Leapfrogging to Energy-Efficient and Climate Friendly Air Conditioners – Model Regulation Guidelines

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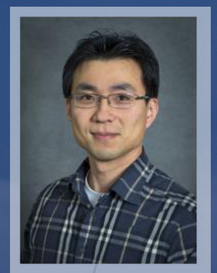

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Lawrence Berkeley National Laboratory (LBNL)

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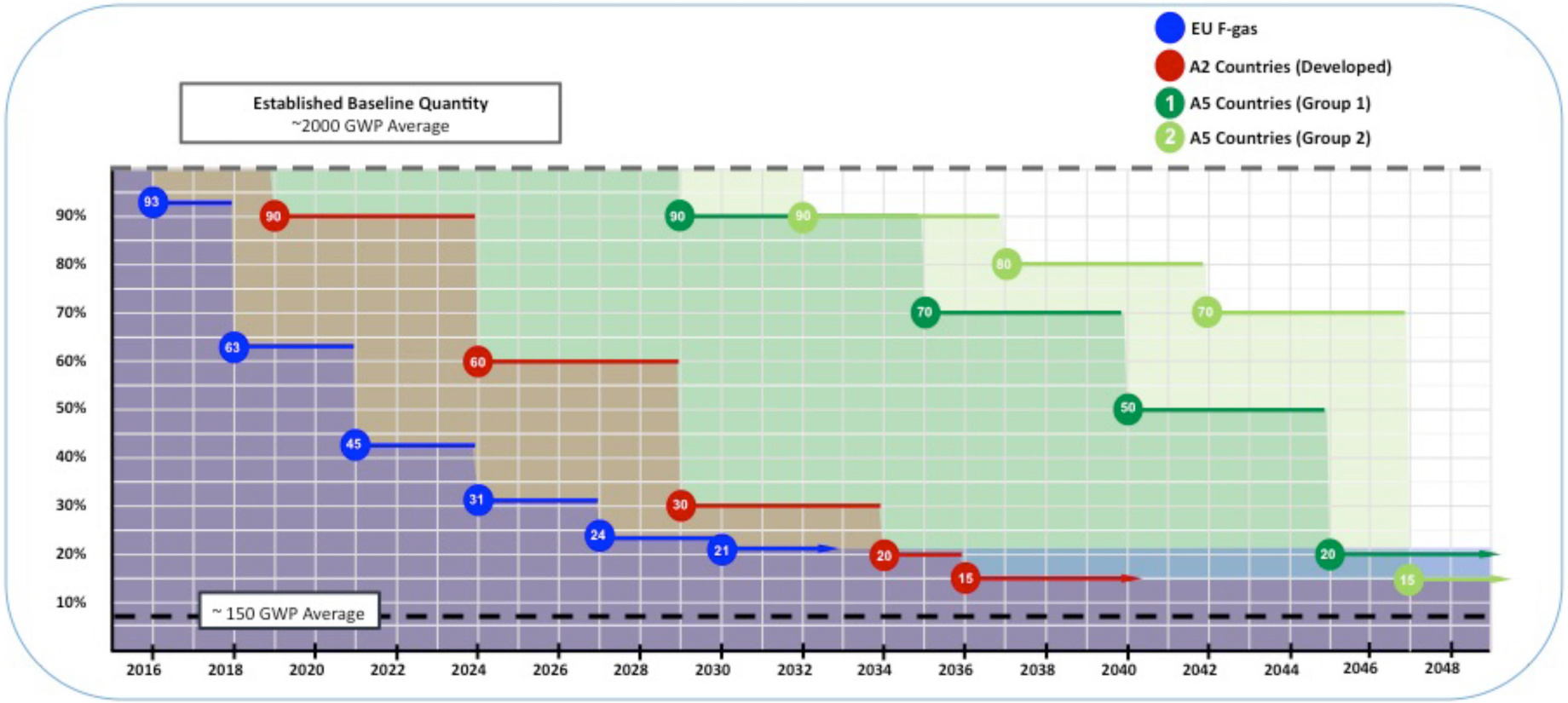
Lawrence Berkeley
National Laboratory

- 13 — Nobel Prizes
- 13 — National Medal of Science recipients
- 3,100 — Employees
- 200 — Site acreage

- Dedicated to solving the most pressing scientific problems facing humanity.
- More than three decades of work internationally on clean energy and climate policy, appliances, buildings, transport, industry, air quality.
- Significant focus on energy efficiency, including technical support to US DOE Appliance Standards Rulemakings.
- Technical support for Kigali Amendment negotiations.
- Technical support for market transformation programs on efficient ACs and refrigerators in various countries including China, India, Brazil, Mexico, Egypt, Indonesia, Rwanda, and United for Efficiency (U4E) “Model Regulation Guidelines”.

