MIT Climate Grand Challenges
White Paper Submission Guidelines

Last updated March 29, 2021.

I. Broad Goal of the Climate Grand Challenges Initiative

The goal of *Climate Grand Challenges* is to mobilize the MIT research community around some of the most challenging problems in climate science, climate change mitigation, climate adaptation and resilience, and climate restoration – problems whose solution would have game-changing consequences for the world.

We are seeking transformative projects that are broad in scope and large in ambition and that have the potential to make major advances in solving the big problems that currently stand in the way of an effective global climate response. These new projects will augment the existing research portfolio in MIT units that are pursuing climate science and solutions as an important part of their missions, including the MIT Energy Initiative, the MIT Environmental Solutions Initiative, the Departments of Earth, Atmospheric and Planetary Sciences and Civil and Environmental Engineering, J-PAL, the Sloan School, and the School of Architecture and Planning.

Climate Grand Challenges is a response to the growing recognition that the success of the world's efforts to address the climate emergency will depend in significant part on the development of solutions, strategies, and tools that do not now exist. It is also a response to urgent calls by MIT students and other members of our community for MIT to raise its game on the climate issue. This response has three important features:

- *Climate Grand Challenges* is focusing specifically on those problems where progress depends on **the advancement and application of forefront knowledge** in the physical, life, and social sciences and/or the advancement and application of cutting-edge technologies.

- Many of these problems have to do with how people live and work, and the solutions will require technology adoption or behavioral change on a large scale. Such solutions are possible only if we understand their economic, political, psychological, social, and cultural drivers. Successful solutions must also recognize the unequal burdens of climate change borne by different groups, communities, and societies and should therefore consider whether proposed climate strategies are equitable as well as

effective. For these reasons, *Climate Grand Challenges* is a **whole-of-MIT initiative**, involving a synthesis of scientific, engineering, social scientific, and humanistic knowledge and policy choices, insights, and approaches.

- The urgency of the global climate challenge means that all *Climate Grand Challenge* projects should include explicit consideration of **how to accelerate each stage of the development process**, going beyond the research stage to include implementation, demonstration, and societal uptake at scale. It will therefore be necessary to work with downstream partners including companies, impact investors, and entrepreneurs who seek social or environmental impact in addition to financial return, as well as governments, non-profits, and private individuals.

II. Goals of the white paper phase

In Phase II of Climate Grand Challenges, the authors of 28 letters of interest (LOIs) have been invited to prepare white papers. Each white paper will provide a comprehensive plan for a new MIT research initiative that has the potential to make a major contribution to strengthening the world's climate response.

A white paper may describe a broad research initiative that covers multiple approaches to a global challenge and combines the topics in several LOIs. Alternatively, a white paper may describe a more focused research initiative intended to address a particular climate-related problem of strategic importance. In both cases, we are seeking potentially transformative projects addressing problems worthy of the "grand challenge" designation. The white paper should address the full range of considerations bearing on the successful application of the research outcomes.

We anticipate that many of these project plans will raise questions concerning feasibility, **and we emphasize that current obstacles to feasibility will not be a disqualifier in the evaluation process**. What is important is that the white paper teams demonstrate an awareness of these barriers, how they might affect the likelihood of ultimate success, and – as appropriate – how they might be overcome.

The most promising of these white papers will be selected for further development and fundraising with the expectation that they will become flagship research projects in MIT's overall climate efforts. Review details of the evaluation process and the selection criteria below.

The white papers are due by 11:59 p.m. ET, September 1, 2021.

III. White paper framework

This framework was developed by the Faculty Review Committee during its evaluation of the LOIs in the first phase of Climate Grand Challenges.

White papers should be developed within the following framework, which is intended to:

- Broaden the scope of each white paper's research to encompass the full range of issues that must be addressed in order to make significant climate progress.
- Encourage white paper teams to include all of the knowledge and skills from MIT departments, labs, and centers that are necessary to address these issues.

The framework consists of a 3x3 matrix of broad climate themes (see Figure 1).

