# Defining 'Clean Cooling'

**Comprehensive Clean Cooling – which will include standards by which to measure the impact of cooling systems – is a prerequisite for a sustainable and resilient future.**

## Introduction

"Cooling" refers to any human activity, design or technology that dissipates heat and reduces temperatures, typically including refrigeration and air conditioning. Cooling contributes, in both the built and transport environments, to achieving: (i) safe/adequate thermal comfort for people, or (ii) preservation of products (food, medicines, vaccines, etc.), or (iii) effective and efficient processes (for example, data centres, industrial or agricultural production, and mining).

Recognising both the growth in demand for cooling and the paradigm shifts that are affecting both our communities and global markets, we developed the term "**Clean Cooling**" to take cooling to a much higher level, encompassing a portfolio of elements outlined below. "The Clean Cooling Landscape Assessment," was published in 2018 and released at the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP24), with support from the Kigali Cooling Efficiency Programme (K-CEP) and endorsements from Mission Innovation and the U.K.'s Department of Business, Energy and Industrial Strategy (www.clean-cooling.ac.uk).

To build on the work to date, and to help accelerate the transition from traditional cooling to **Clean Cooling**, the Centre for Sustainable Cooling and shecco are, over the course of 2020, leading a new collaborative project to develop a set of measurable standards for **Clean Cooling** against which cooling innovation and projects can be assessed. These standards will help all stakeholders to properly understand and quantify the true sustainability (financial, social and environmental) of cooling technology, including $CO_2e$ emissions reduction. Depending on market interest, this could become the basis for a first-of-its-kind formal **Clean Cooling** Audit-and-Certification Program.

We accept **Clean Cooling** is setting a very high bar when compared with the many incremental improvements being rolled-out – and we absolutely recognise the value of every efficiency improvement, every use of lower GWP refrigerants. But given the size of both the societal and climate challenges we face, we need to go further, faster. We have to deliver the ambition of **Clean Cooling**. To achieve this, we have to properly define and quantify what that means and be able to assess the extent to which new cooling systems meet the challenge.

As we create the framework for the definition and measurement of **Clean Cooling**, we welcome comments from all stakeholders.

## Current definition of Clean Cooling

**Clean Cooling** provides resilient cooling for all who need it without environmental damage and climate impact. It incorporates smart thinking to mitigate demand for active cooling where possible, minimised and optimal use of natural resources, and a circular-economy design that includes repurposing of waste heat and cold (thermal symbiosis)[1] throughout the lifespan of the cooling system.

**Clean Cooling** meets cooling needs while contributing towards achieving society's goals for greenhouse gas (GHG) emissions reduction, climate change mitigation, natural resource conservation and air quality improvement. It necessarily must be accessible, affordable, financially sustainable, scalable, safe, and reliable to help deliver societal, economic and health goals as defined by the United Nation's Sustainable Development Goals (SDGs).

In short, **Clean Cooling** is the benchmark at the intersection of the Paris Climate Agreement, the Kigali Amendment, the Montreal Protocol and the SDGs. It is environmentally, socially and economically sustainable cooling that helps the global community adapt to and thrive in – but also mitigate the impacts and risks of – a warming world.

## A radical reshaping of cooling

**Clean Cooling** starts with what we can do today to reduce demand for cooling and deliver incremental efficiency improvements in cooling systems, while providing access to cooling for all. This includes, among other things, behavioural change; more effective use of passive design elements such as shade and natural ventilation in building design; cool roofs; doors on chilled display cases in supermarkets; best-in-class, very low global warming potential (GWP), high-efficiency refrigeration and air-conditioning equipment; district cooling systems where possible; and the use of waste heat in parallel thermal processes. Clean Cooling also requires regular preventive and predictive maintenance to ensure optimal operating performance.

These interventions are essential, but, given the growth in cooling demand, they will not deliver the required reductions in energy usage, emissions and pollution, nor will they adequately increase resource productivity, or deliver access to cooling for all who need it.

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[1] *Thermal symbiosis is the use of waste thermal streams from one process to provide valuable thermal services to another process, thereby replacing primary energy consumption. Examples include harnessing the waste heat of supermarket chiller cabinets to provide hot water; using industrial waste heat to drive sorption cooling for air conditioning; and harnessing the waste cold of LNG regasification.*

Delivering Clean Cooling is, therefore, also about investing in a radical reshaping of cooling provision to design more ambitious routes to mitigation and management of energy use and cooling demand. This will include:

- Starting with understanding the first principles of "what we are trying to do" to meet the cooling needs for all;
- Prioritising how to mitigate cooling demand and meet it through behaviour change and design;
- Recognising the portfolio of free, natural and energy-waste resources to help meet demand;
- Defining the right mix of energy sources, natural refrigerants[i], thermal energy storage, cooling technologies, business models, manufacturing, maintenance regimes, end-of-life management and policy interventions – and then to optimally, *and safely,* integrate all available energy resources through complete system approaches;
- In short, thinking thermally, which means, among other things, defining a new set of incentives and behaviour changes that impact individual and organisational decisions - how we mitigate cooling demand; de-electrify cooling where possible; store energy for use on-demand; balance heating and cooling; and transition fully from fluorinated to natural refrigerants;
- Also ensuring that we have an adequate skilled workforce to design, install and maintain **Clean Cooling** systems;
- Finally, in delivering the above, driving inclusive and sustainable industrialisation in a holistic approach to create resilient and future-proof communities.

