



Efficient Appliances for People & the Planet



CLASP Report on World's Best MEPS

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March 15, 2023



MISSION



CLASP improves the energy and environmental performance of the appliances & equipment we use every day, accelerating our transition to a more sustainable world.

Global Progress on Efficiency Relative to Benchmarks

New report and interactive web page



- <https://www.clasp.ngo/tools/worlds-best-meps/>
- Or scan here:



Scope of Analysis

- What efficiency levels have been achieved today

- Brazil
- Canada
- China
- European Union
- India
- Indonesia
- Japan
- South Africa
- United Kingdom
- United States

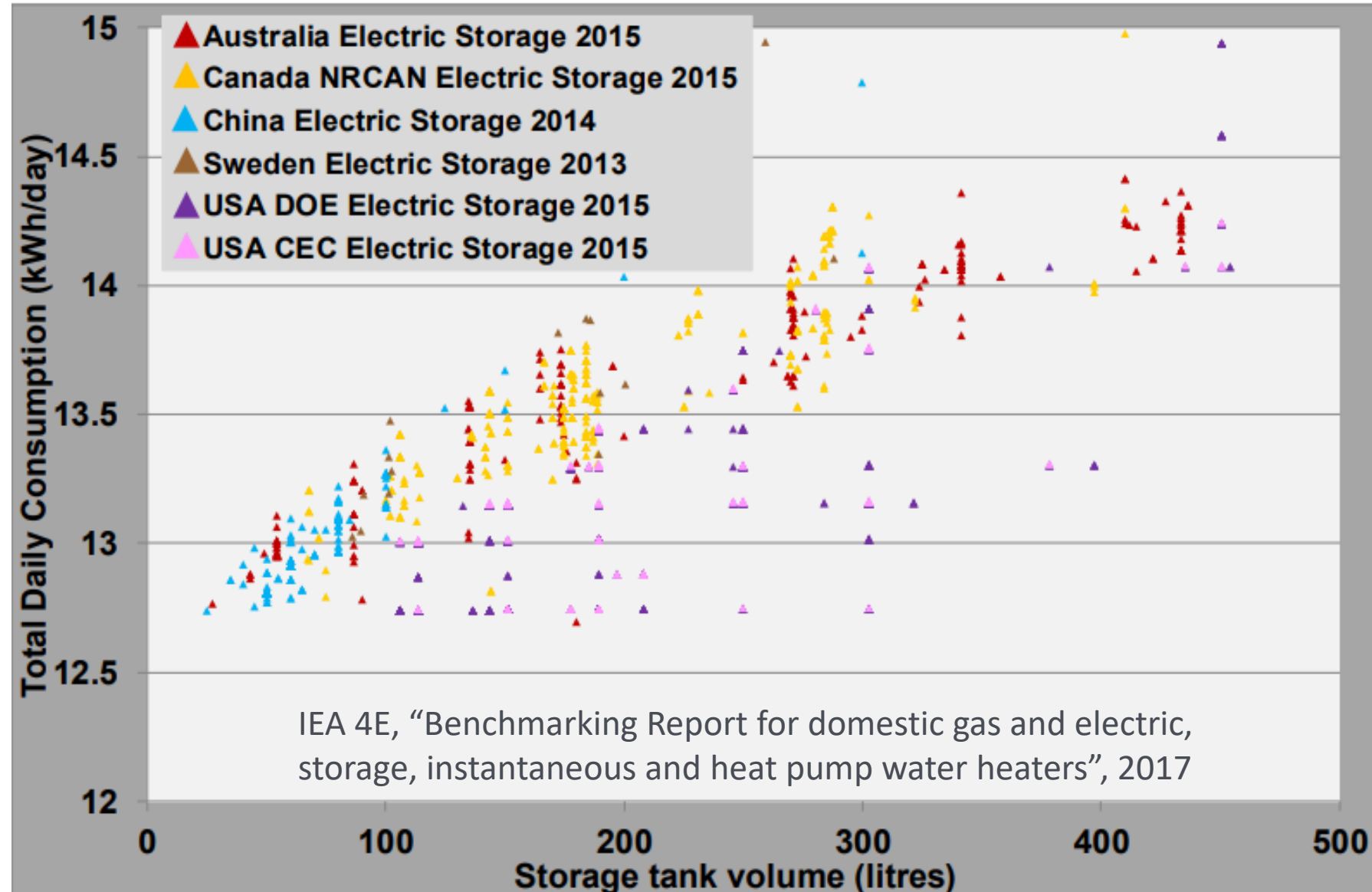
- Global goals and benchmarks

- United for Efficiency (U4E Model Regulations)
- COP26 Call to Action on Doubling Appliance Efficiency
- Electrification
- Net-zero Energy

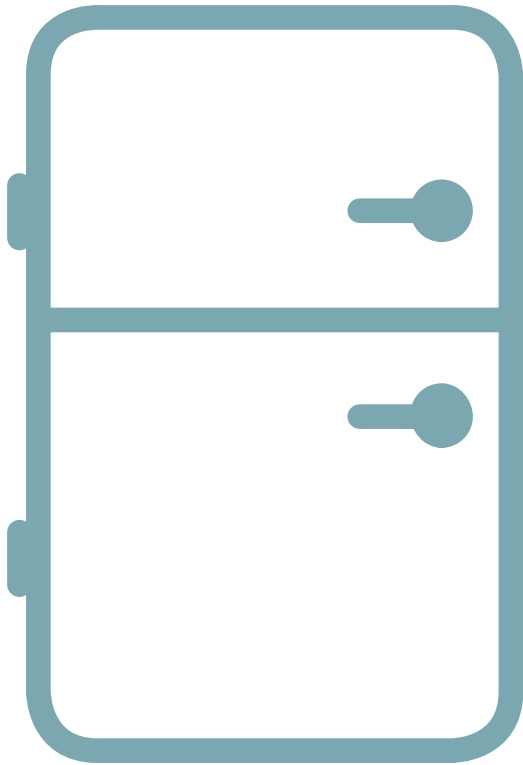
- Learn and drive ambition around the world

Conducting a Fair Comparison

- Not all economies can reach the same levels
 - Climate
 - Product availability
 - Economics
- Also, sometimes products are not completely comparable



Refrigerators



Product

- 400 L frost-free refrigerator-freezer
- 300 L fresh-food compartment
 - 100 L top-mounted freezer compartment (3 star/-18 °C)

