ENERGY EFFICIENCY IN A/C SECTOR

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Environment

Compatibility

Alternative Refrigerants

Refrigerant Properties

KIGALI AMENDMENT AND RELATED DEVELOPMENT ON ENERGY EFFICIENCY

- The Kigali amendment to the Montreal Protocol to phase down the production and consumption of HFCs provides opportunity to realize **energy efficiency gains** when replacing HFC/HCFC-based equipment

- CCAC Marrakesh Communiqué recognizes that Kigali Amendment can avert as much as 0.5 degrees Celsius of warming over the course of the century…with additional climate mitigation possible from **improving the energy efficiency**

- Philanthropist organizations have pledged US$52 million in grants [the Kigali Cooling Efficiency Program] to **support energy efficiency of cooling.**

- The World Bank Group will make available US$1 billion in **funding for energy efficiency** in urban areas by 2020 that could include support for the development and deployment of high-efficiency cooling technologies using climate-friendly refrigerants.

KIGALI COOLING EFFICIENCY PROGRAM [K-CEP]

- K-CEP focuses on the energy efficiency of cooling to increase and accelerate the climate and development benefits of the Kigali Amendment

- K-CEP's four areas of focus (windows):
  1. Strengthening for efficiency,
  2. Policies, standards, and programs,
  3. Finance,
  4. Access to cooling.

- 18 foundations and individuals offered support to K-CEP for a fast-start in developing countries to expand energy efficiency while phasing out HFCs

CHALLENGES WHEN SELECTING ALTERNATIVE REFRIGERANTS

- A/C industries have concerns about meeting the Montreal Protocol reduction targets -Article 5 countries.
- Currently commercially available technologies posses high GWP, and perform less efficiently in high ambient conditions.
- Alternative refrigerants are still being studied -work not completed yet.
- We need to obtain a basic understanding of their properties such as:
  1. burn velocity,
  2. compatibility with lubricants
  3. other system materials and components,
  4. Its energy efficiency

- Testing Standards and Codes still do not exist since alternative refrigerants are still being investigated

- Refrigerant manufacturers are reporting data on energy effcient that need to be verifired..Holistic approach and uniformity of testing of alternative referigerants is needed.