By pooling demands and fully understanding the portfolio of resources available, **Clean Cooling** can facilitate a re-mapping and integration of processes, thermal energy storage and technology to achieve efficiencies and harness all resources; and it will enable new business models to make cooling affordable and accessible to all. This would not be possible with a siloed or sub-system approach

Deploying such integrated solutions will require smart coordination among many actors and industry sectors in planning, implementation, business models and systems management. In addition, to ensure that the cooling needs of their people are met equitably and sustainably – including for the most vulnerable – governments must understand what these needs are for health, food, productivity and safety across the built environment, logistics and transport, etc. In short governments must determine how much cooling is actually required to meet societal, environmental, health, well being, economic and adaptation goals, with no one left behind in a warming world?

There is a significant probability that if countries fail to answer these questions, any thermal planning will be inadequate, and they risk contributing to a lack of ambition in policy, infrastructure and technology development; this could ultimately have far-reaching social, economic and environmental consequences, with both SDGs and climate targets not being achieved.

**Clean Cooling** specifically demands clean cold chains for food and medical needs. This means integrated, seamless and resilient networks of interconnected refrigerated and temperature-controlled storage, aggregation, distribution and process points, and transport modes. The objective is to maintain the safety, quality and quantity of food, medicines, vaccines, blood, etc. while moving them swiftly from source to point and time of use. This is especially true for health-related cold chains in times of peak demand that are responding to natural disasters or epidemics/pandemics.

**Clean Cooling** strategies also need to consider the unique challenges of cooling in passenger transport and logistics as we see a significant increase in vehicles on the road and aspire to move away from diesel. Alongside the transition to electric vehicles, thermal management interventions will be needed; otherwise, the rapid growth in energy demand for passenger transport cooling will complicate both grid resilience and managing peak energy demands.

**Clean Cooling** is, ultimately, about future-proofing society and ensuring a more sustainable relationship between humans and the planet we live and, we hope, thrive on. Today, our urgent goal is to ensure basic needs are met for all people in a warming world, while living within our natural resource limitations and mitigating future risks to our survival on the planet. But equally, we need to improve the quality of life for all, while simultaneously delivering environmental growth in collaboration with the global and local ecosystems that provide the resources upon which we depend to survive and thrive.

Rising ambient temperatures and the increasing frequency and severity of heat waves will demand more cooling for health, food, productivity, data and, increasingly, safe living. Thus, the provision of comprehensive **Clean Cooling** is a prerequisite for a sustainable and resilient future. The sooner we recognise this fully and invest accordingly in the step-change interventions required to deliver access to environmentally and socially sustainable cooling for all who need it, the better the outcome for humans in the 21st Century.

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*Refrigerants endnote – see overleaf*

[i] ***Refrigerants***

*Clean Cooling by definition includes the complete transition from fluorinated refrigerants to natural refrigerants, including $CO_2$, ammonia, hydrocarbons, water and air.*

*However, there are circumstances in which a particular societal need for cooling – often with life-and-death implications – is not aligned with the use of natural refrigerants. In these cases, natural refrigerants and related technology – as well as skilled technicians who can address the safety and technical challenges associated with natural refrigerants – may not be available in the short term. Thus, alternatives may need to be employed to support critical cooling of foods and medicines, particularly in developing countries.*

*In these exceptional cases, we should still be targeting ultra-low-GWP refrigerants – i.e. with a GWP of less than 30 – if a system is still to be regarded as representing Clean Cooling. But this could be lifted to a maximum GWP of 250 where there is supporting Total Equivalent Warming Impact (TEWI) or Lifecycle Assessment (LCA) data or safety assessments to justify not using natural or ultra-low-GWP refrigerants; there must also be maintenance programmes in place to minimise leakage and facilitate end-of-life management. This maximum GWP should be regularly reviewed based on available technology, system enhancements and skills development.*

*The use of fluorinated rather than natural refrigerants in Clean Cooling systems must never be viewed as anything other than a short-term expedient measure needed to address particular exigencies, with a clear eye to transitioning to naturals as soon as possible.*