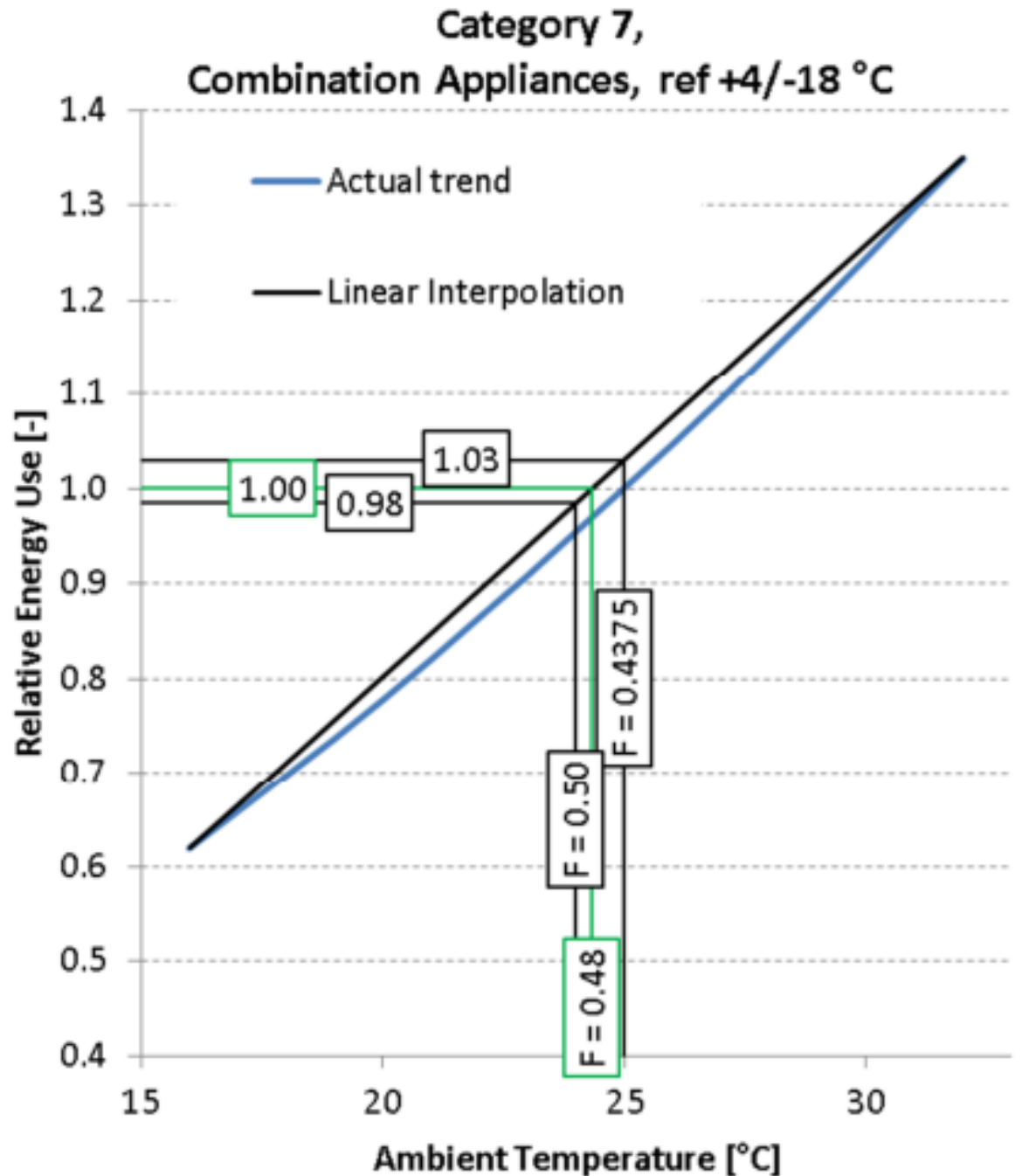
Metric

Annual energy consumption (kWh)

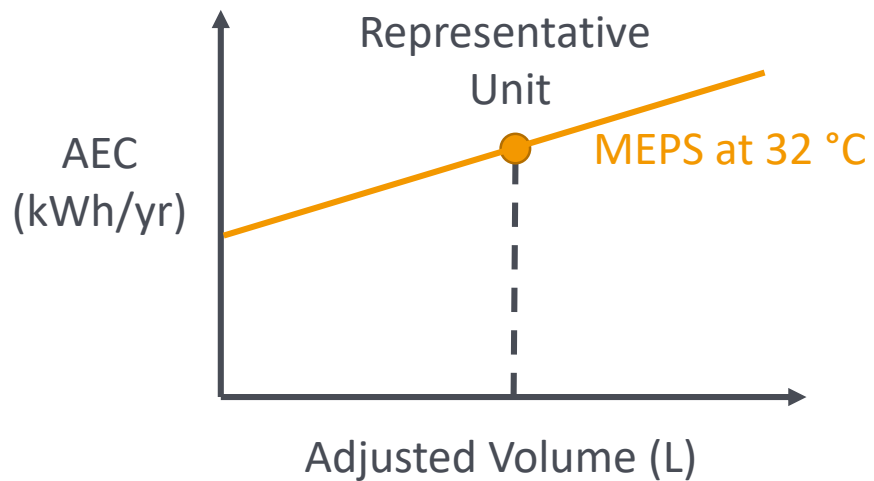
Refrigerators

MEPS evaluated at 32 °C were normalized to 24 °C

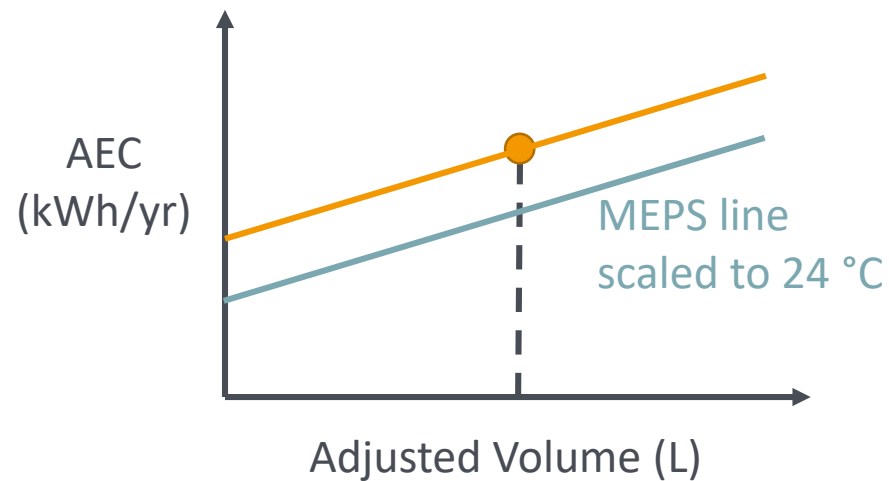
- Lower heat load
- Higher COP



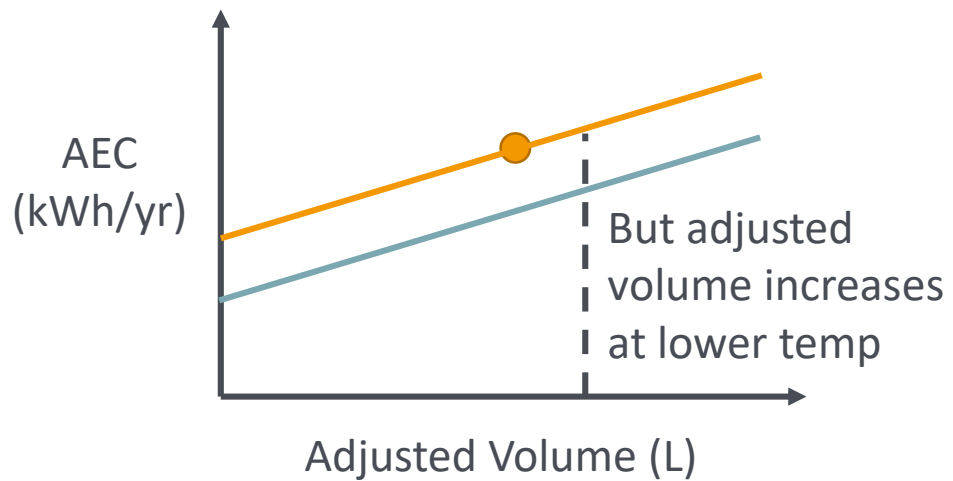
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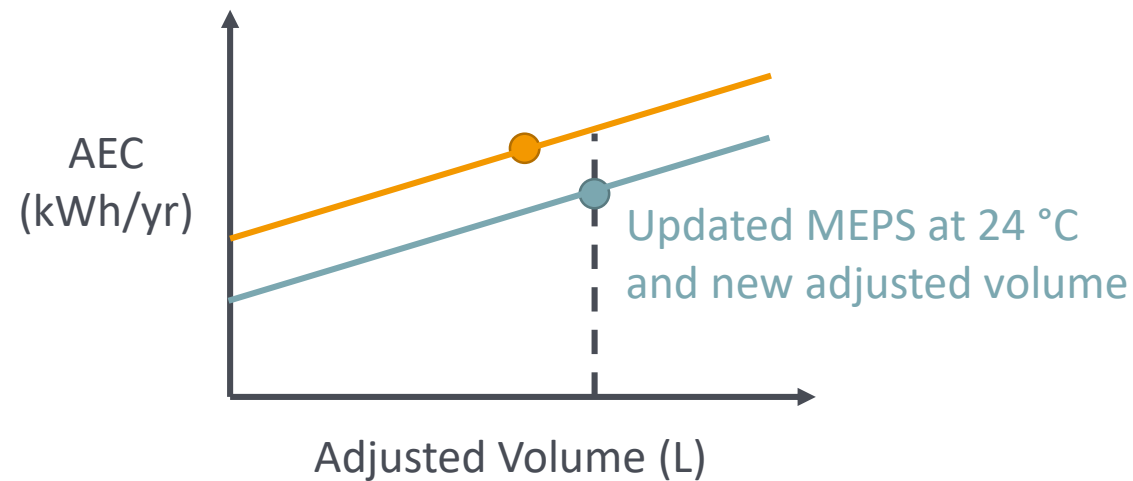
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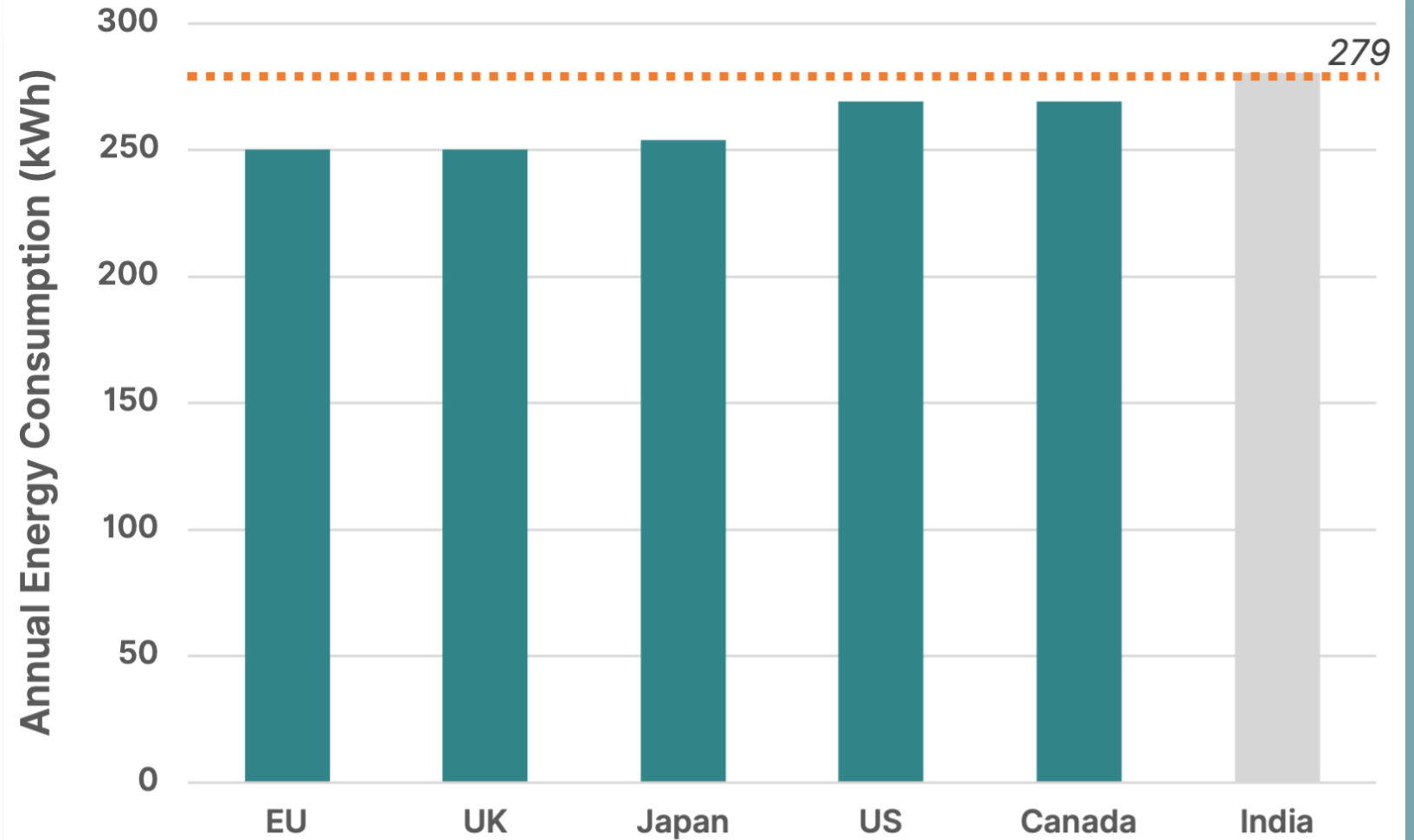
3.



