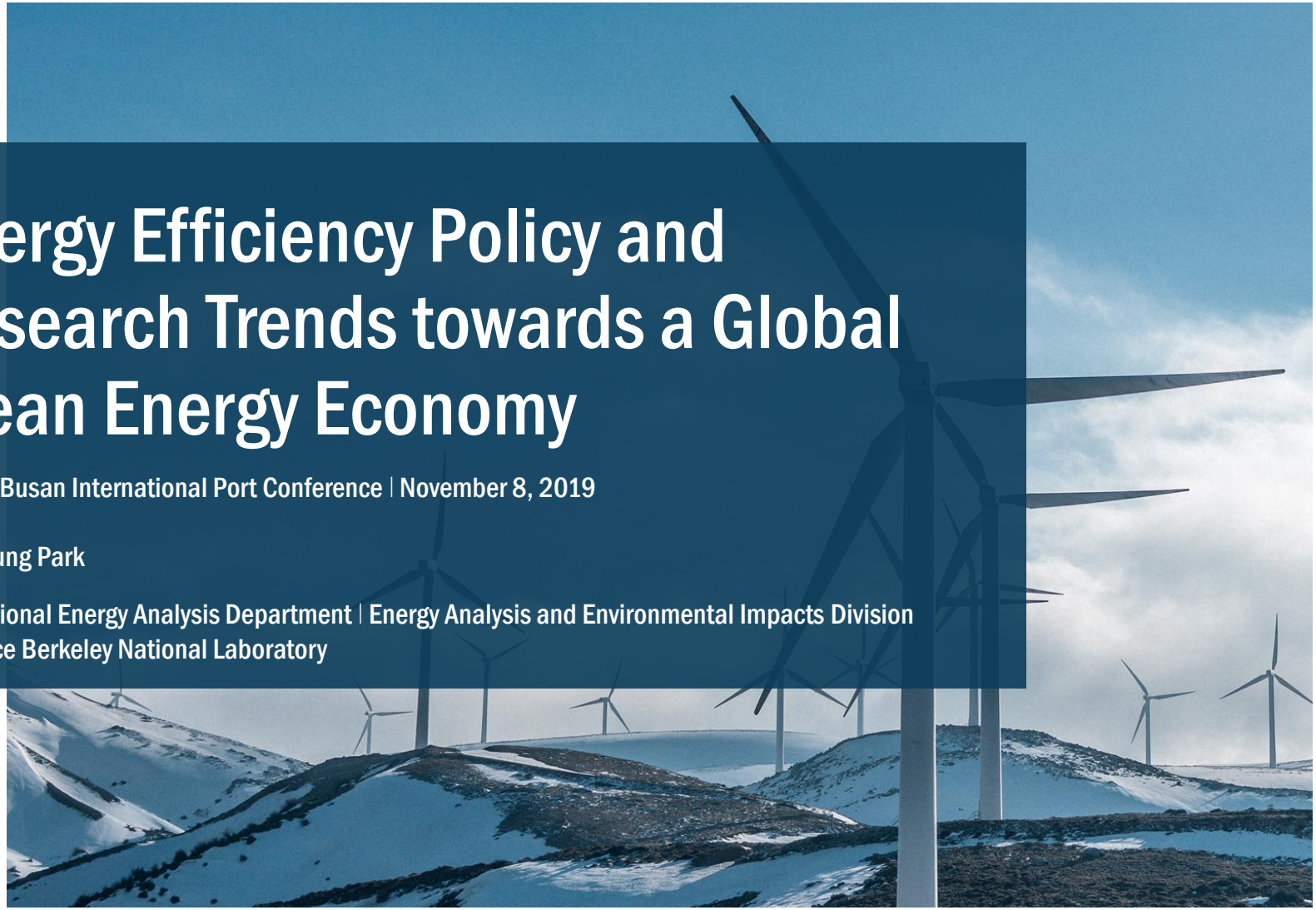


Energy Efficiency Policy and Research Trends towards a Global Clean Energy Economy