Global Cooling Industry in Transition

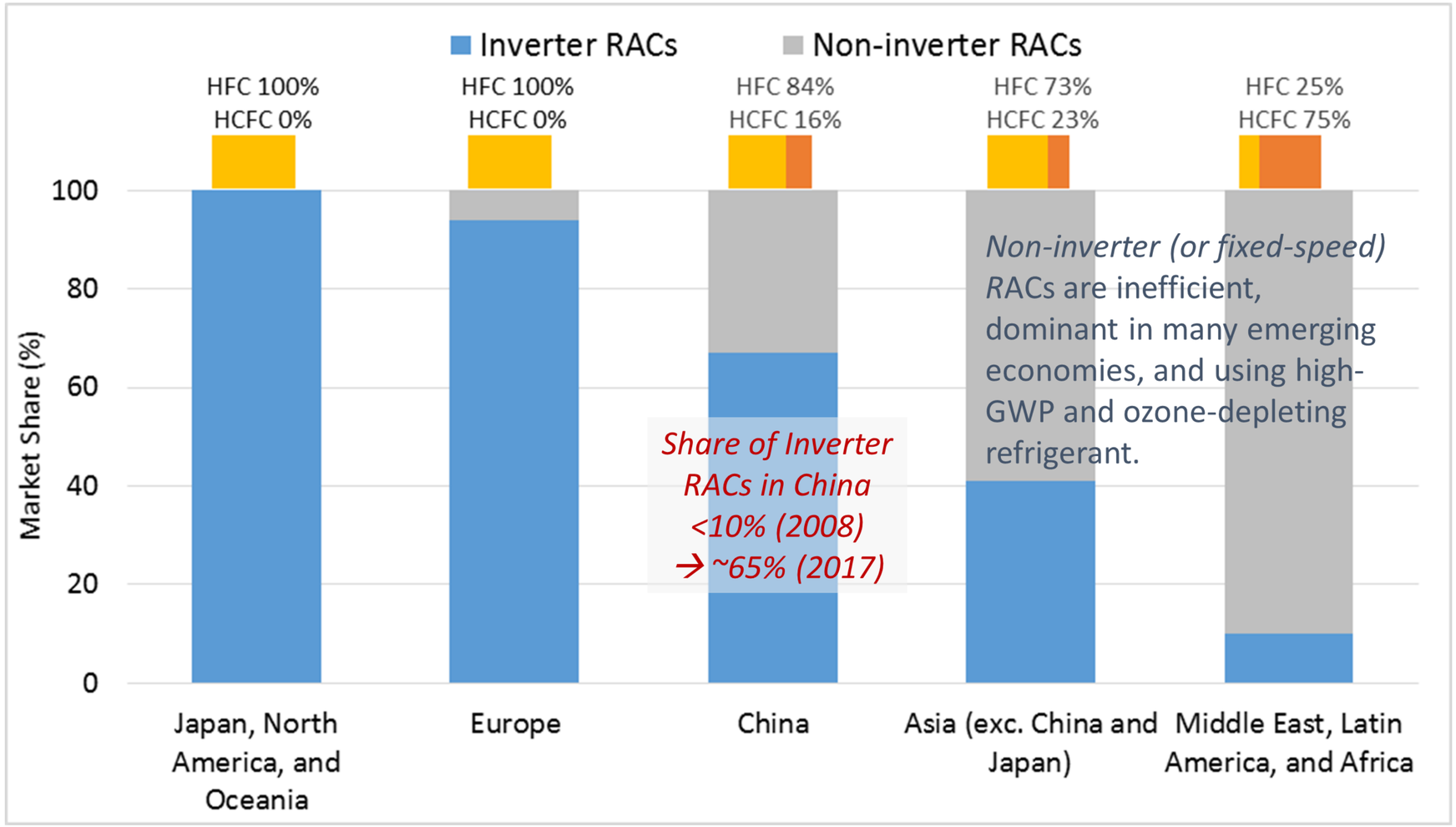
- Kigali Amendment estimated to save ~0.5 deg of global average temperature rise.
- Global cooling industry is at a “disruptive moment” due to refrigerant transitions.
- The world has 3-4 years to put in place the “right” cooling technologies.



