



Energy Technologies Area

Lawrence Berkeley National Laboratory

China can lead global green cooling

中国引领全球绿色制冷

2018 CCICED Annual Meeting

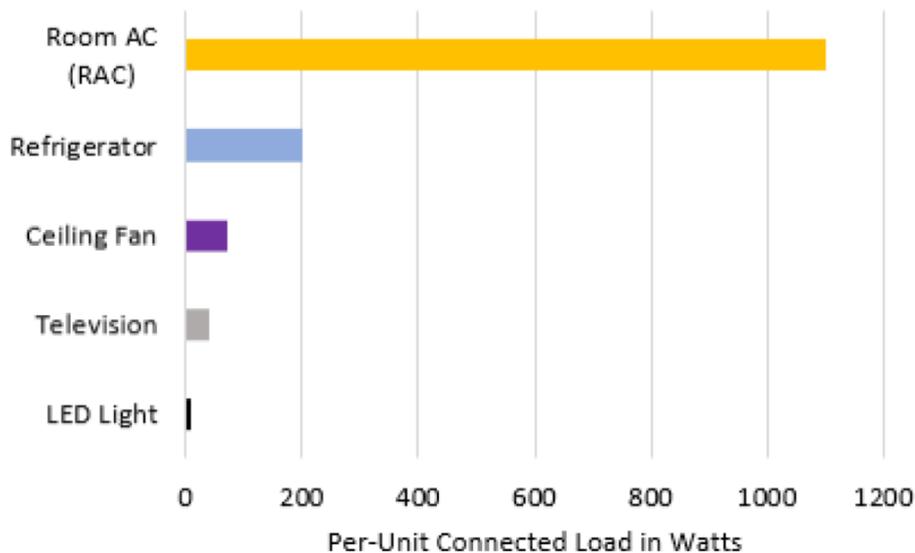
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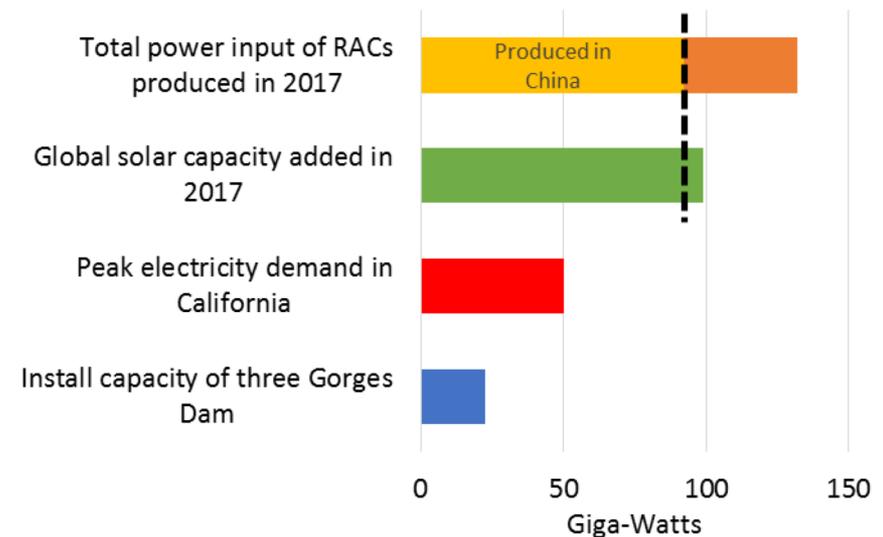
Why focus on room ACs? 为什么关注家用空调？

- China is estimated to produce about 84 million room air-conditioners (RACs) in 2017, accounting for about 70% of the total RAC production worldwide (120 million units). 据估计，2017年中国生产约8400万台房间空调器(RACs)，约占全球房间空调器总产量(1.2亿台)的70%。
- Total load added by ACs in China is comparable to total solar capacity added in 2017 (100GW). 中国制造空调增加的总负荷相当于2017年全球太阳能光伏新增装机容量。