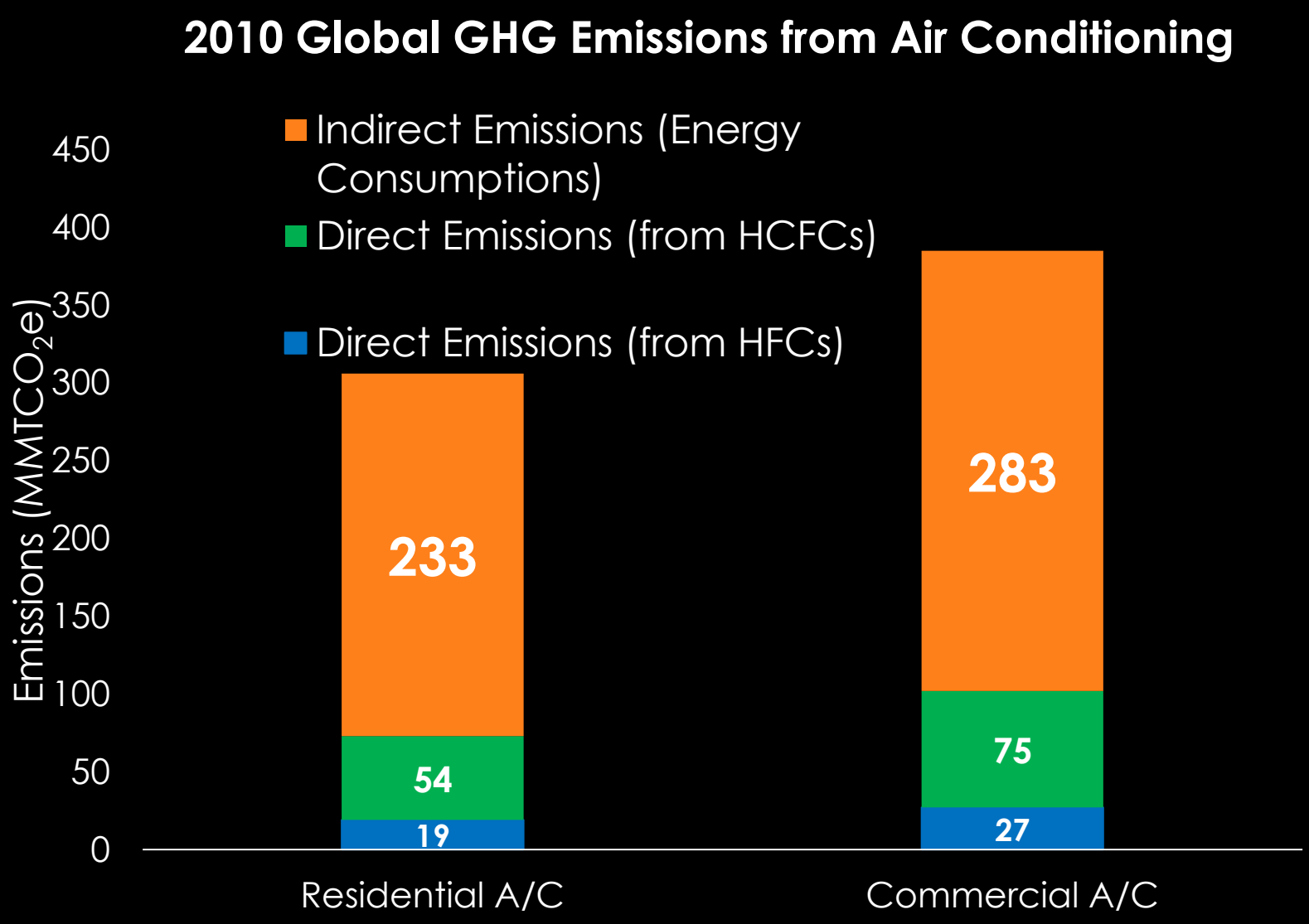
- Introduce safety codes

  - Conduct Risk Assessments
  - Provide sustainable and substantial training and certifications

TECHNOLOGY REQUIREMENTS FOR ENERGY EFFICIENCY

- Full system re-design is required to adopt low-GWP refrigerants
- Increased focus on technology transfer
- Remaining countries that have A/C manufacturing operations depend on available technologies- Product and component development is limited to a few countries
- The selection of refrigerant is not the only factor contributing to reduce CO_2 emission

A/C CO2 EMISSIONS



Source: US Dept. of Energy, The Future of Air Conditioning for Buildings (2016)