The 7th Busan International Port Conference | November 8, 2019

Won Young Park

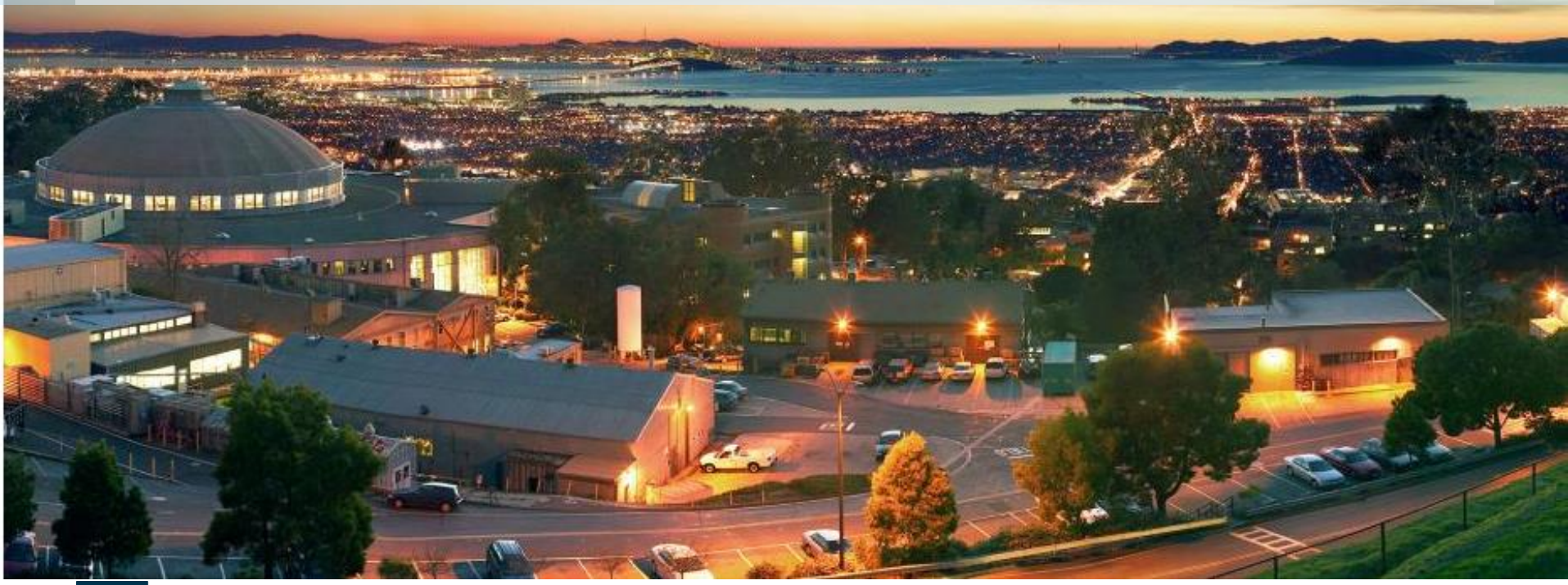
International Energy Analysis Department | Energy Analysis and Environmental Impacts Division
Lawrence Berkeley National Laboratory

BERKELEY LAB

INTERNATIONAL ENERGY ANALYSIS DEPARTMENT

Lawrence Berkeley National Laboratory

- A US DOE National Lab operated by University of California
- Founded in 1931
- 13 Nobel Prizes
- > 3,000 Employees
- > 1500 IP licenses for software and inventions in last 10 years:
- > 50 Startups based on Berkeley Lab technology
- > 200 UC faculty on staff at LBNL
- Annual operating cost $872M (FY 2018)



Managed by the University of California for the United States Department of Energy

BERKELEY LAB

Dedicated to solving the most pressing scientific problems facing humankind.

- Bio Sciences
- Computing Sciences
- Earth & Environmental Sciences
- Energy Sciences
- Energy Technologies
- Physical Sciences

Building Technology & Urban Systems

FLEXLAB & Systems Integration; Modeling & Simulation; Windows & Daylighting; Lighting & Electronics; High-Tech & Industrial; Urban Science

Energy Analysis & Environmental Impacts

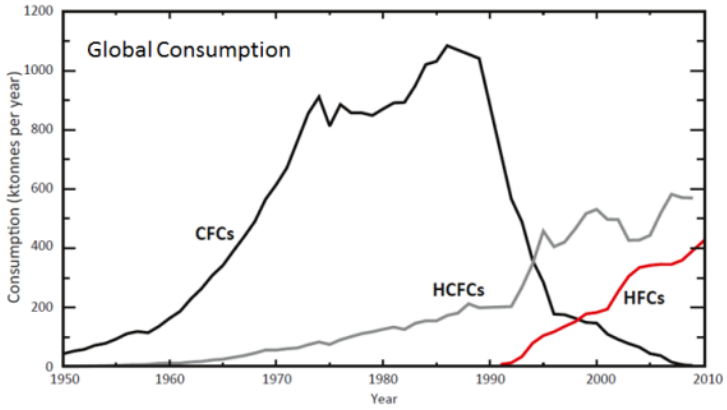
Electricity Markets and Policy; Energy Efficiency Standards; Indoor Environment; Sustainable Energy Systems; International Energy

