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The Global Cooling Prize

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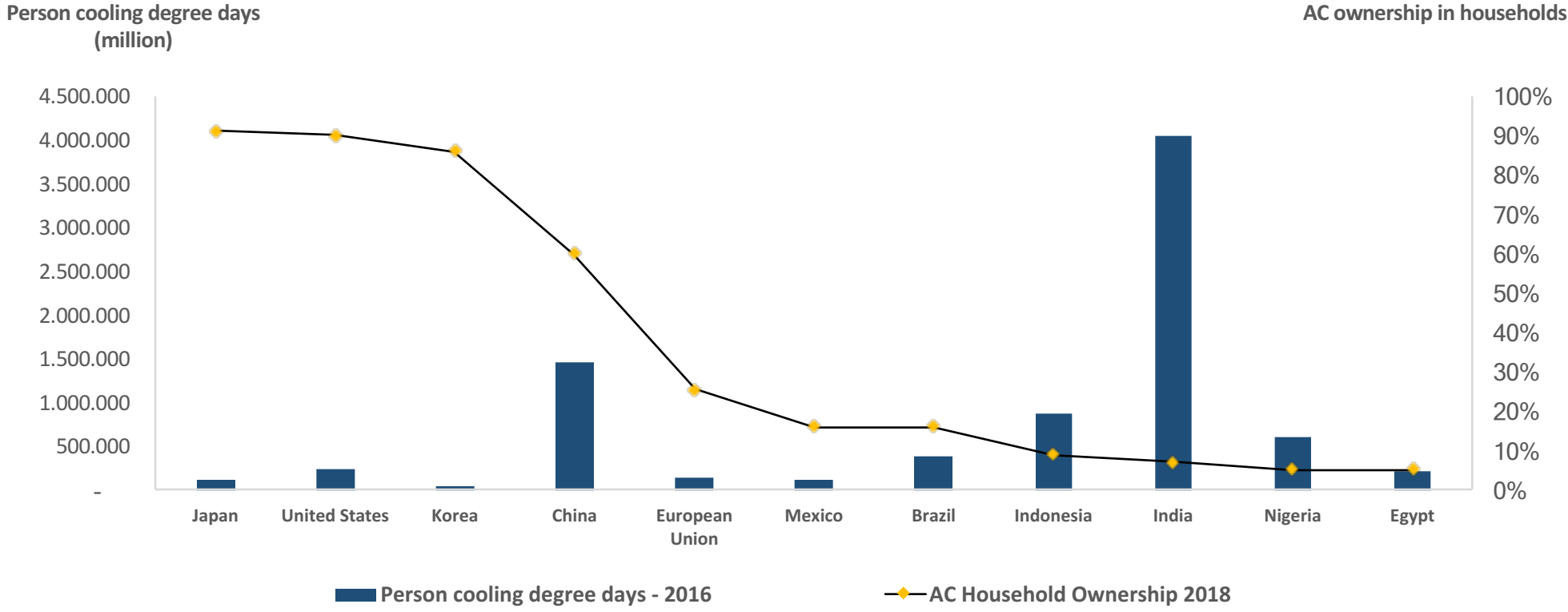
#GoNatRefs



The Cooling Dilemma.....

Increasingly seen as a societal need but at an environmental cost we cannot afford

Cooling in the rearview mirror has not captured much attention... looking at the road ahead, it needs to be on everyone's agenda



Source: IEA Report: The Future of Cooling: Opportunities for Energy-efficient Air Conditioning (2018); United Nations, Department of Economic and Social Affairs, Population Division (2017); <https://www.degreedays.net/>

In addition to today's unmet needs, major future demand accelerators are at work

POPULATION GROWTH
Population is growing by over 80 million people/year, with 97% of growth in developing countries



INCOME GROWTH
GDP growth for non-OECD countries will exceed 4.5% through 2025, making comfort economical for millions of new consumers

Cooling demand will increase ~4x by 2050

URBANIZATION
99% of population growth is occurring in urban environments, worsening heat island effects

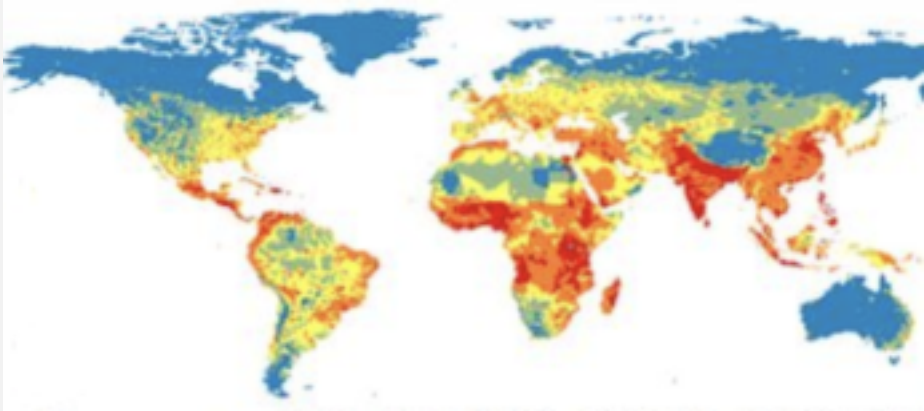


A WARMING PLANET
Global average temperatures expected to rise over 2.0°C by 2100, making summers longer and hotter

Source: United Nations Sustainable Development Goals (2017), United Nations World Urbanization Prospects (2014), Population Reference Bureau World Population Data Sheet (2012), ExxonMobil Outlook for Energy (2018)

