DETAILS AND CRITERIA

ABOUT THE GLOBAL COOLING PRIZE

The Global Cooling Prize (GCP)—initiated by Rocky Mountain Institute (RMI); Department of Science & Technology, Government of India; and Mission Innovation— is rallying a global coalition of leaders to solve the critical climate threat that comes from growing demand for residential air conditioning. By harnessing the power of innovation, we can provide cooling solutions that enhance people's lives without contributing to runaway climate change. This groundbreaking competition led by RMI, Conservation X Labs, Alliance for an Energy Efficient Economy (AEEE), and CEPT University, is designed to incentivize the development of a residential cooling solution that will have at least five times (5X) lower climate impact than today's standard AC units. This technology could prevent up to 100 gigatons (GT) of CO_2-equivalent emissions by 2050,[1] and put the world on a pathway to mitigate up to 0.5°C of global warming by 2100, all while enhancing living standards for people in developing countries around the globe.

THE NEED

If the global demand for cooling continues to increase on a business-as-usual trajectory, the number of room air-conditioner (RACs) units in service are estimated to increase from 1.2 billion units today to 4.5 billion units by 2050. Developing countries will see a fivefold increase in demand for RACs over this same period. This increase in demand will alone be responsible for over 0.5°C increase in global warming by 2100, making it difficult for us to achieve the Paris climate goals. Therefore, the Global Cooling Prize will act as the necessary catalyst to spur innovation and develop a cooling technology with five times (5X) lower climate impact.

THE PRIZE

The competing technologies will be awarded up to US$2 million in intermediate prizes to support design and prototype development. The winning technology will be awarded at least US$1 million to help finance and support its commercialization.

THEORY OF CHANGE

The Global Cooling Prize will have a profound impact on the future of air-conditioning technology in India and beyond, creating a strong ripple effect across industry:

- It will shine a spotlight on promising technologies and help to build and reward a culture of innovation—galvanizing innovators, engineers, and corporations around the world to focus on the need to design superefficient climate friendly cooling solutions.
- This high-profile demonstration will validate what is technically possible, and provide insights as to what can be realistically scaled.
- This demonstration and subsequent economic analysis is likely to spur greater international awareness around the issue of cooling, sustainable development and climate.

[1] Depending on how fast the grid transitions to cleaner energy sources, and how fast the breakthrough technology can be scaled.

- The competition is expected to instill government confidence to move beyond incremental energy improvements and adopt much more aggressive efficiency codes.
- The whole system benefits, including savings in utility retail rate subsidies, and avoided grid infrastructure can be used to support early movers.
- Once the technology is established, government policy signals can help catalyze the rapid industrialization required to drive down technology costs.

EVALUATION CRITERIA

The Global Cooling Prize aims to identify an innovative residential cooling solution that far exceeds the performance of today's AC units on the market. The prize criteria are performance-based ensuring that the prize is accessible to all technologies and fully technology agnostic. The winning cooling solution must have at least five times (5X) lower climate impact than the climate impact of the baseline AC unit for equivalent performance as specified under the 'operation' criteria. The baseline unit for the purpose of evaluation will be a 1.5 TR (5.3 kW) fixed speed split AC unit with Energy Efficiency Ratio (EER) of 3.5 W/W and using R410A refrigerant with a global warming potential (GWP) of 2,088.[2] The winning cooling solution must also be no more than twice the first cost of baseline unit at assessed scale (it results in a simple payback period [associated with the incremental cost of such a unit] of less than 3 years for the consumer).[3] In addition, the solution should also operate within predefined limitations on refrigerants, water, full-load power consumption, materials and operational requirements.

The Global Cooling Prize has a specific criteria that the participating technology solutions will be evaluated against to qualify in the competition. The following criteria must be demonstrated by every competing technology:

SUMMARY OF TECHNICAL CRITERIA

Criteria	Minimum Technical Requirement to Compete in the Prize
PRIMARY CRITERIA	
Climate Impact	***Solution must have at least 5X lower climate impact than the baseline AC unit***. The climate impact will take into account both energy and refrigerant use. Designs will be selected as finalists and invited to develop and produce prototypes for testing that show potential for at least 80% lower climate impact than the climate impact of the baseline unit, considering the reduction in grid electricity consumption (kWh) and refrigerant GWP (with an 80-20