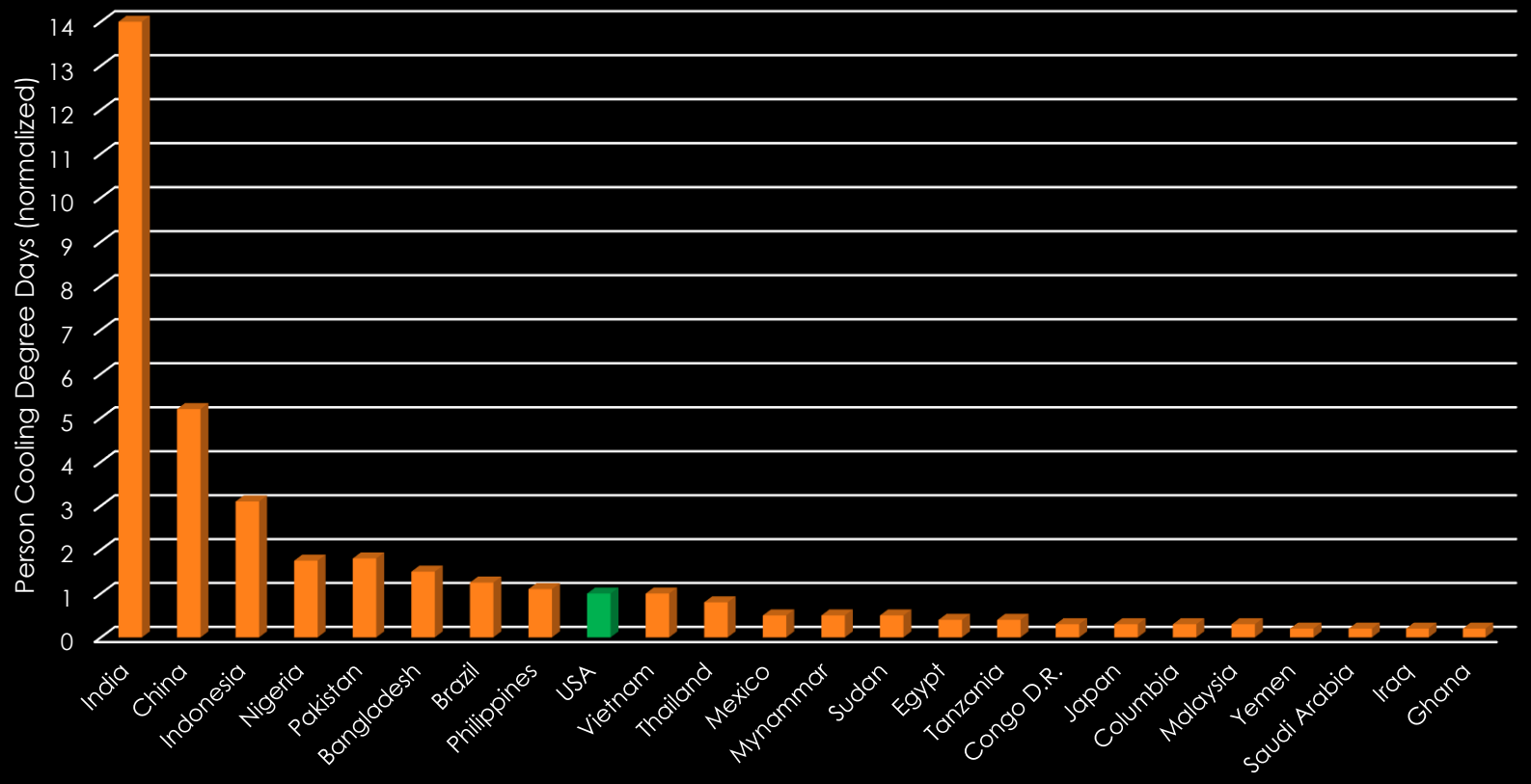
WHY ENERGY EFFICIENCY IS VITAL

- When departing low GWP refrigerants, energy efficiency is essential due to high cooling demand-global trend

  ✓15% of global energy consumption per ca is for cooling (7% growth/year until 2050) [IEA]