Source: LBNL analysis

Per-unit connected load of an RAC and other end-uses
房间空调器和其他用电器的单位负荷

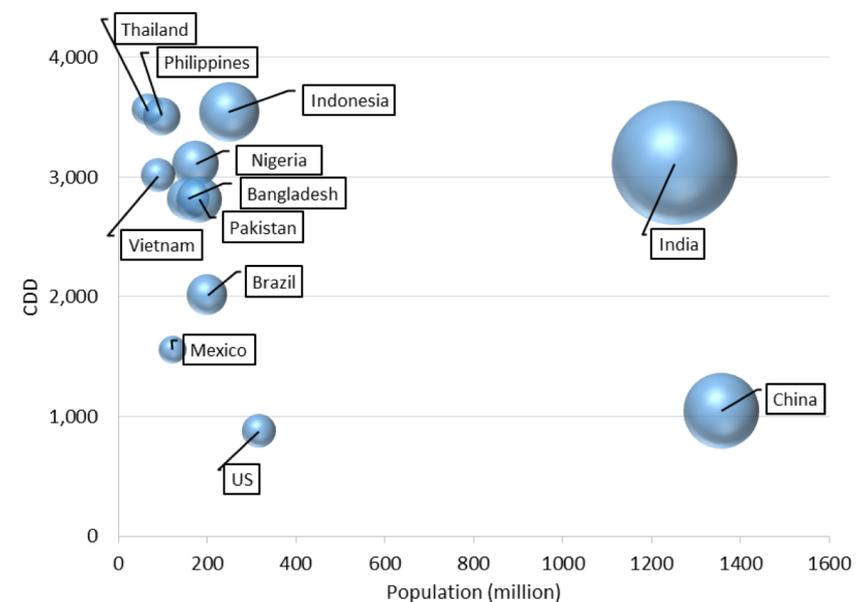
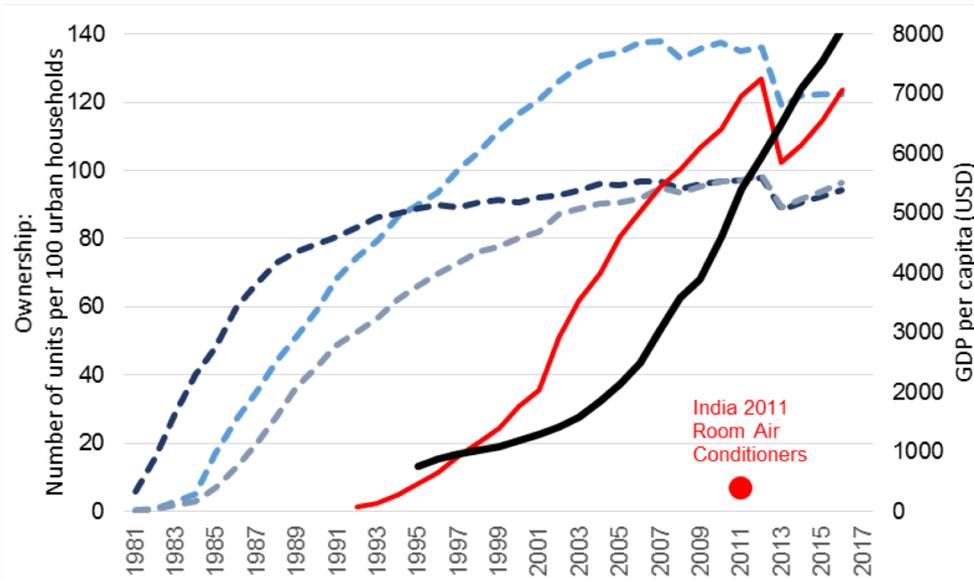


Source: LBNL analysis

Total power input from RACs produced in 2017 and selected comparable electricity demand and generation capacity
2017年房间空调器生产的总电力投入和其他几个电力需求和发电能力的对比

Why does action by China matter? 中国的行动为何尤为重要？

- RAC penetration in China increased from less than 5 units per 100 urban households in 1995 to more than 124 units by 2015. 房间空调器在中国的普及率从1995年的每百户城市家庭5台上升到2015年的超过124台。
- Expected similar rates of massive RAC demand growth in highly populous and hot/humid countries such as India and Indonesia requires China's leadership in green cooling. 在人口稠密、气候炎热/潮湿的国家，如印度和印尼等，预计未来房间空调器的需求将以类似的速度大幅增长，因此需要中国在绿色制冷方面发挥领导作用。



Sources: Shah et al. (2015). *Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning* and China Statistical Yearbook

Penetration of key appliances in urban Chinese households 中国城市家庭主要家电的拥有率

Adjusted from Davis, L. W., & Gertler, P. J. (2015).