[2] This baseline unit represents the most common RACs product sold in India and is in accordance with the Bureau of Energy Efficiency, Government of India defined Indian Seasonal Energy Efficiency Ratio (ISEER) rating of 3.5 for a 3-star AC in 2018. It is equivalent to EER 3.5 of a 5-star AC in 2016-17.
[3] Assessed scale is a manufacturing scale of 100,000 units

	electricity-refrigerant weighting, reflecting the climate impact of room air conditioners). Evaluation and Scoring Method: The climate impact of a cooling technology will be determined by a combination of two factors - electricity reduction (kWh) and refrigerant GWP reduction, using assigned weighting of 80:20 respectively, as compared to the baseline. The weighting for electricity and refrigerant is based on RMI modeling and the report of the Technology and Economic Assessment Panel (TEAP) in 2018, which show that refrigerant emissions are ~ 20 percent of life-cycle GHG emissions for room air conditioners, and operational emissions are ~ 80 percent, taking into account developing market grid emissions intensity factors. To achieve a 5X lower climate impact, an overall reduction of 80% (electricity kWh and refrigerant GWP combined) as compared to the baseline will be required.[4] For example, if a technology achieves a 75% reduction in electricity from the baseline and also uses a zero GWP refrigerant, it achieves a 100% reduction from the GWP baseline (R410A at a GWP of 2088). The overall percentage reduction achieved using the assigned 80:20 weighting would be 80% or 5X lower climate impact. This weighted percentage reduction from the baseline will then be converted to equivalent points. A zero percent reduction from the baseline i.e. a technology at baseline will receive zero points. A technology achieving 100% reduction from the baseline will receive 100 points. Any percentage reduction between 0% and 100% will be ratably converted to equivalent points between 0 to 100. Example: A technology achieving 80% reduction from the baseline will receive 80 points. These assessed points will be utilized to compare competing technologies that exceed the stated criteria limit. If a participant can demonstrate in their application that the cooling technology effectively delivers the full 5X lower climate impact through a combination of the standalone unit performance and reducing energy consumption in adjacent systems (example: reduced energy consumption for hot water generation), the Technical Review Committee may decide to consider such application as complying with the climate impact criteria. In such a case, the technical review committee will include the corresponding incremental climate impact and to the degree appropriate award additional points. This scoring methodology will be used to evaluate the Detailed Technical Applications of the participants and rank the top 10 finalists. To the extent that

[4] While the cooling technology should be able to meet or exceed the 5X lower climate impact criteria under varying outdoor conditions as specified in the Testing Protocol Overview section, the Detailed Technical Application requires the participant to demonstrate that the cooling technology achieves at least 5X lower climate impact than the baseline unit when operating in New Delhi. The TMY3 file for New Delhi will be provided to participants as part of the application.

	the total number of qualifying finalists selected, that meet or exceed the 5X lower climate impact criteria, falls short of the desired number of teams to go through to the final round, the Technical Review Committee may decide to invite designs that meet all other prize criteria for the prize (mentioned below), show high early stage potential to exceed 80% climate impact reduction in the future and currently exceed at least a 64% climate impact reduction from the baseline, to develop prototypes for testing. Following field and lab testing of the baseline unit and proposed solution, the top 10 cooling solutions will receive an updated score following the same scoring methodology.
Affordability	***Solution's installed cost to consumers must not be more than 2X that of the baseline AC unit when manufactured at a scale of 100,000 units*** The installed cost of the cooling solution to consumer at a manufacturing scale of 100,000 units must be no more than 2X the baseline AC unit's cost. The participant must provide the unit bill of materials cost scaled at 100,000 units per year, cost of external components and cost of consumables required to operate the solution. The unit bill of materials cost of the competing technologies will be independently assessed by a panel of industrial engineers at a manufacturing scale of 100,000 units using the submitted bill of materials. The typical margins, labor costs and distribution costs will be added to this assessed cost to arrive at the total installed cost to consumer excluding the standard installation labor costs and any Goods and Services Tax (GST). The cost of any renewable generation source incorporated as part of the design will be considered in determining the total cost to the extent that it is required to achieve the stated 5X lower climate impact i.e. the total installed cost of the solution including the appropriate proportion of renewable source cost must be no more than 2X the cost of the baseline AC unit. The baseline AC unit's cost to the consumer provided below for year 2017-18 acts as a reference for the purpose of helping the participants to determine the target cost of their prototype. The baseline unit's cost will be finalized by the technical review committee with reference to the previous full year's average cost of a 1.5 TR fixed speed 3-star split air conditioner offered by the market player with highest share. For determining the reference cost of the baseline AC unit to consumers, we studied the 2017 India room air conditioner market report and determined the

