UN environment

United Nations Environment Programme

Cooling in a warming world

Opportunities for delivering efficient and climate friendly cooling for all

In a warming world cooling will be increasingly important for people's health and productivity, and for achievement of many of the Sustainable Development Goals

A warming world will increase the need for access to cooling, from the "cold chain" necessary to ensure the safety of the food we consume, to the refrigeration needed for vaccines, from the cooling of data centres to ensuring comfort and productivity in homes, institutions and workplaces. Globally, an estimated 3.6 billion cooling appliances are in use today, and this is projected to increase to 9.5 billion appliances by 2050. If cooling is provided for all who need it in a warming world—and not just those who can currently afford it—this would require up to 14 billion cooling appliances by 2050.

The growing demand for cooling will, if current approaches are continued, **contribute significantly to further global warming**, both from the emissions of HFCs and other refrigerants, and from the CO_2 and black carbon emissions from the mostly fossil fuel-based energy currently powering air conditioners and other cooling equipment.

3.6 billion **cooling appliances** today

9.5 billion **appliances** by 2050

Cooling needs

Food

Homes

Workplace

Medicine

Institutions

Transport

The Climate Challenge urgently needs accelerated action and enhanced ambition

UN Secretary-General António Guterres has asked all leaders to come to New York on 23 September for the Climate Action Summit with concrete and realistic plans to enhance their Nationally Determined Contributions (NDCs) by 2020.

The recent IPCC 1.5°C special report and the UNEP Emissions Gap report have provided the scientific underpinning for the challenge facing the global community. The Paris Agreement provides the political framing and sets out exactly what needs to be done to stop climate disruption and reverse its impact. But so far **the ambition in the submitted NDCs is highly inadequate and will need urgently to be tripled to meet the well below 2°C goal and increased at least fivefold to meet the 1.5°C goal**.

Energy efficient and climate friendly cooling can make a major contribution to these global mitigation efforts

phase down HFC

energy efficiency

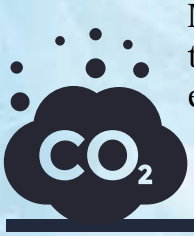
A combined strategy to improve energy efficiency of cooling equipment while phasing down HFC refrigerants under the Kigali Amendment to the Montreal Protocol presents one of the biggest mitigation opportunities available today.

Like the strategies for reducing HFCs, the strategies for improving energy efficiency of cooling equipment can be deployed quickly, at scale, and at low cost, with the potential for an accumulated saving of nearly $3 trillion in investment and operating costs by 2050 for AC equipment alone.

If robust policies are implemented quickly to promote the use of best available technologies in the cooling sector, the associated emission reductions will make a significant contribution to meeting the Paris Agreement goals. The International Energy Agency finds that cost effective policy to double the efficiency of new stationary air conditioners alone would further contribute accumulated emission reductions of approximately 6 $GtCO_2$ by 2030 and 39 $GtCO_2$ by 2050 in an already de-carbonizing electricity system.

Considering the full potential across air conditioning and refrigeration and both the energy-related and HFC emissions, the US Lawrence Berkeley National Laboratory estimates that the maximum potential fully utilized would avoid cumulative emissions of 38 - 60 $GtCO_2e$ by 2030 and up to 130-260 $GtCO_2e$ by 2050, depending on future rates of de-carbonization of electricity generation. The mobile air conditioning sector, where energy consumption is expected to nearly triple by 2050, offers further mitigation potential.

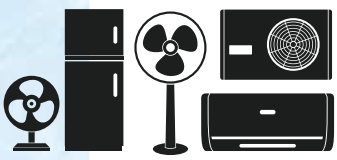
Rapid implementation of more efficient cooling systems will in addition to contributing significantly to the goals of the Paris Agreement also will contribute to meeting the Sustainable Development Goals on poverty, hunger, health and well-being, affordable and clean energy, sustainable cities and communities, among others.



Moving to best available cooling technologies would reduce cumulative emissions by:

38 $GtCO_2e$ by 2030

130 $GtCO_2e$ by 2050



The Kigali Amendment
will contribute significantly
to reducing global warming.