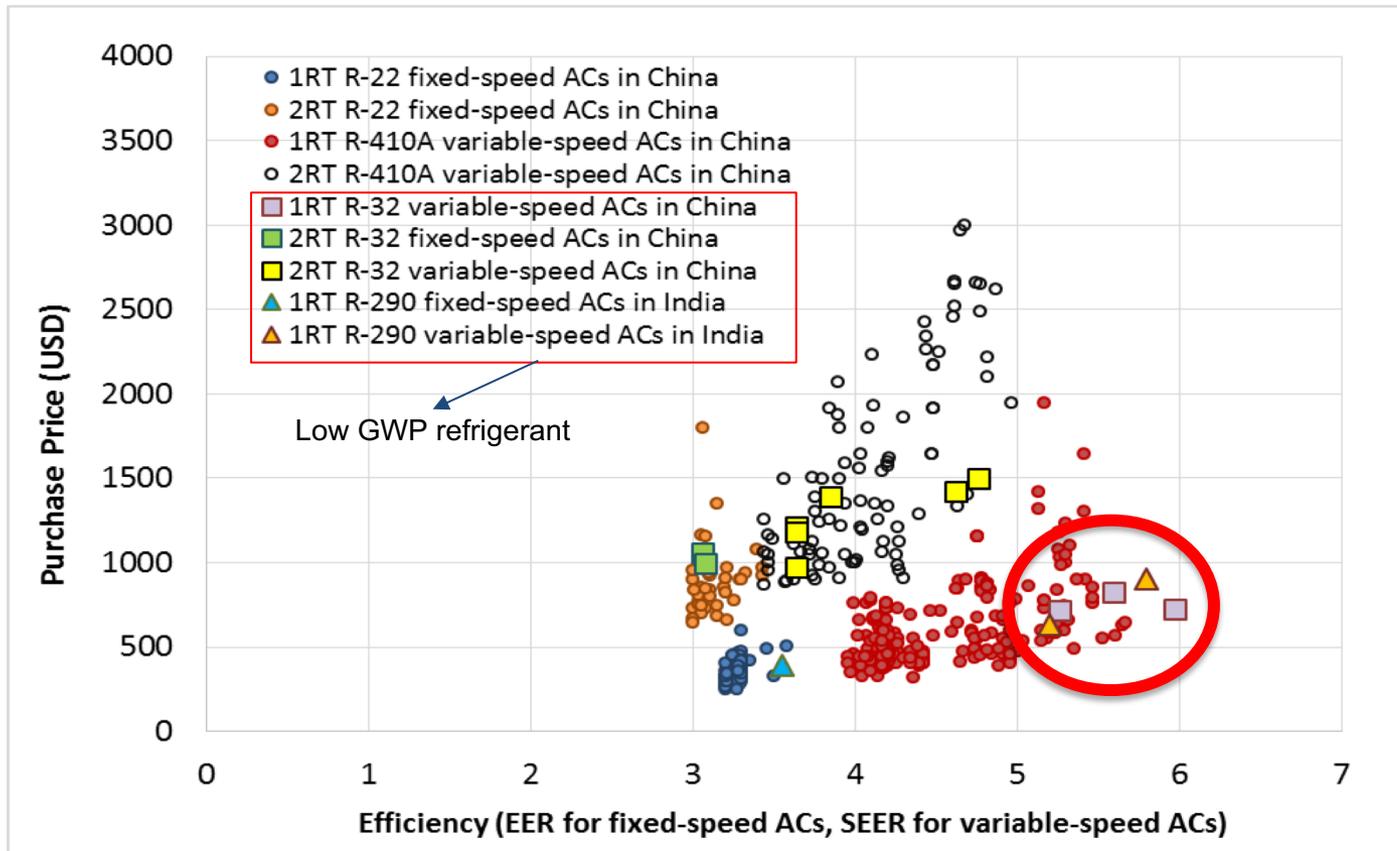
Contribution of air conditioning adoption to future energy use under global warming. Proceedings of the National Academy of Sciences, 112(19), 5962–5967.