Source: ASHRAE (2019)

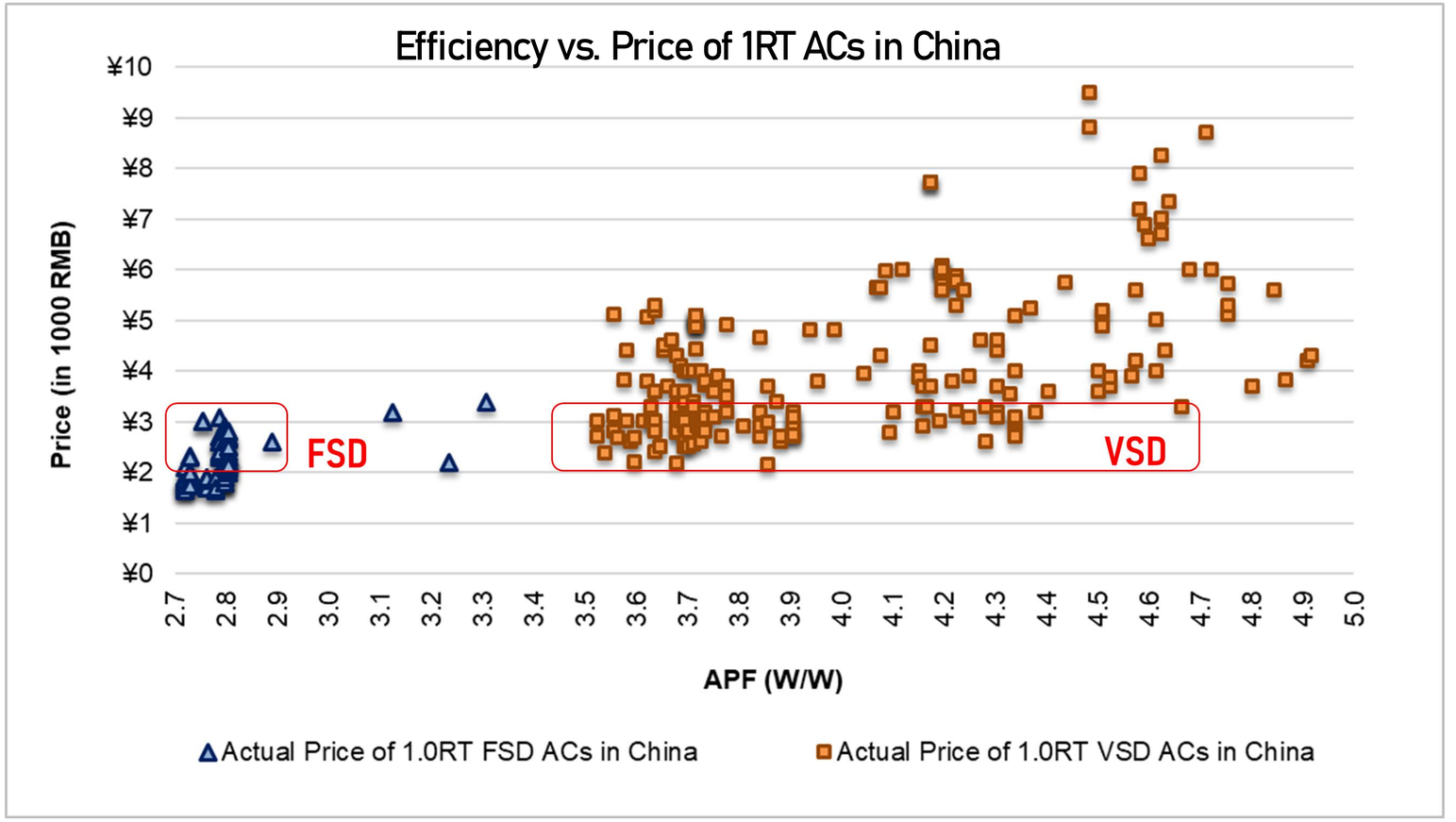
Global Room AC Market

- The global room AC (RAC) market and policies are in the midst of transition toward energy-efficient and sustainable solutions.