The Kigali Amendment to the Montreal Protocol entered into force on 1 January 2019 and its phase-down schedule will achieve at least an 80% reduction in HFC production and consumption by 2047. Most developed countries have begun to phase down HFC use in 2019, whereas a majority of developing countries will freeze consumption and production in 2024 and begin the phasedown five years later. The Scientific Assessment Panel to the Montreal Protocol in their 2018 assessment concluded that "The Kigali Amendment is projected to reduce future global average warming in 2100 due to hydrofluorocarbons (HFCs) from a baseline of 0.3° to 0.5°C to less than 0.1°C. **The magnitude of the avoided temperature increase due to the provisions of the Kigali Amendment (0.2° to 0.4°C) is substantial in the context of the 2015 Paris Agreement".**

Faster implementation of the Kigali Amendment may be possible building on the Montreal Protocol's 30 years of experience with a "start and strengthen" approach. Stopping HFC production completely in 2020 would avoid the build-up of banks of HFCs embedded in cooling equipment and make an even greater mitigation contribution. In addition to the long-term temperature impacts, **the reduction of HFCs and other short-lived climate pollutants will facilitate a steady and lower temperature trajectory towards the temperature goals of the Paris Agreement,** which is important in allowing ecosystems to adapt to a changing climate.

Phase down
HFC

Increase
Efficiency

There are significant climate benefits from linking the phase down of HFC with energy efficiency improvements in cooling systems.

According to the Technology and Economic Assessment Panel to the Montreal Protocol, approximately 80% of the climate impact of cooling equipment is from indirect emissions (CO_2 emissions from fossil-fuel electricity generation) and 20% is from direct emissions of HFC refrigerants.

A major reason for the high-energy consumption for cooling is the low energy efficiency of equipment. **Of the 141 million air conditioners sold in 2018, most are two to three times less efficient than best available on the market (see IEA figure).**

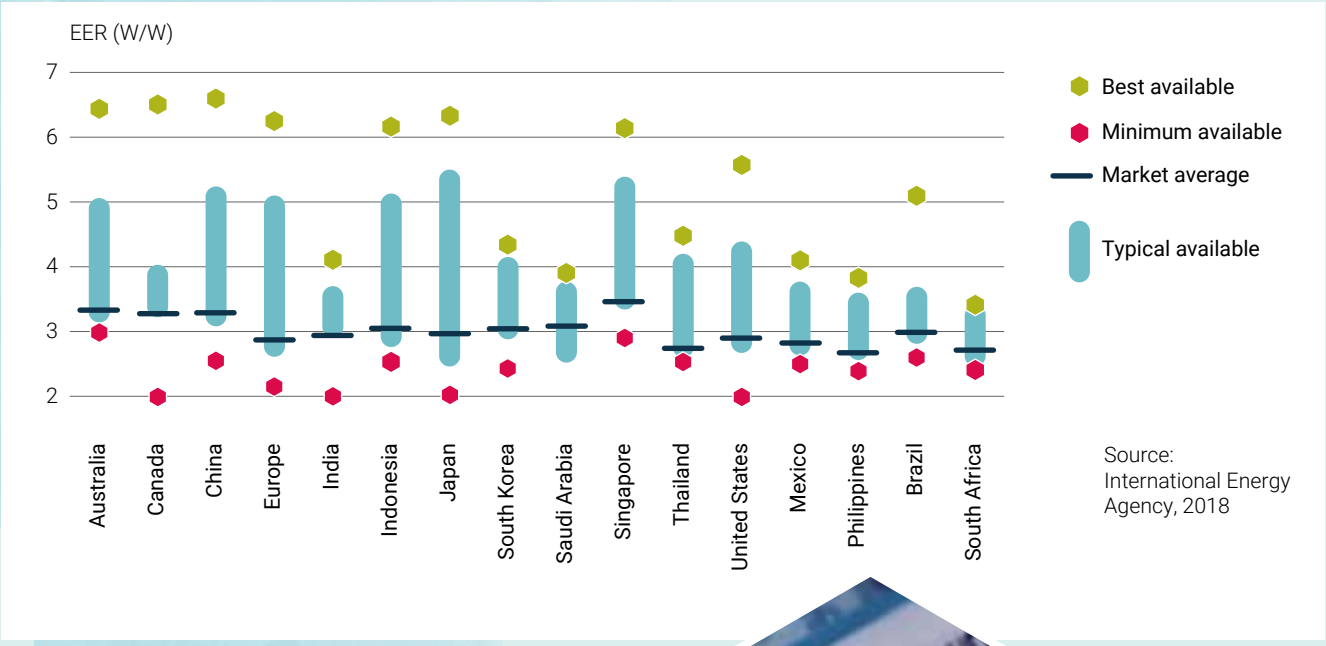
In 2018 the global cooling equipment stock (for air conditioning, refrigeration, and transport) is estimated to consume around **3,900** TWh/year globally of electricity.