Cooling degree days (CDD) and population of selected economies 不同经济体的制冷度日数(CDD)和人口

China already makes highly efficient ACs

中国已生产很多高效空调

- China already makes highly efficient ACs, including models with low-GWP refrigerants that are ~ 2 times more efficient (i.e. SEER 6 vs SEER 3.1) than average.....中国厂商已生产高效空调器，包括低GWP制冷剂的型号，其能效约为平均水平的2倍(即SEER 6 vs SEER 3.1)
-but not at large scale. How to achieve scale? 但规模不大，如何实现规模化？

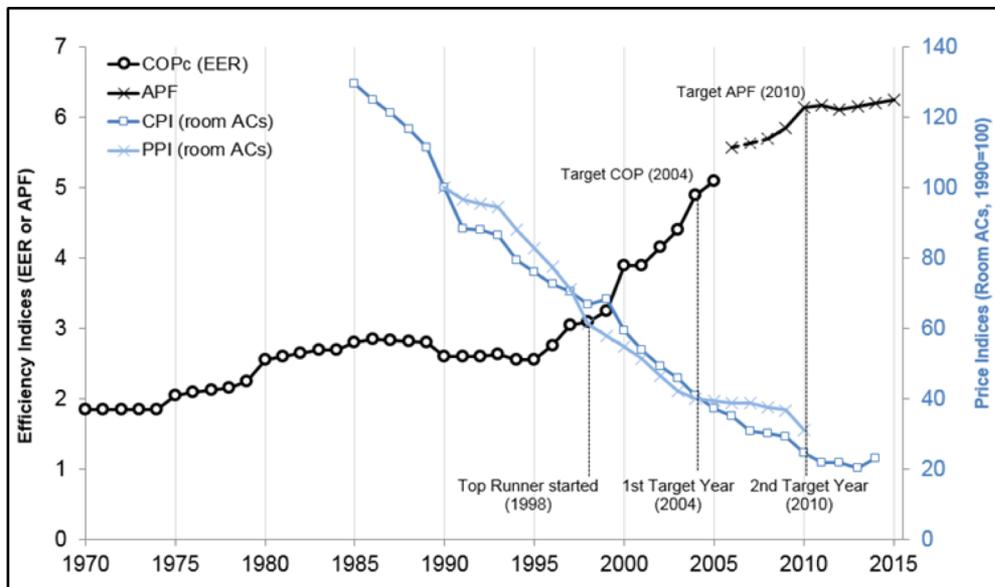


Note that the AC data used in the study were collected in 2016 from retail sites in China, and cross-referenced the results against the certification data from CNIS.