The **column** themes are:

1. Human, community, and social impacts of climate change and climate response (including health, environment and natural disasters, and social inequities)
2. Implementation and policy (including legislative, regulatory, and educational activities intended to shape public attitudes and behavior regarding climate risks and responses)
3. Climate science and technology (including technology development, data acquisition and processing, climate system dynamics, climate-related forecasting, and climate risk)

The **row** themes are:

4. Carbon capture, removal, utilization, and sequestration
5. Greenhouse gas emission reductions ("mitigation")
6. Climate change adaptation and resilience.

Figure 1: Framework for determining white paper scope

	(1) Human, community, and social impacts of climate change and climate response, including social inequity	(2) Implementation and policy	(3) Climate science and technology: Development, observation, dynamics, forecasting, and risk
(4) Carbon capture, removal, utilization, and sequestration			
(5) Greenhouse gas emissions reductions			
(6) Climate change adaptation and resilience			

Each white paper team will enter this frame through one of the row themes or column themes (the "portals"). The white paper team should then seriously consider each of the three themes that appear in the orthogonal columns or rows. The white paper will explain how each of those themes is relevant to the proposed project – or, if it is not relevant, why not. Teams entering through the "climate science and technology" portal (column 3) may also need to consider the adjacent column themes.

Applying this framework will help to ensure that the white papers address the full range of issues needed to make progress. The framework will also inform efforts by white paper leaders to strengthen their teams by engaging with MIT researchers working in complementary fields and will also support efforts by MIT researchers currently unaffiliated with any of the teams to reach out to them to explore opportunities for collaboration.

IV. Building the project teams

During this phase, the leaders of the white paper teams should make demonstrable progress towards building the integrated, multidisciplinary teams needed to develop and execute these plans. Evidence that these capabilities have been fully identified will be an important part of the white paper evaluation process.

- There will be important roles here for experts in public policy, in business models suitable for rapid scale-up of new products, services, and systems, in supply chains, and in developing effective means of engagement with stakeholders on the ground.

- White paper teams may decide to join forces with LOI teams that weren't selected for the white paper phase. They may also recruit individual members of those teams, as well as individuals from MIT units that did not participate in the LOI phase.

- We encourage individuals from LOIs that were not selected as well as from MIT units that did not participate in the LOI phase, to explore their participation in a white paper team.

- White paper teams are also free to include researchers from other institutions.

- White paper teams who submitted separate LOIs may decide to join with each other to submit a combined white paper that integrates parallel approaches to a broad global challenge, or submit a 'network' of white papers on closely-related themes.

- **Teams that have been selected for the white paper phase may only submit one white paper.** However, individual researchers may participate in more than one white paper team.

- Many teams will eventually need to include downstream partners and/or individual participants from industry, finance, non-profits, and other sectors needed to develop and implement the solutions rapidly, as well as science communicators able to engage with stakeholders.

White paper team leaders will decide when it makes sense to expand their teams, i.e., before or after the next selection stage. The key evaluation criterion will not be whether the teams have already been augmented, but whether this aspect of implementation has been thought through in the plan.

V. Scope: Broad versus focused white papers

White paper teams may elect to join with each other to submit a combined white paper that incorporates parallel approaches to a broad global challenge. Alternatively, a white paper may describe a more focused research initiative intended to address a particular climate-related problem of strategic importance. In both cases, we are seeking transformative projects addressing problems worthy of the 'grand challenge' designation. Also, whether "broad" or "focused", the white paper should address the full range of considerations required for successful outcomes. For focused white papers, a higher risk of failure need not be a disadvantage if the potential beneficial impact is also large.

White papers will self-identify whether they are positioned as broad or focused proposals. Broad white papers will in general have a higher budget envelope and less stringent page limits.

We expect at least one broad proposal to emerge from this process, and likely multiple focused proposals. The threshold for MIT to support a broad, integrated initiative will be high. This will include demonstrating that there are synergies across the components and that the proposal meets the relevant evaluation criteria in each component area so that MIT can credibly aspire to leadership in this broad challenge.

There will also be opportunities for teams to affiliate with each other or be grouped together for fundraising purposes after the white paper phase.

White papers that are highly ranked but that aren't selected in either of these two categories will benefit from MIT showcasing and increased visibility to a wide range of potential donors.

