**The International Energy Agency has identified three areas of energy use that they regard as blind spots for international governments and policy makers.**

**We looked at Petrochemicals a couple of weeks ago. The second area is heavy goods vehicles and trucks, which we’ll focus on in a future program. But perhaps the scariest of the three is the rapidly growing demand for cooling across many parts of the world. The irony is that as our world gets warmer, the market for air conditioning expands. Between 1990 and 2016 sales of AC units have quadrupled from thirty-three million to a hundred and thirty-five million per year. There are now about one point six billion air conditioners in use around the world and more than half of them are in just two countries. The Peoples Republic of China and of course the good old US of A. But the rest of the developing nations are catching up fast. All that electrically powered cooling inevitably increases energy use which in most countries is still mainly met by fossil fuels. That means more CO2 up into the atmosphere and even higher temperatures, which in turn means even more demand for air conditioners. So just when you thought we had big enough problems with multiple temperature feedback loops up in the ARCTIC, it turns out we humans have managed to develop another very effective one all on our own. And the 2020 pandemic looks set to reduce investment in building energy efficiency measures by more than 10%.**

**So, what exactly does the International Energy Agency suggest the future looks like for the climate and the global cooling industry.**

**Hello and Welcome to Just Have a Think,**

**In July 2020 the IEA published this report which builds on their 2018 Future of Cooling analysis.**

**The report tells us that the use of air conditioners and electric cooling fans accounts for nearly 20% of the total electricity used in buildings around the world today. And it’s a trend that’ll continue going upwards as the world’s economic and demographic growth increases in the hotter countries.**

**We do need cooling of course. In fact, the UN says that efficient cooling contributes towards achieving each one of the seventeen sustainable development goals.**

**And it’s not just domestic air conditioners either. Mobile cooling in private vehicles and on public transport is becoming increasingly essential. We also need industrial and commercial refrigeration to keep pharmaceuticals like vaccines viable and to ensure that fresh food is kept at the right temperature at every step of the cold chain, from harvesting all the way to supermarket shelves or restaurant tables. And of course, we also need to keep our working environments at reasonable temperatures so that human beings in workforces can remain productive.**

**All in all, there are an estimated three point six billion cooling appliances in use globally today, and that number is growing by about ten devices every second. It’s a staggering rate of growth which carries a double whammy of climate impact. Most of us know that air-cooling devices are very energy hungry. That’s the first problem. But on top of that, the gases they use in their refrigeration pipes are hydrofluorocarbons or HFCs. And HFCs are extremely potent greenhouse gases. That’s not a massive problem whilst they’re safely captured in a closed loop system during operation, but a significant amount of leakage occurs when new units are installed and gassed up, as well as during any repairs or maintenance on the system and of course at the end of life of a system if it’s not correctly disposed of.**

**About thirty years ago the world enacted the Montreal Protocol, which is widely acknowledged as the world’s most successful environmental treaty. It solved the first great threat to the global atmosphere by banning the chlorofluorocarbons, or CFCs that were destroying the ozone layer. It’s reckoned that this one piece of coordinated action alone has avoided a level of atmospheric warming equivalent to the amount we’ve caused by all our CO2 emissions. In other words, without that action, the world would already be two degrees Celsius warmer than pre-industrial levels.**

**It helped that the hole in the ozone layer was so bloody obvious that no sane minded policymaker could pretend it wasn’t there in the way that some of them do with climate change today, but nevertheless, it showed that globally coordinated action is possible. The latest addition to the Montreal Protocol is now specifically targeting HFCs. It’s called the Kigali Amendment and its been in force since 2016. HFCs don’t affect the ozone layer, which is why they replaced CFCs in the first place. But as I mentioned earlier they’re still a very potent greenhouse gas. Replacing HFCs with climate friendly refrigerants and improving the efficiency of cooling equipment, will avoid the equivalent of about two hundred and sixty billion tons of CO2 emissions by 2050 say the IEA, saving nearly three trillion dollars in energy generation and transmission costs and avoiding half a degree Celsius of warming by the end of the century.**

