Policy Brief

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Cooling developing countries

How income and climate drive air conditioning adoption

In brief:

- Over 90% of people living in hot areas lack air conditioning. The expansion of air conditioning in these areas will bring comfort but increase greenhouse gas emissions from power plants and refrigerant leaks and could stress electric grids.
- This study develops country-specific estimates of how air conditioning saturation relates to climate and household income and how it could grow over time.
- The authors find that higher income households are beginning to adopt air conditioning in countries such as Pakistan and India, but air conditioning remains rare at all income levels in other countries such as Ghana and Sierra Leone.
- The authors suggest that policy reforms are increasingly urgent in countries where adoption is accelerating. Reforms could include minimum efficiency standards, reduction of electricity price subsidies and rapid phase down of the most harmful refrigerants.
- Further, hot countries should collect data about air conditioning ownership and household income regularly in order to better anticipate when ownership will begin to accelerate.

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Overview of the research

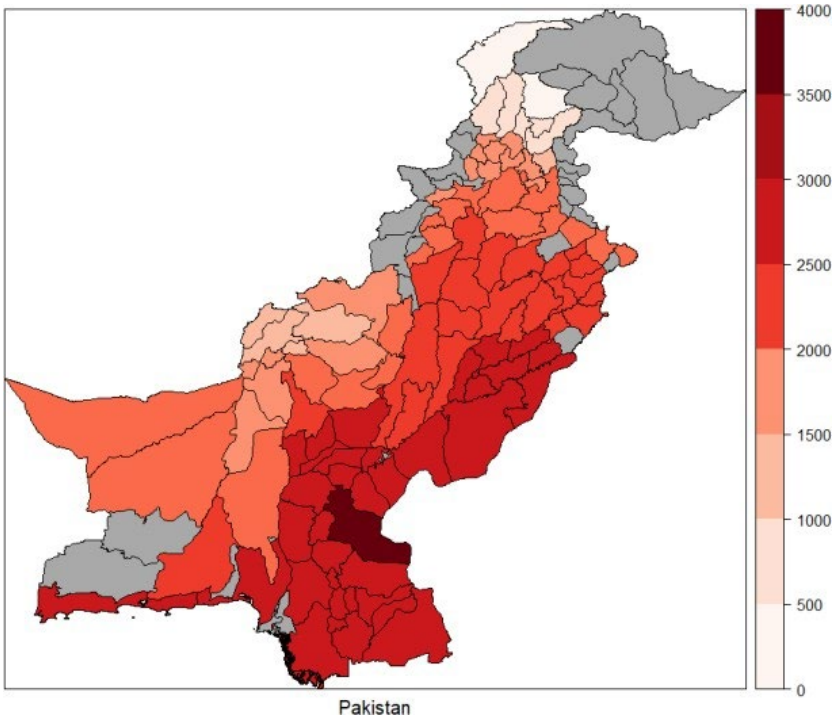
Air conditioning sales are booming worldwide, especially in warm countries with growing economies. Thailand, Indonesia, and Vietnam, for example, increased air conditioner sales by 60%, 129%, and 159%, respectively, over the last five years. Yet despite this rapid growth, only 8% of the nearly 3 billion people living in the hottest parts of the world have air conditioners. Understanding the path that air conditioning adoption will take in the developing world is important so that governments and utilities can develop policy and infrastructure responses.

This study estimates the path that air conditioning adoption is taking, and will take in the future, in specific countries. The study builds on insights from prior research that shows how air conditioning demand is driven by a combination of climate and household income. Data about air conditioning saturation in countries including India, Pakistan, Ghana and Sierra Leone are used to identify the existing relationship between household income and air conditioning ownership. This analysis can then be used to estimate future air conditioning adoption and analyse the effect of different policies.

The study used granular weather data from a non-profit, Berkeley Earth, to determine precise measurements of temperatures at the location of each household. The study also used nationally-representative survey data that included information about both air conditioning ownership and household income for each country studied.

