Optimization, monitoring, and maintenance of cooling technology

KIGALI
COOLING EFFICIENCY PROGRAM

This Knowledge Brief from the Kigali Cooling Efficiency Program, outlines the need for maintaining and servicing of cooling technology. It estimates that better optimization, monitoring, and maintenance of cooling equipment the potential to save 30Gt of CO_2 emissions by 2050.

THE NEED FOR COOLING EFFICIENCY

Cooling is essential to health, prosperity, and the environment, underpinning many of the Sustainable Development Goals. Yet currently most cooling is energy intensive and highly polluting. Demand for cooling is booming, so there is an urgent need to not only cut pollution from existing cooling but to ensure future cooling needs are met sustainably.

COOLING ACCOUNTS FOR > 7% GHG EMISSIONS

Use of cooling technologies causes substantial global GHG emissions of between 3.8[1,2], and 4.1[3] $GtCO_2eq$ p.a. (>7% global emissions). The International Institute of Refrigeration has estimated that cooling consumes 17.2%[4] of global electricity (c.3,500 TWh p.a. based on 2015 consumption)[5]. Indirect emissions from electricity to power cooling technologies causes 63% of cooling emissions[6]. The impact of global GHG emissions from cooling equipment is projected to grow between now and 2050 as developing nations gain access to energy and new technologies. It is estimated that improving the efficiency of cooling equipment between now and 2050 can avoid the emission of approximately 80Gt CO_2eq.

OPTIMIZATION, MONITORING, & MAINTENANCE CAN REDUCE TOTAL COOLING GHG EMISSIONS BY 13%

Neglecting the optimization, monitoring, and maintenance of cooling equipment results in increased energy use, lower cooling performance, and shortens equipment life. Effective optimization, monitoring, and maintenance of cooling equipment could deliver substantial electricity savings of up to 20%[7] (700 TWh), particularly if equipment has not been maintained for a long time, leading to emissions savings of up to 0.5Gt CO_2eq p.a.

The global stock of room air conditioners is expected to grow from 900 in million in 2015 to 2.5 billion units in 2050. (Clean Energy Ministerial, 2016)

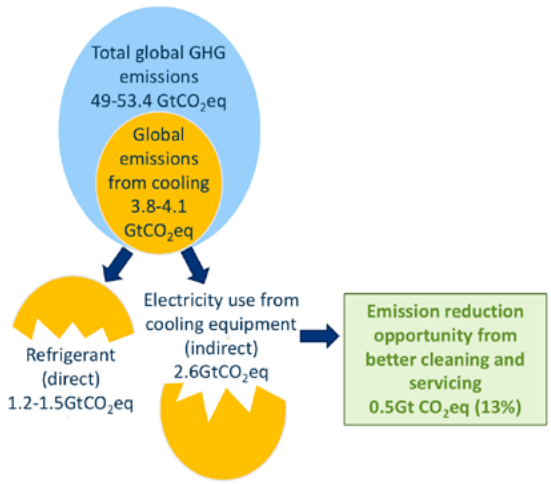
The Carbon Trust, the International Institute of Refrigeration, ans ASHRAE have supported the Kigali Cooling Efficnency Program in the publication of this brief.

'Better optimization, monitoring, and maintenance of cooling equipment has the potential to save 30Gt of CO_2 emissions by 2050 – contributing a further 38% of savings on top of those delivered through the planned phase down of high GWP refrigerants agreed at Kigali.'

– Didier Coulomb, Director-General, International Institute of Refrigeration

Policy makers should make effective optimization, monitoring, and maintenance of cooling equipment a key goal as the 20% savings in electricity translate into a 13% reduction in total cooling emissions (including GHG emissions from refrigerants). Figure 1 breaks down annual global GHG emissions to the opportunity presented through better optimization, monitoring, and maintenance of cooling equipment.

Figure 1 – Breakdown of annual total global GHG emissions to the cleaning and servicing opportunity



Sources: PBL Netherlands Environmental Assessment Agency, 2017; International Institute of Refrigeration, 2017; IPCC, 2014; Green Cooling Initiative, 2016, Carbon Trust analysis. All carbon savings numbers in Figure 1 relate to potential cumulative savings from now to 2050. They represent an initial, indicative view of savings and will be refined through further work.

SECTOR FOCUS: UNITARY AIR CONDITIONING

Unitary air conditioning (UAC) refers to ductless split, ducted split and rooftop ACs, variable refrigerant flow (VRF) systems and self-contained units. Typically, one unit will be installed per room, apart from VRF systems and multi-splits which can be used to cool several rooms (Green Cooling Initiative, n.d.).