This is approximately **17%** of the world's total demand for electricity.

Air conditioning accounts for the largest share and currently consumes approximately **2,000** TWh/year –

...a number that is projected to triple by 2050.

Figure 1. – Air conditioner efficiencies in select countries



Note: Efficiency levels cannot directly be compared across countries

An additional concern about the high energy demand is that the major use of cooling happens during periods of peak load; in tropical climates air conditioning can represent more than 50% of peak electricity demand, and the demand during heatwaves in temperate climates often outstrips the available capacity.

Efficiency improvement would therefore not only reduce direct energy consumption and associated GHG emissions, but it would also contribute significantly to reducing investments in electricity generation capacity.

Energy efficiency improvements are readily realized for many other cooling applications, such as refrigerators, mobile air conditioners, and commercial refrigeration, and alternatives like district cooling systems and demand reduction through building design, behavioural changes.

Double efficiency of air conditioning would reduce the need for power generation by

1,300* GW by 2050

* Equivalent to current coal fired generating capacity in China and India combined

Well-tested policies are available to promote best available technologies in the cooling sector.

The maximal climate and development benefits will come from a combined strategy that links the phase down of HFCs required by the Kigali Amendment with improved cooling efficiency. This will require integration of policies for enhanced cooling efficiency into the broader frameworks of energy and climate policy, and the enhanced Nationally Determined Contributions of the Paris Agreement.

Fortunately, a range of well-proven policy options are available to promote energy efficiency:

- **Regulation,** such as Minimum Energy Performance Standards for equipment, which remove the poorest performing systems from the market.
- **Information,** such as endorsement labels or comparison labels, product databases, capacity building and training courses for a wide range of market actors, including policy makers, producers and end users
- **Incentives,** such as tax schemes, subsidies or rebates that increase the uptake of high efficiency products, or those with low GWP refrigerants. Aggregating demand through public procurement and private buyer's clubs can speed uptake of best available cooling technologies and drive down the cost of efficient and climate-friendly cooling equipment.
- **Limiting imports** of inefficient cooling equipment.

Broader policy efforts include tightening building codes, integrating cooling considerations in urban planning, adopting more effective logistic systems, and stimulating behavioural change.

A number of countries have agreed to develop National Cooling Action Plans, such as those adopted recently in China, India, and Rwanda, to ensure integration of environmental, energy performance, and refrigerant safety standards in future NDCs

International collaboration will be instrumental.

The Kigali Amendment is itself a landmark example of the value of international collaboration. A large number of initiatives have been established to support implementation of the Amendment and the associated energy efficiency possibilities. Parties to the Montreal Protocol agreed when the Amendment was adopted to assess the opportunities for increased efficiency of cooling equipment, and a number of philanthropies quickly came together to create the Kigali Cooling Efficiency Program (K-CEP) to support this process. More recently, governments, private sector, and civil society have come together under the UN led Cool Coalition, and the Climate and Clean Air Coalition has established a ministerial-led Efficient Cooling Initiative.

Reflecting the increasing political understanding of the crucial role of cooling in the future Heads of States and Governments at the recent G7 Summit in Biarritz launched the "Biarritz Pledge for Fast Action on Efficient Cooling".

The "Cool Coalition" will be featured at the Climate Action Summit convened by the UN Secretary General highlighting the increasing importance of cooling in global mitigation efforts for life in a warming world.

Food *Homes* *Workplace* *Medicine* *Institutions* *Transport* *Data centers*

The paper is based on key findings from an on-going scientific assessment study by UNEP and IEA on Efficient and Climate-friendly Cooling funded by Kigali Cooling Efficiency Program.

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COOLING EFFICIENCY PROGRAM

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HFC

Increase
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