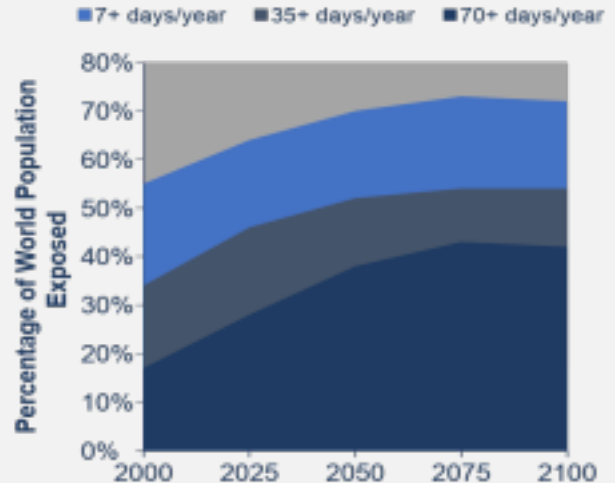
For many people comfort cooling is transitioning from a perceived luxury to a vital enabler of health, productivity, & prosperity

Present day heat exposure risk



Worldwide, by 2030, extreme heat could lead to a \$2 trillion loss in labor productivity. India's economy alone stands to lose \$450 billion

Projected exposure to deadly heat

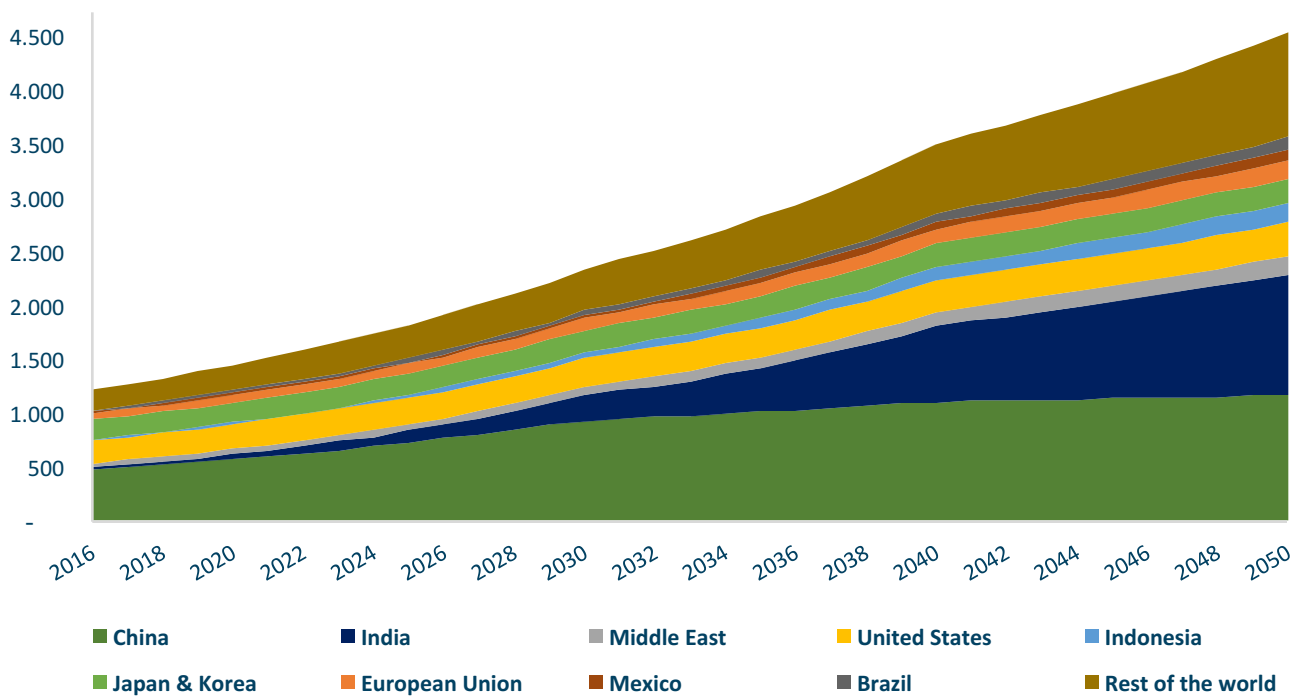


“Air conditioning was a most important invention for us, perhaps one of the signal inventions of history. It changed the nature of civilization by making development possible in the tropics. Without air conditioning you can work only in the cool early-morning hours or at dusk. The first thing I did upon becoming prime minister was to install air conditioners in buildings where the civil service worked.” - Prime Minister Lee, Singapore 2009

Source: Tord Kjellstrom, PhD, Mmeng. Impact of Climate Conditions on Occupational Health and Related Economic Losses. Asia-Pacific Journal of Public Health. January 2015. Climate Change and Labour: Impacts of Heat in the Workplace. International Labor Organization (ILO). April 2016

Entry level cooling provided by the ubiquitous residential / room air conditioners (RAC) in operation could grow nearly fourfold by 2050

Expected global stock of room air conditioners, 2016-2050
RAC units, millions



PRESENT
Approx. 1.2 billion RAC units in the world; sales growing at 10-15% per year in developing economies.