	average cost of 1.5 TR fixed speed 3-star split air conditioner offered by the market player with highest share.[5] The cost is determined to be INR 35,600 ($546, 2017 average USD to INR conversion rate from Reserve Bank of India) based on the average real price offered in the market in 2017-18. Evaluation and Scoring Method Points will be awarded to the cooling technology based on assessed cost estimates. A hypothetical zero cost will receive 40 points and a five-times cost from the baseline will receive zero points. Any assessed cost figure between the zero and five times of the baseline cost will be ratably converted to equivalent points. Example: A technology achieving two times (2X) the baseline cost will receive 24 points. These assessed points will be utilized to compare competing applications that exceed the stated criteria limit. If a competing technology is not able to achieve the 2X cost limit at assessed scale but the participants can demonstrate in their application that the cooling technology brings reduced cost benefits in adjacent systems, the Technical Review Committee may decide to consider such applications as complying with the criteria and reflect the corresponding reduction in costs.
SUPPLEMENTARY CRITERIA *All the proposed solutions will have to meet the minimum threshold of performance and environment criteria mentioned below.*	
Power	***Solution should consume no more than 700 W of power from the grid.*** The maximum power drawn by the solution from the electricity grid should not exceed 700 W while delivering the rated cooling capacity of 1.5 TR (5.3 kW) under standard conditions as well as over the span of lab and real-world test.
Water	***Should consume no more than 14 liters of water per day when averaged over a year, with a daily maximum limit of 28 liters, if any is required for operation*** The onsite water consumption, if any is required for operation of the proposed solution, should not exceed 14 liters per day when averaged over a year with a maximum daily limit of 28 liters.
Emissions	***Solution should have zero onsite emissions from any captive power or heat source.***

[5] Motilal Oswal, Room Air Conditioners, 2017. Retrieved from http://institution.motilaloswal.com/emailer/Research/ENGG-20170424-MOSL-SU-PG054.pdf Average price based on 15 fixed speed 1.5 TR air conditioners available in 2018, RMI research.

	The proposed solution should not combust fossil fuels onsite to generate a heating medium or electricity for operation of the unit.
Refrigerant	***Solution should use a refrigerant that has zero Ozone Depleting Potential (ODP), is of lower toxicity (Class A) and complies with IEC 60335-2-40 or ISO 5149*** The proposed solution should use a refrigerant that has a zero ODP in line with the Montreal Protocol. The proposed solution should use a lower toxicity (Class A) refrigerant as per ISO 817:2014 standard. The proposed solution should be capable of meeting test market regulations, or in their absence, international guidelines IEC 60335-2-40 (2018 or the latest amended version) or ISO 5149:2014 pertaining to safety and environment performance of systems using flammable refrigerants. It is preferred that the compliance to these standards is met to ensure safe operation, however, the participating team will not be disqualified in case of a non-compliance with these standards. In addition to above requirements, including the GWP of the refrigerant reflected in the Climate impact calculation, the technical review committee may also take into consideration the charge quantity where materially different to that of the baseline unit.
Scalability	***Solution should be scalable and not exceed 2X the size of the baseline AC unit.*** The proposed solution should be usable in existing homes, rather than requiring a “designed in” engineering solution and the total volumetric size should not exceed 0.42 cubic meters i.e. twice the volumetric size of the baseline unit. The installation of the proposed solution should not involve any major structural/design modifications to the building envelope. The total volumetric size must include any dedicated renewable power generation resources that make up the proposed solution. For example, if the participant proposes a split AC solution, the volumetric size shall not exceed 0.27 cubic meters for the outdoor unit and 0.15 cubic meters for the indoor unit. If the proposed solution is a packaged unit, the volumetric size shall not exceed 0.42 cubic meters.

