AIR CONDITIONING

Cooling off in a warming world

This summer, the International Energy Agency (IEA) published a high-profile report outlining a range of strategies to mitigate rising emissions from cooling systems. *Andrew Williams* asked some industry insiders to see how these recommendations might be put into practice.

Around 35% of people alive today live somewhere where it is hot every single day of the year, and only 10% of them have an air conditioner. As urban populations and living standards rise across the planet's warmest regions, so will demand for air conditioning. This will not only have implications for the building sector, but for grids and utility firms, as well.

It should go without saying that any dramatic spike in energy use will have serious consequences for global climate targets. In its annual cooling report – published this June – the International Energy Agency (IEA) set out a number of priorities that could help to limit limit the growing demand for space cooling, including:

- Promoting reduction of energy needs for space cooling via improved building design – including suitable insulation, shading, passive design, ventilation and reflectivity, as well as better urban planning.
- Progressively increasing the energy performance of air conditioners (AC) towards the current best available market products, ensuring existing performance standards and testing procedures reflect actual operating conditions.
- Supporting R&D to foster innovation in AC equipment, including towards climate-friendly cooling solutions, as well as more compact and efficient units. If the technologies are reversible, efficiency, climate and economic benefits can be expanded to the heating market, providing additional economy-of-scale benefits to reduce the upfront cost of energy efficiency products.
- Supporting industries to integrate renewable cooling solutions and storage, and supporting manufacturers and utilities to deploy more responsive AC options and enforce regular inspections of AC units.

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Dr Radhika Khosla, Oxford University

Cultural changes

Chiara Delmastro – an Analyst at the IEA and the report's lead author – explains that although many initiatives and programmes exist in each of these areas, trends indicate that the market needs a further push. In mustering such a push, Delmastro admits a number of challenges still need to be faced, including the fact that almost two-thirds of countries lacked mandatory building energy codes in 2019. In addition, minimum energy performance standards are still absent or weak in hot and humid regions where a rapid demand growth is expected.

Delmastro also points out that the typical efficiency rating of units sold in major cooling markets is just 10%-60% better than the available product minimum, while best available technologies are twice as efficient or more. Compounding matters is the fact that there are significant gaps between the rated and operational efficiency of both equipment and whole cooling systems.

In Delmastro's view, these challenges could be overcome with a combination of policies and financial measures, supported by international collaboration, to enable market transformation in the cooling sector. Such a framework should, she believes, involve stakeholders within the building and cooling industry, as well as energy utilities. Crucially, there must be buy-in from architects, engineers and cooling system installers – who prioritise efficiency in cooling at the building and urban-planning level.

In turn, policymakers could work with manufacturers and utilities to enable demand-side responses that address the impact of peak electricity demand, as well as to improve data collection and statistics relating to cooling. Ultimately, energy consumers have an important role to play in enabling an efficient future for cooling.

'[We need to] work with industry to improve the awareness of AC maintenance, management and operations among consumers and building operators,' Delmastro emphasises. 'We also need to develop innovative business models, subsidies and incentives to reduce the upfront cost of best available space cooling technologies.'

According to Dr Radhika Khosla – the Principal Investigator of the Oxford Martin School's interdisciplinary programme on the Future of Cooling – each of the recommendations and priorities set out by the IEA's report are strategic and important. However, improved building design is particularly relevant as, she says, it is often ignored in practice in spite of being low-hanging fruit. Khosla believes it is equally important to focus on behavioural strategies for energy conservation, carbon reduction and adaptation to life in a warmer world.

Cooling with natural and passive carbon-neutral approaches, such as increased ventilation, green roofs and walls and adequate clothing can all help to reduce heat-induced discomfort, adds Khosla.

'The IEA recommendations are achievable but will require swift action beyond the declaration of targets, with engagement from the public sector, industry and individuals at all levels,' she says. 'Cooling remains an ignored area in sustainability debates. It is telling that hardly any of the COVID green recovery packages or country climate pledges include cooling. The challenge is of awareness and will require leaders across sectors.'