Energy Storage & Distributed Resources

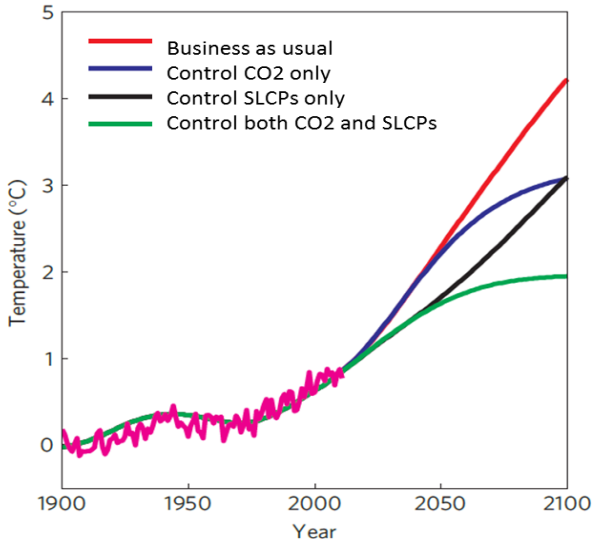
- Researchers perform analysis, research, and development in a wide range of topics to improve energy infrastructure and maximize socio-economic benefits –from buildings and batteries, to indoor air quality, electricity grid, transportation, and environmental impacts.
- Researchers have been providing technical support to U.S., China, India, Mexico, Brazil, and other developing economies to improve energy policies and programs.

Low GWP Refrigerants

- Under the Kigali Amendment to the Montreal Protocol, 197 countries committed to cut the production and consumption of hydrofluorocarbons (HFCs) — potent greenhouse gases (GHGs) used in refrigeration and air conditioning — by more than 80 percent over the next 30 years.



UNEP (2011). HFCs: A Critical Link in Protecting Climate and the Ozone Layer



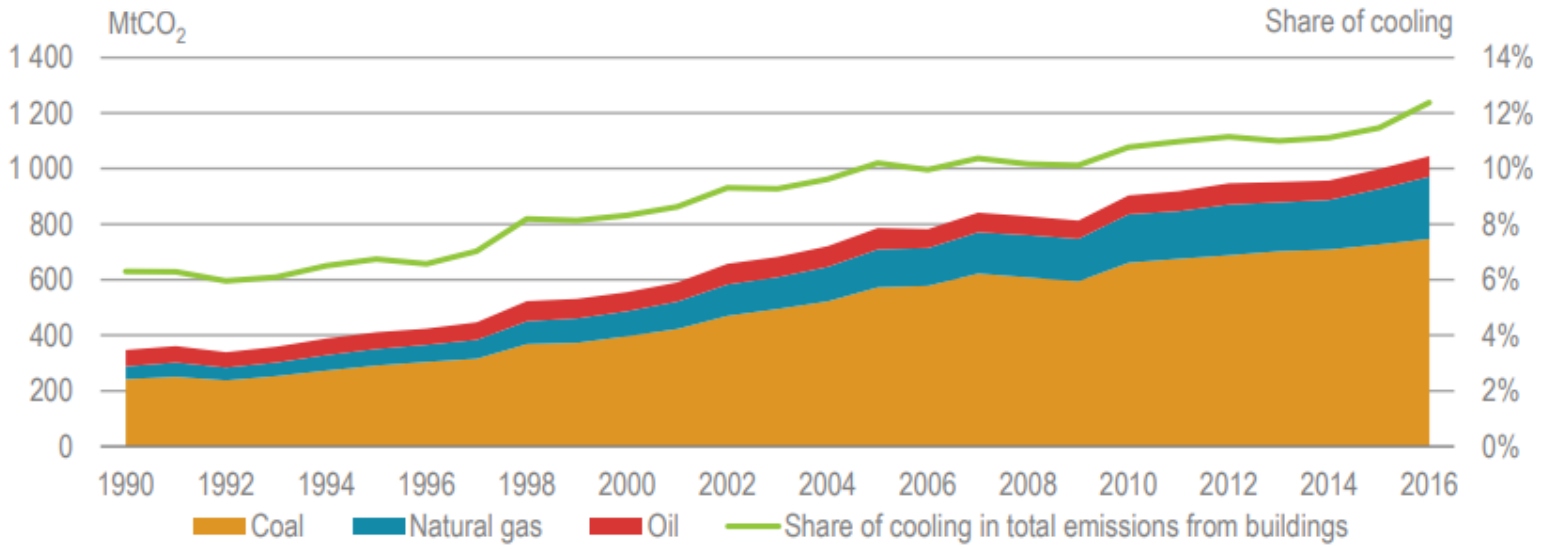
SLCP: short lived climate pollutants

Hu et al. (2013). Mitigation of short-lived climate pollutants slows sea-level rise. Nature Climate Change

Space Cooling Energy Use

- GHG emissions related to the use of energy for space cooling hinge primarily on the fuel mix in power generation - fossil fuels accounted for 65% of globally total power generation in 2016.

