KIGALI COOLING EFFICIENCY PROGRAM

Cool Coalition

CARBON TRUST

FUTURE OF COOLING | OXFORD MARTIN SCHOOL | UNIVERSITY OF OXFORD

RACE TO ZERO

CLIMATE ACTION PATHWAY

Net Zero Cooling

Action Table

2021

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Action Table structure and approach

Cooling is critical for health, prosperity, and the environment. It keeps our vaccines safe and our food fresh, ensures we have comfortable buildings to live and work in, and is central to our livelihoods, industrial and transport infrastructure. However, cooling is typically energy intensive and highly polluting due to the emissions from the energy that powers this equipment (generated mostly from carbon intensive sources) and the refrigerants and insulation foam gases used in it (especially if not properly managed, recovered and recycled). Conventional cooling already causes up to 7 percent[1] of global greenhouse gas (GHG) emissions – more than those from the aviation and maritime transport sectors combined – and these emissions are increasing rapidly.[2] We urgently need to cut cooling emissions and meet the increasing demand for future cooling sustainably. The Kigali Amendment to the Montreal Protocol, which has already been ratified by over 100 countries, and regional frameworks such as the EU F-Gas Regulation, demonstrate how refrigerant emissions can be reduced.[3] However, further refrigerant action is needed. Meeting future cooling needs sustainably can reduce the costs of renewable energy build out by up to $3.5 trillion by 2030[4] and accelerate the net zero transition by up to eight years.[5]

This Action Table complements the Net Zero Cooling Pathway Executive Summary and highlights specific, promotable actions to deliver net zero[6] cooling for all through a focus on three impact areas:

- **Passive cooling:** Widespread adoption of measures that avoid or reduce the need for mechanical cooling including reductions in cooling loads, human centric design[7] and urban planning;
- **Super-efficient equipment and appliances:** A 'race to the top' S-curve transformation where the norm is super-efficient cooling equipment[8] and appliances that are smart and powered by zero carbon energy;
- **Ultra-low global warming potential (GWP) refrigerants:** Market domination of ultra-low (<5 GWP) refrigerants across all cooling sectors and applications.

These three impact areas are not sector specific. Currently two cooling sectors cause the largest amount of emissions – air conditioning and refrigeration – and each of these sectors has four main applications – domestic, commercial, industrial, and mobile/transport. Net zero cooling for all underpins all Sustainable Development Goals (SDGs)[9], including SDG 7 on achieving sustainable energy for all by 2030 and SDG 13 on climate action, and represents an opportunity to avoid substantial greenhouse gas (GHG) emissions. Today over 1.1 billion people are at significant risk from a lack of access to cooling[10]. Continued warming and demographic changes are likely to see these risks grow, making cooling critical for adapting to climate change.

[1] Some recent estimates suggest this could be as high as 10%
[2] https://k-cep.org/wp-content/uploads/2018/03/Optimization-Monitoring-Maintenance-of-Cooling-Technology-v2-subhead....pdf
[3] https://www.eea.europa.eu/publications/fluorinated-greenhouse-gases-2020
[4] This does not include costs of expanding transmission and distribution networks to meet cooling demand so the actual number will be higher.
[5] Economist Intelligence Unit (2020) *The Power of Efficient Cooling* https://eiuperspectives.economist.com/energy/power-efficient-cooling
[6] The net zero aim is to eliminate GHG emissions from cooling rapidly in line with the high ambition approach taken by the COP26 High Level Champions as part of the Race to Zero and, where not possible to completely eliminate, then allowance for some offset should be carried out in strict accordance as per race to zero guidance
[7] Human centric design is an approach to problem solving, commonly used in design and management frameworks, that develops solutions to problems by involving the human perspective in all steps of the problem-solving process.
[8] Equipment includes cooling heat pump solutions
9 Khosla et al (2020) https://www.nature.com/articles/s41893-020-00627-w
[10] SEforAll, Chilling Prospects: tracking Sustainable Cooling for All 2020

There is no single solution for net zero cooling. However, an '*avoid-shift-improve*' approach provides a diverse solution set across these sectors and applications. The cooling sector also heavily relies on the decarbonisation of other industries particularly energy. Cooling products will need to be powered by net zero grid systems and utilize load shifting techniques to reduce peak power demand in order to balance the consumption of cooling and the strain it places on the energy system. Additionally, thinking thermally not just electrically is important to considering cooling as a system and will help to improve efficiency of cooling storage, use and reuse across the different sectors.

This Action Table should be read alongside the Net Zero Cooling Pathway Executive Summary and is relevant to each of the Climate Action Pathways developed under the UNFCCC and Marrakesh Partnership initiative. In practice there is no single pathway that covers every geography and sector but instead a collection of pathways to net zero that are sensitive to specific conditions such as climate, infrastructure type and policy. For this reason, a 'Cool Calculator' is also being produced. This calculator supports raising cooling ambition by providing a transparent way to engage with how to get to net zero cooling by 2050. This aligns with the ambition of the COP26 High Level Champions to achieve net zero by 2050 and is far enough out for ambitious planning (including leapfrogging opportunities) while not being so distant to be unrealistic. The Cool Calculator allows stakeholders to make their own assumptions and to create a combination of solutions towards net zero. The objective with this scenario planning tool is to support identification of net zero cooling pathways out to 2050. There are several other sophisticated cooling models that already provide detailed analysis of cooling emissions or are being developed including in specific sectors and/or regions. The Cool Calculator has not been designed to replace these detailed models but rather to help stakeholders to run simple but open calculations on key aspects of cooling decarbonisation to enable them to identify the set of solutions that works best for them.