4.



Refrigerators

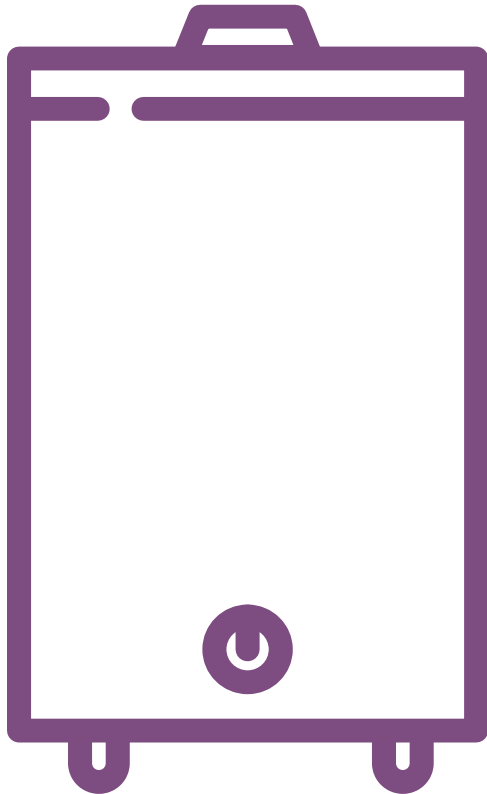


Refrigerators

Recommendations

- At a minimum, all economies should aim for MEPS at 279 kWh/year.
- Next, match U4E's intermediate target of 223 kWh/year.

Residential Water Heating



Product

Gas storage & instantaneous
Electric storage

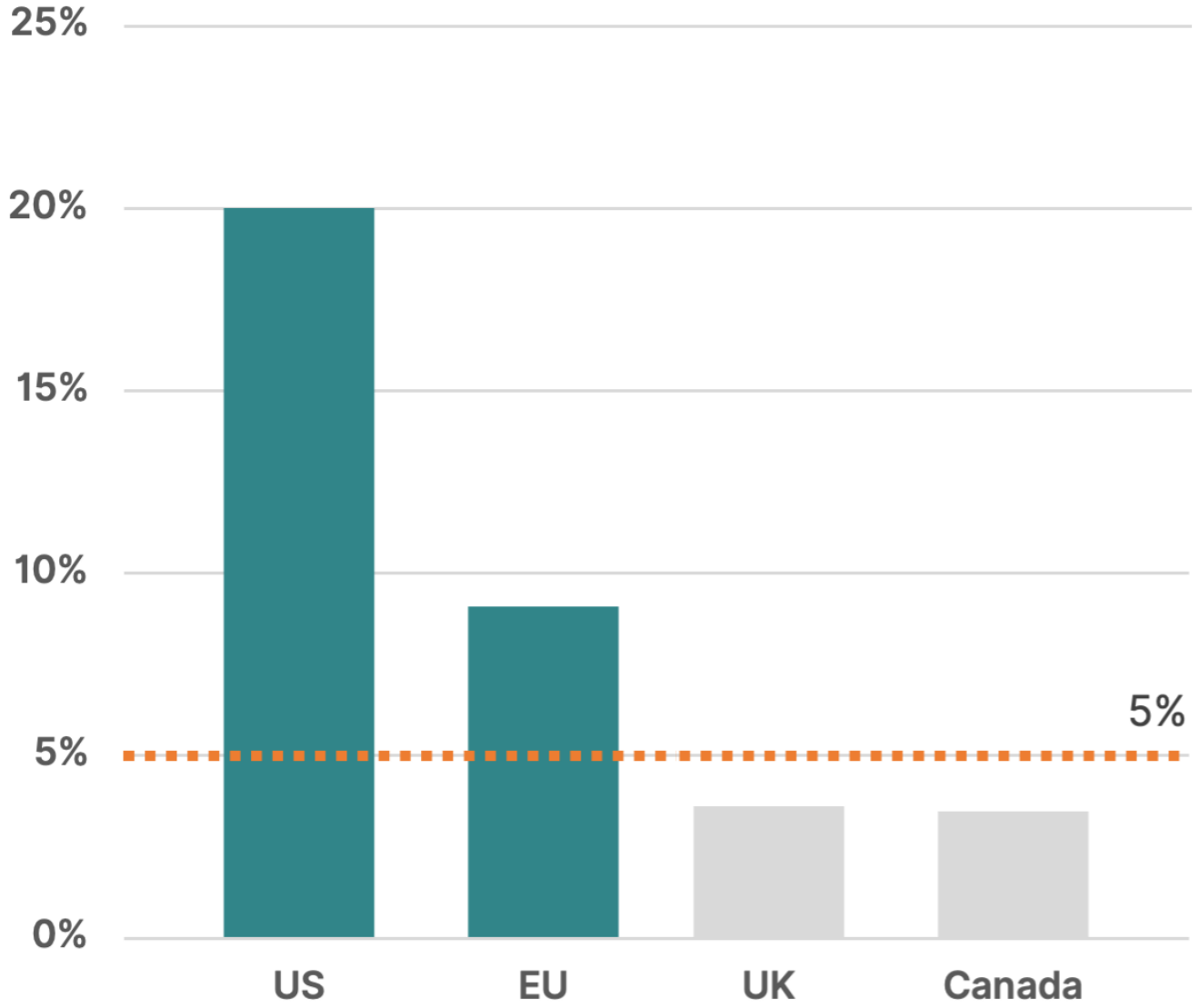
Did not evaluate solar water heating

- China: 7–65% stock share
- India: 13% market share
- South Africa: 6% stock share

Focused on major technology shifts: condensing ($\geq 86\%$) and heat pumps ($> 100\%$)