**One potential replacement for HFCs is a refrigerant class known as hydrofluoroolefins, or HFOs. The scientific explanation of how HFOs differ from HFCs is outside the scope of this video, but here’s why the difference matters.**

**The global Refrigeration, Air Conditioning and Heat Pump market, known as RACHP, categorises refrigerants according to their global warming potential or GWP, on a sliding scale of severity from one to more than twenty thousand.**

**The calibration gas is carbon dioxide with a GWP of one. You can see that methane and nitrous oxide gram for gram are far more impactful to atmospheric warming than CO2, but check out HFCs. Absolute nightmare!**

**According to the United Nations Emissions Program, the weighted GWP average for HFCs is 2,200 and the most widely used HFC refrigerant, HFC-134a, has a GWP of 1360.**

**In stark contrast, HFOs have a GWP in the low single digits. This chart from the IEA report shows the commonly used gases in the various industries along with their GWP values compared to the recommended alternatives, including several HFOs.**

**HFCs in vehicle climate control systems account for about one third of total HFC emissions. According to a 2019 study moving to low GWP refrigerants like HFOs could prevent as much as two hundred million tons of CO2 equivalent each year. Another 2019 study found that a variant called HFO-1234yf was in use in over 70 million vehicles as of the end of 2018. That’s a start, but there are well over a billion vehicles on the world’s roads and more than sixty five million cars were sold in 2019, so vehicle manufacturers need to get a serious move on.**

**Many people argue that we should be reducing the overall demand for refrigerant gases and perhaps even reducing the requirement for refrigerant based cooling systems in the first place. So how do we do that?**

**Well, much better design, manufacturing and servicing of cooling systems is a must, but recovering and reclaiming refrigerants from products that have reached the end of their life will also be crucial. There’s currently very little funding or incentive to deal with obsolete kit responsibly. The result of that is a constant danger of leakage from storage tanks and discarded equipment.**

**There are also alternative cooling systems that don’t involve the compression of gas – so called ‘not-in-kind’ cooling systems including something called magnetocaloric refrigeration, which leverages a phenomenon called the magnetocaloric effect, in which a suitable material heats up when subjected to a magnetic field, and cools down when removed from it, chilling a secondary glycol fluid that can then be circulated through the cooling system. That’s a development that’s already gaining traction in commercial and medical refrigeration.**

**Another alternative is absorption cooling, which takes excess heat from industry or wastewater treatment plants and through a series of quite convoluted steps involving heat exchangers, evaporators and condensers, causes an ammonia water solution to absorb heat from an air conditioned space in a closed loop cycle.**

**Then there’s district cooling, like this system in Paris operated by a company called Climespace, with a total cooling capacity of 285 MW. The system takes water from the River Seine and chills it to an average temperature of 5°C through seventy one kilometres of pipelines supplying five million square metres of space in hotels, offices, government buildings, theatres and museums. The cold water and ice are produced during the night, reducing the need for chiller capacity during peak demand hours and lowering operating costs via cheaper night-time electricity and colder ambient night-time temperatures.**

**Evaporative cooling is another promising possibility for cooling buildings. This could come from a body of water next to the building or a water spray over the roof. Or it could be direct evaporative cooling drawing hot, dry air through a continually dampened pad and** [**supply**](https://www.designingbuildings.co.uk/wiki/Supplies)**ing cool, humid air inside the building through the process of evaporation in just the same way that evaporating water, or sweat draws heat from our overheated skin during exercise. Some of these systems can use as little as ten percent of the energy required by conventional** [**chillers**](https://www.designingbuildings.co.uk/wiki/Chillers)**. If humidity is a problem then indirect evaporative cooling can be achieved by using a heat exchanger to cool the supply air. It’s not as efficient as direct cooling but the ambient air remains drier.**