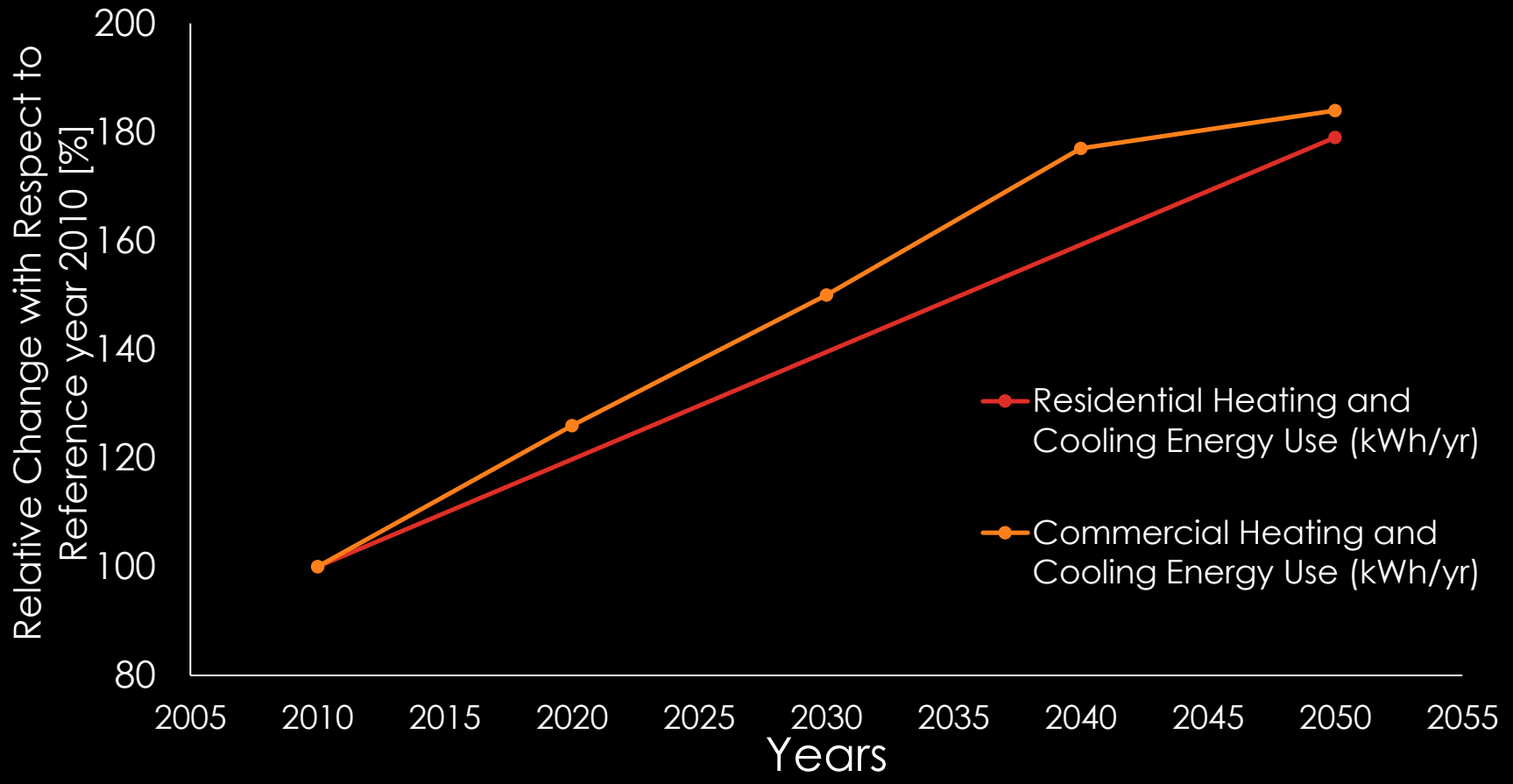
  ✓In 2015, RAC consumed about 17% of the overall electricity worldwide [TEAP 2017]