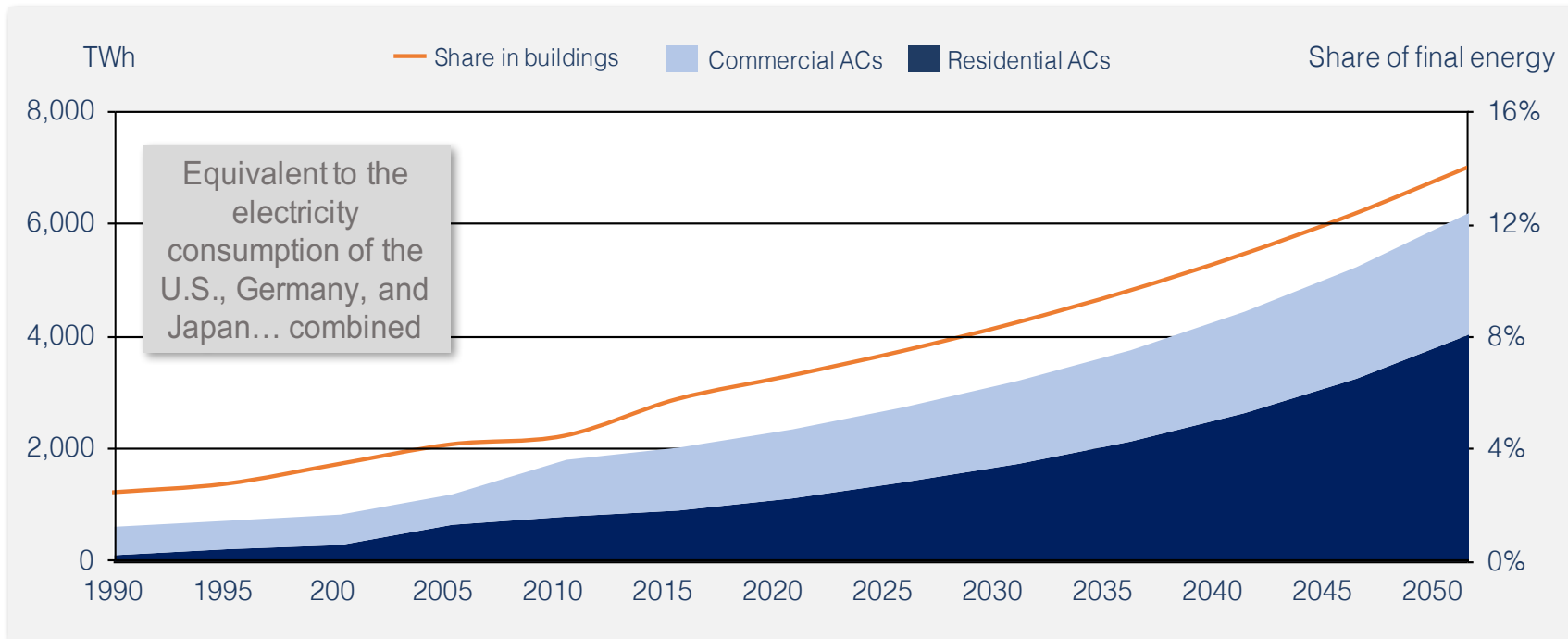
2050
Approx. 4.5 billion RAC units in operation worldwide. Demand driven by non-OECD countries.

2100
50-fold increase in worldwide RAC energy demand from year 2000.

Source: International Energy Agency (IEA) (2018), The Future of Cooling. LBNL Report: Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning (2015), IPCC, "Fifth Assessment Report", 2014

Residential AC's will account for 2/3^{rds} of cooling electricity demand and over 10% of global electricity use by 2050

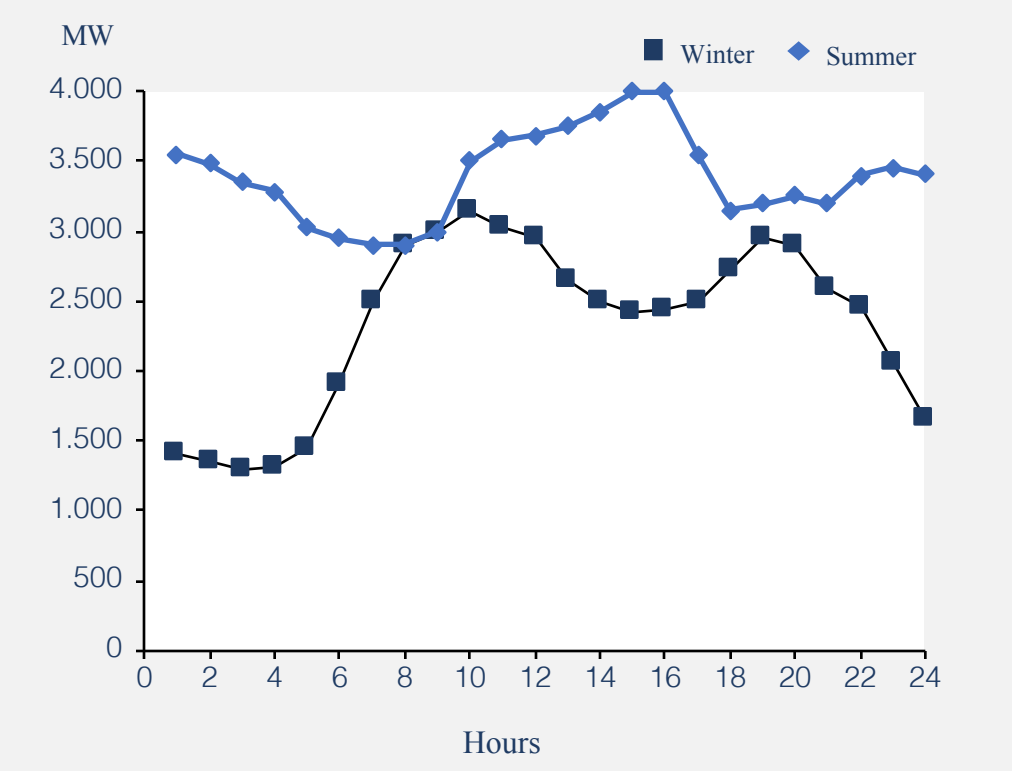
Energy consumption associated with comfort cooling, 1990-2050