CO_2 emissions associated with space cooling energy use

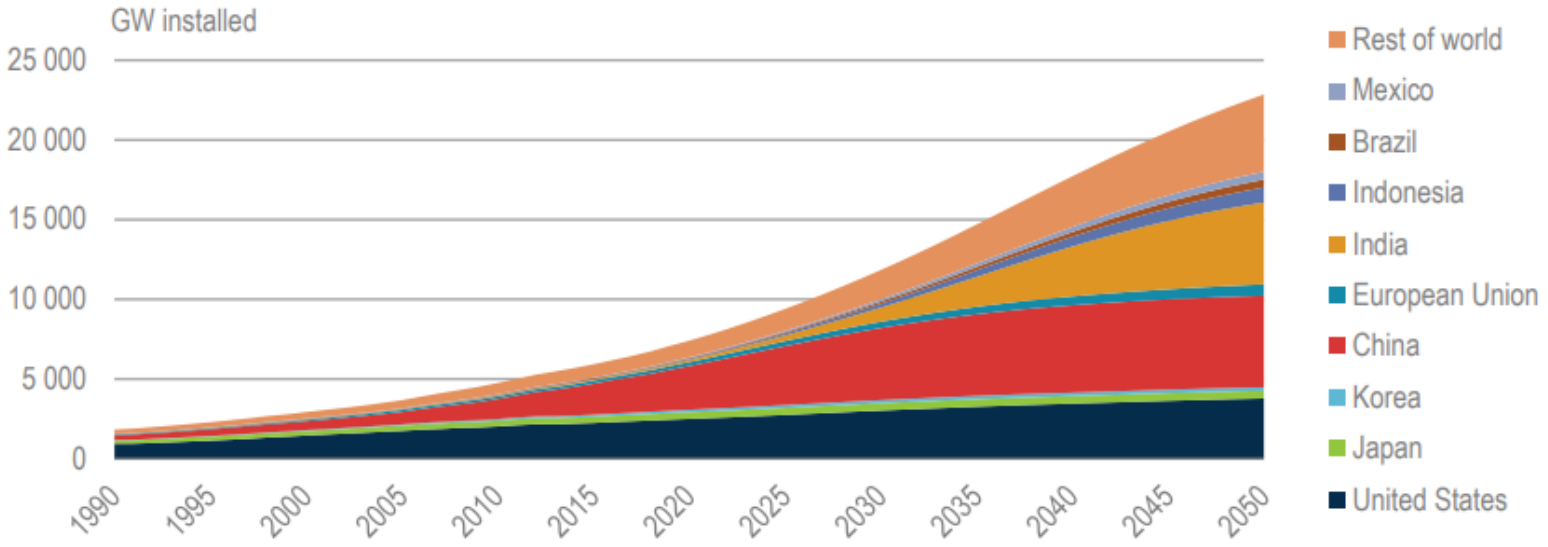


Source: IEA (2018). The Future of Cooling.

Space Cooling Energy Use

- Increasing incomes and urbanization – as well as a warming climate – are driving up the global stock of ACs, particularly in emerging economies with hot climates. Accordingly AC energy consumption and related GHG emissions are expected to increase substantially as the stock of ACs rises.

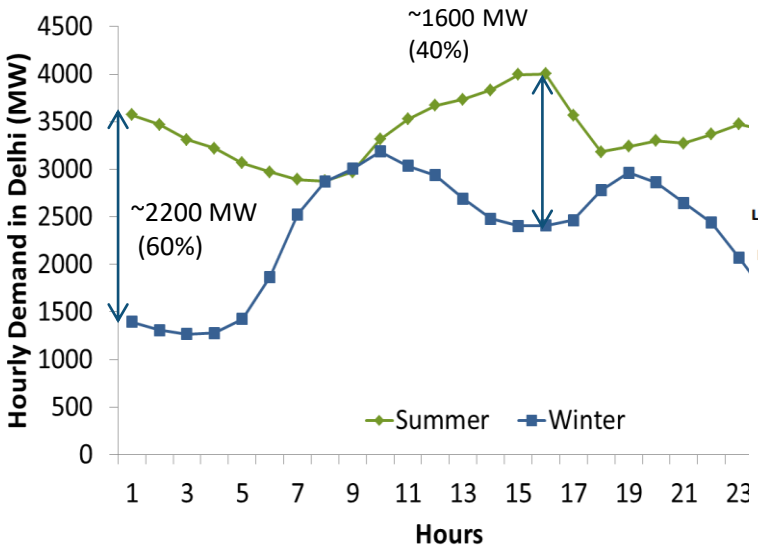
Energy use forecast in air-conditioners



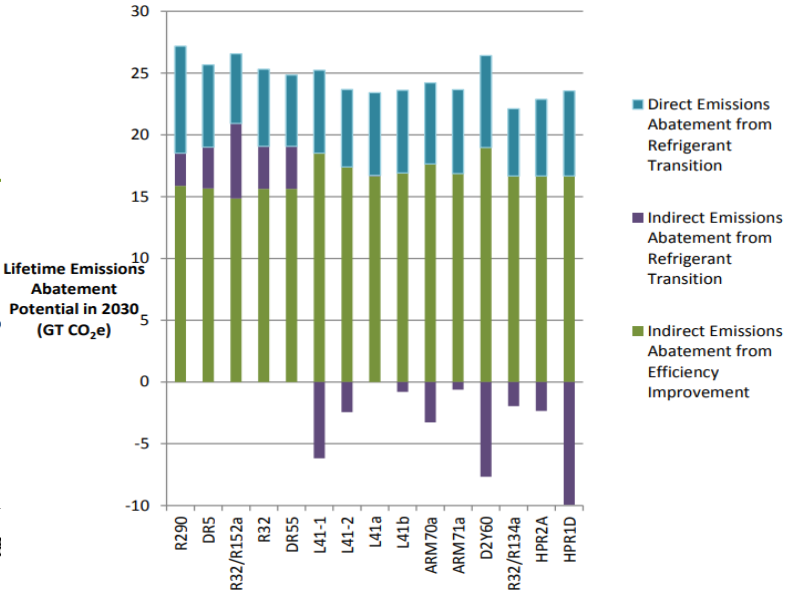
Source: IEA (2018) The Future of Cooling