VI. White paper outline

The following elements should be considered in the white papers. The emphasis will differ for each white paper but the list provides guidance:

Clear statement of objectives

- What is the problem to be solved or the advance to be made?
- What will become possible as a result of this solution or advance that cannot now be achieved?
- Why has this progress not been made until now, what is the current state of relevant knowledge, and what are the principal obstacles that will need to be overcome?
- If the solution or advance that is sought is part of a larger system, why will solving this problem provide a key leverage point in the development of the overall system?
- Are similar large-scale initiatives in this area underway at other universities?

Solution approach

Description of the desired outcomes that will be sought, and a plan for achieving this:

- What is the expected output of the project? (Recommended time horizon: five years or shorter)
- What evidence is already available to validate the proposed solution or otherwise indicate its feasibility?
- How will the problem be attacked? What are the key milestones of progress and the critical activities that will be required to achieve each milestone? What is the anticipated timeline?
- What kinds of data or other evidence will be needed to measure progress towards the intermediate milestones and final goal? What methods will be used to collect these data? Will new methods be needed to measure progress? If so, how will they be developed? If progress is to be measured by the team itself, how will these results be verified?

- What is the role of the MIT researchers in the project, and what are the roles of non-MIT partners (if any)? If the project team involves both MIT and non-MIT participants, indicate why the expected contribution of the MIT participants is critical to the success of the project.
- If alternative approaches to solving this problem are being pursued by others, why is this one preferred?

Project risk assessment

What are the principal risks affecting the outcome of the project, what is the likelihood of success, and how does this compare with competing approaches?

Economic assessment

For solutions where economic performance matters when the results of the research are implemented, teams should develop a rough order of magnitude cost estimate and, if appropriate, a basis for comparing with other options.

Assessment of impact of proposed outcome

- How should the potential impact of the proposed solution be measured? (e.g., for greenhouse gas emission reductions, the total or fractional reduction in global emissions, or the impact on atmospheric concentrations, as a function of time; for carbon removal and sequestration, the rate of removal from the atmosphere as a function of time; for adaptation, populations potentially affected, as measured in terms of human well-being and welfare, including economic impact; for scientific advances, the enhanced ability to determine science-based priorities for climate action at national, regional, urban, and community scales, etc.)? If collateral impacts – e.g., other environmental or sustainability benefits – are important to consider, these should be included.
- What are the expected impacts? What are the key assumptions on which these estimates are based? Over what timeframe will these impacts occur? (Where possible, recognized tools for assessing impact should be used. If new tools will be needed to assess impacts, how will they be developed?)
- Both negative and positive impacts should be considered.
- In assessing the impacts of proposed solutions, it will be important to consider the unequal burdens of climate change borne by different groups, communities, and societies and to consider whether solutions are likely to affect the distribution of these burdens in either a positive or negative direction.

Implementing, introducing, and scaling the proposed solution as fast as possible

- The white papers should also consider the stages beyond the proposed research project needed for further development and/or implementation of the results. How will the solution be operationalized? What is the ultimate outcome that is envisaged?

- If the proposed solution is not a stand-alone result and must be integrated into a system with other components, those components should be described and consideration given to how the integration will be achieved.
- What are the other principal obstacles that must be overcome? (Examples might include regulatory approval, community approval, market design, etc.)
- What management and governance structure will be needed for each stage of the innovation process?
- What are the key barriers to achieving impact at scale?
- If the research is likely to lead to results affecting particular populations, the white paper will consider the implications for environmental equity and how they should be managed. What is the expected timeline? Could the overall schedule be shortened by addressing any aspect of these during the 5-year span of the Climate Grand Challenges project? Do you plan to do so?
- For applied research that is focused on developing particular products, systems, or services, a plausible plan for achieving commercial viability will be an important element of the white paper, with attention to cost-effectiveness relative to alternatives, with consideration of environmental, health, safety and regulatory factors, and with a focus on human behavior and social engagement, with feedback to research and design as appropriate.
- More generally, the white papers should describe strategies for compressing the time needed for field-testing, implementing, and scaling of the resulting solutions, and should consider whether these strategies should influence the plans for the research itself, and if so how.

