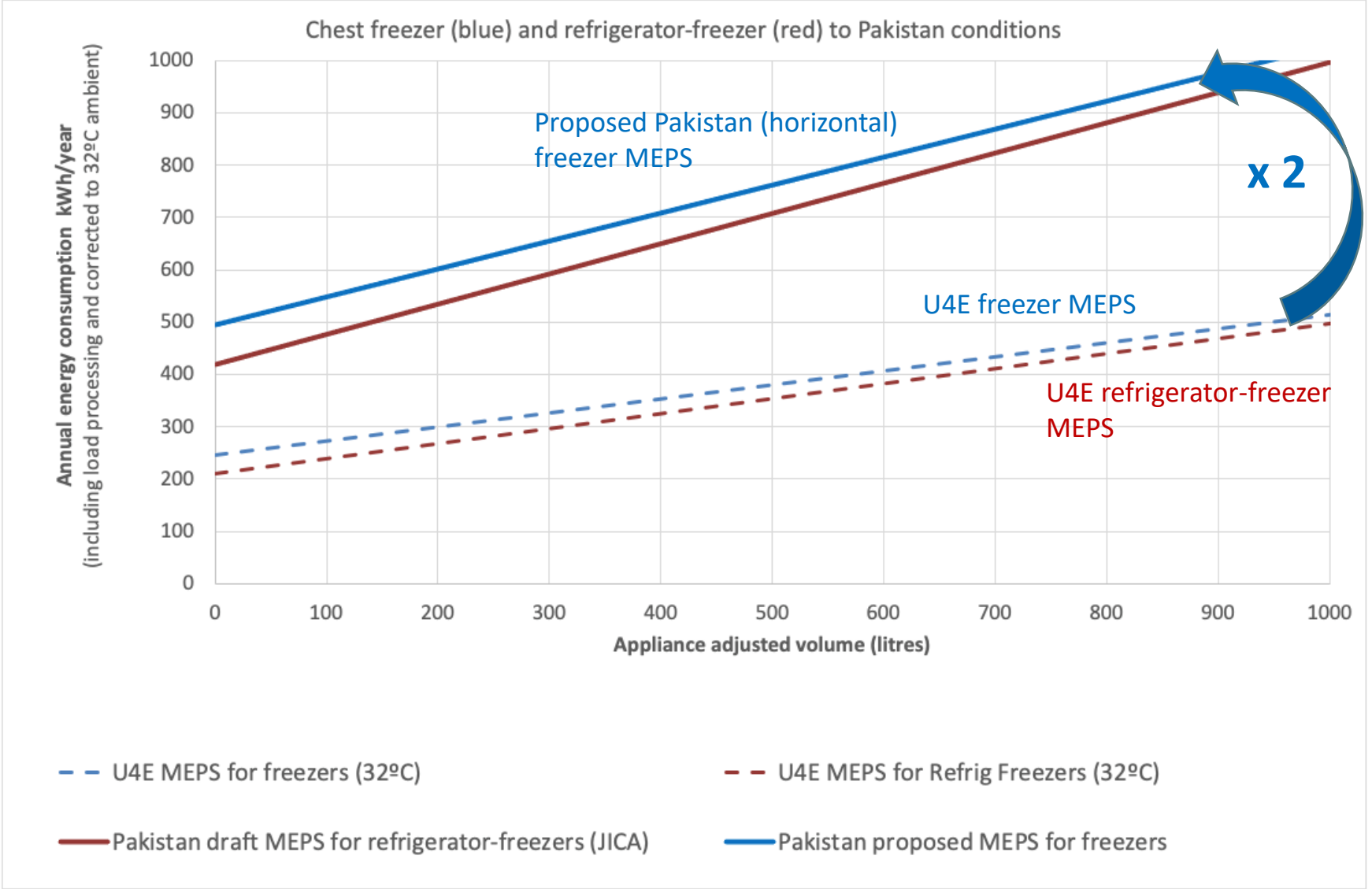
Draft JICA MEPS for refrigerator-freezers are twice the U4E MEPS (as already explained).



# MEPS for horizontal freezers - transposed from U4E

Draft JICA MEPS for refrigerator-freezers are twice the U4E MEPS.

So Pakistan MEPS for freezers are proposed as twice the U4E MEPS for freezers.