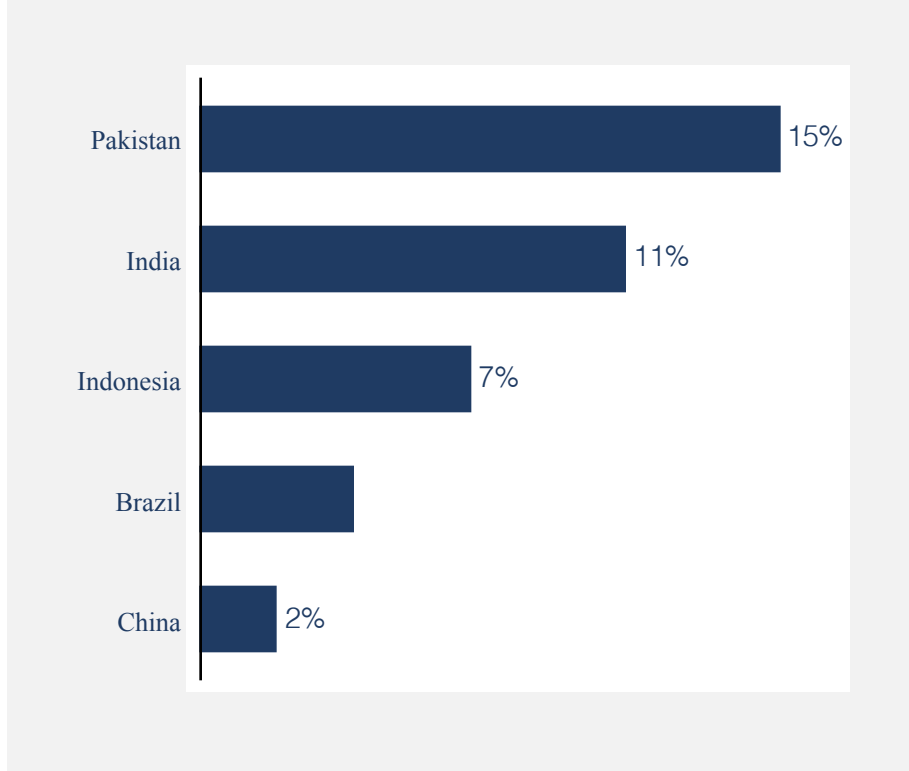
Source: IEA Report: The Future of Cooling: Opportunities for Energy-efficient Air Conditioning (2018); RMI: Solving the Global Cooling Challenge – How to Counter the Climate Threat from Room Air Conditioners

Air conditioning demand will place significant burdens on grids where it drives peak loads and consumers pockets

New Delhi's grid electricity demand profile, hourly



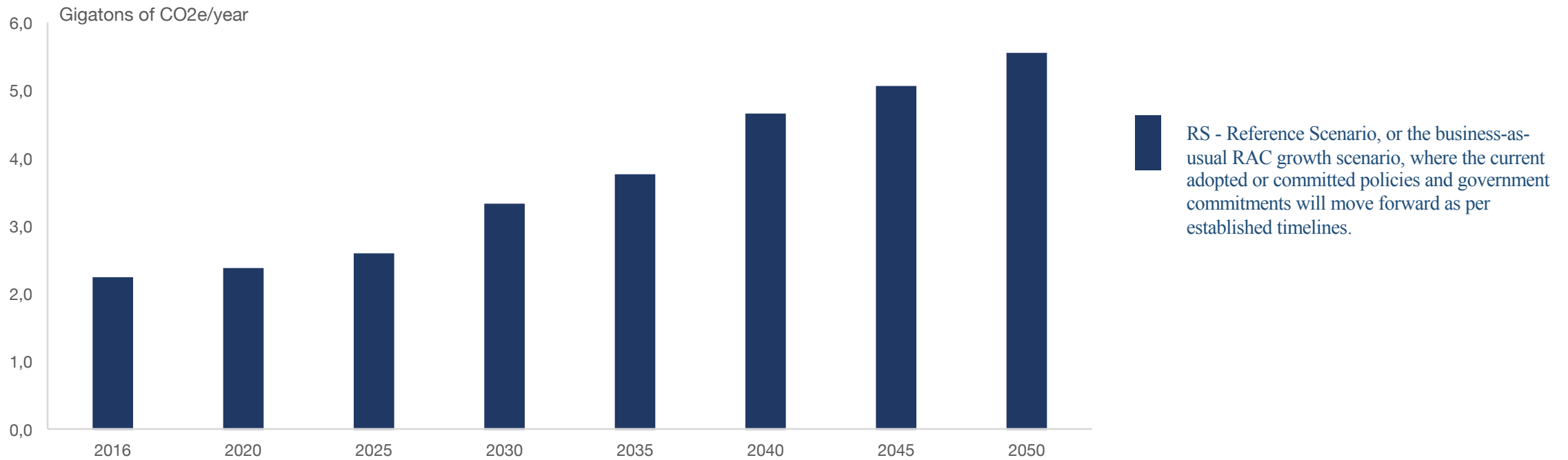
Cooling costs as % of median household income



Source: LBNL Report: Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning (2015), Global Industry Analyst Market Research, Enerdata, UCSUSA, Eco Climate Network Article, NRDC (2015), IECS and Christian Aid Report (2017); IPCC, "Fifth Assessment Report", 2014

Even projecting trends in buildings codes, equipment efficiency and grid emissions intensities – annual cooling emissions will almost triple by 2050

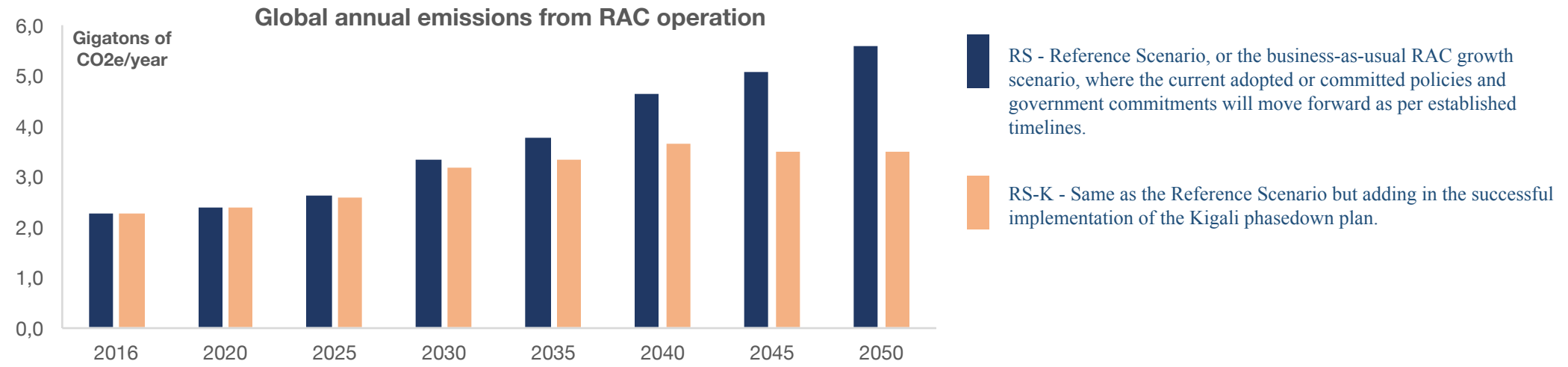
Global annual emissions from RAC operation