While net zero compatible cooling technologies already exist, these aren't being implemented, used or scaled at the pace required to achieve net zero cooling by 2050. There are a range of barriers to overcome including: policy and political will; finance and economic; technology and innovation; business commitments and supply chain readiness; and a lack of awareness and understanding of how to decarbonise the sector. The actions outlined below aim to help overcome these barriers and provide milestones that key stakeholders can target to unlock net zero cooling.

This Action Table recognises and aims to build on the leadership shown by existing initiatives and associated guidance on frameworks, practices and terminology that is helping to progress towards decarbonising the cooling sector. This net zero cooling pathway is a high ambition document that proposes actions and steps to get to net zero cooling as quickly as possible and with scientific integrity. This means that in many cases actions have been defined that go beyond existing approaches and standards in order to meet the overarching aim of achieving net zero cooling rapidly in line with the high ambition approach taken by the COP26 High Level Champions as part of the Race to Zero. This involves a transition from what is possible today to the milestones that need to be achieved on the pathway to net zero emissions – the term net zero compatible cooling is used in various places in the action table to reflect this.

There are a number of actions that apply to multiple impact areas – for example, champion countries committing to include new commitments on cooling in nationally determined contributions (NDCs) this year. Three important cross cutting considerations are outlined below that need to be tackled more broadly to achieve an effective transition to net zero alongside the specific actions laid out in the impact area tables.

Resilience

Efforts to protect those most at risk of heat stress in highest risk countries need to be implemented alongside the actions outlined in this document. Early actions in this area by 2021 include: carrying out further work to understand the countries and regions at the highest risk of suffering from heatwaves and strengthen the evidence on the cause and key demographics for heat stress and heat related deaths highlighting those at the greatest risk and why, and setting targets for the number or percentage reductions in heat related deaths and the number of people covered by up-to-date heat wave plans. Policies will need to provide mechanisms helping those most at risk to get improved access to net zero compatible cooling. By 2025, and even more so by 2030, policies will be implemented that protect those most at risk of heat stress in highest risk countries leading to a significant increase in the number of people with improved access to net zero compatible cooling and significant increases in the number of people covered by up-to-date heat wave plans. By 2040, all at risk people will be covered by up-to-date heat wave plans and have access to thermal comfort protecting them from any heat stress related risk. Community groups and non-governmental organisations (NGOs) will actively contribute to this effort by implementing initiatives reducing heat stress and death risks. The Resilience Pathway for the Marrakesh Partnership provides useful guidance for adapting to rising heat and other climate impacts.[11]

Skills and training

Skills development and training is required across all three impact areas. This is a critical enabling factor to achieving the outcomes highlighted in the action tables effectively. The key areas of focus identified include: capacity building on designing and implementing passive cooling measures in building and infrastructure planning and design and for investors and regulatory policy makers; appropriate sizing and maintenance of super-efficient equipment and appliances for effective operation; and upskilling around health and safety for safe handling of ultra-low GWP refrigerants.

Measurement and tracking impact

There are several actions across different stakeholder groups outlined in the tables below that need to be delivered successfully to achieve net zero cooling. This transition should be underpinned by a robust and transparent measurement and tracking framework to ensure the cooling sector is aware of the trajectory of progress and that interventions are taken at the right time to stay on course to net zero. Such a framework is required across technology, policy development, business models, investments and consumer behavior nationally and globally.

[11] Resilience Pathway Executive Summary available at https://unfccc.int/sites/default/files/resource/ExecSumm_Resilience_0.pdf and Action Table at https://unfccc.int/sites/default/files/resource/Action_table%20_Resilience.pdf. Accessed on 22 March 2021.

Impact 1

Passive cooling

Cooling

Mitigation & Adaptation/ Resilience

NEXUS

	By 2021	By 2025	By 2030	By 2040
Policies (national, subnational, local)	▪ Covid-19 stimulus packages to promote passive cooling measures focused on human-centred solutions ▪ Revise building regulations to promote passive cooling (e.g. building envelope and design, green and cool roofs, green walls) in leading countries and regions ▪ Cities commit to integrate passive cooling into city 'master plans' with identified Local Climate Zones to adopt most	▪ Countries, cities and regions in largest cooling countries and regions (China, India, South East Asia, US, EU, MENA) have introduced best practice passive cooling policies (including nature based) solutions for human settlements and/or food focusing on new buildings being net zero compatible by 2030 and linking to energy planning ▪ Policy on financial mechanisms to include incentives to support the market as needed	▪ All new buildings and urban areas are required to incorporate passive cooling measures through building codes and regulations as well as architectural standards adapted to local cultures and conditions ▪ Rates increased significantly to at least 3% per year for retrofit to include passive cooling measures in existing buildings	▪ All existing buildings are refurbished to passive cooling standards ▪ Passive cooling building regulations enforced in all countries ▪ City level projects that involve cooling are only approved if they optimise passive cooling ▪ All countries have policies on passive cooling for food and health cold chains