Japan's Top Runner: Efficient ACs at scale

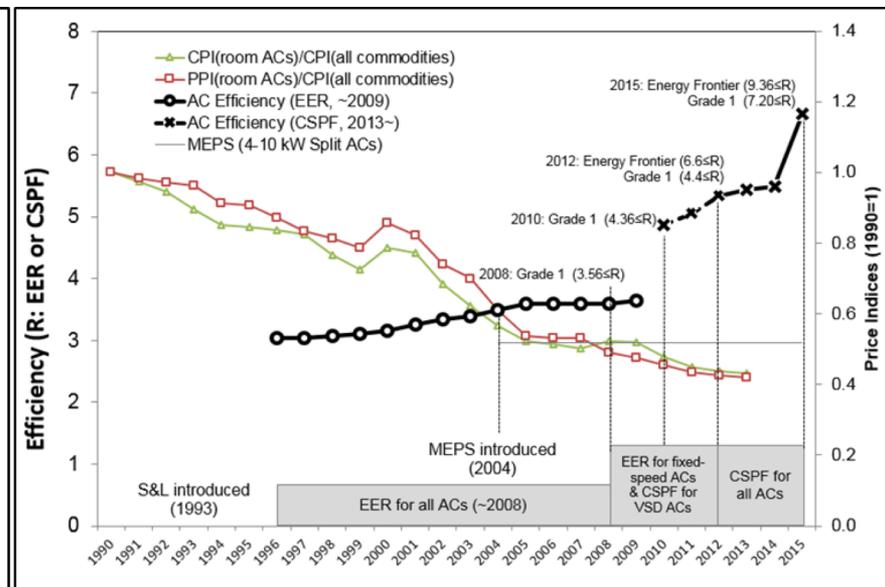
日本的领跑者项目：高效空调规模化

- If efficient ACs are made “at scale”, the cost of efficient technology falls due to “economies of scale”. 如果高效空调的制造实现“规模化”，那么高效技术的成本就会因“规模经济”而下降。
- Similar examples from US, Korea, India, EU for different appliances e.g. refrigerators and washing machines. 类似的来自美国、韩国、印度、欧盟不同家电的例子，如冰箱和洗衣机 (Abhyankar et al 2017 and Spurlock, 2013)



Room AC efficiency and price trends in Japan
日本房间空调器能效和价格变化趋势

Source: Amol Phadke, Won Young Park, Nikit Abhyankar, Nihar Shah. 2017. Relationship between Appliance Prices and Energy-Efficiency Standards and Labeling Policies: Empirical Evidence from Residential Air Conditioners. Presented at the 9th INTERNATIONAL CONFERENCE ON ENERGY EFFICIENCY IN DOMESTIC APPLIANCES AND LIGHTING (EEDAL).

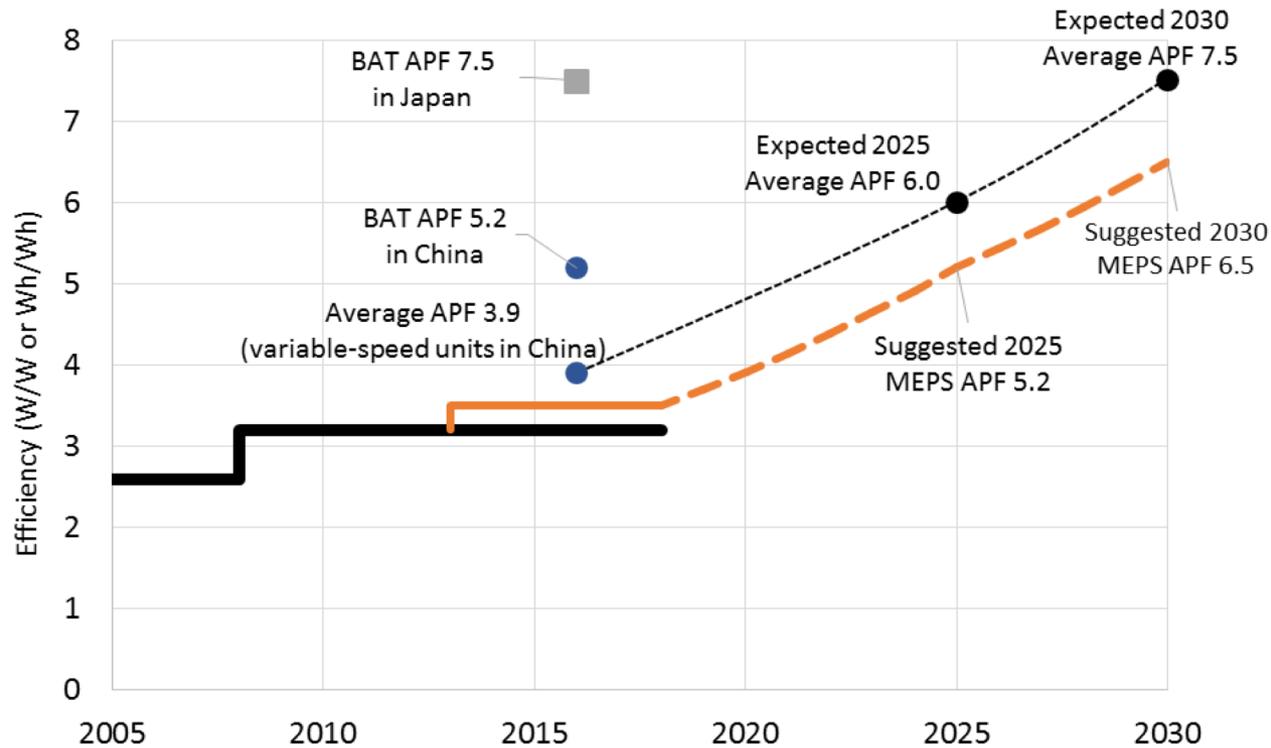


Room AC efficiency and price trends in South Korea
韩国房间空调器能效和价格变化趋势

What does ambition look like?

