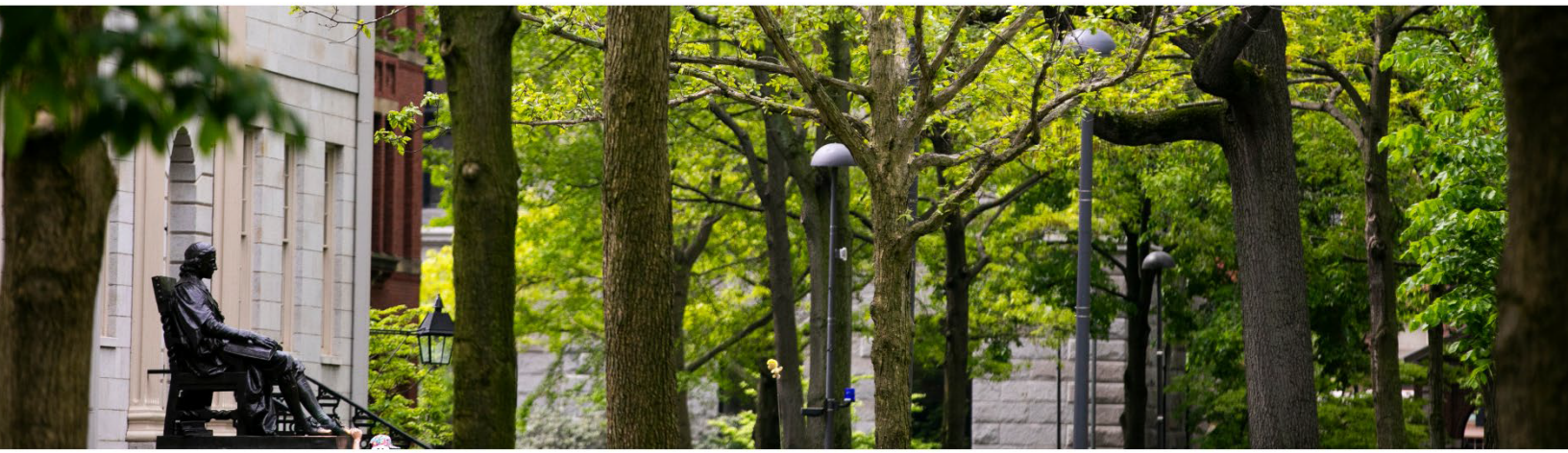
RECOMMENDATIONS FROM THE FOSSIL FUEL-NEUTRAL BY 2026 SUBCOMMITTEE

HARVARD UNIVERSITY | Sustainability

PURPOSE OF THIS REPORT



This report was prepared by the Harvard Office for Sustainability with the Presidential Committee on Sustainability (PCS) *Subcommittee on Fossil Fuel-Neutral by 2026: Renewable Energy and Offsetting Mechanisms*. This PCS Subcommittee was co-chaired by Henry Lee; Jassim M. Jaidah Family Director of the Environment and Natural Resources Program, Faculty Co-Chair of the Sustainability Science Program, and Senior Lecturer in Public Policy at Harvard Kennedy School (HKS); and Mike Toffel, Senator John Heinz Professor of Environmental Management and Faculty Chair of the Business and Environment Initiative at Harvard Business School (HBS) (see Appendix 1 for full membership).

The Subcommittee has been asked to recommend:

1. How Harvard should define "fossil fuel-neutral"
2. How the University should track progress against the fossil fuel-neutral by 2026 goal
3. Criteria the University should use to qualify and prioritize various offsite emissions reduction project options

This Recommendation is one component of the broader climate action strategy toward fossil fuel-free by 2050. Other subcommittees will advise on further emissions reduction opportunities in Harvard's buildings and energy supply, which remains the University's priority to address emissions, and on the University's approach to Scope 3 emissions. A fourth subcommittee is focused on Harvard's second-generation Sustainability Plan, vision, principles, priorities, and overall action plan.

All of this work builds on the attainment of Harvard's first-generation climate goal to reduce absolute greenhouse gas (GHG) emissions by 30% (2006-2016).