	By 2021	By 2025	By 2030	By 2040
	adapted passive cooling measures to cool specific areas ▪ Review policy options and evidence on passive cooling for food and health ▪ Governments include passive measures such as building regulations and architectural standards, new passive food and health cold chain technology demonstrations in their enhanced NDCs, energy planning strategies and other policy documents	▪ Additional commitments on passive cooling included in enhanced NDCs, energy planning strategies and other policy documents	▪ City master plans with defined Local Climate Zones are enforced so any new development and retrofit projects comply ▪ Many countries introduce policies on passive cooling for food and health cold chains	
Finance and Investment	▪ Costs and benefits quantified for large scale deployment of passive cooling, considered as infrastructure investment where appropriate ▪ Multi-lateral, regional and national development banks review their cooling finance to identify how to scale up investment in passive cooling ▪ New financing mechanisms designed to support demonstration and scaling up of passive cooling (including for food) ▪ Scale and type of funding needed to meet the net zero cooling challenge is estimated	▪ Multi-lateral, regional and national development banks have significantly increased funding for passive cooling, and include passive cooling measures where relevant in any new cooling / energy efficiency schemes ▪ Increasing percentage of Official Development Assistance (ODA) funding allocated to passive measures including capacity building ▪ Leading investors commit to adopting and promoting passive cooling ▪ Passive cooling considerations included in climate risk	▪ Further significant increase in development bank and ODA finance for passive cooling with a focus on those measures that can deliver at scale and speed including capacity building ▪ Most investors actively screening whether passive cooling sufficiently adopted in projects ▪ Investors financing passive cooling measures at large scale for buildings, food and health	▪ Finance for passive cooling consistent with net zero cooling pathway and finance does not flow to new buildings or building refurbishments that have not considered passive cooling

	By 2021	By 2025	By 2030	By 2040
		appraisals and as a first principle to capture mitigation and adaptation co-benefits (e.g. disincentivise investment in thermally inefficient buildings)		
Technology and Innovation	▪ Strengthen evidence base across key cooling countries on passive and related active cooling measures particularly space cooling in buildings, food preservation, and medicine preservation (e.g. coatings /dehydration/urban farming/packaging and storage containers) ▪ Research, development and demonstration on innovative passive cooling solutions in new and existing buildings, for food and medicine that are human-centred and specific to local cultures and conditions	▪ Innovative higher performance cooling technology being demonstrated at scale ▪ Innovative passive cooling solutions being demonstrated at scale for space cooling in new and existing buildings, medicine preservation and food preservation ▪ Optimising cooling demand at the design stage is embedded as a development practice	▪ Passive cooling measures shown to have the largest impact on demand are deployed at scale in countries with the highest cooling need ▪ Ongoing research and development on new passive cooling solutions	▪ Innovative passive cooling measures deployed at levels consistent with net zero cooling pathways
Business and Services	▪ Raise awareness among businesses of opportunities for passive cooling including profiling businesses and services that show what is possible ▪ Businesses make passive cooling commitments including	▪ Leading businesses and developers commit to adopt and promote passive cooling measures ▪ Passive building certification (e.g. Passive House standard) and commitments (e.g. World Green Building Council's Net Zero Carbon Building	▪ Most large businesses and many small businesses are adopting and/or promoting passive cooling measures ▪ Businesses self-financing passive cooling measures at large scale for buildings and food	▪ All large businesses and most small businesses are adopting and/or promoting passive cooling measures ▪ Capacity building means all large businesses and small businesses are able to integrate and promote passive cooling measures

	By 2021	By 2025	By 2030	By 2040
	for certification and standards, as part of the Race to Zero ▪ Develop in-house technical and commercial capacity (e.g. architects, engineers, building developers, infrastructure investment) on how to first avoid the need for cooling before including cooling technologies into buildings	Commitment) are widely used and scaled up with industry support	▪ Businesses are investing in internal capacity building to embed passive cooling approach across cooling related activities	
Civil Society	▪ Implement initiatives to raise awareness of passive cooling opportunities and diversity. This includes tracking evidence on passive measures, technology and business model innovations, impact and applicability. It also includes raising awareness on cultural and human-centred design and nuances specific to different regions that need to be captured in passive cooling applications to facilitate adoption ▪ Develop and/or enhance a simulation tool able to estimate applicability and energy saving potential of individual passive measures for a specific set of input on climate and building conditions as well as sharing	▪ 250 million people with improved access to passive measures ▪ New behavior change campaigns launched to promote passive measures ▪ Consumers demand passive solutions and associated business models	▪ 1 billion people have enhanced access to passive cooling measures ▪ Behavior change on passive cooling measures the norm in the majority of countries	▪ Access to passive cooling measures for all (including for transport and human settlements) ▪ Passive cooling seen as the normal and first cooling priority measure in all countries

	By 2021	By 2025	By 2030	By 2040
	▪ cost impact and disadvantages of each measure simulated ▪ Identify new ways to encourage behavior change to promote passive measures ("be cool")			