THE A/C FUTURE NEEDS



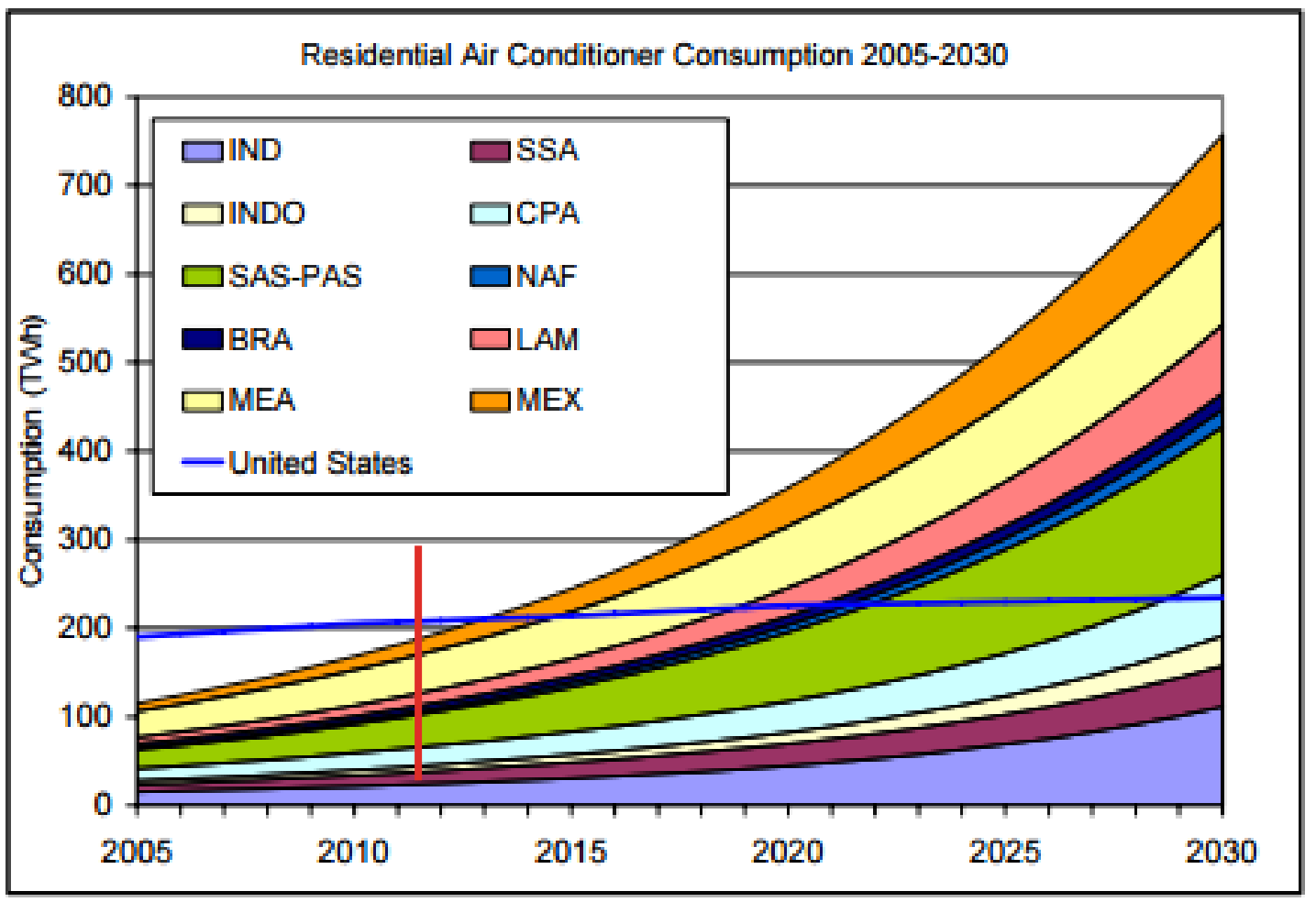
Source: "Will AC Put a Chill on the Global Energy Supply?" by M. Sivak in American Scientist.

GLOBAL COOLING AND HEATING ENERGY NEEDS



Source: IPCC report (chapter 9), Buildings and Ürge-Vorsatz et al. (2013)