Materials	***Solution should be developed with regard to minimal usage of rare earth materials and embodied carbon*** There will be no threshold requirements in relation to embodied carbon and rare earth materials, but the Technical Review Committee will, at their discretion, include an assessment of life cycle impact on any solution if they believe, in their judgement, that the solution includes materials with excessively high embodied carbon or rare earth materials in their final determination of suitability for progression to award.
Operation	***Solution should be designed to meet a 1.5 TR (5.3 kW) cooling load at standard outdoor conditions as specified in IS 1391 (Part 1): 2017, IS 1391 (Part 2): 2018 and ISO 16358:1 - 2013*** The solution should be able to deliver the cooling capacity of 1.5 TR (5.3 kW) under the standard test conditions of 35°C dry bulb temperature (DBT) and 24°C wet bulb temperature (WBT) as specified in IS 1391 (Part 1): 2017, IS 1391 (Part 2): 2018 and ISO 16358:1 - 2013. ***Solution should be able to maintain below 27°C dry bulb temperature (DBT) and 60% relative humidity (RH) indoor conditions for the duration of the test period under varying outdoor conditions with exception of the defined unmet hours allowance.*** During testing in the lab and real-world apartments (see Testing Protocol Overview below), the cooling solution or prototype should be able to maintain below 27°C DBT and 60% RH indoor conditions under varying outdoor conditions for the duration of the test period. The prototypes as well as the baseline unit will be operated in a continuous operation mode for all days of the testing period to determine their energy consumption while assessing their ability to maintain the desired indoor conditions. An “unmet hours” allowance will be provided recognizing that the ramp up period and precision of operation of prototypes is likely to be less than that of the established baseline unit. Refer to the “**Testing Protocol Overview**” section below for more details.

During evaluation of the Detailed Technical Application, points obtained by a competing technology on the climate impact criteria and affordability criteria, as explained earlier, will be used to determine the total points. For example, if the technology scores 80 points on the climate impact criteria and 24 points on the affordability criteria, the total points scored will be 104. After the evaluation of the applications, up to 10 teams will be selected as finalists based on how their submitted design ideas meet the technical criteria outlined above and the total points obtained. These 10 or fewer finalists will then be awarded up to US$ 200,000 each for development, production and shipping (if developed outside India) two prototypes to India, where these prototypes will be tested for performance in accordance with the aforementioned

primary and supplementary criteria in both lab environment and real-world apartment building in India. During evaluation of the Detailed Technical Application, if one or more supplementary criteria are not met, the Technical Review Committee will take a decision on whether or not the participant is qualified to compete in the competition.

Following the testing of prototypes, the 10 finalists will receive an updated score based on their performance against the prize criteria. The final winner will be selected with primary regard to the ranking based on the climate impact criteria combined with the affordability criteria, as determined by the technical review committee and as described under the above primary criteria. The points obtained by a competing technology on the climate impact criteria and affordability criteria, as explained earlier, will be used to determine the total points and adjust the ranking of the finalists, reflecting the Prize's objective of identifying a solution with 5X lower climate impact at no more than 2X the cost of today's standard AC units to consumers. During the testing stage, in case one or more supplementary criteria are not met by the competing technologies, the technical review committee will take a decision on whether or not the participant is qualified to compete in the final round.

TESTING PROTOCOL OVERVIEW

The selected finalists will use the interim prize money of US$ 200,000 to support the development and production of two prototypes of their cooling solution and ship it to India (if manufactured outside India) for the testing purposes. The testing phase, spanning over a period from May to September 2020, will comprise of three different testing stages.

In the first stage, the prototype will be sent to a National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited lab for ISEER rating. The ISEER test will be conducted in accordance with ISO 16358-1:2013, IS 1391 (Part 1): 2017, and IS 1391 (Part 2): 2018 and will determine the prototype's ability to deliver 1.5 TR (5.3 kW) cooling capacity under standard test conditions. The IS 1391 standard, as applicable to the testing of prototype design (example: unitary or split type), will be followed accordingly.

In the second stage, the prototype will be tested in a lab environment for 10 days to evaluate its performance through a series of conditions simulating the range of a full year. The internal conditions will be simulated to represent a typical daily sensible and latent load profile observed in a home and external conditions will be simulated to reflect a series of typical daily profiles of warm and dry, warm and humid, hot and dry, hot and humid, and extreme conditions observed across India. A set of 10 daily weather profiles covering range of 16 - 44°C dry bulb temperature and 20 - 95% relative humidity will be simulated and each prototype will be operated continuously for all these 10 typical days of an up to 12 days of the test period to assess its performance.

In the third stage, the prototype after the ISEER test will subsequently be installed and tested for performance in a real-world apartment in India. The apartments leased for the competition will be representative of the apartments that are south-facing with proportionately equivalent exterior wall surface area and have typical cooling load of 1.5 TR in a hot and dry / hot and

humid climate in India. Further, these apartments will be assessed to ensure that these are materially equivalent in all aspects.