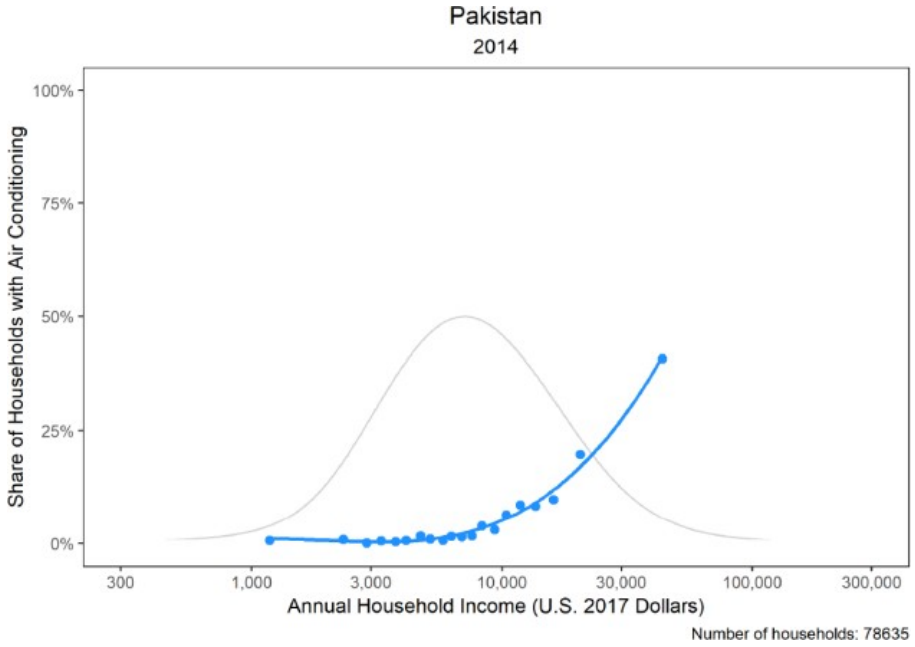
The temperature data was used to calculate the potential demand for cooling by region within each country. Figure 1 shows the 10-year average annual cooling degree days (CDDs) for Pakistan. CDDs reflect both the number of hot days and the intensity of the heat on the hot days. For Pakistan, CDDs vary from the 3000s in the south to 1000s in the north. For reference, in the United States annual CDDs have been 1,200 to 1,600 over the last decade.

Figure 1: Average cooling degree days – population-weighted within region



Next, for each studied country the relationship between air conditioning ownership and household income was plotted (Figure 2, blue line), along with the distribution of household income (Figure 2, grey distribution). For Pakistan, air conditioning saturation is greater for higher income households, but most households have income levels at which ownership is uncommon.

Figure 2: Relationship between air conditioning adoption and income



Policy motivation for research

Air conditioning makes indoor space more comfortable. It also helps people escape the harms of heat, including increased mortality, worsening air quality and lowered productivity. On the other hand, air conditioners increase greenhouse gas emissions and strain the electric grid, even causing blackouts in some instances. Policymakers must wrestle with the challenge of enabling the benefits of air conditioning while mitigating the costs to the environment and economic activity.

To develop effective policy and infrastructure responses, policymakers need to understand the country-specific trajectory of air conditioning adoption. Estimates that ignore country- specific factors may entirely miss the likely timing of rapid air conditioning adoption.

Country-by-country estimates provide baselines to assess the impact of policy reforms. One possible policy response is the adoption of minimum efficiency standards that remove the least efficient air conditioners from the market. However, the least efficient air conditioners are also likely the least expensive, so removing them could make air conditioning unaffordable for some households.

Another policy response is reforming how electricity is priced. In some countries electricity is subsidised. Removing these subsidies would reduce socially inefficient cooling demand and mitigate the contributions of cooling at peak times. Price reform could also encourage the adoption of evaporative cooling as an alternative to air conditioning in some settings. The adoption estimates will help assess the likely impact of pricing reform.

Estimates of future air conditioning will also assist governments and electricity utilities to expand the

capacity of the electric grid at the right pace.

Findings

- The potential for increased air conditioning adoption is very high. For example, heavily populated parts of India and Pakistan, where air conditioning is rare, have considerably hotter temperatures than the hottest parts of the United States, where air conditioning is commonplace.
- In India and Pakistan, air conditioning saturation increases rapidly at annual household income levels above US$7,500. While most households have incomes below this level, a large number of households are about to reach this point, pointing toward enormous potential increases in the short-term.
- In other countries, such as Ghana and Sierra Leone, saturation is low at all income levels despite the heat.
- Currently, very few household-level surveys ask a question about air conditioning, so data about air conditioning saturation is very limited or non-existent in some countries.

Policy recommendations

- **Consider minimum efficiency standards for air conditioners, especially in countries with accelerating saturation.**

  Removing the least efficient models from the market can mitigate the harms caused by air conditioning and meet households' demand for cooling with less energy and, thus, pollution. However, governments also need to consider that the least efficient air conditioners are likely the least expensive, so removing them could push air conditioning out-of-reach for some households.

- **Reform electricity pricing.**

  Reducing electricity price subsidies can reduce excessive, wasteful use of air conditioning. Pricing reform could also encourage more energy efficient alternatives for cooling such as evaporative cooling. Higher prices during peak periods when infrastructure is constrained could also be appropriate.

- **Re-evaluate international plans to phase out the most harmful refrigerants.**

  The 2016 Kigali Amendments adopted a schedule to phase down the climate impact of refrigerants over the next 30 years. The impact of the schedule should be re-evaluated to determine whether the schedule will remove the most harmful refrigerants from the market before the cooling revolution accelerates.

- **Systematically collect data about air conditioning ownership and household income.**

  Information about air conditioning ownership should be collected regularly by countries to monitor how the relationship between air conditioning, income and climate are evolving over time.