The access to affordable cooling challenge: managing rising demand in a warming climate with a combination of better building design and efficient air conditioning

Global emissions and energy use – residential and commercial space cooling

Emissions today	Energy use today	Energy use in 2050	
		With growing demand from higher incomes and warmer climates	*+ With better building design, improvements to existing buildings, and more efficient AC*
1 $GtCO_2$ *3% of global emissions*[1]	2,200 TWh *Of which ~100% electricity*	↑↑ 5,000 TWh *But could be higher with greater climate change*	↓ 1,200 TWh *But relies on strong policy action*

Space cooling technologies:

- Comfort in hot countries depends on two factors – temperature and humidity. Air conditioning (AC) will be by far the dominant cooling technology, but with roles also for technologies which cool the air by causing hot water to evaporate ("evaporative cooling"), for dehumidifiers in humid climates, and for fans as a low-cost (but less effective) solution.

- AC is an electric technology so decarbonising cooling is primarily a question of decarbonising wider electricity systems as rapidly as possible.

Managing rising demand for cooling with efficient AC and better building design:

- Climate change is expected to result in an additional 700 million people, or ~10% of the global population, living in hot climates by 2050.[2] Demand for cooling is projected to more than double by 2050 from 2,000 TWh-5,000 TWh due to rising incomes and warming climates.[3] If emissions do not fall fast enough to prevent even greater temperature rises, demand for cooling could be even higher.

- Despite growing access, more than 40% of people living in hot climates will not have access to cooling by 2050, either because they cannot afford it or they don't have access to electricity.[4] Expanding access to cooling is a health and equality imperative.

- The growth of demand for cooling is inevitable and should be welcomed since it will improve living standards for many low-income people living in hot climates. But this has large implications for electricity demand, and in particular for electricity required at peak times of day. This can, however, be managed in three ways:

    1. The single most effective lever to reducing electricity needs for cooling is to ensure that households purchase the most efficient AC. Currently, there is a huge difference in the average efficiency of ACs on the market both across and within countries, with significant potential for improvement.

    2. Better building design and urban planning to reduce how hot buildings get, and therefore how much air conditioning and electricity is required. Many of these can be fairly low-cost, such as painting roofs white to reflect heat and external shading by planting trees and installing window shades. In individual buildings, these "passive cooling" techniques can reduce a building's cooling energy needs by 25–40%, but the impacts can be even greater the more these can be done across entire neighbourhoods. Getting this right in new buildings is a critical opportunity; if all new builds can be built to higher standards, this could reduce annual global electricity needs for cooling in 2050 by around 20%.

1 The 1$GtCO_2$ emissions relates just to fossil fuel use to generate electricity. We estimate that an additional ~1 $GtCO_2$ of emissions relates from refrigerant leakage and venting from AC.
2 IEA (2019), *Helping a warming world to keep cool.*
3 IEA (2023), *World Energy Outlook 2023.*
4 IEA (2019), *Helping a warming world to keep cool.*

3. Consumer behaviour, such as setting thermostats at optimal levels in higher-income countries, also has a significant influence, with very major differences in the typical temperatures at which ACs are set across the world. For instance, the average Indian household with AC uses about 700 kWh per annum to achieve a typical target temperature of 24-26°C, versus a typical US household in Texas using 4,000 kWh a year, with temperature setting around 22°C.[5]

Managing emissions from refrigerants used in air conditioners and heat pumps

- ACs contain refrigerants, which contribute to global warming if they are leaked or released into the atmosphere. If leakage and release rates are not reduced, rising use of ACs could lead to 3 GtCO2e in 2050; this is equivalent to 15% of today's annual emissions from buildings.[6]

- Annual emissions in 2050 could, however, be halved with regulation to ban the use of refrigerants which have a higher global warming impact (i.e. hydrofluorocarbons), and with regulations and incentives for the proper disposal of refrigerant at end-of-life, and skills certifications to improve the quality of installations and maintenance.

Priority policy actions to tip the dial:

1. Develop clear guidance and street-by-street approaches to paint roofs white, plant trees and install other external shading across entire neighbourhoods to reduce urban heat island effects.

2. Set minimum energy performance standards for ACs and introduce labelling regulations to improve the efficiency of new ACs.

3. Implement regulations, incentives and skills accreditation schemes for the proper disposal of refrigerant from AC.

5 UE EIA (2020), *Residential Energy Consumption Survey*; Energy Informatics (2022), *Investigation on air conditioning load patterns and electricity consumption of typical residential buildings in tropical wet and dry climate in India.*

6 Systemiq analysis for the ETC. The figures are based on reasonable assumptions about how the type of refrigerant in the stock of ACs and heat pumps might change over time, and use the IEA's AC projections for 2050 and the ETC's estimates on heat pumps. Assumes an average of 10 lb refrigerant charge and a 15 year lifetime for equipment.