13th India-U.S. Track II Dialogue on Climate Change and Energy

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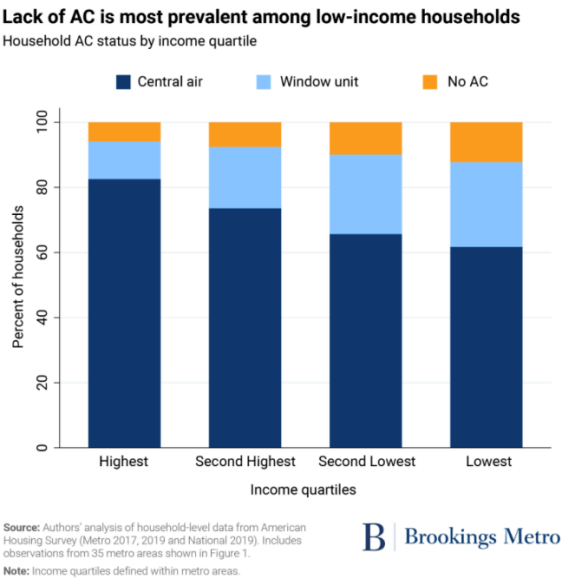
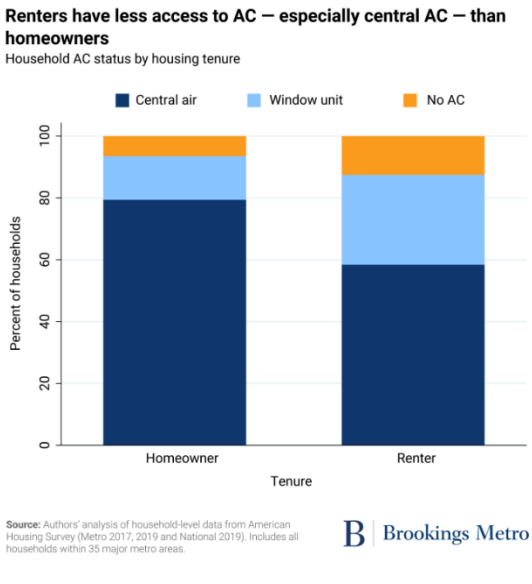
WORKING GROUP PAPER: U.S. HEAT RESILIENCE & COOLING LANDSCAPE

Cooling State of Play

In today's warming world, cooling has changed from a luxury to a health necessity in some places. The number of cooling degree days, i.e., how much higher the day's average temperature is than a "comfortable" 65°F, increased by 4% from 2021 to 2022 and June 2023 was the hottest June on record. On average there are 702 heat-related deaths per year in the U.S according to the Centers for Disease Control and Prevention and heat is the leading cause of weather-related deaths. In the U.S., extreme heat is estimated to cost $1 billion in excess health care costs each year. Exposure to extreme heat and its health effects is not uniformly distributed, with access to air conditioning positively correlated to household income and correlated to race and status as a homeowner versus renter, as shown in the graphs below.





While cooling is becoming an increasing imperative with rising temperatures across the U.S., it is also driving increased GHG emissions, primarily through electricity generation. Cooling is among

the most energy-intensive activities in both residential and commercial spaces - largely affecting electricity demand. In 2020, almost 90% of U.S. households used air conditioning and air conditioning represented about 9% of end-use energy consumption. These numbers are only set to increase as extreme heat becomes more common. 2023's summer heat waves caused air conditioner sales on Amazon in June and July to increase 248% compared to the same period in the previous year and portable AC unit sales increased 208%.

U.S. Cooling Policy Developments

The U.S. Congress and the Administration have taken steps in the last year to address increased cooling needs and weave equity into this work. The U.S. signed on to the Global Cooling Pledge at COP28. The pledge sets as its global targets: the reduction of cooling-related emissions by 68% by 2050, significantly increased access to sustainable cooling by 2030, and a 50% increase in global average efficiency of new air conditioners.