如何实现先进的能效标准？

- Target set to “Best available technology” (BAT) levels in consultation with industry. 与业界协商，制定以“最佳可行技术”(BAT)为几年后的目标水平。
- China already has similar renewable energy targets and Montreal Protocol refrigerant targets (2024). 中国已有类似的成功经验，如可再生能源目标和蒙特利尔议定书的制冷剂目标。
- Provides clear long term signal and certainty to manufacturers to plan investments. 为制造商计划投资提供明确的长期信号和确定性。



Scale in Efficient ACs globally

在全球范围内实现高效空调的规模化

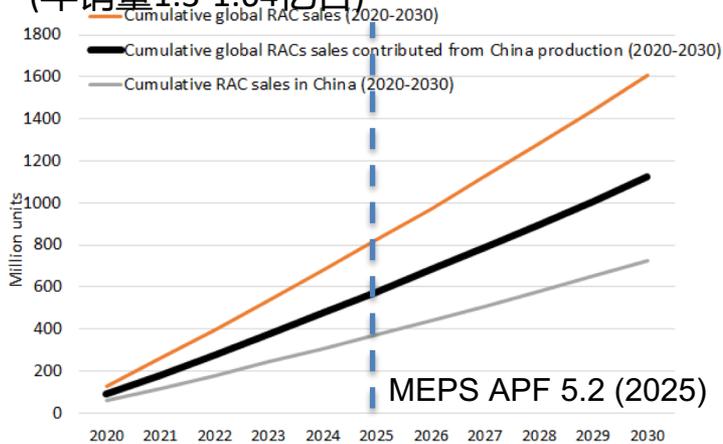
- UN Environment's United for Efficiency (U4E) Initiative model regulations will provide core requirements for energy efficiency, refrigerants, safety, testing, and functional performance. 联合国环境署能效联盟(U4E)的能效倡议示范法规将为能效、制冷剂、安全性、测试和功能性能提供核心要求。
- The content will be designed to be “plug and play” i.e. easily adopted by any economy who wants to adopt or improve its MEPS and encourage introduction of high performance products. 这些内容将被设计成“即插即用”式，即任何想要采用或改进其最低能效标准经济体都能轻易采用，并鼓励引进高性能产品。
- Capacity building will be provided to senior officials from nearly 150 “Article 5” countries during UN Environment's “Twinning workshops” in 2019, and demonstrated in U4E national and regional projects. 2019年，在联合国环境署的“结对研讨会”期间，将向近150个“A5”国家的高级官员提供能力建设，并在U4E国家和地区项目中示范。
- U4E will reference global best practices when developing the content, and it is hopeful that China and others who are updating regulations will adopt sufficiently robust levels to serve as an example. U4E将在开发标准内容时参考全球最佳实践，希望中国和其他正在更新法规的国家能够采用足够强健的能效水平作为一个典范

Consumer savings are more than \$80 Billion in China and \$400 Billion globally 中国消费者将获益超过800亿美元，全球消费者获益将超过4000亿美元

Projected cumulative RAC sales (2020-2030)