Residential Water Heating

Percentage of Market Subject to Ambitious Policies (0-100%)



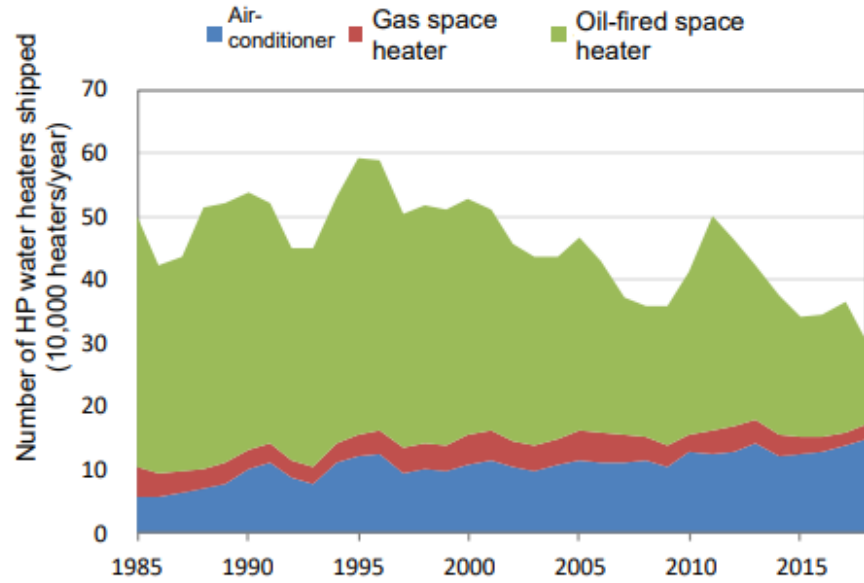
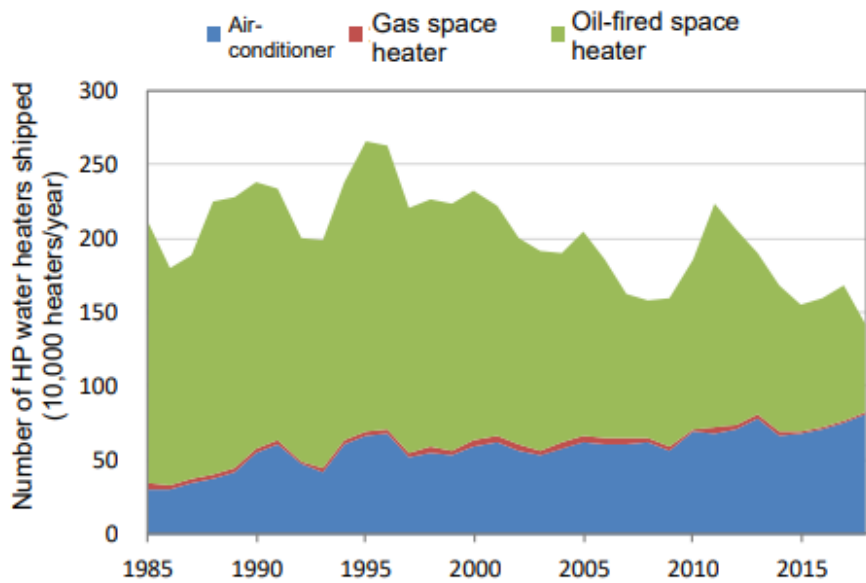
Residential Space Heating



Product

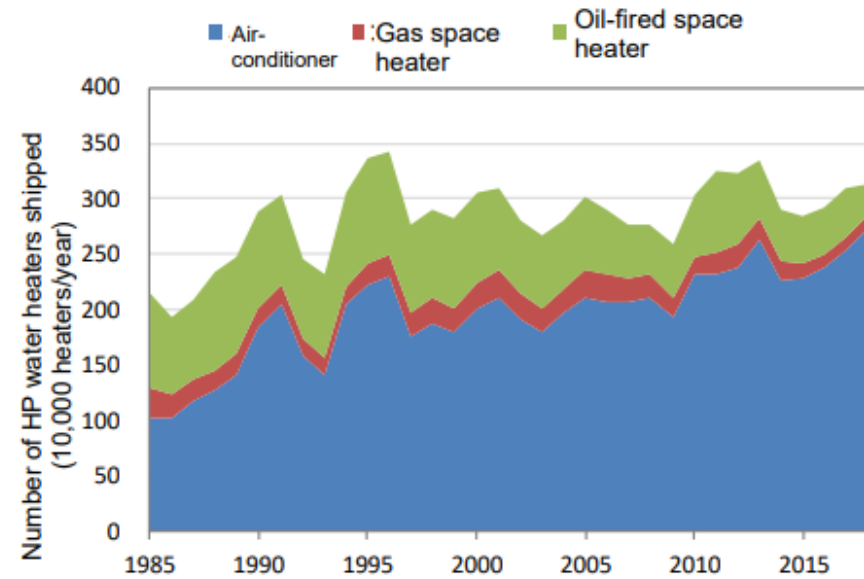
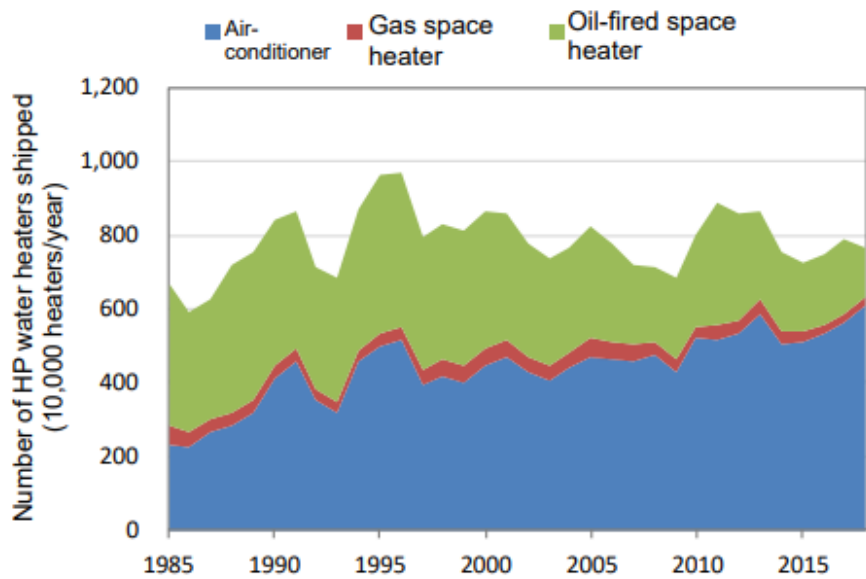
Product types with significant potential for efficiency/CO₂ reduction:

- Gas furnaces & boilers
- Electric resistance
- One-way air conditioners



Market segment (1): Cold region, detached house

Market segment (2): Cold region, apartment house

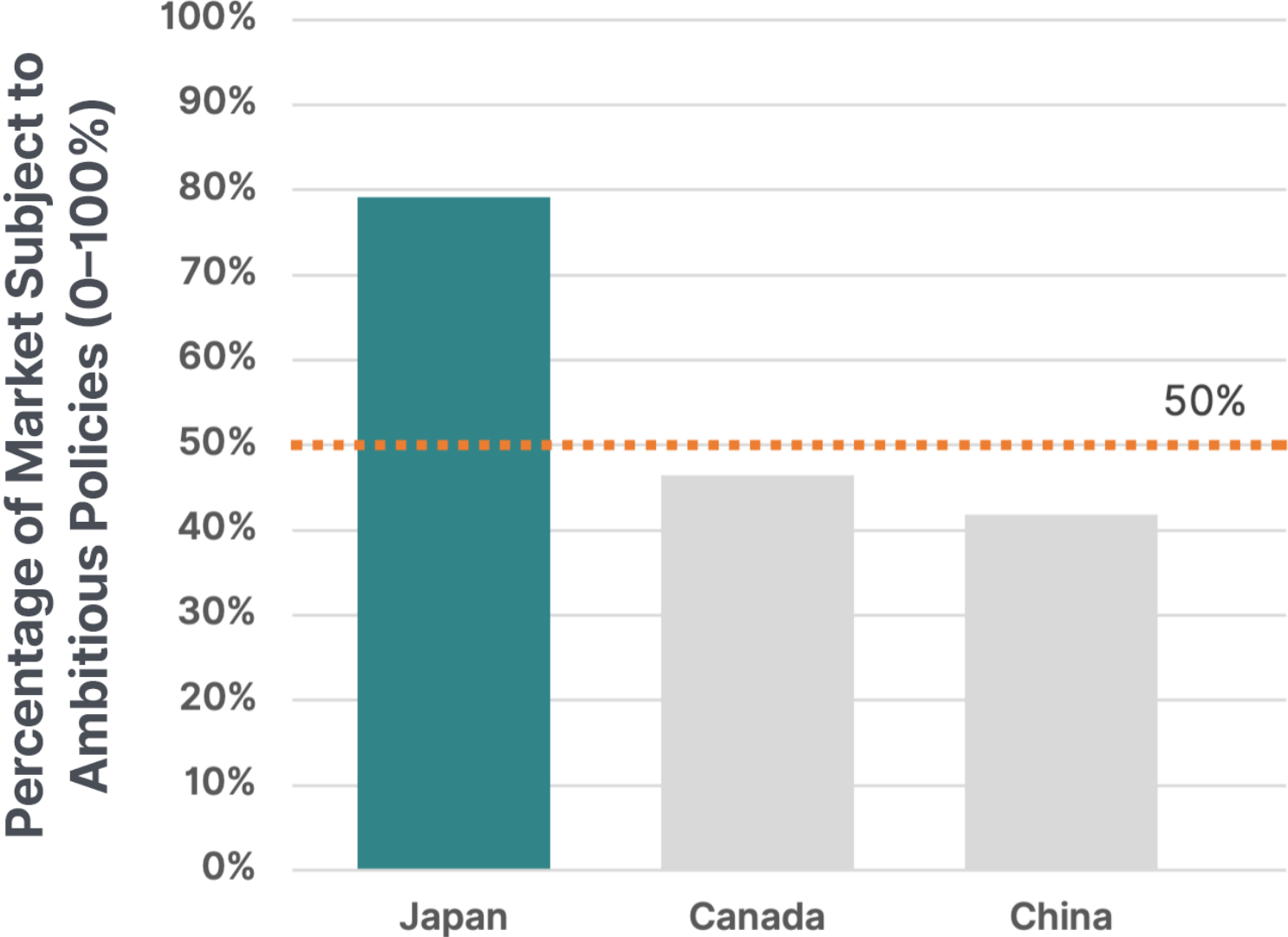


Market segment (3): Warm region, detached house

Market segment (4): Warm region, apartment house

Heat Pump & Thermal Storage Technology Center of Japan, "FY2020 Survey on Heat Pump Diffusion Prospects," August 2020. Note y-axis should be labeled "space heaters".

Residential Space Heating



Residential Space Heating

Recommendation

- Require condensing efficiencies and heat pumps
- Replace one-way air conditioners with heat pumps

Energy and Mines Ministers' Conference. [*Paving the Road to 2030 and Beyond: Market transformation road maps for energy efficient equipment in the building sector*](#), 2018.

Figure 5. Aspirational goals to 2035 for space heating in Canada

Short term: By 2025,

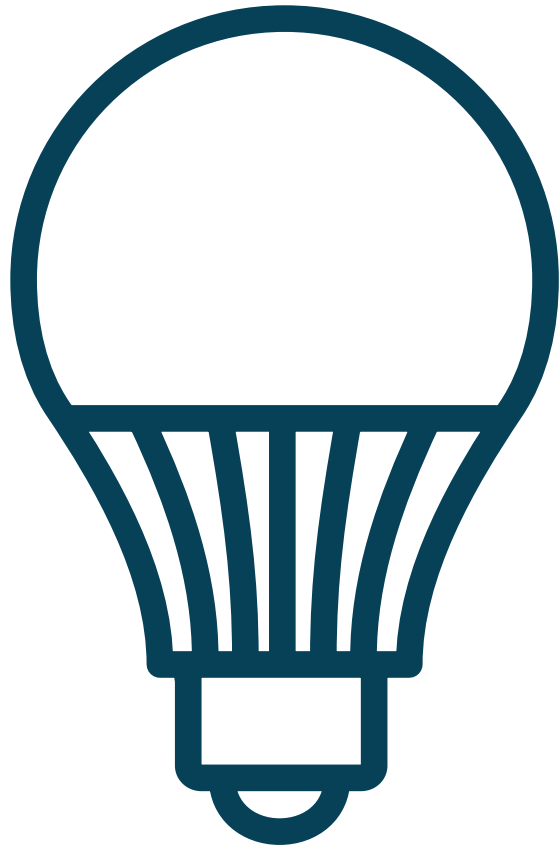
- All fuel-burning technologies for primary space heating for sale in Canada meet an energy performance of at least 90% (condensing technology).
- All air-source heat pumps for sale in Canada meet a SCOP greater than 2.5,¹⁰ at least 30% better performance than today.

Medium term: By 2030,

- A residential natural gas heat pump with a SCOP greater than 1.2 can be manufactured and installed cost-effectively.¹¹
- A residential cold climate air-source heat pump with a SCOP greater than 2.75 can be manufactured and installed cost-effectively.¹²
- The deployment of heating systems using renewable technologies and renewable resources is supported.

Long term: By 2035, all space heating technologies for sale in Canada meet an energy performance of more than 100%.

Residential Lighting



Product

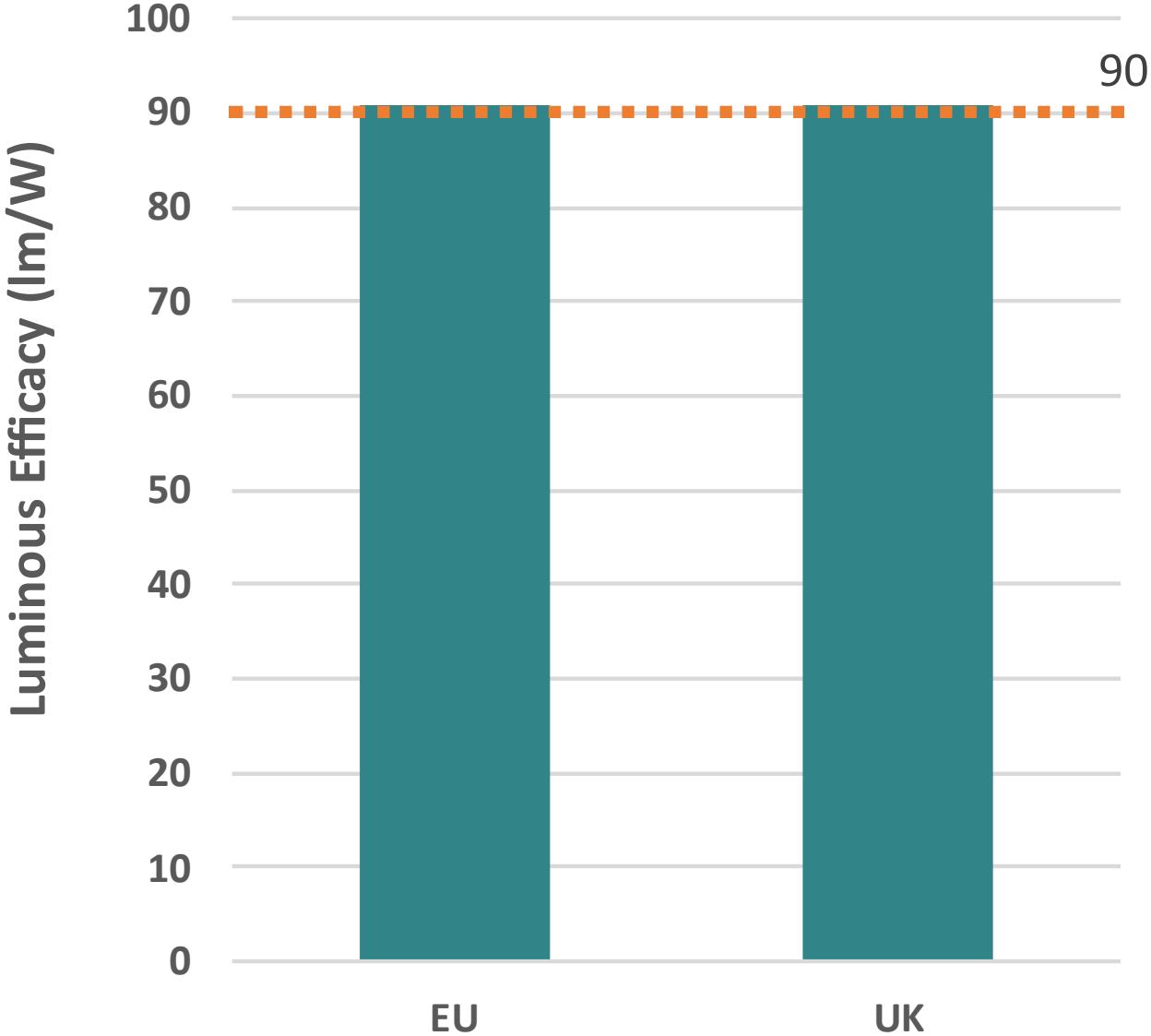
Indoor, non-directional general service lamps