Domestic Regulatory and Legislative Actions Achieved in the U.S. in 2023 to Address Cooling:

- The Inflation Reduction Act (IRA) – The IRA addresses cooling through the Energy Efficient Home Improvement tax credit, which went into effect in 2023 and includes credits for high-efficiency air conditioners and heat pumps, among other efficiency upgrades. Taxpayers can claim a credit of up to $600 for high efficiency air conditioners meeting and can claim up to $2,000 per year for heat pumps with a 75% thermal efficiency rating.
- Energy efficiency rules for room air conditioners and cleaners - In March 2023, the Department of Energy finalized new energy efficiency standards for room air conditioners and portable air cleaners. Compliance with the new rules is required starting on December 31, 2023, for air cleaners and in 2026 for room air conditioners. The new standards are expected to save consumers over $25 billion over the next 30 years and significantly cut pollution.
- Hydrofluorocarbon (HFC) phase down rule - In October 2023, the U.S. Environmental Protection Agency issued a final rule as part of the American Innovation and Manufacturing Act, restricting the use of hydrofluorocarbons in specific sectors, establishing a process for submitting technology transition petitions, and establishing recordkeeping and reporting requirements. The rule's effective date was December 26, 2023.

Congressional Efforts in 2023 to Address Cooling:

There have been several bills introduced to promote equitable cooling, mainly focused on energy efficiency and access to cooling, including:

- Stay Cool Act - First introduced in 2022, then reintroduced in June 2023, and currently awaiting review by relevant committees, the act includes air conditioning as a covered utility in public housing. It also creates and implements safe residential temperature standards for federally assisted rental dwelling units, sets up a grant for senior check-in programs during extreme heat events, and sets up public greenspaces and cooling centers in overburdened communities.
- Extreme Heat Emergency Act - A bipartisan bill introduced in June 2023, this act adds extreme heat to FEMA's list of major disasters, which would enable the use of federal money to address extreme heat. As one of the bill's sponsors, Mark Amodei (R-NV), has argued: "Extreme heat kills more people in the U.S. than all other natural hazards and extreme weather events."
- Excess Urban Heat Mitigation Act - Introduced in both the House and the Senate, this bill would provide $30 million each year in Department of Housing and Urban Development grants to address extreme heat in urban areas, which are more likely to experience high temperatures due to limited tree cover, high impervious surface cover, etc.
- Heating and Cooling Relief Act (HCRA)- This act reauthorizes and expands coverage under the Low-Income Home Energy Assistance Program (LIHEAP). LIHEAP authorized the Department of Health and Human Services (HHS) to award grants to states to assist low-income households. The HCRA builds on and expands coverage to households with a monthly energy burden of 3% or more. It also requires that states protect households receiving assistance under the program from energy shut offs and certain late fees. Finally, the HCRA requires HHS and the Department of Energy to work together on plans to reduce energy burdens for eligible households, and these plans must promote the reduction of energy from fossil fuels.

Administrative Policy Framework

The Climate Resilience Framework, released by the White House in September 2023, addresses cooling in two of its core objectives. In the first it states that efficient cooling technologies and building materials that reflect heat and insulate are requirements for a climate resilient nation. In the second, it calls out the role of urban greening programs which can reduce cooling costs for low-income and overburdened communities and improve health conditions related to heat and poor air quality, among other potential actions. The framework also addresses adapting architectural standards to deal with future climate-related loads, such as extreme heat.

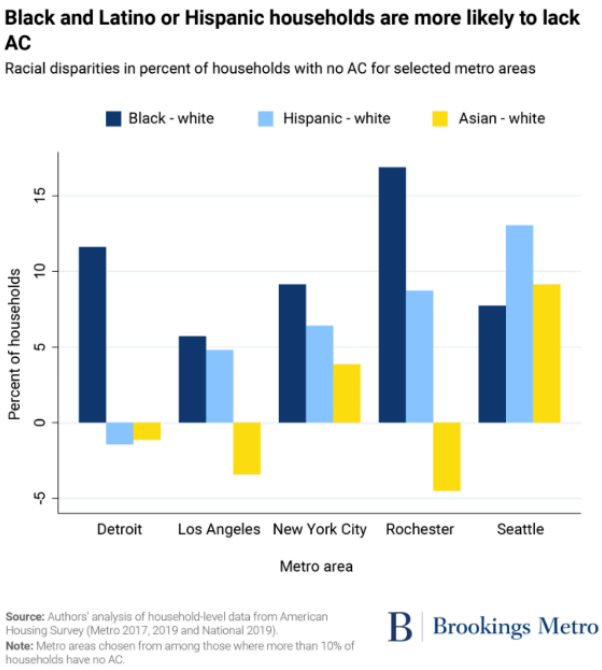
Emerging priorities and gaps

Improved technology

While significant progress has been made to improve the efficiency of air conditioners, there is significant ongoing work to continue to improve this technology – including other methods of cooling, beyond air conditioners. A recent study found that reforestation in the southeastern U.S. has contributed to what's known as a "warming hole" over parts of southeastern U.S. where temperatures have stopped increasing or even started decreasing. Passive strategies such as increasing tree cover and green space, building design that minimizes the need for cooling, and better insulation, are all part of a sustainable cooling system and the methods and technologies for passive cooling must be developed to become scalable and more effective.