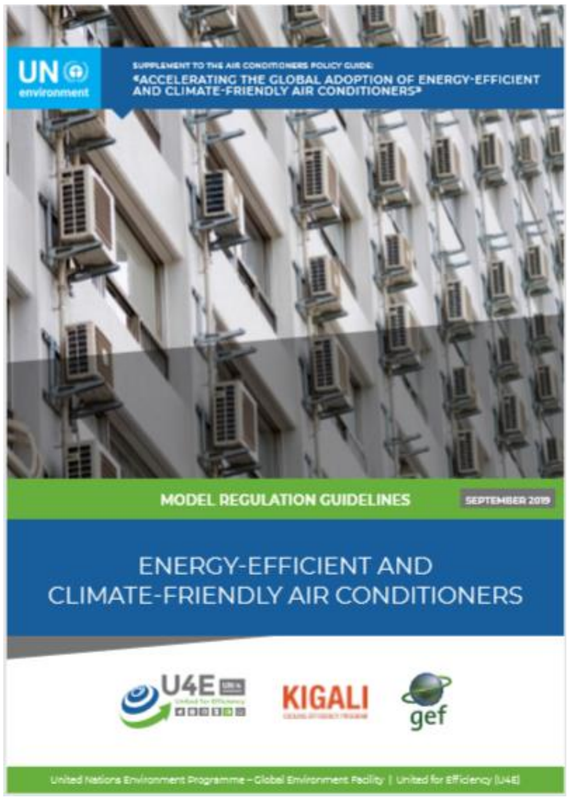
Global Room AC Market

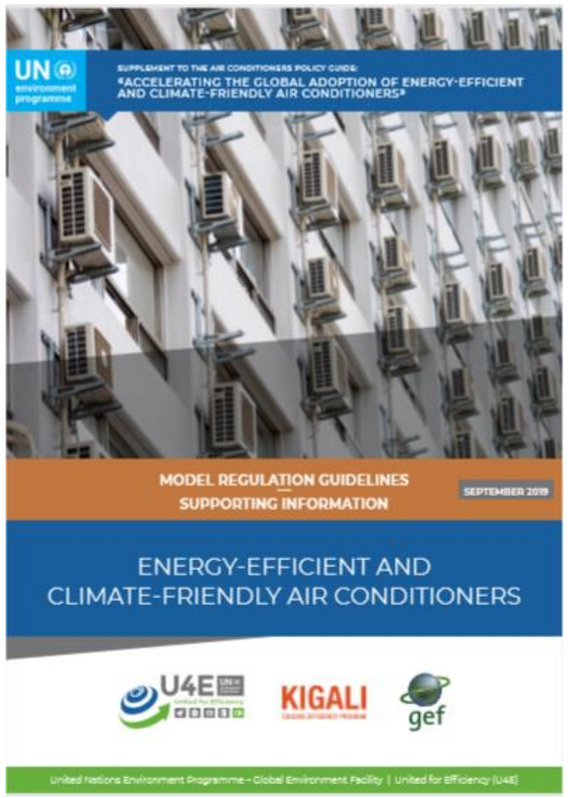
- Both efficient fixed-speed (FSD) and variable-speed (VSD) ACs are available at reasonable cost.
- Market prices appear to reflect the bundling of AC features other than efficiency, because prices at the same efficiency level vary by over 200%.



Source: LBNL

U4E Model Regulation Guidelines for ACs and Refrigerators





→ Intended as guidance to help inform regulatory authorities and policy makers

→ Sets a minimum efficiency floor to prohibit future sales of inefficient products from the market.

→ References global technology and policy trends

→ Deployed in various countries and multiple regions (including ASEAN, EAC, SADC, etc.)

Available in English Spanish, Chinese, French, Arabic versions upcoming

Resources: https://united4efficiency.org/resources/model-regulation-guidelines-for-energy-efficient-and-climate-friendly-air-conditioners/
https://united4efficiency.org/resources/model-regulation-guidelines-for-energy-efficient-and-climate-friendly-refrigerating-appliances/

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Benefits for supporting the adoption of Model Regulation Guidelines

Simplify adoption and implementation of a robust regulation

- Target energy-efficiency + lower-GWP refrigerants simultaneously
- Encourage higher performing products through labelling
- Vary requirements to capture climatic differences
- Use proven best practices and tap into global policy and technology trends

Catalyze product innovation, giving consumers more choice

Easier to harmonize requirements to reduce trade barriers and unlock economies of scale to make products more affordable

Enable more effective market enforcement using proven test procedures and an easier exchange of compliance info

Overview of Model Regulation Guidelines for ACs

Scope and product categories

- Rated cooling output of at or below 16 kW
- Air conditioners and heat pumps (reversible)
- Non-ducted single-split, self-contained, and portable
- Fixed-speed and variable-speed

MEPS & performance labelling requirements

- Based on international practices, underlying analyses, and market availability of energy-efficient ACs
- Developed assuming interested countries would put them into effect in approximately 2023

Test methods and efficiency metrics

- ISO 5151
- ISO 16358: 2013; ISO 16358-1: 2013/Amd 1: 2019
- Outdoor temperature bin hours for various climate regions
- CSPF for cooling-only units; APF for reversible heat pumps

Refrigerant requirements

- GWP 150 or lower for self-contained systems
- GWP 750 or lower for ductless split systems

* Model Regulation Guidelines does not include product registry, lab certification procedures, and monitoring, verification & enforcement (MVE) procedures.

Evaluating Efficiency Performance of ACs

- Along with the technology trend, seasonal energy efficiency metrics have been designed to estimate the efficiency performance, based on full- and part-load operations at multiple temperature conditions depending on climate.