Details of team and evidence that it includes the relevant capabilities

- The team leaders (3 or less)
- A list of MIT team members, including resumes and explanations of why their roles are critical.
- If the team includes non-MIT partners, please explain the role they will play, why this role is necessary, and why they are best able to play it (e.g., experts with relevant industrial expertise who may be needed to prepare estimates of the cost of future industrial systems embodying the advance, experts on supply chains, experts on business model innovation, etc.)

Project budget (including overhead) and project milestones

In general, budgets and milestones should extend out for up to five years, but there is no expectation that practical impact should follow within a set timeframe. If white paper teams judge that a period of research longer than five years will be required before translational activities could begin, the plan should make clear what will be necessary to get to that point.

VII. Evaluation criteria and process

The white papers will be reviewed in two stages:

1. In the first stage, panels of subject matter experts from MIT and elsewhere will evaluate the white papers against the review criteria described here and in accordance with the above framework.
2. In the second stage, a decision panel appointed by President Reif will consider the rankings of the expert panels and add its own overall assessment of the white papers with respect to the broad goal of Climate Grand Challenges (i.e., to launch novel, potentially game-changing research projects that promise to deliver solutions to some of the biggest problems currently standing in the way of an effective global climate response.)

The criteria in the first stage of the evaluation will include:

- Scientific/technical promise and feasibility
- Economic feasibility
- Novelty
- Estimated impacts, including human, community, and social impacts – both positive and negative
- Pathway to achieving impact: Feasibility of plans for accelerated development and implementation, including plans for addressing regulatory, legal, and policy challenges, if relevant
- Feasibility of plans for stakeholder outreach
- Project risk analysis and management
- Analysis of implementation risks
- Capabilities of team
- Budget justification

For some of these criteria (e.g., impact assessment), evaluation of multiple white papers may be conducted by a single review panel. For others, specialist panels may need to be convened for individual white papers. These panels will be recruited by the Climate Grand Challenges team.

First stage reviewers will include research leaders from inside and outside MIT in the natural, physical, social, and management sciences, the humanities, and engineering, as well as leaders in the public policy domain and practitioners with successful track records in commercializing environmental and energy technologies and/or in mobilizing stakeholder groups around social goods and goals.

VIII. Deliverables

- Written proposal document (white paper)
- Short video presentation to describe the project

- Two-page fact sheet

The white paper teams may also be asked to work with MIT communication and resource development teams to promote their proposals during the white paper phase.

More details on these requirements (e.g., page limits, budget detail, formatting, references, figures and tables, video specs, etc.) will be provided at a later date.

IX. White paper phase funds

- $100k will be transferred to a fund account under the lead PI's supervision or their designee. The costs will incur fund account indirect cost rates.
- The funds are provided to **support the preparation of the white papers only**. These resources should support the work of the entire team, not just the lead PI.
- The funds are for internal MIT use only. The funds can be used to pay the costs of MIT salaries, as well as vendor services, external consultants, travel, etc., but they are not intended to support collaborator/subaward costs.
- Work on the white papers is to be complete by September 1, and accounts will close on October 31, 2021, to allow account supervisors time to do final reviews, adjustments, and process final payments.

X. Timeline (tentative)

- Workshops/roundtables to assist white paper teams in proposal development and in building stronger teams: May-August, 2021
- White papers due: September 1, 2021
- First stage review completed: November 1, 2021
- Response to reviewers completed: November 15, 2021
- Second-stage review completed: January 10, 2021
- Announcement of results of white paper phase: January 15, 2021
- Climate Grand Challenges Conference: January 2022
- Climate Grand Challenges Showcase: Ongoing from January 2022

XI. FAQs

Q: Is it desirable to identify potential or committed funders?
A: The expectation is not that the white paper teams will do all the fundraising. However, if white paper teams are aware of potential sources of support, this will be helpful to note, even though evidence of such support won't drive the decision-making.

Q: Should white papers include letters of support?

A: This will not be a requirement. However, statements of support and commitment from potential downstream partners will be helpful.

Q: What is the desired level of detail for budgets?
A: Guidance will be provided later.

Q: Can white paper funds be used to support students who have been admitted but who aren't registering until F'21?
A: Yes.

Q: Can white paper funds be used to support students in AY21-22?
A: The expectation is that the funds will be used to support the development of the white papers, which are due on September 1, 2021.

Q: Who should questions be directed to?
A: Please contact climategc@mit.edu