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BACKGROUND ON HARVARD'S CLIMATE GOALS

In 2018, Harvard was one of the first organizations to set a clear goal to eliminate the use of fossil fuels to heat, cool, and power buildings and vehicles by 2050 **without** the use of offsetting mechanisms. The University also committed to become "fossil fuel-neutral" by 2026, as a **bridging strategy** to drive down global emissions more quickly and cost-effectively using market mechanisms, while continuing to aggressively reduce and eliminate the use of fossil fuels in campus operations – to zero by 2050.

The 2017 Climate Change Task Force recommended the "fossil fuel" framing, as opposed to a carbon framing, because fossil fuels are the largest source of GHG emissions and because a focus on only carbon (or GHG emissions) **leaves out the additional impacts on public health and ecosystems from other pollutants and wastes** associated with the sourcing, production, and burning of fossil fuels. These public health impacts are in addition to the health damages that we already see as a result of climate change, such as drought, wildfires, sea-level rise, food supply, drinking water supply, and other impacts.

Fossil fuels are also the largest source of air pollution emissions globally.[i] According to the Lancet Commission on Pollution and Health report, air pollution remains a leading cause of death resulting in 6.5 million premature deaths a year, much of which can be attributed to fossil fuel use.[ii] There are also other upstream health and ecosystem impacts of fossil fuel production, which are also not accounted for in a social cost of carbon analysis.

Air pollutant emissions do not impact all locations or all communities equally. Black, Indigenous, People of Color (BIPOC) communities and low-income communities are more vulnerable to damage and disease from these pollutants due to other social determinants of health, as well as historical inequities from siting pollution sources near minority communities. Examples are outlined in the Lancet Commission on Pollution and Health report.[iii] Understanding who fossil fuel pollution is harming is necessary in understanding the full impacts of fossil fuels on public health today.

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A. CONTEXT

Why a fossil fuel-neutral goal?

The goal to become fossil fuel-free by 2050 will require the University to transition to a fossil fuel-free energy system for the campus (i.e., district energy system, transportation system, and electricity supply) by 2050 without the use of offsetting mechanisms, to the extent possible. **This transition will require time, resources, and technological innovations.**

The interim goal to be fossil fuel-neutral by 2026 is in response to the latest scientific findings that the world is not reducing global emissions fast enough to mitigate the worst public health, ecosystem, and economic impacts of climate change. We need **bold, large-scale action now** to rapidly reduce global emissions, in parallel with the work to eliminate fossil fuel use on campus. Harvard and others can play a role in increasing the demand for — and thus the supply of — more fossil fuel-free energy production. By working with our researchers to identify new, cost-effective global solutions that can have the biggest immediate impacts, **we can encourage and accelerate the provision of new technology, helping to transform the whole economy.**

The commonly used options to achieve carbon neutrality goals (Renewable Energy Certificates and carbon offsets) do **not** consider air pollution public health impacts from fossil fuels. Understanding, with data, the full public health impacts of fossil fuels can inform where and how we choose to offset Harvard's emissions, and **more importantly how cities, states, and national governments should prioritize their efforts to eliminate fossil fuels.**

B. RECOMMENDATIONS

The Subcommittee recommends that Harvard pursue the following steps to achieve its goal of becoming fossil fuel-neutral by 2026:

The fossil fuel-neutral by 2026 goal addresses Scope 1 and 2 emissions currently, which is the focus of this report. We encourage the PCS Subcommittee on Scope 3 Emissions to consider whether the strategies outlined in this report might also apply to their work to address Scope 3 emissions.

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Harvard's overall approach should:

- Be based on the latest science and research, and highlight gaps that can become research opportunities
- Promote innovation and experimentation
- Focus on scalable solutions
- Incorporate post-project evaluations to assess the impacts of real-world projects to inform future decisions
- Be transparent

Recommendation 1: Define and measure fossil fuel-neutral

The methodology for tracking and measuring fossil fuel-neutral needs to be rigorous and grounded in research, but also practical and flexible to new technology, innovation opportunities, and policy changes. It should also be an approach that other organizations can follow without significant administrative overhead. The learnings and findings from research and pilot projects should inform the criteria and implementation over time. The following policies ensure that the University balances these objectives:

1.1 Tally GHG and criteria air pollutant emissions data. Harvard should (a) continue tallying GHG emissions resulting from all on-campus activities and purchased electricity (Scope 1 and 2), and (b) begin tallying criteria pollutant emissions[iv] resulting from fossil fuel combustion on campus and the generation of the electricity Harvard purchases.