In the second and third stage, the ability of the baseline unit and the prototypes to maintain indoor conditions below 27°C DBT and relative humidity 60% and their performance against the technical criteria, will be compared to determine the relative performance.

After the testing phase, the top 10 prototypes will receive an updated score based on their performance against the prize criteria. **The final ranking to determine a winner from the 10 selected finalists will depend on the technology's performance based on the 5X climate impact and affordability criteria.**

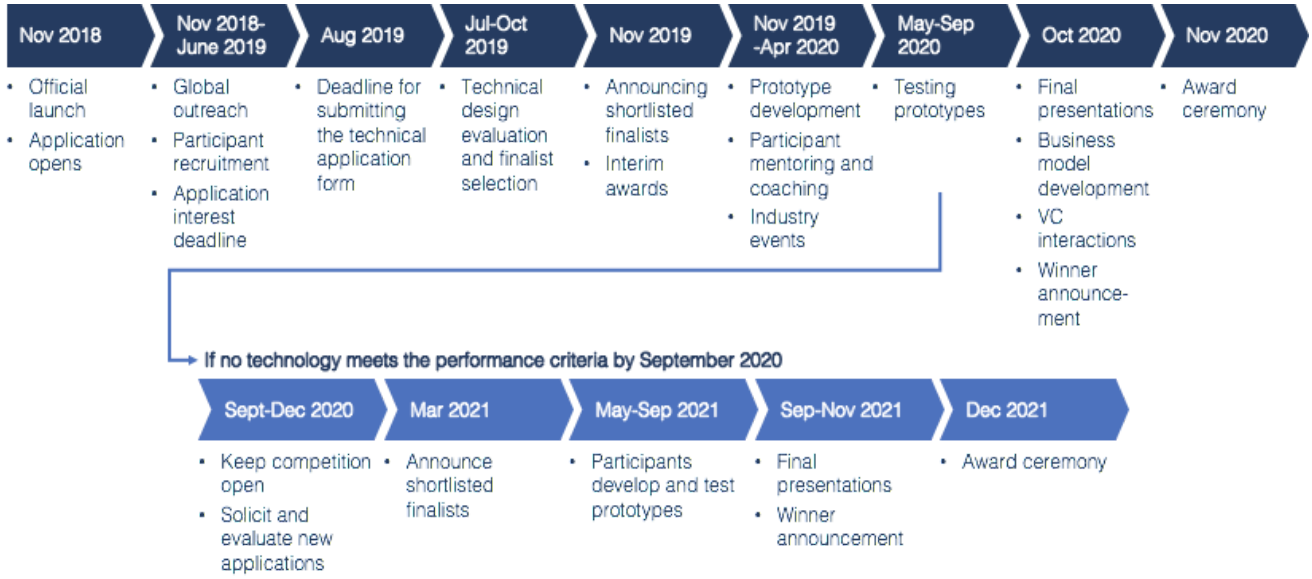
INTELLECTUAL PROPERTY (IP)

Participants in the Global Cooling Prize (GCP) will be developing novel inventions or designs that may constitute IP that should be appropriately protected. The GCP's approach to IP is as follows:

- All participants entering the prize will do so at their risk and will be solely responsible for ensuring that they have taken appropriate steps to protect any IP that forms part of their application.
- Participants are responsible for ensuring the information they submit does not infringe on any third party IP rights. Further, if the participants are part of an organization that through its contracts of employment has IP ownership provisions for the designs developed by its employees, it is the sole responsibility of the participants to ensure that their participation in the Prize does not infringe on the IP rights of their organization.
- All participants are encouraged to review their applications with a patent attorney and submit provisional applications where appropriate.
- Participants should be aware that their applications for the GCP containing technical details of their innovations would likely constitute a public disclosure of their invention/design, and could vitiate their ability to subsequently secure patent/design rights. It is, therefore, imperative that participants understand the risks and take all necessary steps to prevent any adverse impact of their submissions to the GCP.
- All individuals serving on the committees and councils and all third parties that have access to GCP technical participant applications and plans will be required to sign/execute confidentiality and non-disclosure agreements when accepting their role with the requisite committee or council.
- The Prize Organizers do not make any representation or warranty regarding the treatment or confidentiality of any submissions received and disclaim all responsibility for the protection of participant IP, or any consequence resulting from participant submissions.
- The Prize Organizers will not provide IP advice directly to participants but will provide access to an India patent attorney during the launch event and one webinar in 2019. Any additional support required would need to be separately procured by the participants.
- Participants selected for interim awards and subsequent prototype testing that have not secured the protection provided by a provisional patent application or granted patent will

also be required to sign waiver agreements absolving the Prize Organizers from liability due to the increased exposure of technology through the real world testing process.