Metric

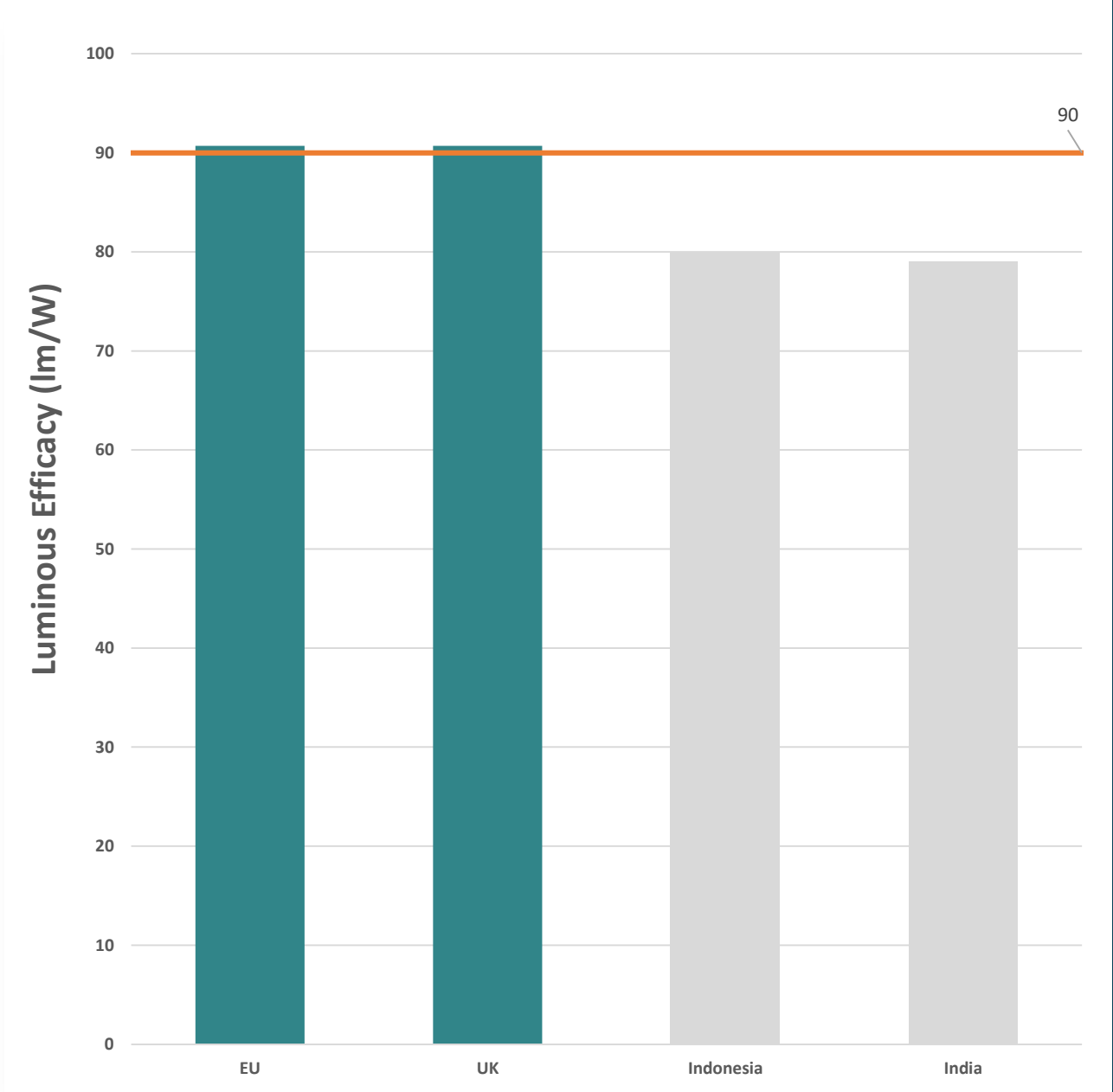
Minimum luminous efficacy (lm/W)

	Column 1	Column 2	Column 3
Item	Energy-using Product	Energy Efficiency Standard	Period of Manufacture
1	General service lamps that have a luminous flux of < 750 lm	Nominal power ≤ 29 W Life ≥ 1 000 hours Colour rendering index ≥ 80	On or after December 31, 2014
2	General service lamps that have a luminous flux of ≥ 750 lm and < 1 050 lm	Nominal power ≤ 43 W Life ≥ 1 000 hours Colour rendering index ≥ 80	On or after December 31, 2014
3	General service lamps that have a luminous flux of ≥ 1 050 lm and < 1 490 lm	Nominal power ≤ 53 W Life ≥ 1 000 hours Colour rendering index ≥ 80	On or after January 1, 2014
4	General service lamps that have a luminous flux of ≥ 1 490 lm	Nominal power ≤ 72 W Life ≥ 1 000 hours Colour rendering index ≥ 80	On or after January 1, 2014

Residential Lighting



Residential Lighting

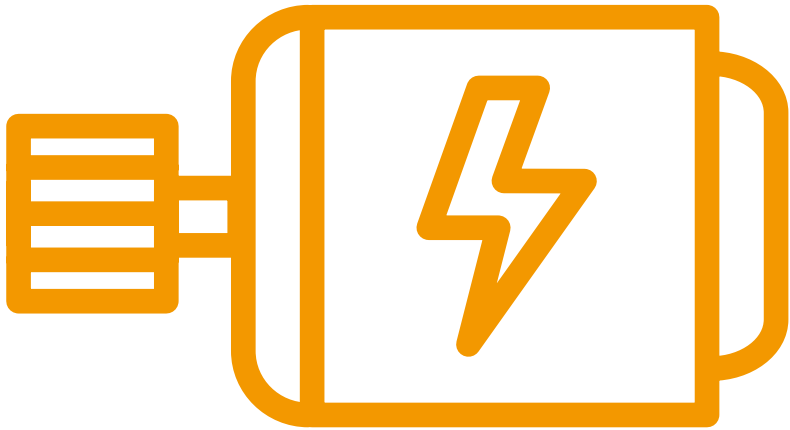


Residential Lighting

Recommendations

- All economies should adopt **technology-neutral MEPS** at 90 lm/W or greater.
- Economies already meeting this requirement should strive for more stringent MEPS of at least 120 lm/W.