*While existing cooling emissions
& efficiency efforts are critical,
they are not sufficient*

Successful implementation of the Kigali Amendment will significantly reduce cooling related emissions – but we need to do more



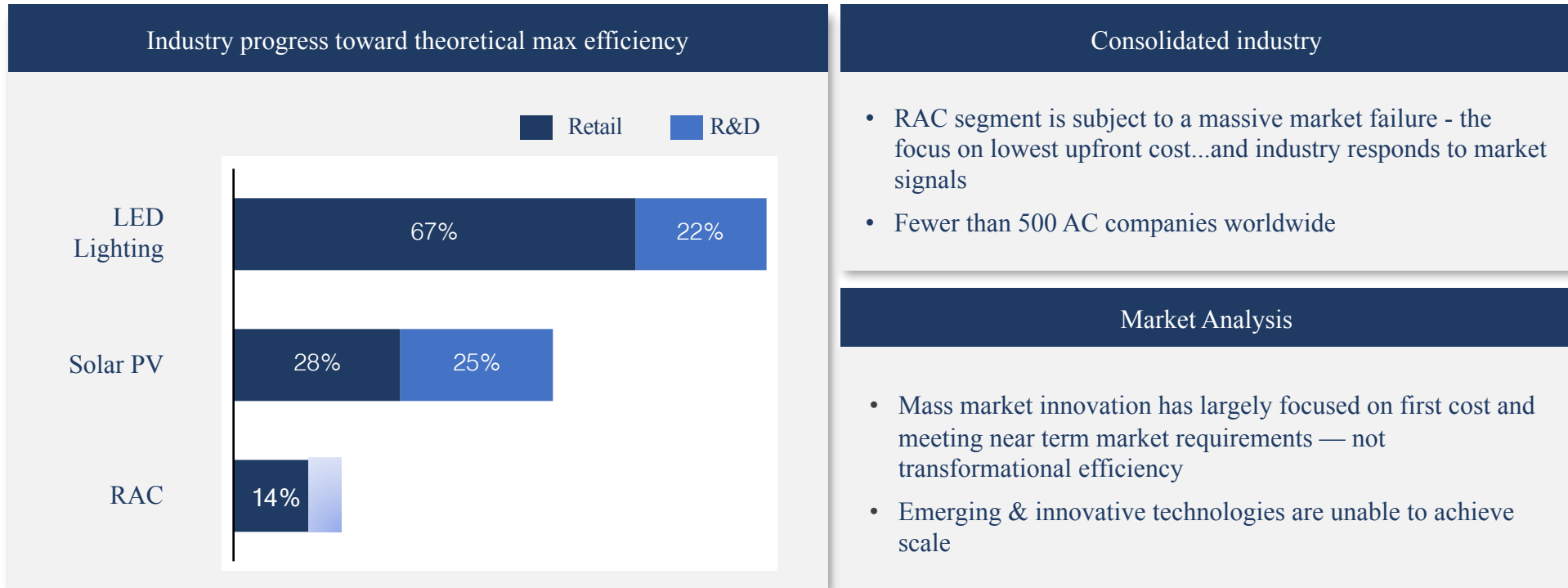
We are building better buildings and being smarter in how we operate them, which helps reduce cooling loads



... but the energy consumption of the equipment serving these cooling loads remains a massive and critical component



The efficiency opportunity remains largely unaddressed by the RAC industry due to lack of market and policy signals












Source: Greentech Media, “Sunpower Again Holds Record for World’s Most Efficient Rooftop Solar Panel”, 2017; PHYS, “White LEDs with Super-High Luminous Efficacy Could Satisfy All General Lighting Needs”, 2010; Fujitsu, 2017; CLASP, “AC Challenge Program for India”, 2017; LBNL, “Addressing Air Conditioner Energy Efficiency Lost in Translation to Strengthen Policy”, 2018



Do we allow inertia to define us or do we do what humankind has done through the ages and look for innovation to move us forward

A prize has the potential to spur climate-friendly innovation and address the market failure in the cooling industry

The Prize Criteria ensures that next generation RACs will deliver effective cooling at a dramatically lower environmental cost

| | | |
|--|---|--|
| <p>CLIMATE One-fifth of the life-time climate impact (electricity and refrigerant) of the baseline AC unit</p>  | <p>AFFORDABILITY At manufacturing scale of 100,000 units, costs no more than twice the cost of the baseline AC unit to consumers</p>  | |
| <p>POWER Consumes less than 700W from the grid at rated cooling capacity or during test period</p>  | <p>EMISSIONS Zero onsite emissions from any captive power or heat source</p>  | |
| <p>SCALABILITY Usable in existing homes, no “designed in” solution; less than 2x volumetric size of the baseline unit</p>  | <p>OPERATION Designed to have 1.5 TR cooling capacity at standard outdoor conditions and Maintains below 27°C DBT and 60% RH indoors for the duration of test period</p>  | |
| <p>WATER (if any is used) Consumes <u>an</u> yearly average of 14 liters/day with daily maximum limit of 28 liters</p>  | <p>REFRIGERANTS (if any is used) Zero ODP, lower toxicity, and compliance with safety standards</p>  | <p>MATERIALS Minimal usage of high embodied carbon or rare earth materials</p>  |