EXISTING INITIATIVES PASSIVE COOLING

Million Cool Roofs Challenge	A $2 million global competition sponsored by the Kigali Cooling Efficiency Program (K-CEP) in collaboration with the Global Cool Cities Alliance (GCCA), Sustainable Energy for All (SEforALL) and Nesta's Challenge Prize Centre. The award aims to rapidly scale up the deployment of highly solar-reflective 'cool' roofs in developing countries. The Challenge awarded $100,000 grants to ten teams in 2019 to deploy solar reflective coating and/or materials in 10 countries across Africa, Central America, and Southeast Asia. In 2021, an additional $1 million will be awarded to the team that has demonstrated the best sustainable and transferable model for rapid deployment of cool roofs.
Passive House Institute (PHI)	PHI is an independent research institute that plays a crucial role in the development of the only internationally recognised performance-based energy standard, the Passive House Concept. They play a critical role in reducing cooling loads in buildings and have demonstrated proof of concept with projects reducing >50% of cooling needs thanks to passive design.
Global Alliance for Buildings and Construction (GlobalABC)	The GlobalABC connects governments, the private sector and organisations to drive the transformation towards a net zero emission, efficient and resilient buildings and construction sector. The alliance has played a key role in connecting sectoral stakeholders and sharing knowledge on driving measures to avoid and reduce the need for cooling in buildings.
Program for Energy Efficiency in Buildings (PEEB)	The Programme for Energy Efficiency in Buildings (PEEB) aims to significantly transform the building sector by promoting sustainable building design and construction. PEEB combines financing for energy efficiency in large-scale projects with technical assistance through policy advice and expertise for building sector professionals. It promotes the use of passive design for projects in hot climates to avoid the need for cooling and provide thermal comfort.

Zero Carbon Buildings for All	The Zero Carbon Buildings for All Initiative, launched at the 2019 UN Secretary-General's Climate Action Summit in New York, unites leaders across sectors in a strong international coalition to decarbonise the building sector and meet climate goals.
Whole Building Design Guide – Net Zero Energy Buildings	The Whole Building Design Guide is a web-based portal providing government and industry practitioners with one-stop access to up-to-date information on a wide range of building-related guidance, criteria and technology from a 'whole buildings' perspective. They have a collection of resources on Net Zero Energy Buildings across technology, applications with case studies and relevant codes and standards.
World Green Building Council's Net Zero Carbon Building Commitment	This Commitment challenges business, organisations, cities, states and regions to reach net zero carbon in operation for all assets under their direct control by 2030, and to advocate for all buildings to be net zero carbon in operation by 2050. The Commitment provides a framework to develop globally ambitious yet locally relevant, flexible and universally viable solutions for buildings within their portfolio, city, state or regional boundary. It sets actions to reduce energy demand and achieve net zero carbon through renewable energy and offsets (as a last resort). For businesses, the Commitment is one of three pathways available to join EP100.
#ThisIsCool	This is Cool is a campaign to show what can be done across the world to make sustainable cooling a reality. Over 1 billion people are at high risk due to lack of access to cooling, and a further 2.2 billion lack access to clean and efficient cooling. In a warming world, access to sustainable cooling is not a luxury. It is an issue of equity and a service that must be delivered to everyone. This campaign highlights accessible and simple cooling solutions and sustainable and transformative solutions to ensure access to nutritious food and safe medicines, and provide protection from heat in the transition to affordable and clean energy.

Impact 2

Super-efficient equipment and appliances

Cooling

Mitigation & Adaptation/ Resilience

NEXUS

	By 2021	By 2025	By 2030	By 2040
Policies (national, subnational, local)	▪ Champion countries commit to 'product performance ladders-labels-incentives' policies with inbuilt ratchets and GWP limits which increase ambition from Minimum Energy Performance Standards (MEPS) to High Energy Performance Standards (HEPS) that drive towards best available technology. MEPS take into consideration the total cost of ownership (least lifecycle cost) to ensure the broad uptake of equipment and leverage the United for Efficiency (U4E) Model Regulation Guidelines for Energy	▪ The majority of developing and emerging economies (50% of the global market) have adopted and are implementing MEPS and labels consistent with or exceeding requirements in the U4E Model Regulation Guidelines or similar ▪ Enhanced product performance ladders-labels -incentives policies to continue to drive energy efficiency gains and enabled smart operation alongside GWP reduction are in place in largest cooling countries and regions (China, India, South East Asia, US, EU, MENA)	▪ Enhanced product performance ladders, labels and incentives adopted and in force for 80% of the global market ▪ NDCs with commitments consistent with net zero cooling path in place for 90% of the market ▪ Scale up of district cooling networks beyond leading regions	▪ Enhanced product performance ladders, labels and incentives consistent with net zero cooling are in place for all cooling technologies and regions ▪ NDCs with commitments consistent with net zero cooling being actioned and enforced ▪ District cooling adopted as norm for all cooling dense applications globally as appropriate