Electric Motors



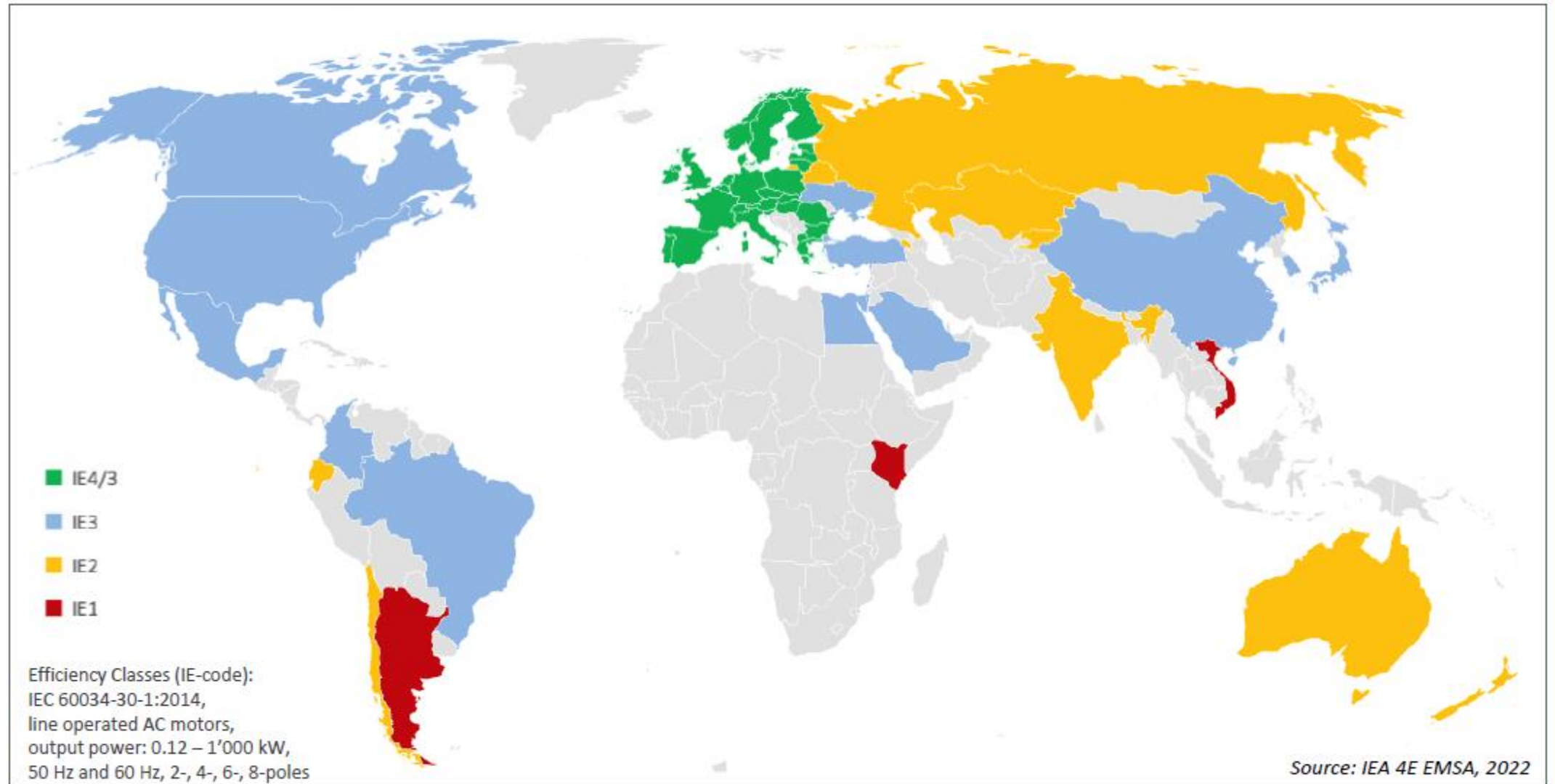
Product

3-phase Induction Motor <1000 V

Metric

Efficiency class under IEC 60034-30-1 & additional MEPS for motor driven applications

Minimum Energy Performance Requirements Electric Motors



EU: **Tier1** per 15/7/2021: IE3 (0.75-1'000 kW), IE2 (0.12-0.75 kW), **Tier2** per 1/7/2023: same as Tier 1 + IE4 (75-200 kW). Note: UK and CH have applied EU regulation in full.

IEC and ISO Standards and MEPS motors, converters, pumps, fans, compressors

Component	Scope	Testing Standard	Efficiency Classification Standard			Performance Requirement	
				efficiency metric	P ^I		EP
Motor	3-phase induction motors (Low Voltage < 1'000 V)	IEC 60034-2-1 IEC 60034-2-3	IEC 60034-30-1 IEC 60034-30-2	IE	x		Mandatory MEPS ^{II} 30+ countries/regions, see
Converter	Variable Frequency Converter (VFC, VSD)	IEC 61800-9-2	IEC 61800-9-2	IE	x		EU
Pump	Rotodynamic water pump	ISO 9906	- EU: EN 16480 US: DOE x CN: GB-x	- MEI PEI EI	 x x	 x	EU USA China
Fans	Industrial	ISO 5801	ISO 12759-1 ISO 12759-2 ISO 12759-3 ISO 12759-4 ISO 12759-5 ISO 12759-6 (CD)	standard losses FEG FMEG JFEMG FEI	 x	 x x	- China EU US
Air compressor	Compressor package	ISO 1217	ISO 1217 ISO 1217, Am.1:2016	Compressor efficiency grade Isentropic efficiency		x x	China USA

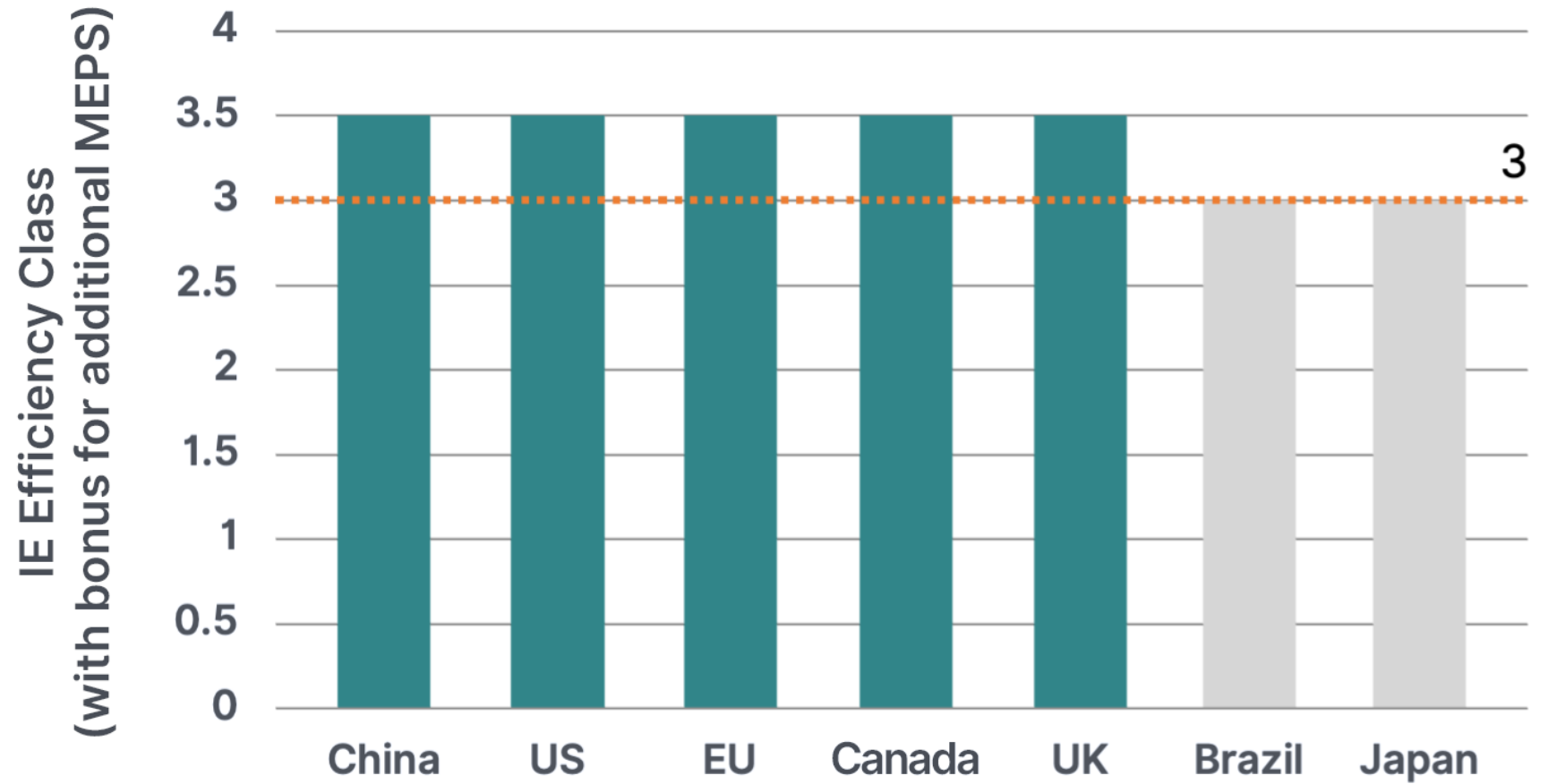
01 05 2022

I P = product, EP = extended product (motor, control, transmission, pump/fan/compressor)

II MEPS = Minimum Energy Performance Standard (set as requirement by regulators)

Source: IEA 4E EMSA, 2022

Electric Motors

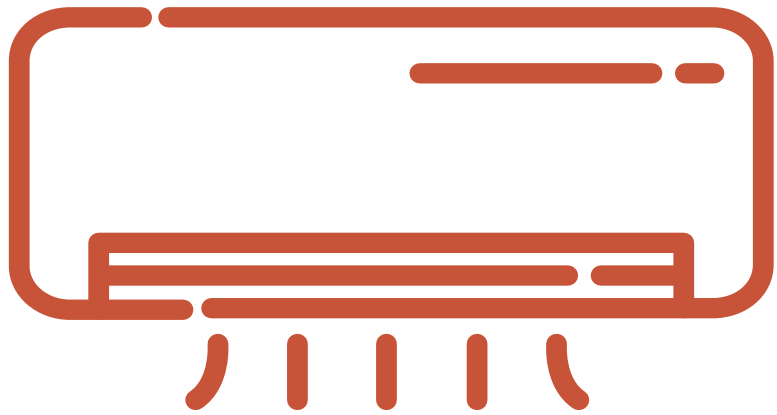


Electric Motors

Recommendations

- All economies should require a **minimum efficiency class of IE3**, while leading economies should strive for IE4 or IE5.
- Economies should also consider adopting requirements for additional components such as **variable speed drives** or for **industrial pumps, fans, and air compressors**.