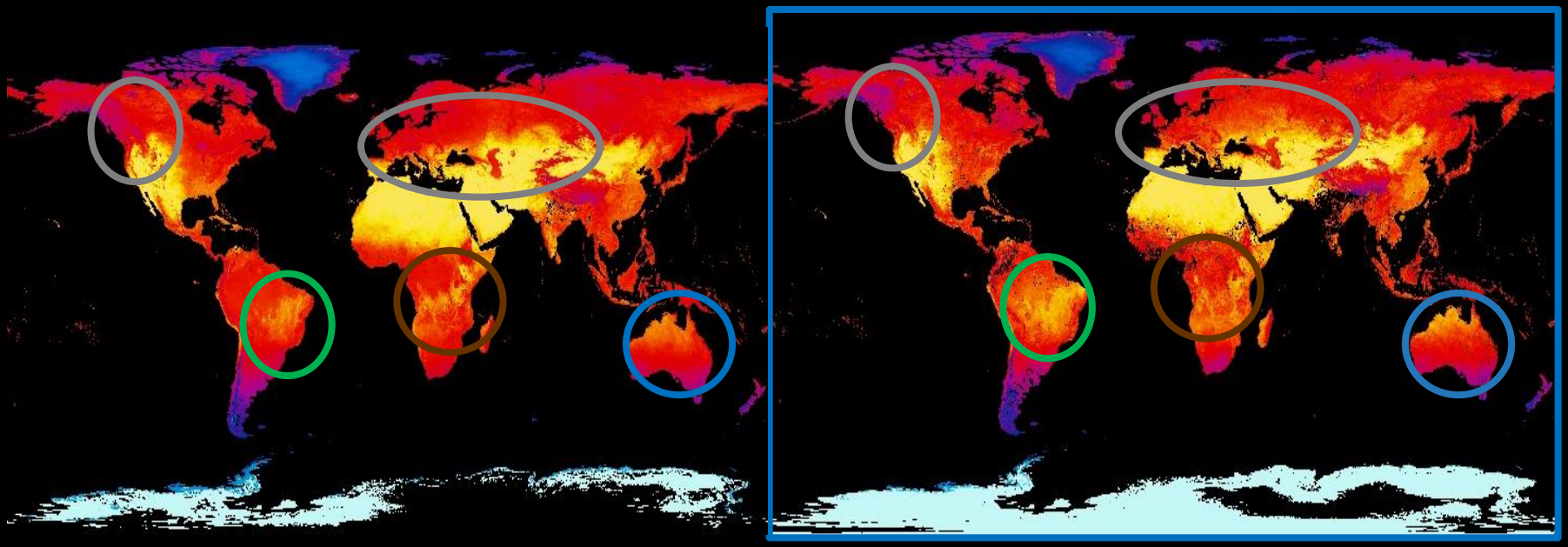
POWER CONSUMPTION INCREASE FROM 2015 TO 2030



MEX = 375%
MEA = 138 %
LAM = 330 %
BRA = 300 %
NAF = 200 %
SAS-PAS = 270%
CPA = 80 %
INDO = 500%
SSA = 100 %
IND = 260%

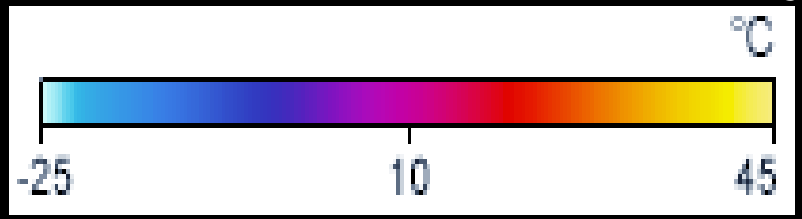
Source: 2007, McNeil and Letschert

AMBIENT TEMPERATURE MAP



Source: NASA, July 2000

Source: NASA, July 2016



CURRENT STATISTICS (TEAP 2017)

- Over 80% of the global warming impact of RACHP systems is associated with the indirect emissions.
- The best current RAC equipment is operating at around 50-60% of the theoretical maximum EE.
- In the coming decades, technological innovation can be expected to improve performance to approximately 70-80% of the theoretical limit.

RECOMMENDATIONS (TEAP 2017)

- Unlikelihood to solve the GW impact of RAC from an undiscovered novel refrigerant in vapor compression cycle
- Support of "NIK" technologies that are still in the R&D stage, study the EE of such systems)
- Improve the components in RACs such as compressors, heat exchangers, control systems, and reduce leakages
- Improve the building envelopes, eg. having tinted windows, more thermal insulations, etc.…
- Introduce MEPS in developing countries that do not have them in place, while strengthening the MEPS in others that are currently using them

DEFINITIONS

- Performance ratio = Capacity / power
- IP Units:
  - Energy Efficiency Ratio (EER)
  - EER = Capacity(BTU/hr)/Power (W) –BTU/Whr
- SI Units:
  - Performance Ratio = Power (kW)/Capacity (tons)-kW/ton
- Dimensionless:
  - Coefficient of Performance (COP)
  - COP = Capacity (W)/Power (W)