Low-GWP Refrigerant and Energy Efficiency

- LBNL studies find that it is highly beneficial to pursue high energy-efficiency in concert with the transition to lower global warming potential (GWP) refrigerants to achieve maximal GHG reductions with the least amount of equipment re-design and replacement.



Abhyankar et al. (2017) Accelerating Energy Efficiency Improvements in Room Air Conditioners in India: Potential, Costs-Benefits, and Policies. LBNL report.



Shah et al. (2019) Benefits of Energy Efficient and Low-Global Warming Potential Refrigerant Cooling Equipment. LBNL report.

Opportunity for Market Transformation

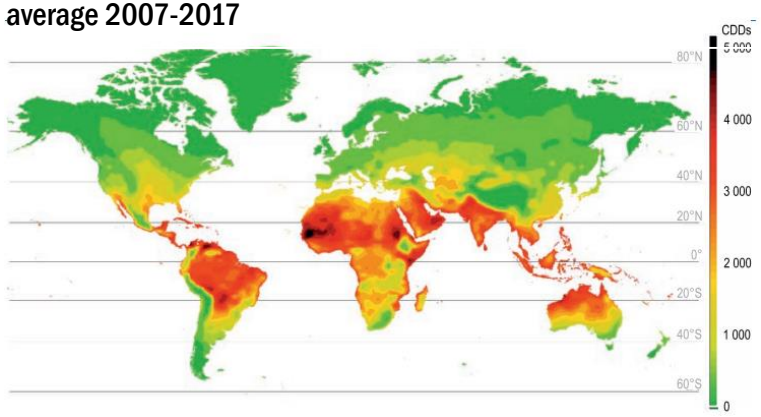
Simultaneous Efficiency Improvement and Refrigerant Transition

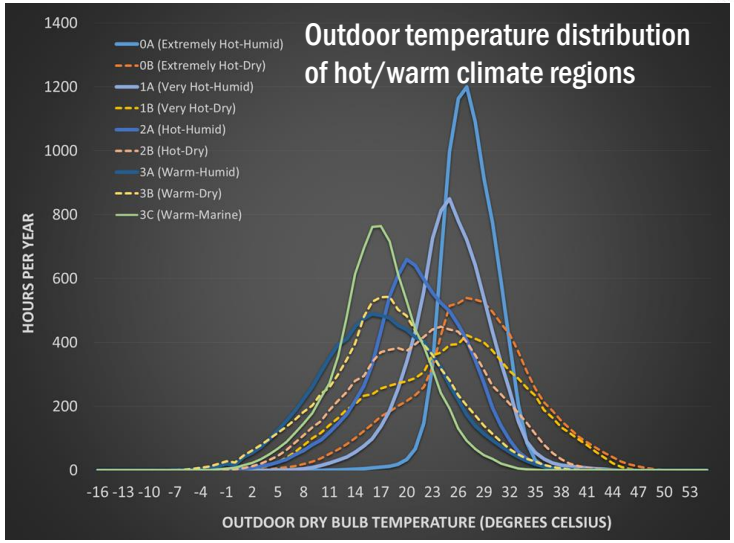
- Air-conditioners and refrigeration appliances are often first products regulated for energy efficiency and will also undergo refrigerant transition under Kigali Amendment or current Montreal Protocol obligations.
- Refrigerant transition and efficiency improvement both typically require redesign of appliances and re-tooling of manufacturing lines.
- Coordinated efficiency improvement with refrigerant transition can keep costs low for consumers, manufacturers, utilities and governments.

Climate Region and Cooling Energy Efficiency

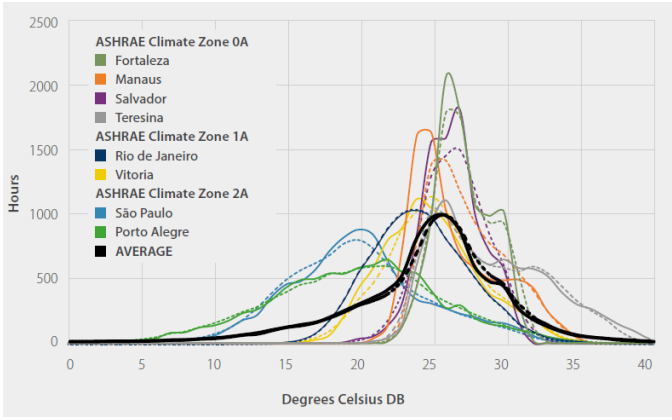
Policy action can be regionally developed/adopted, as well as harmonized with other regions.