Cooling Access and Equity

Access to home cooling is not universal and as average temperatures rise, this issue is shifting from a comfort issue to a health issue, especially among vulnerable populations. Data from the 2010's indicates that Black and Latino households are less likely to have access to cooling. There is, however, a dearth of recent data on who has access to cooling in the U.S., indicating that more focus on this issue is needed.



An analysis of heat-related deaths in Maricopa County, Arizona, found that 25% of the deaths occurred in spaces with non-functioning air conditioning and 45% occurred among those without homes, highlighting the increased risk that vulnerable populations face from extreme heat. Tools such as the National Integrated Heat Health Information System's Heat Equity map can help pinpoint communities at highest risk for heat-related health complications and they should be expanded. In this vein, the Director of Public Health, Environmental and Social Determinant of Health at the WHO identified the development of urban heat maps as an important action for municipalities.

Addressing the affordability and sustainability of air conditioning (AC) in India is paramount. It is crucial to devise strategies to make AC units more affordable for the country's poor and vulnerable populations while simultaneously reducing energy consumption and curbing the environmental damage caused by widespread use of hydrofluorocarbons (HFCs).

Furthermore, it is imperative to consider blue-sky cooling solutions, including innovative technologies such as heat exchange systems. Additionally, exploring ways to adapt vulnerable sector workplaces to withstand extreme heat conditions is essential to ensure the greater public health .

Opportunities for Collaboration

Resiliency

Cities have a higher risk of negative impacts from heat waves due to the heat island effect, making heat resiliency plans especially important for city governments. There are five main strategies to address heat islands: increase tree and vegetative cover, install green roofs, install cool roofs, use cool pavement, and utilize smart growth practices which help protect the natural environment. Many communities also have plans for cooling shelters. For instance, the National Disaster Management Authority of India has incorporated cool roofs as part of HAPs to accelerate accessibility in a sustainable and institutionalized manner.

To be as effective as possible, these strategies should be targeted at communities with a high risk of being negatively impacted by extreme heat. However, a study found that in many cases, there was a gap between the populations identified as at risk and the populations targeted by heat resiliency programs. This highlights the need for improved targeting of resiliency action plans.

Cooling Market and Industry

Investment opportunities

India's Cooling Action Plan includes targets to increase the supply of lower impact alternatives to HFCs, reduce cooling demand by 20-25%, and double the energy efficiency of equipment by 2038. Meeting these targets provides an investment opportunity of $1.6 trillion by 2040, $34 billion of which will be needed by 2037 just to phase out HFCs.

India has been investing in the domestic manufacturing of air conditioners through the Production Linked Incentive (PLI) Scheme. Although the PLI has seen mixed results across industries, in the air conditioner industry it has seen an increase from 25% to 45% in the ratio of domestic value addition, marking a significant advancement towards the goal of reaching 75% by FY 2028 despite only being launched a year and a half ago. Manufacturers are also working on introducing energy efficient models and new technologies.

There are also various innovative start-ups that provide an example of successful international collaboration and could provide an opportunity for investment as they scale. One example is the collaboration between Swiss organizations Base and Empa, and Indian start-up Koel Fresh on

cooling solutions for small-holder farmers in India. Insufficient access to markets and refrigeration leads to an estimated 35% loss of fresh produce per year in India, amounting to $13 billion annually. Koel Fresh leveraged Base and Empa's Virtual Cold-Chain Assistant (VCCA) platform to facilitate inventory management, post-harvest and market intelligence, and a Cooling-as-a-Service business model for farmers in Rourkela, India. A study by the World Wildlife Fund found that the barriers faced by start-ups and small-medium enterprises in the cooling space in India include high capital investment requirements, lack of facilities for new product development and prototype testing, and few financing products and funding schemes for end users. These are areas that could be addressed by thoughtful collaboration and targeted investment.