HVAC PERFORMANCE IN HAT

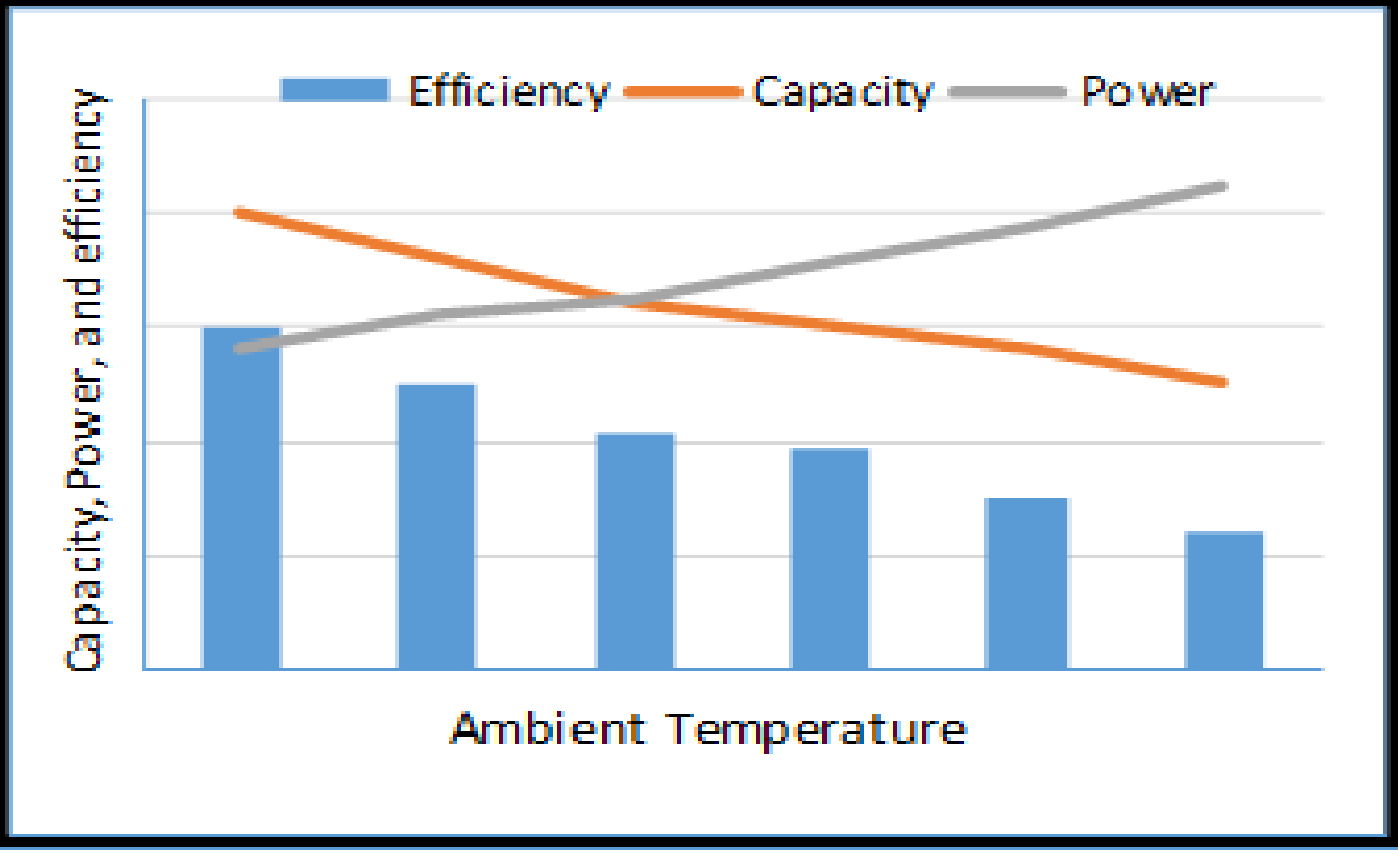


Figure 2.1: Energy efficiency, capacity, and power consumption at different ambient temperatures

QUESTION ?

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