	By 2021	By 2025	By 2030	By 2040
	Efficient and Climate Friendly Equipment where available ▪ Targets set by planners for inclusion of district cooling systems in developments based on cooling loads ▪ Targets set for increases in number of people with improved access to net zero compatible cooling ▪ Governments join the Biarritz Pledge for Fast Action on Efficient Cooling to transform the global cooling sector and lower emissions by coordinating efforts to improve the energy efficiency of air conditioners and other cooling equipment in parallel to the phase down of HFCs	▪ 2020-21 NDC commitments are on track and new commitments included in 2025 NDCs ▪ Large-scale public sector procurement for super-efficient equipment and appliances ▪ Significant adoption of district cooling in leading regions in cooling dense applications		
Finance and Investment	▪ Leading investors commit to develop net zero cooling screening for high volume transactions, and to move, over time, to only fund net zero cooling compatible solutions (aligned with the ladder approach) ▪ Leading investors commit to disengage from financing cooling manufacturers that have not made a net zero commitment	▪ Multi-lateral, regional and national development banks allocating at least 50% of cooling related funds to net zero compatible solutions ▪ Significant increases in percentage of ODA funding for net zero compatible cooling and research and development for breakthrough solutions ▪ Leading investors use net zero cooling standards (and the	▪ Multi-lateral, regional and national development banks allocating 100% of cooling related funds to net zero solutions ▪ Ongoing significant development finance and research and development funding ▪ Widespread deployment of private sector institutional investment together with public procurement	▪ Finance only flows to super-efficient, ultra-low GWP products and investments

	By 2021	By 2025	By 2030	By 2040
	▪ Leading investors adapt proven financial mechanisms (e.g. on-bill finance, rebate, tax incentives, sustainable public procurement) to incentivise customer adoption of net zero compatible technologies ▪ Leading investors demand that businesses buying the most cooling technology commit to net zero ▪ Multi-lateral, regional and national development banks tracking and allocating 25% of cooling related funds to net zero compatible solutions (using U4E Model Regulation and the ladder approach as a guide) ▪ Scale and type of funding needed to meet the net zero cooling challenge is estimated ▪ Covid-19 recovery packages incentivise super-efficient appliances and equipment	ladder approach) when making finance decisions	investments power forward net zero cooling action ▪ Leading investors quit financing businesses that have not made net zero cooling commitments	
Technology and Innovation	▪ Leading cooling suppliers commit to net zero cooling targets ▪ Leading cooling suppliers support 'product performance ladders' and GWP limits for net zero cooling products ▪ Cooling suppliers and operators commit to having net zero	▪ Companies bring to market 5x more climate friendly residential air conditioners ("Champions Breakthrough / Global Cooling Prize") ▪ Majority of cooling suppliers and operators committed to net zero cooling targets	▪ Significant cost reductions in net zero compatible cooling technologies for buildings and food ▪ Usage of waste cooling has been completely optimised and recycled within industry	▪ New technologies and business models make super-efficient, ultra-low GWP equipment and appliances cheaper in most applications ▪ Cooling in all buildings supplied by renewable technologies (solar,

	By 2021	By 2025	By 2030	By 2040
	compatible product available in good time to ensure deployment is possible by 2050 minus the typical product lifetime (e.g. 2025 for a 25-year lifetime product) ▪ Companies (representing >20% of AC sales by revenue) commit to bring to market by 2025 residential air conditioners that are 5x more climate friendly ("Champions Breakthrough / Global Cooling Prize") ▪ Building on the Global Cooling Prize, new innovation challenges launched to support new breakthrough cooling technologies (e.g. thermal energy storage, cooling services etc.) ▪ Cost reductions in net zero cooling equipment for buildings, and smart technologies integrated with renewables, being developed to intelligently manage energy consumption in buildings and couple it with cooling demand ▪ Waste cooling is increasingly utilised and being delivered to district energy networks to meet cooling loads where cost effective	▪ All cooling suppliers and operators committed to product performance ladders ▪ Significant cost reductions in high efficiency net zero cooling equipment for buildings ▪ Usage of waste cooling is being optimised and recycled within industry while also being delivered to district energy networks ▪ Cooling suppliers having net zero compatible products available to ensure deployment is possible by 2050 minus the typical product lifetime (e.g. 2025 for a 25-year lifetime product)	▪ Only net zero compatible cooling products are sold	geothermal, bioenergy, renewable electricity for cold) ▪ Industry on track to full cooling decarbonisation by 2050 with net zero cooling technologies including use of waste cooling

	By 2021	By 2025	By 2030	By 2040
Business and Services	▪ Leading businesses in the largest cooling consuming sectors commit to net zero cooling targets, use of product performance ladders and GWP limits for net zero products ▪ Net zero cooling technology available and innovative business models starting to improve its affordability for businesses	▪ Most large businesses in cooling consuming sectors commit to net zero cooling targets and procurement of net zero compatible cooling solutions ▪ Businesses invest in resources and skills to manage and maintain equipment to operate systems at maximum efficiency and increase energy savings with optimal control settings ▪ Net zero cooling technology scaled up along with more wide spread use of innovative business models	▪ Leading businesses are only buying net zero cooling technology ▪ All large and many small businesses commit to net zero cooling targets ▪ Businesses operate and maintain equipment at optimum efficiency and settings ▪ New technologies and business models make it cheaper to install net zero cooling technologies in most applications	▪ All businesses in all sectors are using net zero cooling technology ▪ New technologies and business models make it cheaper to install net zero cooling across all applications
Civil Society	▪ Significant increase in awareness of net zero cooling through high profile campaigns and information including product guides, models and innovative ideas ▪ Advocacy for political, business and investor leadership on net zero cooling	▪ Civil society demands net zero cooling for all and has driven leading businesses and policymakers to commit to net zero cooling ▪ Civil society commits to net zero cooling solutions in their own operations	▪ Civil society engagement has driven the majority of businesses and policymakers to commit to net zero cooling	▪ Civil society engagements maintain pressure on businesses, investors and policymakers to comply with ongoing delivery of net zero cooling (i.e. monitoring and accountability)