PRIZE PHASING AND TIMELINE



Project Launch

The prize was launched on November 12, 2018 in New Delhi, India in presence of several dignitaries around the world and calls for participation. More information on the launch can be found here.

Participant Application and Selection of Finalists

Participants must submit the first round of applications-Participant Intent to Apply form, by June 2019 to indicate their initial interest in prize participation. Following the preliminary application, participants will be required to submit a Detailed Technical Application by August 2019 including specific details on their technology design and expected performance based on the prize criteria. Sufficient data will have to be provided to assess the performance and manufacturability of the proposed design and submissions are expected to be at a technology readiness level of TRL4, or higher. Applications will be evaluated by the Technical Review Committee using the Supervisory Board-approved evaluation and scoring criteria to select finalists. The decision of the Supervisory Board in selecting the top 10 participants will be final and cannot be challenged. Finalists will be announced at an Interim Award Ceremony in November 2019.

Prototype Development and Testing

Selected finalists will be required to develop two working prototypes between November 2019 and April 2020. Finalists will then send their prototypes in May 2020 to (1) the India Testing Partners for performance evaluation in a lab simulated environment, and (2) a selected lab for

ISEER testing- this second prototype will subsequently be installed in an apartment complex in India for a minimum period of one month to evaluate its performance in real-world conditions.

Participant Training and Market Interactions
Throughout the competition, Rocky Mountain Institute (RMI) will plan several participant-training and industry-mentoring activities and events for participants to learn from experts in the field. These resources aim to enhance both technical and non-technical expertise. The member organizations of the Operating Council, along with the prize partners, will continue to provide resources, webinars, and other tools for engaging and supporting participants. This support will continue in collaboration with the Technical Review Committee and the Investment and Scaling Committee.

Final Presentations, Award Ceremony and Market Scaling
Come October 2020, participants will share their technology, prototype performance, proposed business model, and route to market with the Supervisory Board, Technical Review Committee, Investment and Scaling Committee, Innovation Advisors, and Operating Council in the form of a presentation. The final winner will be announced at a day-long international award ceremony with Mission Innovation, as well as ministerial and funder presence in November 2020. The decision of the Supervisory Board in selecting the winner will be final and cannot be challenged. Following the final prize announcement, the global coalition of partners will continue providing assistance to scale the winning solution in India and across the rest of the developing world.

PRIZE MANAGEMENT STRUCTURE AND SUPPORT
The Global Cooling Prize will be led by the Supervisory Board comprised of RMI, Government of India (represented by DST, BEE and other Government partners), other Mission Innovation member governments and qualifying donors with the administrative and implementation support of the Operating Council, which is a global coalition of leading international research institutes and not-for-profit organizations, namely RMI, Conservation X Labs, Alliance for an Energy Efficient Economy (AEEE), and CEPT University.

Participant Support
A major benefit of participating in the Prize is the commitment from the GCP administrators and partners to support participants through their testing and prototyping phases, as well as helping create market demand for the long-term commercial success of the winning solution. The technology demonstration and support on the business model will provide the confidence to developing countries to move beyond incremental energy improvements in cooling equipment and support the adoption of this climate-friendly cooling solution. The GCP teams plan to work with countries that will see the largest adoption of comfort cooling, such as India, China, Indonesia, and Brazil—among others—to ensure deployment of the winning technology at scale (potentially through advance market commitments, government incentive programs supported by savings in avoided grid infrastructure, and bulk procurement programs).

Market demand coupled with government signals could catalyze the rapid commercialization required to drive down technology costs. The GCP Committees plan to work with other non-governmental organizations and multilateral agencies in order to secure commitments from

other Montreal Protocol Article 5 Parties to scale this superefficient climate-friendly cooling solution. We will also be engaging the real estate development industry, other large buyers, investors, and venture capitalists to spur demand and open access to capital.

WHO SHOULD PARTICIPATE?
Global Cooling Prize invites innovators from across the globe to submit their applications online, at globalcoolingprize.org/apply. We are seeking submissions from everyone and welcome incumbent cooling technology providers, emerging innovators in space cooling and similar technologies, as well as professors, students, and researchers from universities and laboratories around the world to apply. Learn about the application deadlines here.

CONTACT US AND APPLY AT: www.globalcoolingprize.org