EER (W/W)

$$\frac{Total\ Cooling\ Capacity\ (W)}{Power\ Input\ (W)}$$

at given rating conditions (typically at 35°C).

An alternate definition of EER is Coefficient of Performance (COP),

$$\frac{Total\ Cooling\ Capacity\ \left(\frac{Btu}{h}\right)}{Power\ Input\ (W)}$$

1 BTU/h = equivalent to 0.293 W.

Seasonal Energy Efficiency (Wh/Wh)

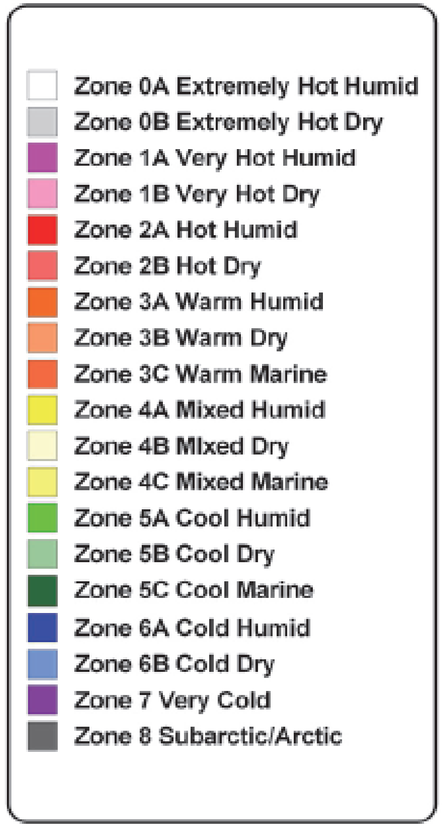
$$\sum cooling\ load\ (t_j) / \sum cooling\ energy\ consumption(t_j)$$

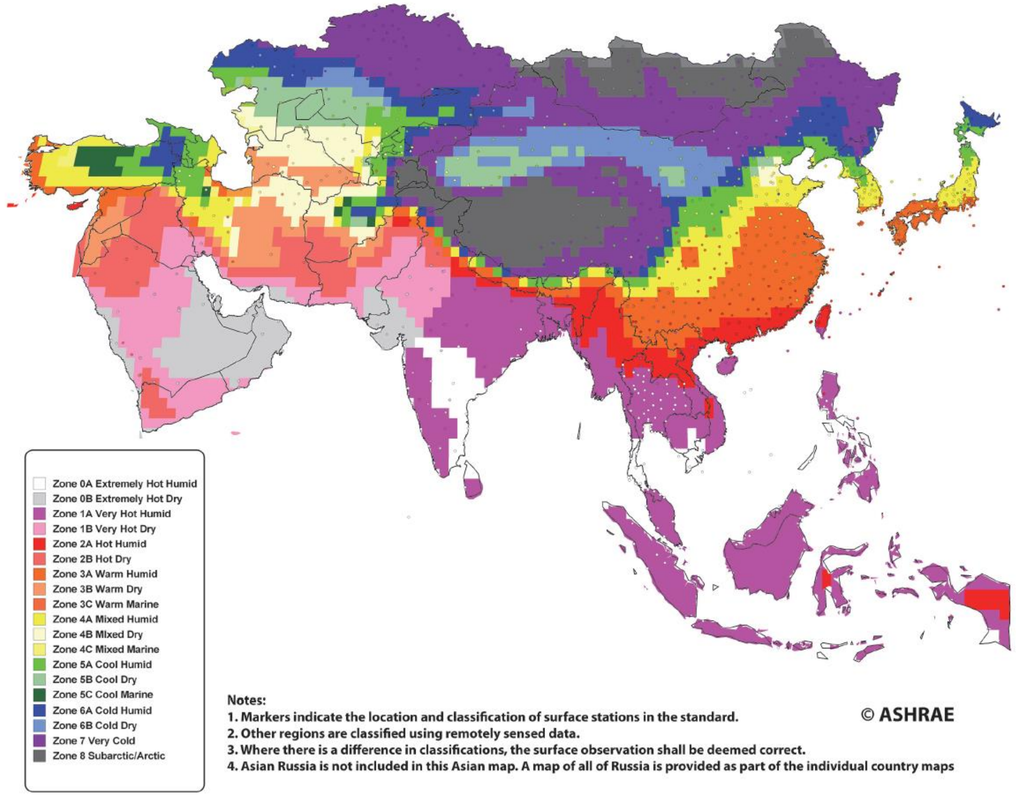
Reference Standards	International (ISO 16358/5151)	EU (EN 14511)	U.S. (AHRI 210/240)
Outdoor temperature range and hours of AC use	e.g. ISO CSPF 21–35°C 1,817 hours	e.g. EU SEER 17–40°C 2,602 hours	e.g. US SEER 65–104°F (18.3–40°C) fractional bins
Seasonal Efficiency Indicator	CSPF, HSPF, and APF (ISO 16358)	SEER, SCOP (EN 14825)	SEER, HSPF (AHRI 210/240)

- Australia, Japan, India, Indonesia, Malaysia, Myanmar, Philippines, Cambodia, Thailand, Vietnam, Lao PDR, Hong Kong, Brazil, Rwanda, etc.
- China's SEER and Korea's CSPF are largely consistent with ISO CSPF.