Air Conditioners



Product

7 kW split-system unit

Metric

Seasonal energy efficiency metric
(ISO CSPF Wh/Wh)

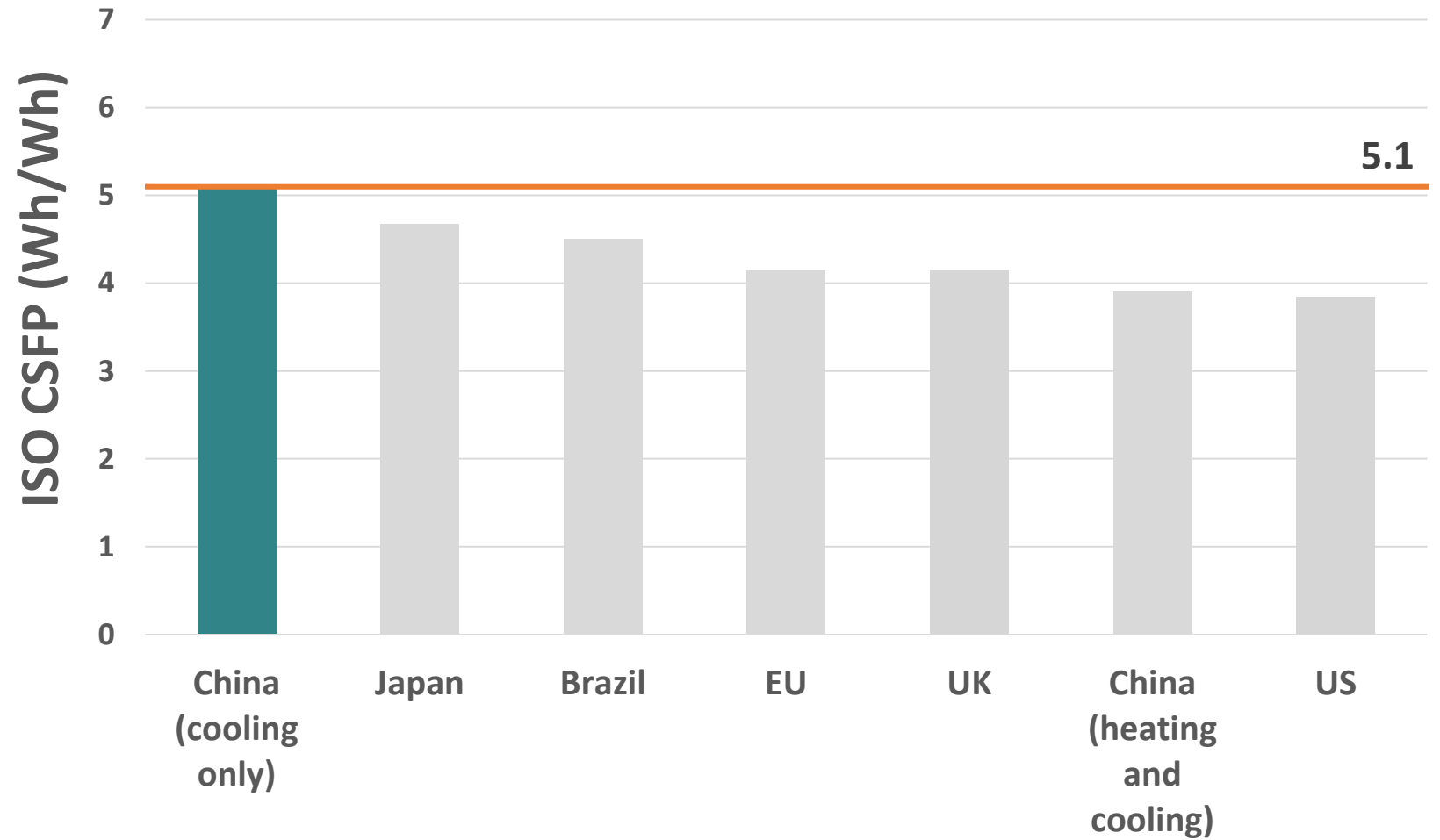
Table B1

Interregional conversion relationships of seasonal energy efficiency for split room ACs, based on the data of two FSD and four VSD models (Group A).

Y	X	$Y = d + \frac{a-d}{(1 + (\frac{X}{c})^b)}$								Alternative (linear, logarithm, or exponential)
		a	b	c	d	R ²	p-value	Std. error		
ISO CSPF	ISEER	1.847	3.269	5.473	12.156	0.999	0.002	0.134	7.726·ln(X)-5.318 (R ² = 0.996)	
	China APF	3.105	7.216	4.659	10.287	0.994	0.011	0.330	1.798·X-2.027 (R ² = 0.970)	
	Japan APF	3.348	5.036	7.349	14.855	1.000	0.001	0.087	1.735·exp. (0.220·X) (R ² = 0.976)	
	Korea CSPF	3.244	4.490	7.179	11.221	0.999	0.002	0.132	0.970·X + 0.048 (R ² = 0.991)	
	U.S. SEER	1.728	1.741	15.127	26.177	1.000	0.000	0.047	0.962·X + 0.087 (R ² = 0.999)	
	EU SEER	-0.600	1.006	521,765	617,390	1.000	0.001	0.079	1.113·X-0.639 (R ² = 0.999)	
ISEER	ISO CSPF	2.465	1.765	15,334	2,215,983	0.996	0.007	0.192	2.085·exp. (0.137·X) (R ² = 0.996)	
	China APF	2.804	4.813	5.305	9.716	0.996	0.008	0.207	1.323·X-0.883 (R ² = 0.986)	
	Japan APF	3.150	3.696	248	1,790,672	0.997	0.006	0.172	1.807·exp. (0.184·X) ^c (R ² = 0.956)	
	Korea CSPF	2.982	3.200	9.533	12.086	0.997	0.005	0.166	2.094·exp. (0.133·X) (R ² = 0.992)	
	U.S. SEER	2.574	1.826	11,731	2,126,699	0.998	0.005	0.159	2.108·exp. (0.132·X) (R ² = 0.997)	
	EU SEER	2.322	1.823	10,862	2,158,012	0.994	0.011	0.239	1.910·exp. (0.152·X) (R ² = 0.995)	
China APF	ISEER	-0.369	0.781	21,142,970	729,082	0.987	0.027	0.278	0.745·X + 0.723 (R ² = 0.986)	
	ISO CSPF	2.405	1.603	33,306	1,919,929	0.974	0.051	0.385	0.539·X + 1.232 (R ² = 0.970)	
	Japan APF	2.936	3.210	486	2,193,369	0.982	0.036	0.321	1.849·exp. (0.160·X) (R ² = 0.967)	
	Korea CSPF	2.215	1.455	50,896	1,076,342	0.980	0.040	0.338	0.527·X + 1.233 (R ² = 0.976)	
	U.S. SEER	2.525	1.695	21,683	1,818,168	0.975	0.049	0.377	0.519·X + 1.280 (R ² = 0.969)	
	EU SEER	2.198	1.598	29,631	1,717,656	0.973	0.053	0.391	0.600·X + 0.887 (R ² = 0.970)	
Japan APF	ISEER	-9,160,614	1.788	0.001	8.854	0.994	0.012	0.248	5.207·ln(X)-2.840 (R ² = 0.956)	
	China APF	1.763	5.614	3.953	8.002	0.987	0.027	0.370	6.061·ln(X)-3.546 (R ² = 0.967)	
	ISO CSPF	-6,822,450	0.975	2.59E-06	10.239	0.989	0.021	0.328	4.428·ln(X)-2.307 (R ² = 0.976)	
	Korea CSPF	-555,719	0.533	5.07E-09	13.961	0.990	0.019	0.315	4.399·ln(X)-2.352 (R ² = 0.985)	
	U.S. SEER	-4,881,884	0.788	1.63E-07	11.142	0.989	0.022	0.337	4.342·ln(X)-2.250 (R ² = 0.979)	
	EU SEER	-7,207,856	1.180	2.94E-05	9.904	0.992	0.017	0.290	4.923·ln(X)-3.205 (R ² = 0.975)	

Won Park, et al., "Lost in Translation: Overcoming Divergent Seasonal Performance metrics to Strengthen Air Conditioner Energy-Efficiency Policies," Energy for Sustainable Development, February 1, 2020, <https://eta-publications.lbl.gov/sites/default/files/1-s2.0-S0973082619313560-main.pdf>.

Air Conditioners



Air Conditioners

Recommendations

- At a minimum, all economies should adopt **technology-neutral MEPS of 5.1 Wh/Wh** or greater.
- Additionally, any economy using an energy efficiency ratio (EER) should **switch to a seasonal performance metric** for fixed and variable-speed ACs.

Thank you!



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