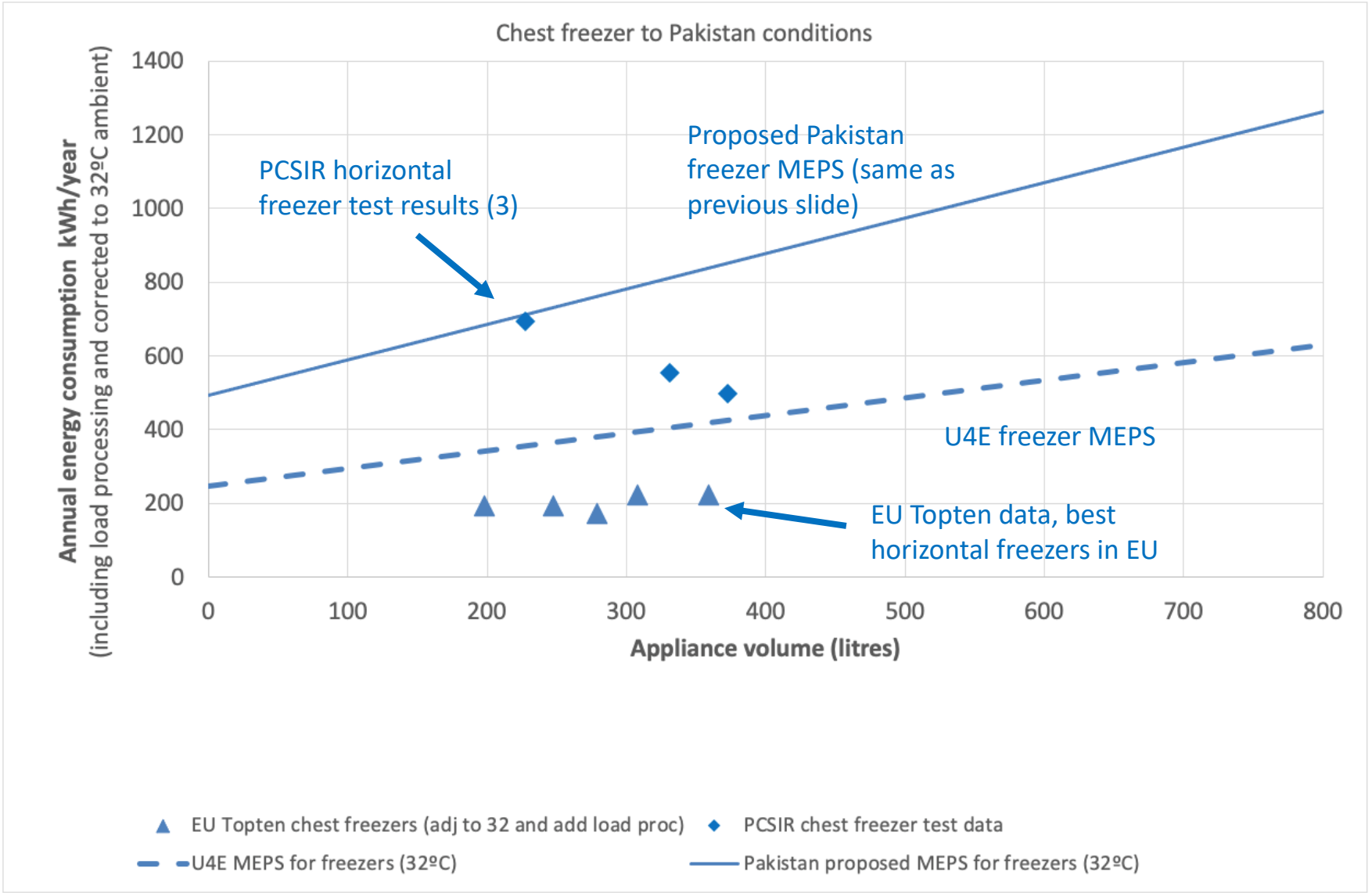


# Energy Labels for horizontal freezers

Test results on Pakistan freezers by PCSIR. All three tested passed the MEPS level.

Also some of the most efficient horizontal freezers in EU.