Efficiency Requirements by Climate Regions

- Model Regulation provides efficiency requirements for various climate regions, as well as ISO 16358 reference temperature bin hours.





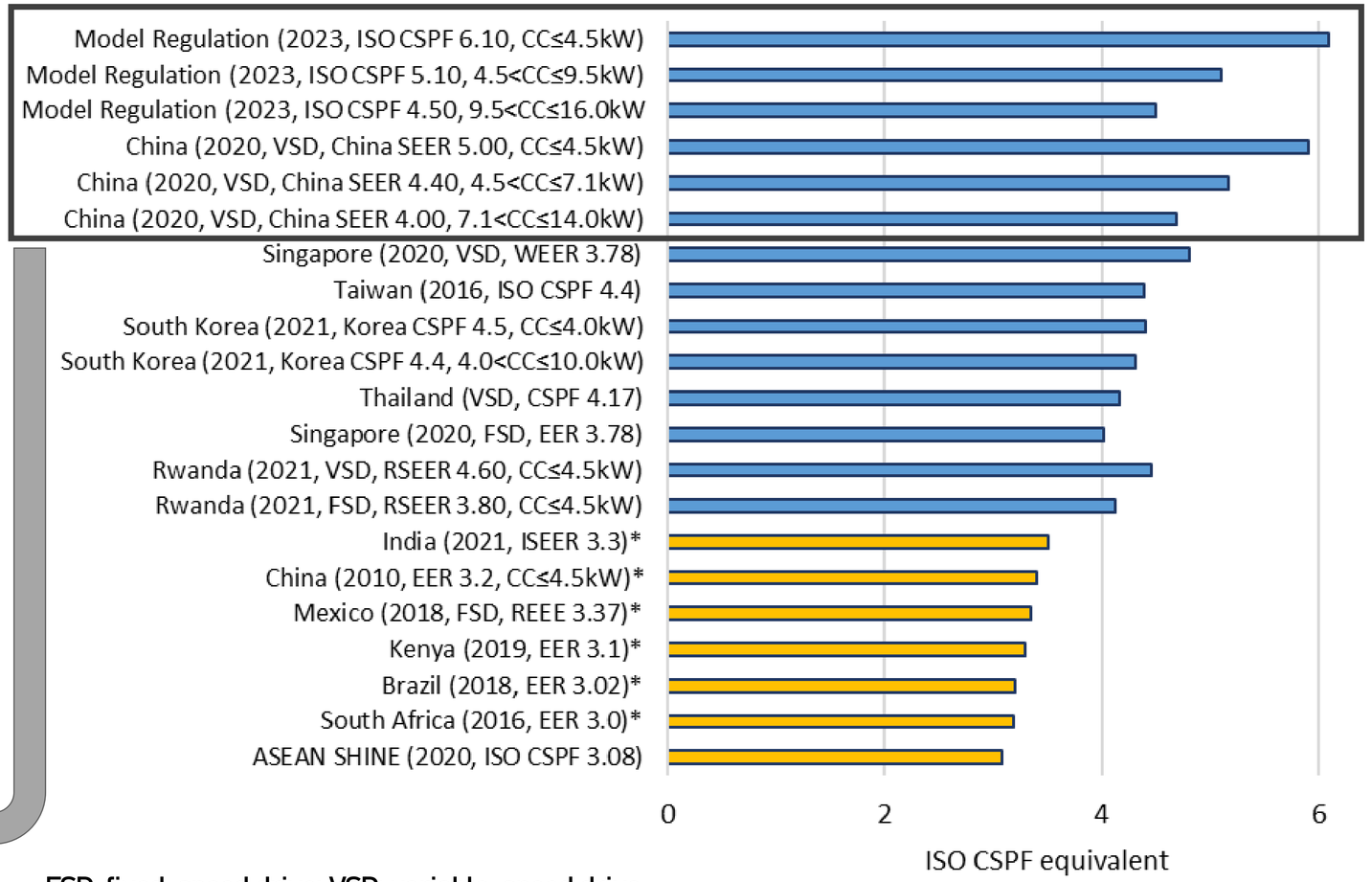
Climate Group (Temperature Bin Hours)	Grade	Rated Cooling Capacity ≤ 4.5 kW	4.5 kW < Rated Cooling Capacity ≤ 9.5 kW	9.5 kW < Rated Cooling Capacity ≤ 16.0 kW
Group 1 (ISO 16358-1: 2013)	High Efficiency	8.00 ≤ CSPF	7.60 ≤ CSPF	7.10 ≤ CSPF
	Intermediate	7.10 ≤ CSPF < 8.00	6.40 ≤ CSPF < 7.60	5.80 ≤ CSPF < 7.10
	Low Efficiency	6.10 ≤ CSPF < 7.10	5.10 ≤ CSPF < 6.40	4.50 ≤ CSPF < 5.80
0A (Model Regulation)	High Efficiency	7.40 ≤ CSPF	7.00 ≤ CSPF	6.60 ≤ CSPF
	Intermediate	6.60 ≤ CSPF < 7.40	6.00 ≤ CSPF < 7.00	5.50 ≤ CSPF < 6.60
	Low Efficiency	5.70 ≤ CSPF < 6.60	4.90 ≤ CSPF < 6.00	4.30 ≤ CSPF < 5.50
1A (Model Regulation)	High Efficiency	7.00 ≤ CSPF	6.60 ≤ CSPF	6.20 ≤ CSPF
	Intermediate	6.20 ≤ CSPF < 7.00	5.70 ≤ CSPF < 6.60	5.20 ≤ CSPF < 6.20
	Low Efficiency	5.40 ≤ CSPF < 6.20	4.70 ≤ CSPF < 5.70	4.20 ≤ CSPF < 5.20
2A (Model Regulation)	High Efficiency	7.30 ≤ CSPF	6.90 ≤ CSPF	6.50 ≤ CSPF
	Intermediate	6.50 ≤ CSPF < 7.30	5.90 ≤ CSPF < 6.90	5.40 ≤ CSPF < 6.50
	Low Efficiency	5.60 ≤ CSPF < 6.50	4.80 ≤ CSPF < 5.90	4.30 ≤ CSPF < 5.40
3A (Model Regulation)	High Efficiency	7.00 ≤ CSPF	6.60 ≤ CSPF	6.20 ≤ CSPF
	Intermediate	6.20 ≤ CSPF < 7.00	5.70 ≤ CSPF < 6.60	5.20 ≤ CSPF < 6.20
	Low Efficiency	5.40 ≤ CSPF < 6.20	4.70 ≤ CSPF < 4.70	4.20 ≤ CSPF < 5.20