Cooling-degree days (CDDs) across the world, mean annual average 2007-2017

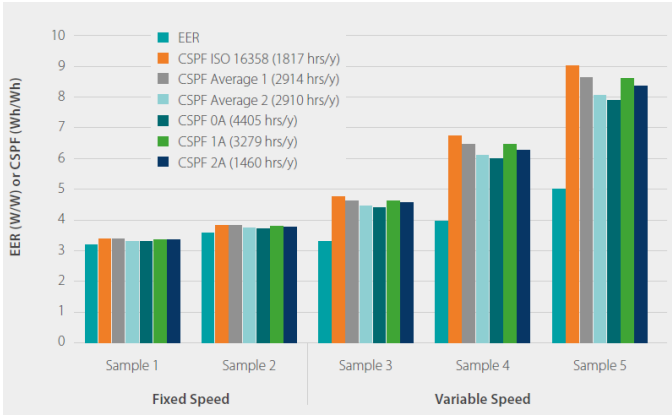




Outdoor temperature distribution of eight regions in Brazil

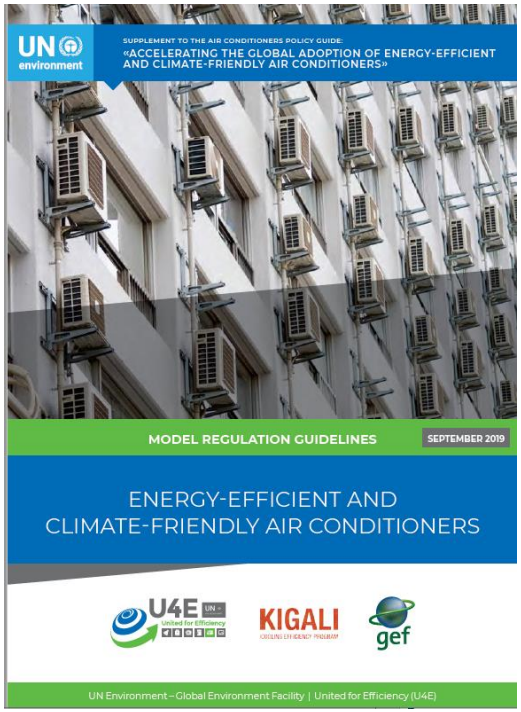


Efficiency of room AC models by different temperature bin hours in Brazil



Policy and Market Transformation

- Policy action and market transformation can be accelerated and effectively harmonized with international effort.



- ☑ Clear scope and definitions
- ☑ Common efficiency metric
- ☑ Common testing standards

Approach

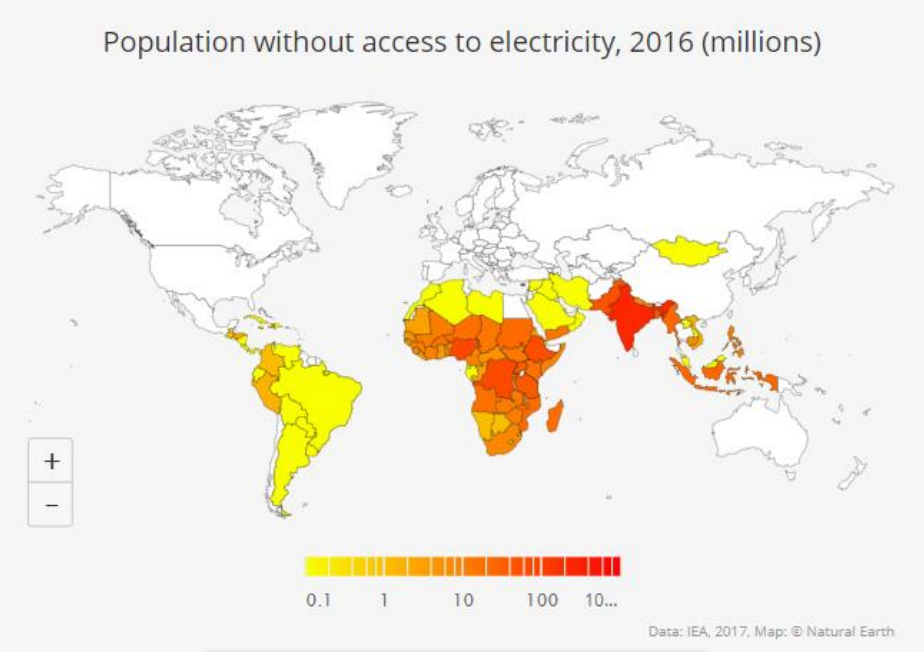
- ✓ Catalyze **product innovation**, giving consumers more choice
- ✓ Harmonize requirements to **reduce trade barriers and unlock economies of scale** to make products more affordable
- ✓ Enable more **effective market enforcement** using proven test procedures and an easier exchange of compliance information