■ Supplementary criteria used to shortlist finalists
 ■ Primary criteria used to determine final award

The Prize is a high-profile technology competition with a \$3M purse supported by a global coalition to spur innovation

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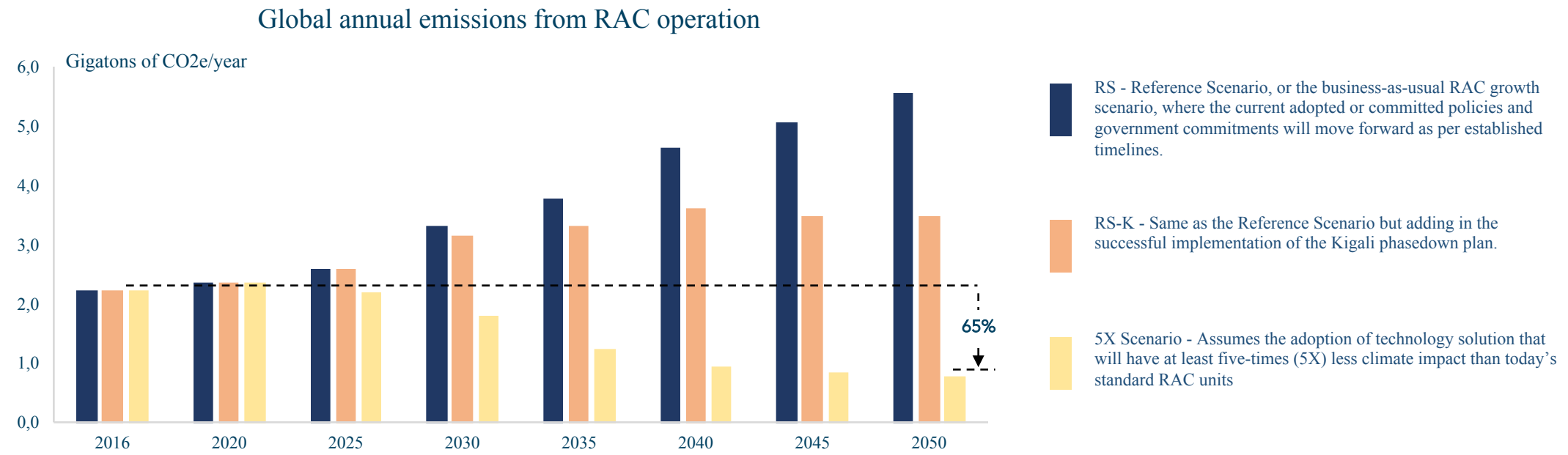




The potential impact of a super-efficient, climate-friendly cooling solution would be profound

... for people, the AC industry, the power sector, and the planet

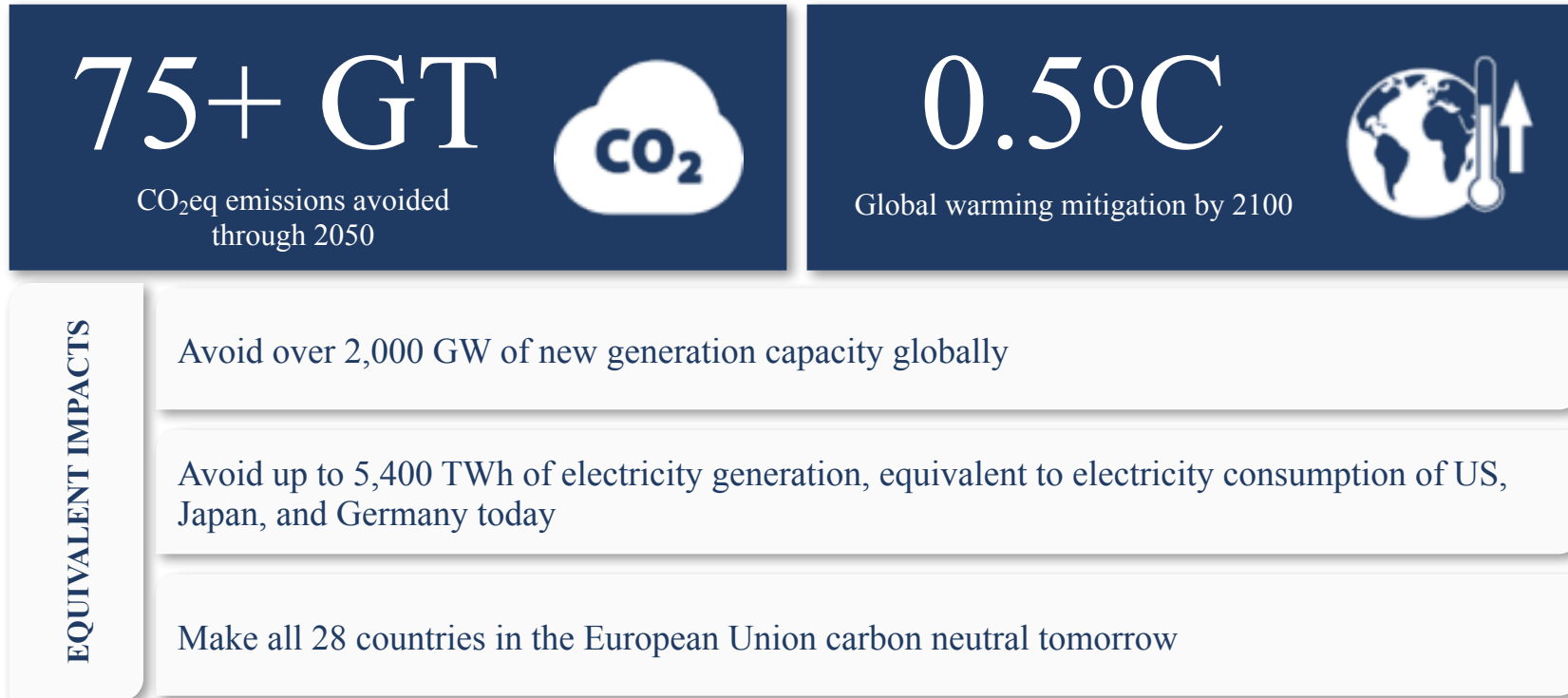
Globally scaling of the 5X solution will reduce RAC associated global annual emissions in year 2050 to a level that is manageable