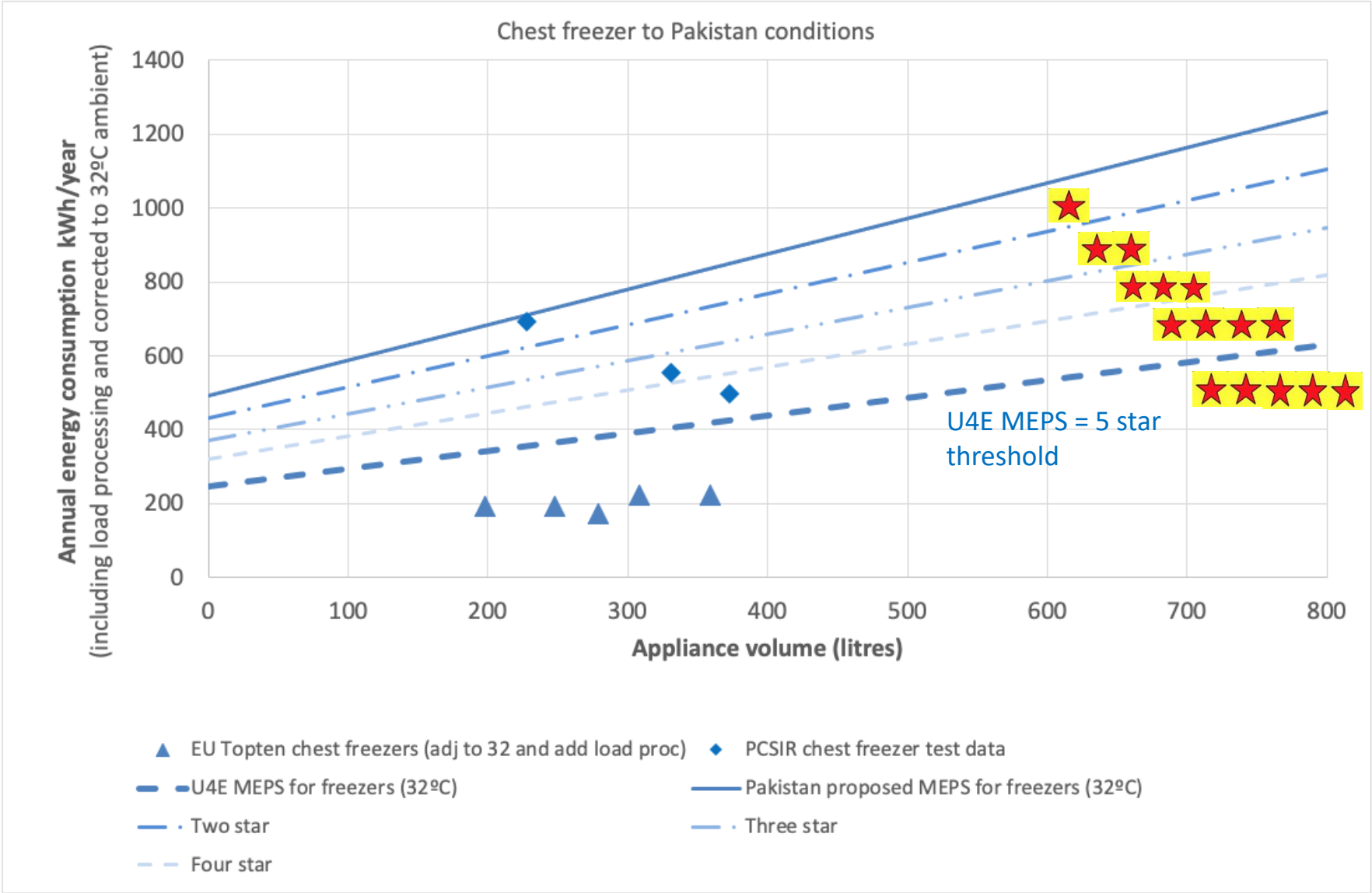
*Note: this chart uses Volume (not adjusted volume)*



# Energy Labels for horizontal freezers

Star labels proposed.

The 5 star threshold is the same as the U4E MEPS (same as for refrigerator-freezers).



# Regulatory Requirements - Explained

# Horizontal refrigerator-freezer MEPS (same as vertical)

- NEECA / JICA draft regulation
- Cabinets tested to PS 62552
- To determine its Comparative Energy Consumption (CEC):

$$\text{CEC} = E_{Total} = E_{daily32C} \times 365/1000 + E_{aux} + \Delta E_{processing32C} \times 365/1000$$

$$\text{MEPS cut-off level} = 0.576 \times Vadj + 420 = \text{maximum allowed CEC}$$

# Horizontal refrigerator-freezer MEPS (same as vertical)

- NEECA / JICA draft regulation
- Cabinets tested to PS 62552
- To determine its Comparative Energy Consumption (CEC):

MEPS cut-off level = 0.576×Vadj + 420 **= maximum allowed CEC**

The adjusted volume (Vadj) of a refrigerating appliance is calculated by summing the adjusted volume fir each compartment as per equation below.

$$Vadj = \sum_{i=1}^{n} Kci \times Vi$$

where

n is number of compartments in the refrigerating appliance

vi is volume of compartment i, which is determined in accordance with PS:IEC 62552-3/2016, Annex H (litres).