Both countries could outline a list of key heat interventions open to private investment and R&D funding, including energy-efficient cooling instruments, heat-resistant crops, parametric insurance, next-gen HFCs, energy-saving cooling appliances, and urban forestry. This strategy could encourage mutual investments and knowledge sharing.

Mutual benefit: technology export

Researchers at various institutions around the U.S. are working on new air conditioning methods that are more efficient than current methods. Many of these strategies work by splitting the dehumidification and cooling processes, which allows for more efficient cooling. One Florida-based company is expecting to see up to a 90% reduction in energy consumption. While these technologies are promising, several obstacles could hinder their commercial viability, including higher manufacturing and installation costs, industry inertia, and policies that incentivize cheap systems over efficient ones. Collaboration with India's growing manufacturing sector combined with policies that incentivize the production and installation of more efficient technologies, could help bring these technologies to market, benefiting consumers in both the U.S. and India and helping both countries reach their climate targets.

The U.S. could also benefit from work being done in India on innovative cooling methods. For example, Ant Studio, a Delhi based architecture and design studio designed a cooling system using traditional methods that was successful in reducing indoor temperatures by 6°C when tested at an electronics factory. What is unique about this method is that the structure is built from clay which is easily recyclable, and it can function as a zero-energy cooling method.

Technology

Given the potential for cooling to play a major role in the release of greenhouse gasses, efforts are underway to drive down this potential risk through various methods including refrigerant management, higher efficiency air conditioners, and passive cooling methods that do not release operations related emissions.

Tying life cycle refrigerant management

In the United States, the current load of ozone depleting substances (ODS) and HFC equals approximately 3.6 billion tons of CO2e; this is roughly equal to tailpipe emissions from about half of U.S. passenger vehicles each year. By midcentury, the additions to the refrigerant bank[1] under the current HFC phasedown schedule will result in 7 billion tons of CO2e. Globally, 61 billion tons of CO2e of ODSs and HFCs is in use or expected to be produced by 2050.

These existing banks and ones that will exist in the future, provide an opportunity for effective management of these gasses to prevent them from leaking into the atmosphere. Lifecycle refrigerant management, an area of work gaining momentum in the U.S. and now globally, focuses on avoiding and reducing refrigerant leaks, promoting refrigerant recovery, and increasing reclamation rates to mitigate unnecessary refrigerant use and emissions. The guiding principle of a robust lifecycle refrigerant management regime is to prevent molecules from reaching the atmosphere. Several measures can make it possible to prevent the release of a significant portion of the existing and continuously growing refrigerant bank around the world. There are evolving technologies for refrigerant reclamation and reuse. In addition to emissions prevention, refrigerant management will increase the availability of reclaimed refrigerant in the market thus offsetting the need for virgin HFC production.

In October 2023, EPA came out with a proposed rule in—called "refrigerant management" under the AIM Act—which sets leak repair requirements for many systems that use HFCs, promotes the use of "reclaimed" refrigerants, and more. This critical regulation aims to bring down emissions from the installed base of HFC-containing equipment.

In addition to such regulatory action, other levers such as refrigerant stewardship, warranty requirements from both equipment manufacturers and service technicians, leak repair requirements through mandatory regular equipment service and technician training and certification, are being evaluated and pursued in the U.S. Large private companies and institutions like universities, hospitals, banks, supermarkets, and tech companies who handle several equipment types and large volumes of refrigerant can spearhead voluntary efforts to demonstrate how much further refrigerant management policies can go and share lessons-learned.

India is starting its process of planning for the HFC phase down under the Kigali Amendment which provides an important opportunity to include refrigerant management practices in its early plans. Scaling up these practices will provide significant additional flexibility in the HFC phasedown for India. While there are existing initiatives to strengthen proper installation and servicing practices, refrigerant reclamation has not received adequate attention. As the cooling

[1] Aggregate amount of refrigerant in the cooling equipment.

equipment demand is expected to grow exponentially in India over the next few decades and as more and more refrigerant comes into the market, now is the time to set up robust refrigerant management practices to get ahead of new installations and enlarged refrigerant banks. India has included refrigerant recovery, recycling, and reclamation in its earlier phase outs of gases, with limited success (it's practiced in the mobile air conditioning (MAC) sector to some extent).