EXISTING INITIATIVES SUPER-EFFICIENT EQUIPMENT AND APPLIANCES

The Green Technology Selector (GTS)	The European Bank for Reconstruction and Development developed the GTS to promote best-in-class green technologies and encourage businesses to select energy-efficient appliances including cooling technologies. The selector registers products, vendors and manufacturers across 37 different countries.
Top Runner Program (Japan)	Since 1998, the program sets efficiency standards for 21 products including ACs sold in Japan. Products are regularly tested to determine the most efficient model as the baseline for the level of efficiency required from all manufacturers. The benefits of the program include reducing GHG emissions due to decreased energy use, increased market opportunities for energy-efficient products and cost savings opportunities from reduced energy consumption.
Super-Efficient Air Conditioning Programme (India)	The programme aims to collaborate with leaders in the AC industry and introduce super-efficient ACs into the Indian market. They did this by aggregating the demand for efficient technologies and establishing a demand market for participating manufacturers. The bulk procurement delivers super-efficient ACs that are comparably priced with average (3-star) units, over 40% more efficient and perform at high ambient temperatures, are reliable over wide operating voltage range and are backed-up by 5-years of additional warranty.
UNEP United for Efficiency (U4E)	Created in 2009 as a public-private partnership by UNEP, the Global Environment Facility, and the United Nations Development Programme with an array of international partners. The initiative works with developing and emerging economies to accelerate the switch to energy-efficient and climate friendly lighting, appliances and equipment. U4E has market transformation projects in dozens of countries, regional policy harmonization activities in Africa, ASEAN and Latin America, and variety of global tools, training and outreach. U4E's comprehensive *Integrated Policy Approach* includes MEPS, labels, financial mechanisms, market monitoring, testing, enforcement, and recycling to help ensure that interventions unlock deep, lasting impacts.
U4E Model Regulations	The United for Efficiency model regulation guidelines for lighting, appliances and equipment are designed to simplify the deployment, adoption and enforcement of energy efficiency regulations. The model regulation guidelines provide voluntary guidance for Governments in developing and emerging economies that are considering a regulatory or legislative framework. They contain essential elements, including product scope, definitions, test methods, minimum efficiency levels and a set of minimum performance requirements, along with market surveillance measures which ensure consumers can purchase quality efficient products with confidence.
The Kigali Cooling Energy Efficiency Program (K-CEP)	K-CEP is a philanthropic program to support the Kigali Amendment of the Montreal Protocol. It works across different streams (finance, policies, institutional strengthening and access to cooling) to accelerate the climate and development benefits of the Montreal refrigerant transition by maximising improvement in energy efficiency of cooling and meeting HFC phase down and phase out targets of the Kigali Amendment.

Super-efficient Equipment and Appliances Deployment	The Super-Efficient Equipment and Appliance Deployment (SEAD) initiative of the Clean Energy Ministerial and the International Partnership for Energy Efficiency Cooperation aim to make it easier for governments and the private sector to capitalise on appliance and equipment efficiency to reduce energy demand and carbon emissions while lowering energy costs for consumers, businesses, and institutions.
Cool Coalition	The Cool Coalition is a global multi-stakeholder network that connects a wide range of key actors from government, cities, international organisations, businesses, finance, academia and civil society groups to facilitate knowledge exchange, advocacy and joint action towards a rapid global transition to efficient and climate-friendly cooling. The Cool Coalition promotes an avoid-shift-improve-protect approach that is holistic and cross-sectoral to meet the cooling needs through urban form, better building design, energy efficiency, renewables and thermal storage as well as phasing down HFCs.
Cool Coalition initiative on Used Cooling Imports	The aim of this Working Group is to bring together interested officials and representatives from industry and civil society to: (i) Take stock of the current situation of used cooling equipment importation in Africa (ii) Raise awareness on the environmental impacts along the lifecycle of both new and used cooling products in the African context, (iii) Identify relevant resources that are being applied or could readily be applied to address these issues in Africa, and (iv) Select a set of potential transformative actions that could be undertaken by interested actors
Net Zero Initiative	The Net Zero Initiative project, initiated in June 2018 and led by Carbone 4 in collaboration with a dozen pioneering companies, and supported by a high-level scientific council, has published a reference framework for the contribution of organizations to carbon neutrality. The aim of the initiative is to align all the players with the same priorities, the same concepts, and the same horizon.
Global Cooling Prize	An Innovation challenge initiated by Mission Innovation, Government of India and RMI to demonstrate room AC technologies capable of delivering comfort in a hot and humid climate zone with 5 times lower climate impact and no more than twice the first cost at assessed industrial scale as compared to the typical products being sold in the market today. The prize includes prototype testing to ensure performance in extreme ambient conditions can be assessed and demonstrated.
WWF's global Top Ten lists	Topten is a consumer-oriented online search tool, which presents the best models in various product categories. Topten's key selection criteria are energy efficiency and consumption, while other quality aspects like resource efficiency and health are also considered. Topten sites exist in 15 European countries, China, Chile, Peru and Argentina.
UNEP's District Energy in Cities Initiative	The Initiative is a public-private partnership launched in 2015 and hosted by UNEP, that supports national and local authorities in accelerating the deployment of district heating and cooling systems. The Initiative has over 60 partners and is providing technical assistance to 33 cities over 14 countries to identify and support the development of district heating and cooling systems.
CCAC initiative on Efficient Cooling	This Efficient Cooling Initiative brings together governments, intergovernmental organizations, and the private sector to build high-level political leadership and facilitate collaboration among stakeholders. The aim is to enhance energy efficiency in the cooling sector while countries implement the phase-down of HFC refrigerants under the Montreal Protocol.