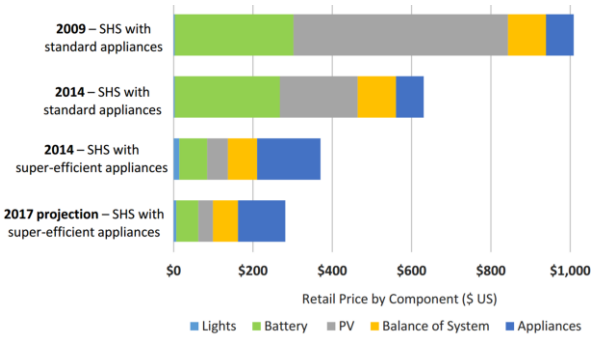
Other Research

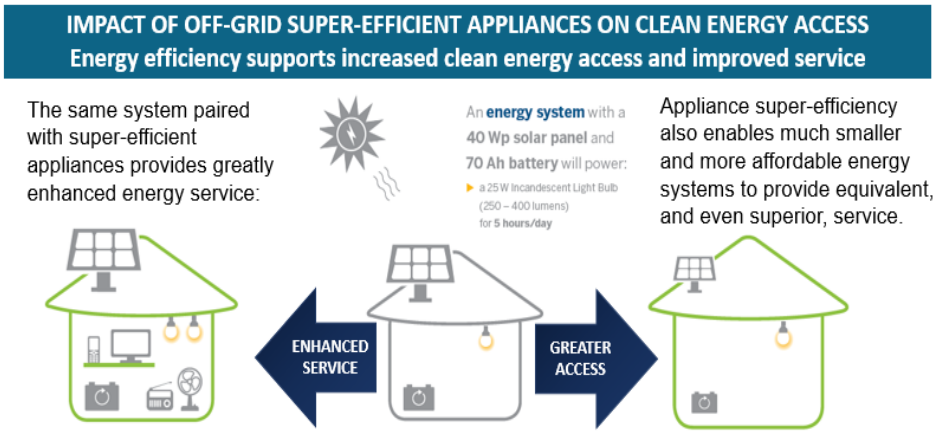
- Efficiency for Energy Access
- Renewable Energy and Efficiency
- Distributed Energy Resources
- Building Energy Efficiency

Efficiency for Energy Access

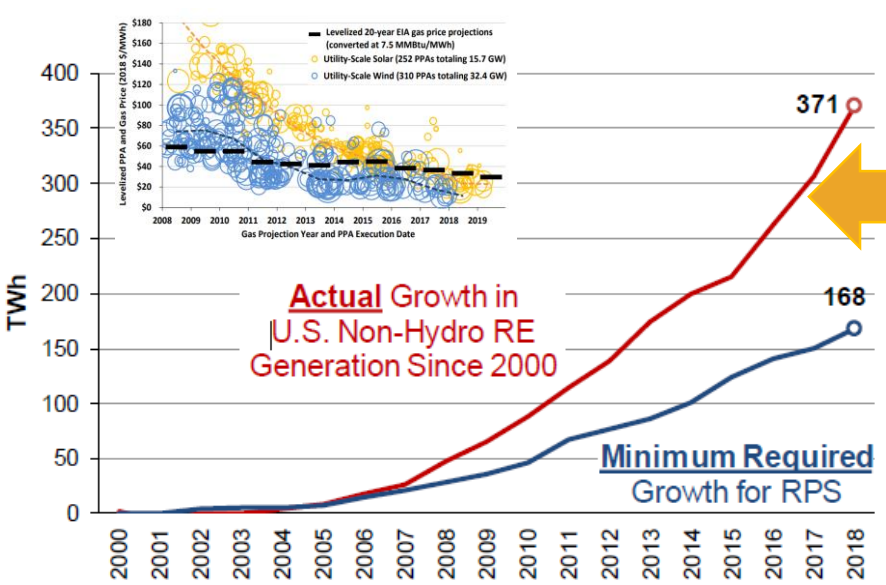
- About 1.1 billion people in the world, largely in developing Asia and sub-Saharan Africa, do not have access to electricity.
- Energy efficiency supports increased clean energy access and improved service.







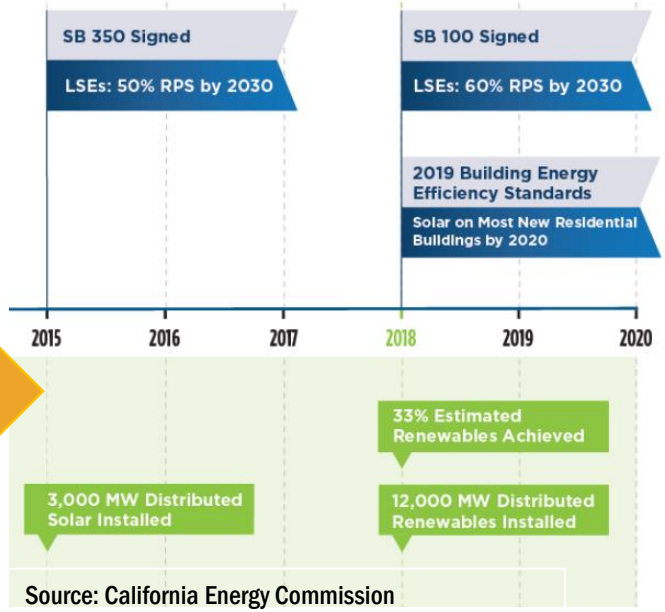
Renewable Energy and Efficiency (U.S.)