The HFC phasedown presents an opportunity to reassess refrigerant recovery and reclamation in India and include it appropriately in India's national strategy. This presents an opportunity for U.S. and India knowledge exchange and technology transfer to assist in developing an ecosystem for effective lifecycle refrigerant management in India. While recovery and reclamation of refrigerants is still evolving in the U.S., there are already many lessons learned which could benefit India. The U.S. can also engage with entities in other countries such as Australia, which have a very evolved system of refrigerant lifecycle management to support India in this direction. The two countries can collaborate to develop globally acceptable, rigorous safety standards and life cycle management mechanisms which will minimize refrigerant leakage and increase reclamation and reuse of refrigerants.

Air conditioners

As the planet heats up and urbanization increases, 3 billion more room air conditioners (ACs) are expected to be installed globally by 2050. Countries with hot and humid climates, like India and Indonesia, may see a five-fold increase in room ACs between now and 2050. Room ACs are increasingly the technology of choice in emerging markets due to the low cost of entry, particularly in the residential sector.

In late 2018, a broad-based coalition led by RMI, the Government of India's Department of Science and Technology, and Mission Innovation launched the Global Cooling Prize with the ambitious goal of developing an affordable residential air conditioner that has five times (referred to as "5X") lower climate impact — factored as a combination of greater energy efficiency and lower global warming potential refrigerants — than the typical units sold at the time in India. As the world's fastest-growing AC market, India was the natural choice as the testbed for the Prize.

The Prize successfully demonstrated through two winning prototypes that the desired improvements are achievable with currently available technology; however, these models are not available to consumers today. Markets must first overcome several supply and demand barriers to make these products commercially available and for their sales to achieve significant market share. Much work is needed to help bring super-efficient room ACs to the market.

Groundwork in this direction has already been initiated by a broad group of partners from the U.S. and India to update current test methods for measuring the performance and energy use of

room air conditioners. However, greater support is needed to bring these technologies to market. The U.S. can play a key role to help India become a potential global manufacturing hub of 5X ACs. Support can be provided to develop mechanisms to unlock investments and drive the manufacturing of super-efficient room ACs. Financial mechanisms such as rebates and low-interest loans could be put in place to jump-start the market and to help overcome the price premium of these super-efficient next-generation ACs. Grants can be mobilized for updating existing testing labs to more accurately measure the performance of new ACs. The U.S. can bring countries together that can provide grants for the Calorimetric Test Labs that can be used, though predominantly Psychometric labs will continue to be used across the global South.

City-to-City Collaboration

Passive cooling

Given rising population growth and urbanization, those suffering most acutely from the increasing heat are located in cities. The world's cities are heating up at twice the global average rate due to the urban heat island effect, i.e., (Energy Sector Management Assistance Program [ESMAP] 2020a[2]). Heat islands are caused by the reduction of natural landscapes, building materials that absorb more heat than natural surfaces, the size and shape of buildings (which can influence wind flow), heat generated by appliances, cars, and other human activities, and weather and geography.

Proactively managing excess warming in our cities – through mitigation of urban heat islands and adopting more urban and climate-friendly cooling practices – is an urgent priority to ensure access to cooling where needed and to support many critical development goals without further warming the city environment.

There is a need for broad-based urban heat island adaptation and mitigation measures along with a shift to more sustainable cooling solutions that can provide access to cooling without more warming. Sustainable cooling, in this context, means achieving human thermal comfort in an urban environment through urban planning and design (both nature-based and infrastructure-related), energy-efficient building design, efficient cooling technologies, and sustainable refrigerant use, resulting in lower GHG emissions and greater access to cooling than business-as-usual. Achieving this requires both policy and market-based interventions, as well as widespread awareness, to accelerate the shift away from current cooling practices and towards more sustainable cooling.

City urban cooling action plans can help cities adopt a comprehensive approach to prioritize and organize the various interventions which a holistic cooling action plan would identify – to

[2] Energy Sector Management Assistance Program (2020a). Primer for Cool Cities: Reducing Excessive Urban Heat. Energy Sector Management Assistance Program Knowledge Series 028/19. Washington, D.C.: World Bank.

advance action on sustainable urban cooling. In this context, there is opportunity for cities like Los Angeles and Ahmedabad in the U.S. and India to collaborate on developing and implementing urban cooling plans. Such collaboration will ensure knowledge and experience sharing. It will also create opportunities for technology transfer and joint development of interventions. Identifying city-specific temperature thresholds can also be a useful tool to identify specific cooling solutions.