Kci is volume adjusted factor for compartment i as determined in accordance with the following equation.

**Table 2: Volume adjustment factor by compartment type**

| Compartment type | Target temperature (°C) | Volume adjustment factor ($K_{ci}$) |
|---|---|---|
| Pantry | 17 | 0.54 |
| Wine storage | 12 | 0.71 |
| Cellar | 12 | 0.71 |
| Fresh food | 4 | 1.00 |
| Chill | 2 | 1.07 |
| Zero star | 0 | 1.14 |
| 1 star | -6 | 1.36 |
| 2 star | -12 | 1.57 |
| 3 star and 4 star | -18 | 1.79 |

# Horizontal refrigerator-freezer Labels (same as vertical)

- NEECA / JICA draft regulation
- Cabinets tested to PS 62552
- To determine its Comparative Energy Consumption (CEC):

CEC = $E_{Total} = E_{daily32C} \times 365/1000 + E_{aux} + \Delta E_{processing32C} \times 365/1000$

**Table 3: Star rating band**

| | Star rating band | |
|---|---|---|
| two (2) door refrigerator/freezer | 1 star | $0.576 \times V_{adj} + 420 \geq CEC > 0.504 \times V_{adj} + 368$ |
| | 2 star | $0.504 \times V_{adj} + 368 \geq CEC > 0.432 \times V_{adj} + 315$ |
| | 3 star | $0.432 \times V_{adj} + 315 \geq CEC > 0.374 \times V_{adj} + 273$ |
| | 4 star | $0.374 \times V_{adj} + 273 \geq CEC > 0.288 \times V_{adj} + 210$ |
| | 5 star | $CEC < 0.288 \times V_{adj} + 210$ |

# Horizontal freezers MEPS

- NEECA / JICA draft regulation
- Cabinets tested to PS 62552
- To determine its Comparative Energy Consumption (CEC):

CEC = $E_{Total} = E_{daily32C} \times 365/1000 + E_{aux} + \Delta E_{processing32C} \times 365/1000$

| Freezers | 0.268×AV+247 |
|---|---|

x 2

MEPS cut-off level = ~~0.576~~ 0.536 ×Vadj ~~+ 420~~ 494 = maximum allowed CEC

# Horizontal freezers MEPS

- NEECA / JICA draft regulation
- Cabinets tested to PS 62552
- To determine its Comparative Energy Consumption (CEC):

CEC = $E_{Total} = E_{daily32C} \times 365/1000 + E_{aux} + \Delta E_{processing32C} \times 365/1000$

| | |
|---|---|
| Freezers | 0.268×AV+247 |

x 2

MEPS cut-off level = ~~0.576~~ 0.536 ×Vadj ~~+ 420~~ 494 = maximum allowed CEC

The adjusted volume (Vadj) of a refrigerating appliance is calculated by summing the adjusted volume fir each compartment as per equation below.

$$Vadj = \sum_{i=1}^{n} Kci \times Vi$$

where

n is number of compartments in the refrigerating appliance

vi is volume of compartment i, which is determined in accordance with PS:IEC 62552-3/2016, Annex H (litres).

Kci is volume adjusted factor for compartment i as determined in accordance with the following equation.

**Table 2: Volume adjustment factor by compartment type**

| Compartment type | Target temperature (°C) | Volume adjustment factor ($K_{ci}$) |
|---|---|---|
| Pantry | 17 | 0.54 |
| Wine storage | 12 | 0.71 |
| Cellar | 12 | 0.71 |
| Fresh food | 4 | 1.00 |
| Chill | 2 | 1.07 |
| Zero star | 0 | 1.14 |
| 1 star | -6 | 1.36 |
| 2 star | -12 | 1.57 |
| 3 star and 4 star | -18 | 1.79 |

# **Horizontal freezers** Labels

- NEECA / JICA draft regulation
- Cabinets tested to PS 62552
- To determine its Comparative Energy Consumption (CEC):