**Most of these solutions will have their biggest impact in urban areas. More than half of the world’s population is concentrated in cities today. By 2050 it’ll be pushing towards seventy percent according to UN data. The urban heat island effect caused by traffic, air conditioning, heating, and great big thermal masses in buildings, makes cities hotter than the surrounding countryside by around three degrees Celsius on hot days and up to twelve degrees during the evenings. An estimated one hundred and thirty billion square meters of new building construction is expected over the next twenty years, and once a building’s been constructed, the amount of cooling required for human comfort gets locked-in. Improvements in the energy efficiency of the building envelope could reduce energy for cooling in hot climates by as much as forty percent according to the IEA.**

**Making roof surfaces and pavements more reflective and increasing vegetation can make huge improvements towards offsetting the effects of urban heat islands too. On a typical sunny summer afternoon, a clean white roof that reflects eighty percent of sunlight will stay about thirty degrees Celsius cooler than a grey roof that only reflects twenty percent of sunlight. It sounds so obvious, but it needs to be imprinted on the psyches of every architect and developer around the world. In fact just as I was about to film this video a new report landed in my inbox featuring research by a team at UCLA who replaced the titanium oxide in white paint with barite and PTFE, or Teflon, to produce a paint that reflects ninety eight of all incoming radiation, not just the visible white light. That’s certainly a report we’ll look at in more detail in a future episode.**

**But just looking after existing buildings properly can make a big difference. Simple things like replacing AC filters monthly, cleaning coils and even making sure people don’t block up the vents. Blocked vents can increase energy use by over twenty five percent.**

**Metering systems allowing users to see how much money they’re spending can lead to better management of internal cooling systems, and choosing part-time, part-space equipment rather than centralized cooling equipment could reduce energy demand by up to eighty percent according to this 2017 research paper.**

**And if our huge supermarkets adopted the latest low energy, low GWP alternatives to their existing food chiller systems, they could improve their efficiency by up to seventy seven percent and achieve CO2 reductions of as much as eighty five percent, according to this 2019 research.**

**All in all, the IEA estimates that on average a well-designed city could cut down the energy it uses for heating and cooling by more than a quarter, with that figure rising significantly in the hotter countries.**

**All these initiatives will require a combination of commercial investment and government policy on a similar scale to the Montreal Protocol.**

**Governments are being urged to build National Cooling Action Plans into the Nationally Determined Contributions that they’re obliged to present at COP26 in Glasgow in 2021.**

**International regulations are urgently needed to stop inefficient cooling equipment getting forced onto developing countries and transitioning economies. That means effective, legally enforceable labelling systems enabling those countries to have the right information about a product before consenting to its import.**

**The Biarritz Pledge for Fast Action on Efficient Cooling, was launched at the August 2019 G7 Summit in Biarritz, where heads of state and governments committed themselves to backing cooling efficiency across their countries.**

**The Cool Coalition is a global network connecting over sixty partners from the private sector, government, cities, international organizations, finance, academia and civil society. It supports a whole host of initiatives including National Cooling Plans, as well as Minimum Energy Performance Standards, district cooling, green roofs, and properly regulated cooling audits.**

**The World Bank Sustainable Cooling Initiative is integrating efficient and climate-friendly cooling into its country engagements and investments.**

**Digital technology allows utility companies to directly control cooling equipment in order to cap consumption during peak periods, usually in return for some financial reward for consumers. China has developed this into a system that can be adjusted to the availability of on-site electricity production, effectively matching the operation of the AC units with the power available from on-site solar panels.**

**The IEA offers this conclusion**

**“There are few certainties when it comes to energy. But one thing to be very confident about is that global demand for space cooling and the energy needed to provide it will continue to grow for decades to come”**

**“ What is much less certain is exactly how quickly cooling-related energy demand will grow and how it will be met, in part because we do not know for sure how governments will act to influence underlying market trends. The consequences, notably for the environment, if governments do not act to curb energy demand for cooling are likely to be severe.”**

**No doubt you’ve got views on this one, so dive down into the comments section below and leave your thoughts there.**

**That’s it for this week.**

**We’re taking a week’s break next week so the next program will be coming your way on Sunday 8th November, by which time we should know the outcome of what many people are calling the most important Presidential election of our lifetime.**

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**As always, thanks very much for watching, have a great week, and remember to Just Have a Think.
See you next week**