Key assumptions:

- RMI analysis assumes an adoption curve for the 5X solution as follows: market adoption starts in 2022 with a 5% share; by year 2030 it gains an 80% share of the annual sales, and by year 2040 it achieves an almost 100% share of the annual sales.
- We assume that building envelope improvements (thermal insulation driven by building codes) have the potential to achieve a 7.5% reduction in cooling demand in 2050 in developed countries. For developing countries, we assume that a 15% reduction in cooling demand can be achieved in 2050 as a significant portion of the building stock is still to be built

Globally, this may be the single biggest demand side action we can take to mitigate climate change



Source: CLASP, "AC Challenge Program for India", 2017; LBNL, "Benefits of Leapfrogging to Super efficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning", 2015; "Statistics", IEA (2018)



Our journey thus far & what's next

Our Journey Thus Far

Outreach and Media Coverage

2,200 publications in 58 countries around the world with over 2.5 Billion impressions.
The Prize has over 14,200 followers on social media with over 1.96 Million impressions.

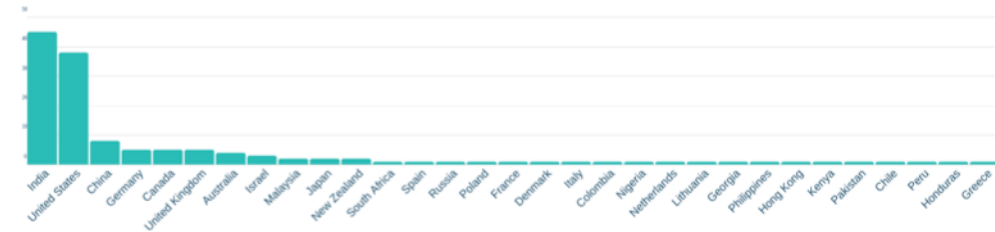


Global Participation

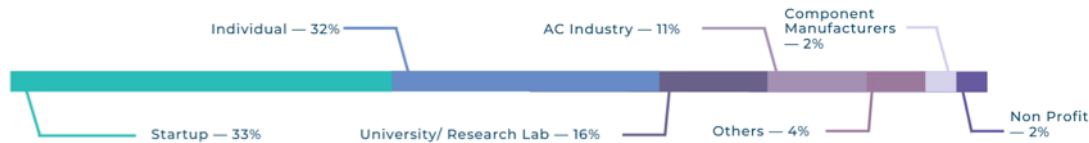
Overall Application Stats



Geographical Diversity of Applications

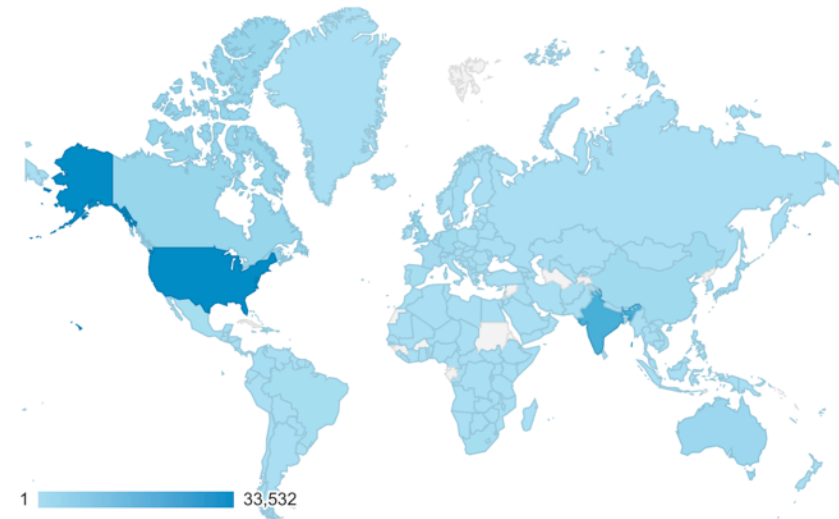


Submissions by Participant Category



Global Awareness

Over 82,000 website users from 197 countries around the world.