UAC is the largest cooling market with an estimated installed base of 870-950 million units (2017)[8], about 30% of the three billion pieces of cooling equipment in use around the globe (International Institute of Refrigeration). UAC annual sales were approximately 100 million units (2012) worth USD 73 billion (Green Cooling Initiative, n.d.).

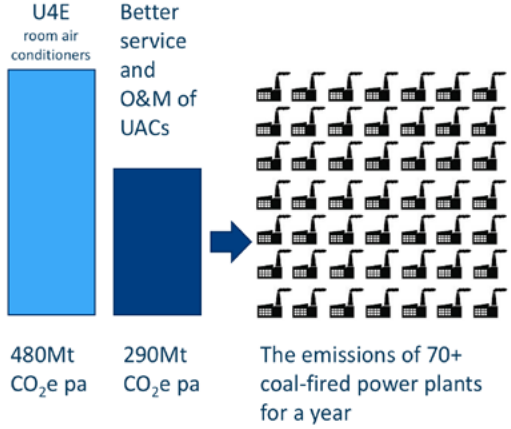
UAC ACCOUNTS FOR 30% OF ALL COOLING GHG EMISSIONS

Given their abundance, UACs are a major contributor to cooling related GHG emissions, estimated by the Green Cooling Initiative to be 1.28Gt of CO_2eq (in 2016) – equivalent to around 30% of total cooling GHG emissions in 2017. The 1.28Gt of CO_2eq break down into 330Mt related to refrigerant emissions and 950Mt from indirect emissions due to electricity consumption. Potential emissions reductions through effective optimization, monitoring, and maintenance are estimated to be 190Mt CO_2eq p.a. based on 2016 electricity consumption, rising to 290Mt CO_2eq p.a. by 2030[9] - equivalent to the emissions of over 70 coal-fired power plants in one year[10]. By comparison, the UN's United for Efficiency (U4E) estimates the total emissions savings opportunity across 150 developing countries of switching to energy efficient and climate friendly air conditioners at 480 Mt CO_2eq p.a. by 2030. Emissions reductions do not include those that exist due to better leakage management.

ACTION TO OPTIMISE, MONITOR AND MAINTAIN COOLING EQUIPMENT COULD SAVE 30GT CO_2EQ BY 2050

Following this same approach, an estimate for the potential impact of better optimization, monitoring, and maintenance on the overall cooling market to 2050 can be obtained. Based on total cooling emissions from electricity in 2016 of 2.6Gt CO2eq, 20% savings would deliver 0.5Gt CO2eq of savings p.a. Again assuming a 3% compound annual growth rate, total savings could reach 1.4Gt p.a. by 2050 – equivalent to the emissions of nearly 350 coal-fired power plants for a year. This would represent a cumulative saving of 30Gt by 2050.

Figure 2 – Potential emissions savings opportunities by 2030



COLLECTIVE ACTION IS ALREADY IMPROVING THE QUALITY OF UAC EQUIPMENT.

Given the scale of GHG impacts due to UAC, current global and regional initiatives are focused on controlling emissions due to product design inefficiencies, including the United for Efficiency initiatives, SEAD, CLASP, and EU EcoDesign.

THE IMPACT OF THESE INITIATIVES COULD BE LOST THROUGH POOR OPTIMIZATION, MONITORING, & MAINTENANCE OF COOLING PRODUCTS.

In addition to initiatives encouraging use of energy efficient products, policy makers are encouraged to develop national cooling equipment optimization, monitoring, and maintenance competencies in industry and the user base. This could include:

- Setting up an independent national standards body
- Creation of national standards for cooling optimization, monitoring, & maintenance.
- Programme of audits of refrigeration technologies to identify optimization, monitoring, & maintenance opportunities
- Investment in facilities providing best practice training in, as examples, equipment optimization and monitoring, supplier maintenance, or customer maintenance management programmes
- Developing supply chains for optimization, monitoring, & maintenance technologies.

Adoption of such practices could reduce needless emissions due to poor optimization, monitoring, and maintenance practices.