Source: LBNL/NREL (2018). Wind Technologies Market Report

- RE additions continue at a robust pace.
- Direct cost of wind and solar continues to decline and faces competition.

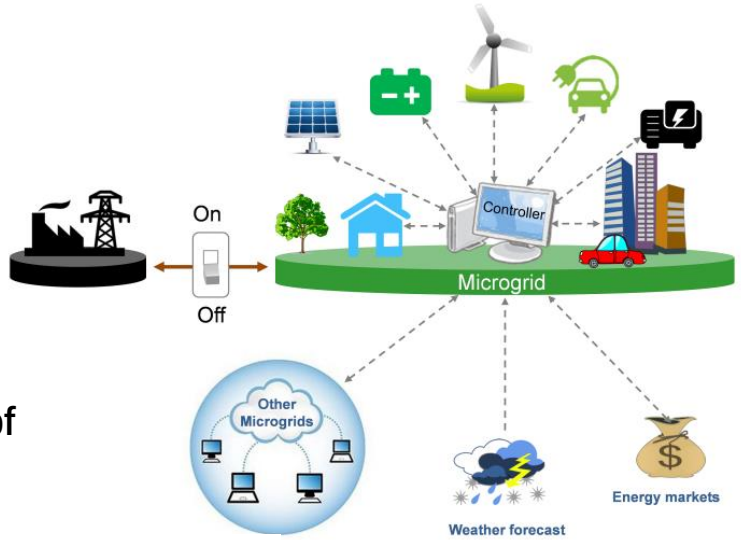
- State clean energy policies are strengthening -- California's Senate Bill (SB) 100 established a landmark policy requiring renewable energy and zero-carbon resources supply 100% of electric retail sales to end-use customers by 2045.

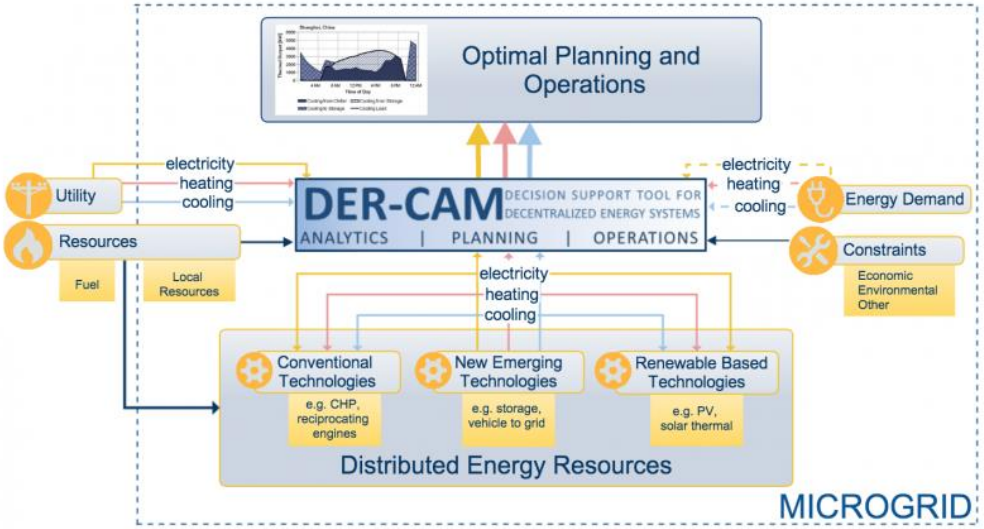


Source: California Energy Commission

Distributed Energy Resources

- LBNL's Distributed Energy Resources Customer Adoption Model (DER-CAM) is a comprehensive decision support tool that help users find optimal distributed energy resource (DER) investments in the context of either buildings or multi-energy microgrids.





A microgrid is a localized solution of electricity sources and loads that typically operates connected to and synchronous with the traditional centralized grid, but can disconnect and maintain operation autonomously as physical and/or economic conditions dictate.

Source: LBNL Energy Storage and Distributed Resources Division

City Building Energy Saver (CityBES)

LBNL's CityBES a web-based computing platform, specialized on energy modeling, benchmarking and performance visualization of a city's building stock to support district or city-scale energy efficiency programs.

Acknowledgment: Dr. Tianzhen Hong, LBNL Building Technology & Urban Systems Division

Thank you.

Won Young Park (wypark@lbl.gov)