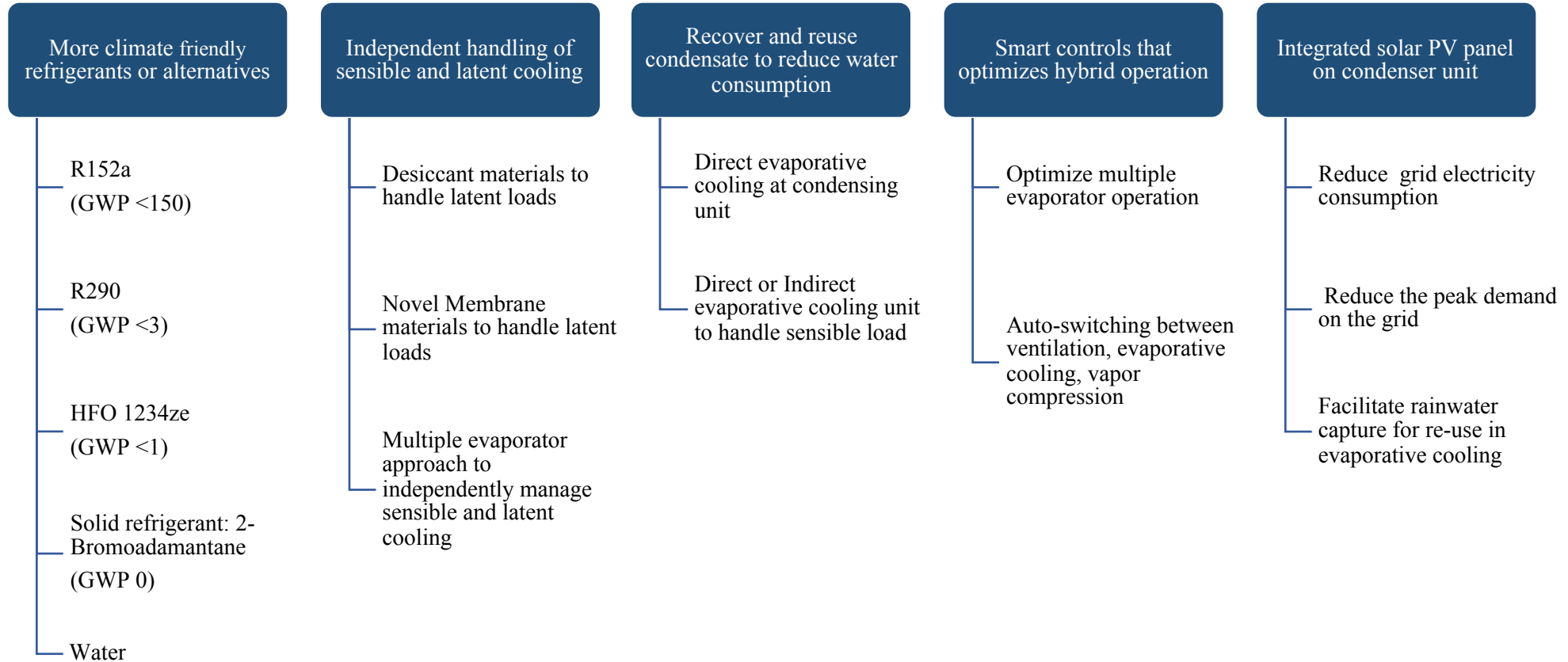
Eight Finalist teams were selected by the Technical Review Committee



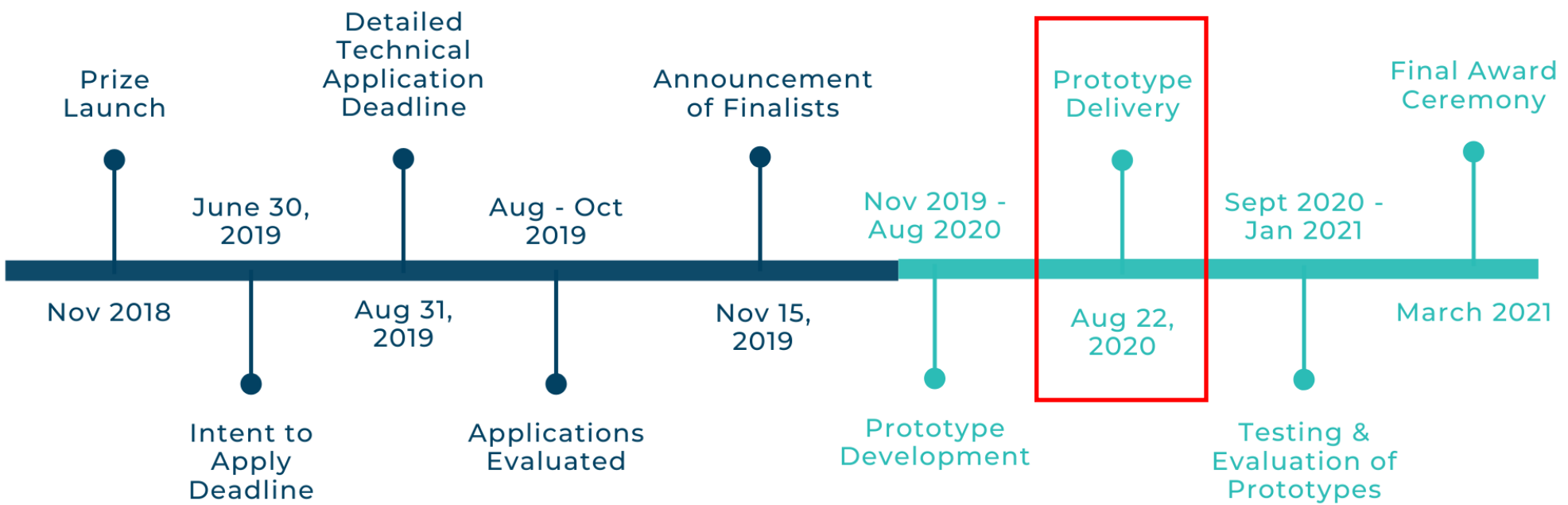
Key highlight is the diversity offered by the selected finalists:

- Diversity of technology
- Diversity of geography
- Diversity of entity profile

Eight Selected Breakthrough Residential Cooling Innovations – Some Themes:



Updated Prize Timeline in the wake of COVID-19



Finalists are required to ship two working prototypes to India by August 22, 2020 for testing



| Test Method | Key Objective | Repeatability | Monitoring | Expected Noise |
|--------------------|--|---------------|-----------------|----------------|
| Lab-simulated test | Controlled Environment | High | Extensive | Minimal |
| Field Test | Replicate real-world scenario with all the variables | Low | Moderate | High |
| ISEER | Alignment with reference Standards | High | As per Standard | Minimal |

Innovation alone is not enough

- Demonstration of what is possible
- Extracting learnings to inform future policy
- Stimulate AMC programs and bulk procurement and in major markets from those end users naturally motivated by lower lifecycle cost
- Stimulate the development of incentive and pay as you save programs to help overcome first cost barriers to sustainable cooling equipment
- Establishment of investor ‘marketplace’ to connect those able to commercialize and invest with consenting innovators looking for investment and support



But first we demonstrate what is possible and will be providing daily windows of performance data from concurrent field testing in New Delhi India through September 2020 – 8 Prototypes Vs 2 Baseline units



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Thank you
for listening!