CEC = $$E_{Total} = E_{daily32C} \times 365/1000 + E_{aux} + \Delta E_{processing32C} \times 365/1000$$

| Star rating band | Upper limit of star rating band | | | |
|---|---|---|---|---|
| 1 star | CEC < | 0,536 | x Vadj. + | 494 |
| 2 star | CEC < | 0,470 | x Vadj. + | 433 |
| 3 star | CEC < | 0,402 | x Vadj. + | 371 |
| 4 star | CEC < | 0,348 | x Vadj. + | 321 |
| 5 star | CEC < | 0,268 | x Vadj. + | 247 |
| MEPS | CEC > | 0,536 | x Vadj. + | 494 |

# How ambitious are the U4E requirements?

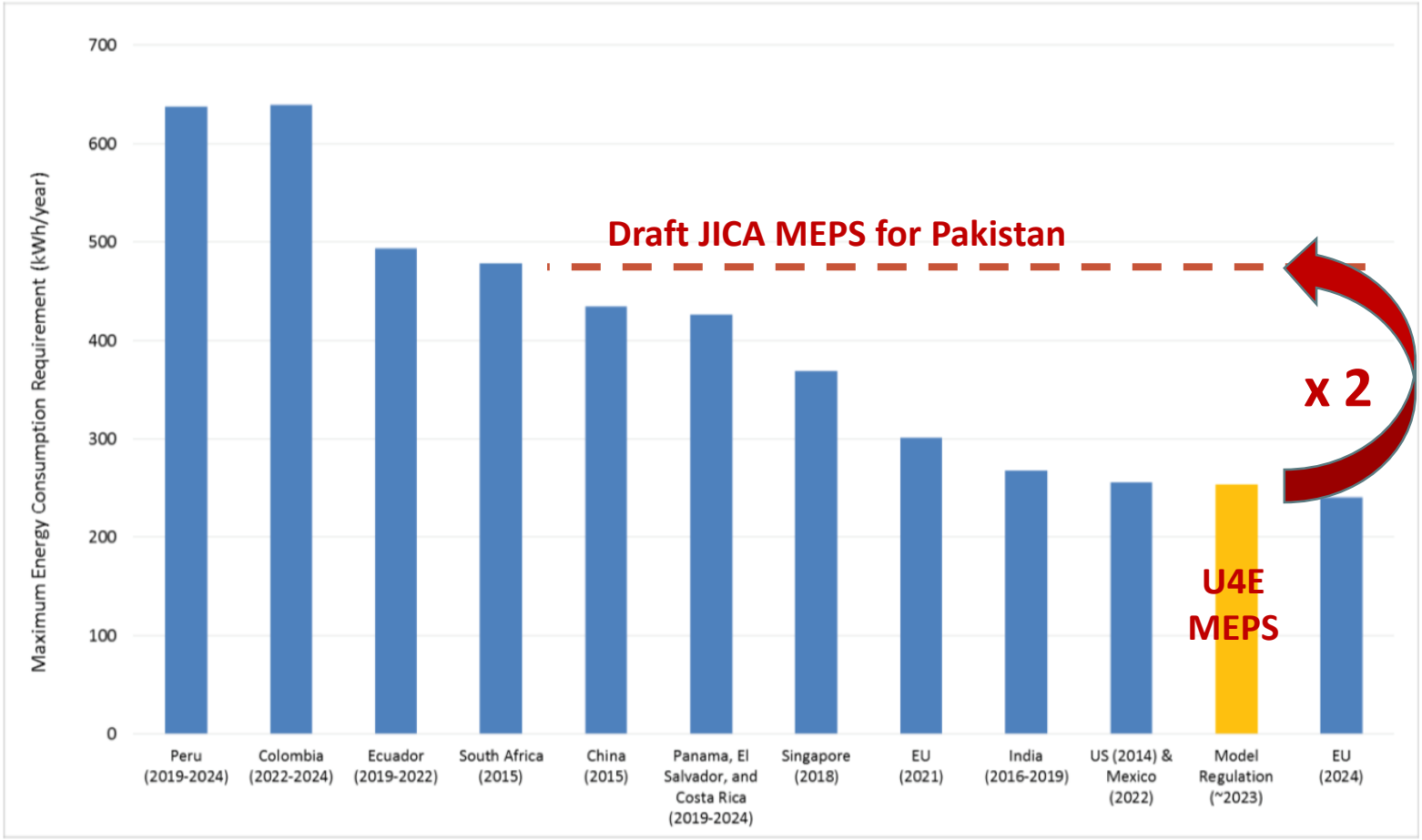



**Figure 3: Comparison of maximum energy use requirements for refrigerator-freezers (25°C)**

Source: Lawrence Berkeley National Laboratory [LBNL] analysis

The **U4E** MEPS for refrigerator-freezers are:

- Close to the future EU MEPS in 2024.