OPTIMIZATION, MONITORING, & MAINTENANCE PROJECTS

From initial research undertaken as part of preparing this brief, few examples of programs focused on better optimization, monitoring, and maintenance of cooling equipment have been uncovered – possibly reflecting difficulties implementing programs in some hard-to-reach sectors (e.g. residential) or that these elements in other sectors (e.g. commercial) are not made explicit. Nevertheless it seems likely that optimization, monitoring, and maintenance programs represent a major opportunity for energy and emissions savings. The following examples of what has been done give a sense of what can be implemented on the ground to take advantage of this huge opportunity.

ASHRAE

A trial to understand the benefits of coil cleaning was conducted at 1500 Broadway, Times Square in New York City between July and September 2005. The 34 storey building has 4 air handling units servicing 111 500 m^2 of air conditioned and heated space. The trial showed that good maintenance and operating practices including coil cleaning significantly improved the energy efficiency of the HVAC&R systems by 10% to 15% and delivered comfort increases. The trial also identified other optimization and maintenance processes that will improve energy efficiency for years to come. ASHRAE (2006)[11].

DEFRA UK

As part of a UK Department of Food and Rural Affairs Programme identifying reductions in energy inputs to the food industry, a trial was undertaken to assess the impact of applying low cost maintenance measures to commercial fridges at the University of Bristol Langfood Canteen. The canteen provides 200 to 300 meals per day. One large upright fridge consumed 40% of the canteens cooling load. Inspection of the fridge showed it had a dirty condenser which when cleaned delivered an 8% energy efficiency saving. The fridge was also found to have too low a temperature set point which was raised from -21ºC to -16ºC, giving an additional 11% energy efficiency saving. Together these two measures delivered a 19% energy reduction. (Defra)[12].

THE CARBON TRUST

The Carbon Trust, the UK Institute of Refrigeration and the British Retail Association worked together to propose a set of monitoring, maintenance and technology optimization measures that when applied could significantly reduce emissions from retail refrigeration equipment. A basket of monitoring, optimisation and maintenance measures could improve energy efficiency by 20 to 30% (e.g. training, cleaning and maintenance, re-commissioning, set-point temperature, store temperature). Additional technologies could significantly increase these savings[13].

ABOUT K-CEP

The Kigali Cooling Efficiency Program (K-CEP) is a philanthropic collaboration launched in 2017 to support the Kigali Amendment of the Montreal Protocol and the transition to energy efficient, climate-friendly, affordable cooling solutions for all. K-CEP's secretariat, the Efficiency Cooling Office, is located at the ClimateWorks Foundation.

K-CEP SUPPORT FOR OPTIMIZATION, MONITORING, & MAINTENANCE

Optimization, monitoring, and maintenance represent a major opportunity for the range of projects and activities funded by K-CEP. Existing and future projects should consider the possibility of adapting or expanding their brief to include an optimization, monitoring, and maintenance element.

FEEDBACK ON THIS BRIEF

The Carbon Trust put together this brief for K-CEP with assistance from the International Institute of Refrigeration and ASHRAE. We would welcome any feedback on calculating the emissions reduction potential of better optimization, monitoring, and maintenance and on better understanding the landscape of optimization, monitoring, and maintenance more generally. Please contact Paul Huggins at paul.huggins@carbontrust.com.

CONTACT US

For more details please visit www.k-cep.org, follow us at @Kigali_Cooling, or contact us at info@k-cep.org.

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4. Cited in International Institute of Refrigeration, 29th Informatory Note: The Role of Refrigeration in the Global Economy, November 2015.
5. Based on 1737 Mtoe (= 20,201 TWh) of total electricity consumed globally in 2015. Taken from IEA, Key world energy statistics 2017, 2017, p41.
6. International Institute of Refrigeration, 35th Informatory Note, The impact of the refrigeration sector on climate change, December 2017
7. Research for this brief indicated savings could range from as low as 3 to 4% to as high as 60% or more. Multiple studies gave savings in the range 15 - 25%.
8. These estimates are based on 750 million UAC units in 2012 (Green Cooling Initiative) and 900 million UAC units in 2015 (Clean Energy Ministerial), extrapolated using a 3% compound annual growth rate (itself sourced from the Clean Energy Ministerial assumption that UAC units would reach 2.5 billion by 2050).
9. This assumes that the 2016 emissions of 1.28Gt of CO2e are produced by 843 million units, which rise to 1,268 units by 2030 and consume electricity with a constant emissions factor. The unit numbers are based on 750 million UAC units in 2012 (Green Cooling Initiative) and a 3% compound annual growth rate 2015-2050 provided by the Clean Energy Ministerial in 2016.
10. Based on calculations using the U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator.
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