Additional Information in the Supporting Documents

Benchmarking the Model Regulation Guidelines

Examples of energy-efficiency performance requirements

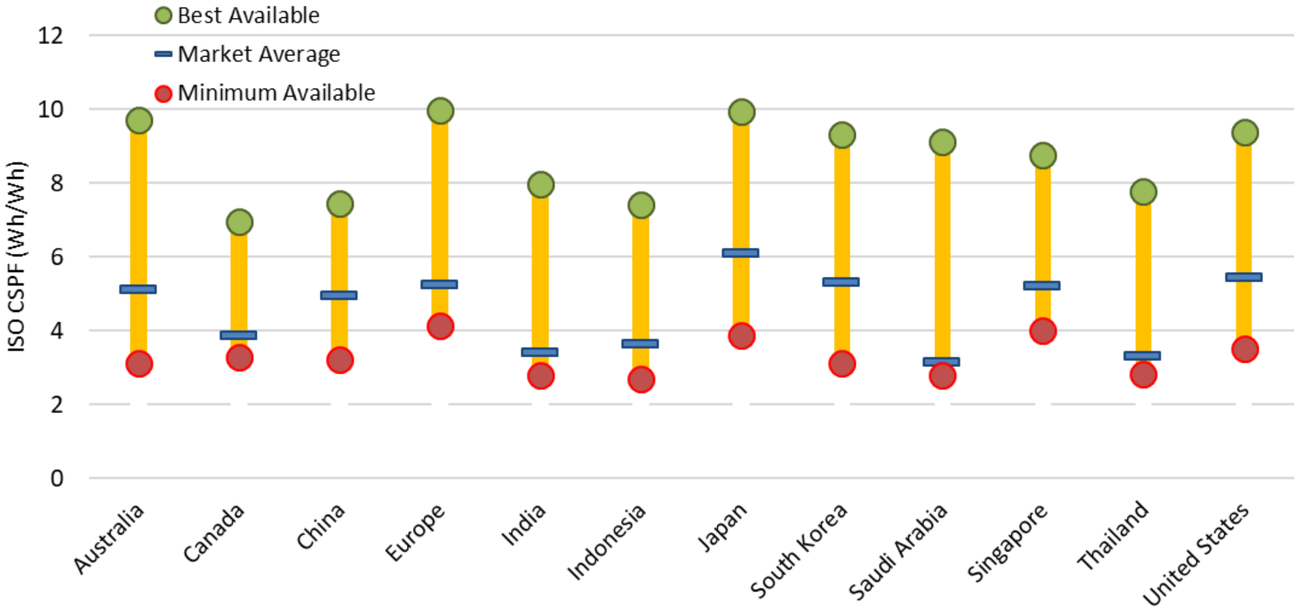
- Model Regulation is aligned with international best practices, availability of technologies, expected market transition, etc.
- China plans to adopt common MEPS levels for variable- and fixed-speed ACs in 2022. These levels align with the U4E Model Regulation Guidelines' minimum efficiency requirements for ACs.