Impact
3

Ultra-low GWP refrigerants (GWP < 5)

Cooling

Mitigation & Adaptation/ Resilience

NEXUS

	By 2021	By 2025	By 2030	By 2040
Policies (national, subnational, local)	▪ Countries agree to an assessment to identify opportunities to avoid growth in high GWP HFCs and achieve rapid reductions, including through integrated regulation for the HCFC phase out and HFC phasedown with progressive energy efficiency improvement ▪ New commitments from leading countries on accelerated uptake of ultra-low GWP refrigerants beyond Kigali Amendment requirements	▪ All countries have ratified the Kigali Amendment ▪ Recognition and agreement from all nations that the Kigali Amendment to the Montreal Protocol needs to be adjusted (accelerated and strengthened as per the mechanism in Article 6 of the Protocol) ▪ Countries are working to an adjusted Kigali Amendment to the Montreal Protocol starting with sectors where earlier progress is easier	▪ Substantial implementation of an adjusted Kigali Amendment to the Montreal Protocol has occurred ▪ Product performance ladders for cooling technologies mandate use of ultra-low GWP ▪ Ultra-low GWP Cooling Accelerator / Innovation Challenge delivers breakthrough ultra-low GWP solutions for all outstanding cooling challenges	▪ Updated Kigali Amendment to the Montreal Protocol has delivered ultra-low GWP cooling ▪ Product requirements for new equipment require net zero compatible products in all sectors and regions and incentives in place to retire inefficient, high GWP cooling equipment

By 2021	By 2025	By 2030	By 2040
▪ At least 75% of the 20 largest countries by population secure ratification of the Kigali Amendment ▪ Nations agree to work together and invest additional funds in F-Gas market surveillance, compliance and enforcement; and also agree to review building codes and product standards which stifle the use of ultra-low GWP net zero products are reviewed (e.g. agree a common view on flammability) ▪ Nations agree to fund an international cooling accelerator or innovation challenge that supports breakthrough ultra-low GWP cooling solutions that address known technological hurdles in cooling markets and reduce the cost of ultra-low GWP refrigerants ▪ Nations commit to work together to develop comprehensive training and skills frameworks for the at-scale deployment of ultra-low GWP technologies ▪ Governments join the Biarritz Pledge for Fast Action on Efficient Cooling to transform the global cooling sector and lower emissions by coordinating efforts	▪ New product performance ladders make explicit requirement to use ultra-low GWP refrigerants in new equipment ▪ Leading cooling nations have developed the training and skills frameworks needed to deploy ultra-low GWP technology are scaled up ▪ Nations tighten regulation on import (and export) of used and high GWP cooling appliances in/to developing countries ▪ Large-scale public sector procurement for equipment and appliances using ultra-low GWP refrigerants		

	By 2021	By 2025	By 2030	By 2040
	to improve the energy efficiency of air conditioners and other cooling equipment in parallel to the phase down of HFCs			
Finance and Investment	▪ Leading investors commit to fund only ultra-low GWP net zero cooling solutions, and develop new financial instruments to support this commitment ▪ Significant replenishment of the Multilateral Fund (MLF) to support action delivering ultra-low GWP net zero cooling and to address high growth rate of HFCs ▪ Accelerated development of novel financing mechanisms and instruments for net zero compatible cooling by Development Finance Institutions ▪ Scale and type of funding needed to meet the net zero cooling challenge is estimated	▪ Many investors commit to fund only ultra-low net zero GWP cooling ▪ Countries commit public procurement to only invest in ultra-low net zero compatible GWP cooling ▪ MLF funds support adjusted action of Kigali Amendment to the Montreal Protocol ▪ Investors commit to only fund manufacturers of ultra-low GWP refrigerants	▪ All investors fund only ultra-low GWP net zero cooling solutions ▪ Investors only funding ultra-low GWP refrigerant manufacturing	▪ All investors only funding ultra-low GWP net zero cooling solutions
Technology and Innovation	▪ Leading equipment and refrigerant manufactures commit to increased R&D and to work together to support an 'Ultra-low GWP Cooling Accelerator' to identify ultra-low GWP refrigerant solutions for hard to achieve cooling applications, particularly air conditioning, industry, and transport	▪ Companies bring to market 5x more climate friendly residential air conditioners ("Champions Breakthrough / Global Cooling Prize") ▪ Accelerator programme delivers a suite of ultra-low GWP refrigerant solutions for hard to achieve cooling challenges.	▪ Manufacturers only sell ultra-low GWP technology options, including for previously hard to achieve applications ▪ Refurbishment of existing cooling technologies with ultra-low GWP options is occurring at scale across nations	▪ Businesses offer the optimum balance of super-efficient equipment and use of ultra-low GWP technology solutions