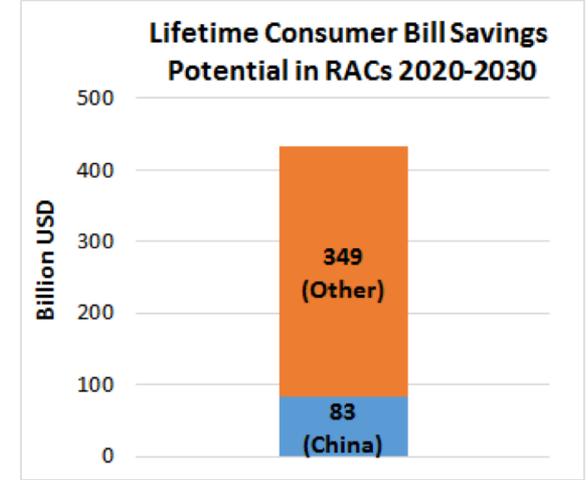
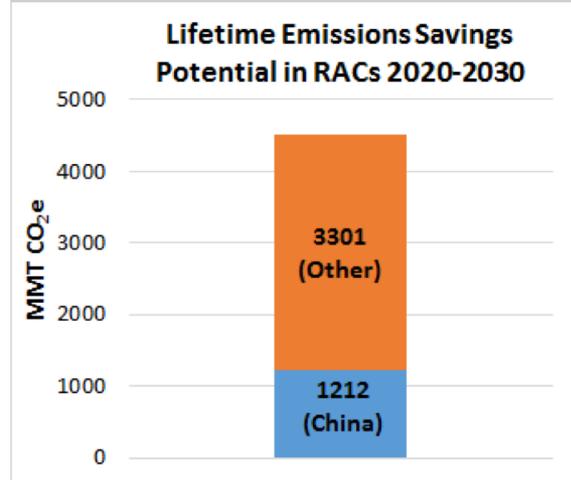
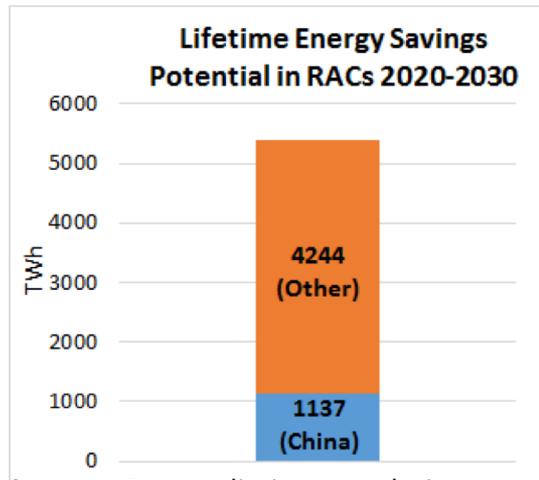
(Annual sales ~130-164 million units)

2019年起中国房间空调器累计销售量预测 (年销量1.3-1.64亿台)



By 2025 if China targets to produce RACs that are at least as efficient as the most efficient RACs produced by Chinese companies today, it will have a significant impact on about 1.5 Billion new ACs (2020-2030) and more beyond 2030 in energy, emissions and consumer bill savings.

到2025年，如中国制造至少等同于中国厂商目前所生产的最高能效的房间空调器，那么在2020-2030年间，将对约15亿新增空调产生重大影响，且持续影响未来能源、碳排放和消费者节电等。



Source: LBNL preliminary analysis

Conclusions 结论

1. Policies that provide a long term and robust signal to the market can accelerate technology innovation 为市场提供长期和有力信号的政策目标可以加速技术创新:
 - making today's best available technology (BAT) the standard/norm in the next 5-7 years, will provide industry the incentive to innovate by providing policy certainty. 在未来5-7年，通过政策确定性，使当今最先进的技术(BAT)成为标准/规范，将为行业提供创新的动力。
2. Such a target will provide a long term policy signal and will allow manufacturers to meet these efficiency targets more cost effectively by providing adequate time to plan their investments. 这一目标将提供长期的政策信号，为制造商提供足够的时间来计划投资，使其可以更有效地实现这些能效目标。
3. Given China's position as the world's largest producer and consumer of cooling equipment, it has the opportunity for ambitious action in making cooling sustainable and economical globally, leading to more than doubling efficiency of most RACs sold in the world. 鉴于中国是世界上最大的制冷设备生产国和消费国，中国有机会通过积极的行动，在全球范围内使制冷变得可持续和经济，从而使全球销售的大多数房间空调器的能效提升一倍以上。
4. By setting such a long-term target, China can help set the global standard for green cooling with GHG emissions reduction of more than 4.5 Billion ton (CO_{2e}). 通过设定这样一个长期目标，中国可以引领全球绿色制冷标准，使温室气体排放量减少45亿吨(CO_{2e})以上（2020-2030）。
5. Consumers in China and worldwide will enjoy more than 450 Billion USD savings, leading to better economic performance and higher consumer welfare. 中国和全球的消费者将节省4500多亿美元电费，从而带来更好的经济效益和更高的消费者福利。