The **draft JICA (Pakistan)** MEPS for refrigerator-freezers are:

- Close to the 2015 MEPS in South Africa
- 10% less ambitious that those for China in 2015

# Proposal

- Domestic Appliance Fridge -Freezer and Freezer (including the original JICA regulations)
  - Star 1 banned 2025
  - Star 2 banned 2027

# Regulatory Requirements – Beverage

# **Horizontal beverage coolers** Star labels

- Same test as Visi (ISO 22044)
- Same calculation of EEI as Visi
- Same energy label thresholds as Visi

# Horizontal beverage coolers Star labels

- Same test as Visi (ISO 22044)
- Same calculation of EEI as Visi
- Same energy label thresholds as Visi

**Table 1. Rated conditions for package temperature and test room climate class**

| M-can temperature class | Test room climate class | Measurement standard |
|---|---|---|
| K1<br>(average temperature equal to or less than 3.5ºC) | CC2<br>(32.2ºC 65% RH) | ISO 22044 |

The energy efficiency index (EEI) of a beverage cooler that is covered by this regulation is calculated in accordance with the following formula:

$$EEI = \frac{TEC}{RTEC} \times 100$$

Where:

**TEC** is the measured Total Energy Consumption over (24 hours), expressed in kWh, derived in accordance with ISO 22044 at rating conditions of Climate Class CC2 and M-can temperature K1.

**RTEC** is the Reference Total Energy Consumption (over 24 hours) of a beverage cooler of the same volume, expressed in kWh, and is calculated using the formula below[1]:

$$RTEC = 2.1 + (0.0067725 \times Vg))$$

Where:

*Vg* is the measured **gross** volume derived in accordance with ISO 22044.

# Horizontal beverage coolers Star labels

- Same test as Visi (ISO 22044)
- Same calculation of EEI as Visi
- Same energy label thresholds as Visi

The energy efficiency index (EEI) of a beverage cooler that is covered by this regulation is calculated in accordance with the following formula:

$$EEI = \frac{TEC}{RTEC} \times 100$$

Where:

**TEC** is the measured Total Energy Consumption over (24 hours), expressed in kWh, derived in accordance with ISO 22044 at rating conditions of Climate Class CC2 and M-can temperature K1.

**RTEC** is the Reference Total Energy Consumption (over 24 hours) of a beverage cooler of the same volume, expressed in kWh, and is calculated using the formula below[1]:

$$RTEC = 2.1 + (0.0067725 \times Vg))$$

Where:

*Vg* is the measured **gross** volume derived in accordance with ISO 22044.

**Table 1. Rated conditions for package temperature and test room climate class**

| M-can temperature class | Test room climate class | Measurement standard |
|---|---|---|
| K1 (average temperature equal to or less than 3.5ºC) | CC2 (32.2ºC 65% RH) | ISO 22044 |

**Table 4: Thresholds to be used for the energy label for products sold up to 31 December 2025**

| Star Level | Maximum EEI |
|---|---|
| 1 Star | 100 |
| 2 Star | 80 |
| 3 Star | 65 |
| 4 Star | 35 |
| 5 Star | 10 |

**Table 5. Thresholds to be used for the energy label for products sold from 1 January 2025**

| Star Level | Maximum EEI |
|---|---|
| 1 Star | Not Used |
| 2 Star | ~~80~~ Not used |
| 3 Star | 65 |
| 4 Star | 35 |
| 5 Star | 10 |

# Registration and Labelling Process

# Other Requirements similar for horizontal refrigerator-freezers; horizontal freezers; horizontal beverage coolers

- Product registration required with NEECA
- Registration supported by a test certificate
- Likely fee


Mandatory information to registered with NEECA and published by suppliers about each cabinet (provisional):

a) type of equipment (i.e., refrigerator-freezer, or freezer or beverage cooler)
b) unique model number
c) family model name
d) country of manufacture
e) name and address of the manufacturer
f) name and address of the supplier
g) size of product (net volume or display area)
h) rated energy efficiency index (EEI) (beverage only)
i) energy-efficiency label class (number of stars)
j) Annual energy consumption in kWh
k) refrigerant and foam-blowing agent designation