Engaging investors

Low-carbon cooling initiatives still suffer from a lack of investment. But the IEA report highlights

Energy demand for space cooling has more than tripled since 1990
Photo: Unsplash

Innovation in vapour compression

In its most recent Energy Technology Perspective (ETP) 2020 report, the IEA observes that more than 80% of what is needed to decarbonise the cooling sector to 2070 will come from technologies that already exist today. These include technologies that have a high potential to lower energy and emissions from space cooling, such as high efficiency vapour compression technologies using low- or zero-global warming potential refrigerant and refrigerant-free solutions.

Even so, Delmastro observes that further innovation will be needed to unlock an additional 20% of emissions savings compared to baseline trends. This will involve, for example, hybrid vapour compression technologies and new components to deal with humidity.

'Space cooling technologies at the prototype level that show promise are based on next generation components for vapour compression technologies, including more compact heat exchangers, refrigerant flow controls and electrochemical compressors, as well as membrane-based evaporative cooling and desiccants, and solid-state cooling technologies, for which coefficient of performance shows improvements with respect to current best available vapour compression technologies,' she says.

that many of the key enabling technologies already exist today – it's merely a matter of rolling then out. Marc Chasserot, Group CEO at Shecco, a 'market accelerator' for the heating and cooling sector, points out that improved building design (incorporating insulation, shading, white roofs and other passive cooling elements) can make a world of difference.

Chasserot welcomes the IEA's focus on leveraging heat recovery from AC and refrigeration for space and domestic hot water heating. He further encourages the use of natural refrigerants and renewables wherever possible. Smart AC controls also make a difference.

'All clean cooling strategies, practices and technologies are available and implementable,' he says. 'Stakeholders need to see the value of this approach through education, training, standards, auditing and policy regulations and incentives. Financial institutions need to base their investments on clean cooling concepts and standards. Beyond reducing cooling demand, and cooling efficiency, attention needs to be paid to underserved communities around the world in order to achieve cooling for all.'

Thomas Motmans, Sustainable Energy Finance Specialist at the Basel Agency for Sustainable Energy (BASE) – a Swiss Foundation and specialised partner of United Nations Environment Programme – also agrees with the priorities presented in the IEA report. In particular, he believes that improved consumer incentives will drive the uptake of low-carbon cooling solutions.

'The implementation and scaling up of innovative market mechanisms and business models, like cooling-as-a-service, overcome key market barriers and enable these measures by aligning the business objectives of the provider with the interest of the end-users and the planet,' he explains.

Motmans believes that the recommendations and objectives of the IEA report can be achieved if enough attention is given to the impact of cooling on climate change and the fast pace of the sector's growth. He also highlights a number of key challenges faced by the cooling industry moving forward, including the fact that sustainable cooling solutions – including smart technologies with improved energy performance – tend to be more expensive upfront, which impacts investment decisions.

'In addition, many cooling users do not trust the performance of the latest technology and perceive high risks in switching to new systems,' he adds. 'Setting up risk mitigation mechanisms and business models to align incentives can help to overcome these challenges. For policies to be implemented rapidly, governments must treat cooling as a high priority.'

Natural refrigerants

Looking ahead, Chasserot notes that there is a growing implementation of natural refrigerants in AC and refrigeration systems throughout the world. These substances offer alternatives to toxic hydrofluorocarbon (HFC)-based refrigerants. 'Godrej already markets propane AC units in India, and Chinese manufacturers are heading in that direction,' he says. 'Further, there is a trend towards integrated CO2 refrigeration and AC systems for which all cooling loads are handled by one CO2 trans-critical system with assorted heat exchangers.'

Motmans agrees that advances in the use of natural refrigerants, such as propane, for air-conditioning will be a key R&D concern over the next few years, particularly since alternatives to HFCs are still underdeveloped in the market compared to the refrigeration industry. Here, CO2 and ammonia are already set to become the new norm.

Khosla singles out photonic-based radiative cooling as one of the most promising passive cooling technologies: 'For active cooling, natural refrigerants and solid-state cooling show a promising trend, although material-related environmental impacts might become a challenge for solid-state technologies.'

There are ultimately policy measures that can encourage the development and uptake of low-carbon cooling solutions. Companies and consumers must be given the incentive to change – or face the grim realities of an ever-warmer world. ●