FSD: fixed-speed drive; VSD; variable-speed drive
ISO CSPF for fixed-speed AC units results in a linear relationship with EER, i.e., CSPF = α × EER (e.g., α=1.062 with the ISO reference temperature bin hours), e.g., The CSPF for an EER 3.2 fixed-speed AC is ~3.40.

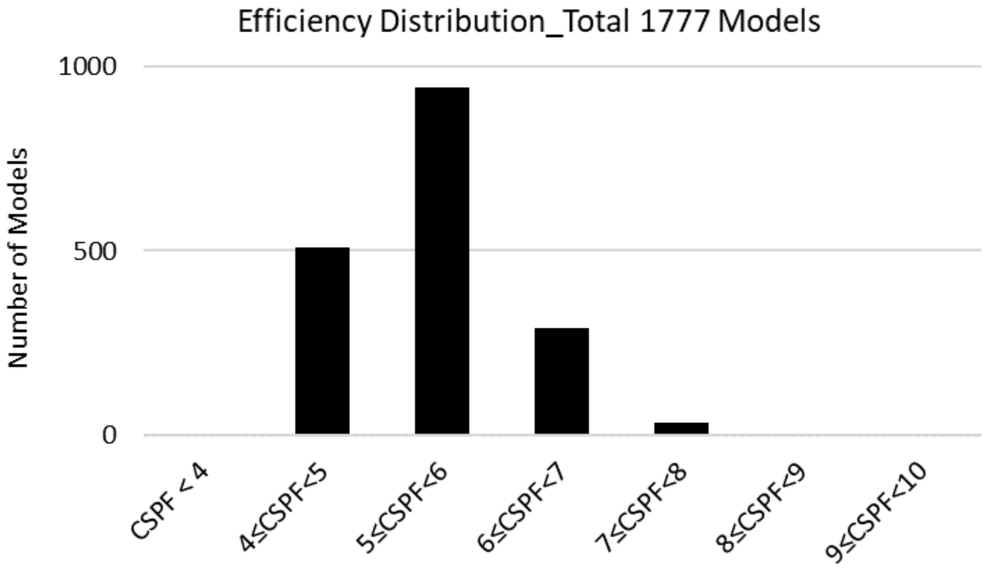
Availability of Compliant AC Models

- There are opportunities to achieve bigger energy savings in commercially available technologies.
- For example, about 1,000 models of 1,777 single split variable-speed AC models in Thailand are likely to meet the Guidelines CSPF requirements.



Source: LBNL's work based on IEA data

Efficiency of available residential ACs in selected regions



Thailand (2020)

The Label No5 Database - about 1,000 models of 1,777 single split variable-speed AC models with refrigerant unspecified are likely to meet the Guidelines CSPF requirements.

Summary and Conclusions

- The global room AC market is in the midst of transition toward energy-efficient and sustainable solutions.
- MEPS and labels are needed to minimize growth in energy use and pollution caused by new ACs. More efficient models are cost-effective for consumers.
- Harmonizing energy-efficiency standards across countries will benefit consumers, manufacturers, and governments by reducing trade barriers, effectively exchanging compliance information, and unlocking economies of scale to make products more affordable.
- China plans to adopt common MEPS levels for variable- and fixed-speed ACs in 2022. These levels align with the U4E Model Regulation Guidelines' minimum efficiency requirements for ACs.
- Given that China accounts for ~70% of the global room AC production, the prices of energy-efficient ACs that meet the U4E model regulations are expected to go down significantly after the new standards go effective, hence South Africa should take advantage of this and help their consumers benefit from both lower first cost and the lower lifecycle cost from energy-efficient ACs.

Let's help the world meet tomorrow's energy needs by leapfrogging to Efficient Cooling **today.**

Thank You.

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