	By 2021	By 2025	By 2030	By 2040
	▪ Companies (representing >20% of AC sales by revenue) commit to bring to market by 2025 residential air conditioners that are 5x more climate friendly ("Champions Breakthrough / Global Cooling Prize") ▪ Manufacturers commit to demonstrate at scale refurbishments of embedded cooling technology with ultra-low GWP refrigerants in hard to abate applications. ▪ Leading manufacturers commit to expand product ranges to include a higher % of ultra-low GWP solutions	▪ Refurbishment to ultra-low GWP refrigerant technology demonstrated at-scale in key applications ▪ Leading manufacturers provide ultra-low GWP refrigerant options for > 50% of product their range ▪ Manufacture commit to resolve outstanding ultra-low GWP refrigeration challenges in hard to achieve applications by 2030		
Business and Services	▪ Leading businesses in the largest cooling consuming sectors commit to only buy ultra-low GWP refrigerant solutions, as they become available ▪ Leading cooling businesses commit to minimising refrigerant leakage and robust refrigerant decommissioning at end of life including recovery, recycling and destruction of both refrigerants and ozone depleting substances and HFC containing foams	▪ All businesses in the largest cooling consuming sectors commit to buy ultra-low GWP refrigerants ▪ Operators are trained to reduce refrigerant leakages and decommission high GWP refrigerants at end of life including recovery, recycling and destruction of both refrigerants and ozone depleting substances and HFC containing foams	▪ Most businesses commit to ultra-low GWP refrigerant solutions ▪ Cooling equipment is decommissioned with refrigerants treated in a robust, environmentally-friendly way including recovery, recycling and destruction of both refrigerants and ozone depleting substances and HFC containing foams	▪ All business commit to ultra-low GWP refrigerant solutions

	By 2021	By 2025	By 2030	By 2040
Civil Society	▪ Civil society documents availability of ultra-low GWP appliances to support uptake by businesses ▪ Calls on manufacturers to increase roll-out of ultra-low GWP appliances ▪ Raises awareness of F-gas enforcement and compliance challenges ▪ Civil society mobilizes support for accelerated and strengthened Kigali Amendment ▪ Implement initiatives to raise awareness of how best to manage and dispose of high GWP appliances to minimize refrigerant leakage including recovery, recycling, and destruction of both refrigerants and ozone depleting substances and HFC containing foams	▪ Ongoing support for accelerated action under Kigali Amendment ▪ Increase demand for ultra-low GWP appliances ▪ Raise awareness of what happens to appliances at end of life and on environmentally friendly disposal routes ▪ Pressure from civil society reduces manufacturing of high GWP appliances ▪ Supports developing countries to leapfrog HFCs to sustainable ultra-low GWP alternatives ▪ Supports measures aimed at reducing illegal trade in HFCs, which undermine uptake of ultra-low GWP appliances	▪ Pressure from civil society forces governments to tighten regulation on importation of used and high GWP appliances in developing countries	▪ All purchased appliances use ultra-low GWP refrigerant

EXISTING INITIATIVES ULTRA-LOW GWP REFRIGERANTS

The Climate and Clean Air Coalition (CCAC)	CCAC is a voluntary partnership of governments, intergovernmental organisations, businesses, scientific institutions and civil society committed to improving air quality and protecting the climate. Their HFC Initiative focuses on disseminating information on and strategies for developing, deploying and promoting climate-friendly technologies. Activities include capacity building, technology conferences and exhibitions, interactive partner tools and many other knowledge sharing activities.
Green Cooling Initiative	The Green Cooling Initiative (GCI) is a global initiative focused on implementation of sustainable cooling, formed through a union of various projects and partners. Since 1995, GCI has been sustainably transforming the cooling sector in emerging and developing countries. The transition to ultra-low GWP refrigerants has been an important part of GCI's work alongside projects that focus on other aspects of green cooling. GCI is supported and funded by the German Government, in particular the Federal Ministry for the Environment, Nature Conversation and Nuclear Safety and the Federal Ministry for Economic Cooperation and Development.
Environmental Investigation Agency	EIA has led multiple campaigns to promote the shift to ultra-low GWP refrigerants including: the chilling facts campaign, which initiated an EU wide shift towards natural refrigerants in commercial refrigeration; the robust revision and implementation of the EU HFC phase-down through the F-Gas Regulation; investigating and exposing the illegal trade in refrigerants and promoting strengthened refrigerant enforcement and licensing; and supporting the case for the Kigali Amendment and international regulation of ozone and climate under the Montreal Protocol.
Global Cooling Prize	An Innovation challenge initiated by Mission Innovation, Government of India and RMI to demonstrate room AC technologies capable of delivering comfort in a hot and humid climate zone with 5 times lower climate impact and no more than twice the first cost at assessed industrial scale as compared to the typical products being sold in the market today. The prize includes prototype testing to ensure performance in extreme ambient conditions can be assessed and demonstrated.
EPEE's white paper Count on Cooling	This paper is a five-step approach to deliver sustainable cooling. It examines the role of cooling in the 21st century, its growth and burden it will play on increased GHG emissions and electricity consumption. The paper describes important steps that can be undertaken to deliver sustainable cooling, including examples of how the EU policy framework has already taken steps forward and an analysis of the remaining challenges.