1.2 Estimate and study the public health impacts of the use and extraction of fossil fuels including air pollutant emissions and the communities impacted. Harvard should work with researchers at the Harvard T.H. Chan School of Public Health and others to use the latest tools and data analysis to estimate these health impacts.

1.3 Use the health impacts analysis (1.2) to inform the selection of offsite projects, and source a portfolio of projects that will mitigate both the future health and societal impacts of GHG emissions and the near-term health impacts of air pollutants (1.1 and 1.2 above), especially on vulnerable populations. Also incorporate the criteria outlined in Recommendation 3. Harvard should source a portfolio of projects that, in total each year, offset (a) the equivalent of Harvard's Scope 1 and 2 GHG emissions (1.1a above) and (b) health damages that are equivalent to those caused by air pollution associated with Harvard's fossil fuels emissions (1.2 above). Therefore, the overall portfolio will offset both the future health and societal impacts associated with climate change and the near-term health impacts associated with air pollution from Harvard's fossil fuel usage.

1.4 Develop a robust evaluation process to compare each project's forecasted costs and benefits to the actual costs and benefits that arise. We acknowledge that there are uncertainties in both the health impacts data (mentioned above), and in the estimates of avoided GHG emissions impact of the projects the University will use to achieve the fossil fuel-neutrality goal. The University should identify the best data available to quantify such uncertainties and develop a robust post-hoc evaluation process to compare the forecasted scenarios to the actual performance of the projects. This analysis will allow the University to iteratively adjust purchases and mitigation strategies to ensure that the goal of fossil fuel-neutrality is met each year.

Recommendation 2: Advance the development of state-of-the-science research that can be applied to better inform actions that might lead to fossil fuel-neutrality.

Applying Harvard's research capacity to address the challenges of eliminating fossil fuels quickly, cost-effectively, and equitably could have a wider beneficial impact to society. Researching and piloting early adoption of innovation opportunities can drive down the costs of and increase the credibility of emissions reduction projects for others beyond Harvard. The University's research can have a wider impact if it influences the behavior of companies and other voluntary purchasers of renewable energy (increasingly universities, nonprofits, and cities) that are driving the development of new renewable electricity generating capacity (see graph in Appendix 3, Exhibit 2), and cities and states that are developing net zero emission policies.[v]

2.1 Harvard should provide new pilot funding for research and teaching in the areas discussed in this report. Apply research findings to real-world projects that will advance Harvard's goals described in this report. The pilot funds should be used to identify and fund innovative research initiatives that have the potential to accelerate the equitable and health-focused transition from a fossil fuel economy. The Presidential Committee on Sustainability (PCS) should convene a standing subcommittee to evaluate and approve priorities for funding on an annual basis. The Subcommittee should ensure the research projects align with this report's recommendations and Harvard's implementation efforts.

Potential areas of focus may include:

- Improving the tools for evaluating the health and climate benefits of fossil fuel reduction strategies and the populations that are benefiting.
- More fully characterizing the health damages caused by the production, use, and disposal of fossil fuels including (a) toxicants released during fossil fuel combustion that are not currently included in valuations of societal impacts (such as mercury, acid gases, and lead) and (b) further studying and understanding the full health damages associated with climate change.
- Studying the offset markets to understand market failures, effectiveness of verification bodies, and other aspects of the markets, both nationally and internationally.
- Studying ideas for optimizing the emission reductions from renewable energy production (such storage, smart grids, real-time emissions data, 24/7 renewable energy portfolios) and developing robust evaluation strategies for comparing modeled projects to actual project performance.
- Analyzing and studying the full social costs and benefits of emerging fossil fuel-free strategies, such as biofuels and renewable natural gas, as well as understanding the full health or environmental impacts of the production use and disposal of materials used in renewable energy production.

Recommendation 3: Construct a portfolio of projects that meet the criteria below.

The following is a preliminary list of criteria that we believe are critical to use when constructing the portfolio of offsite emissions reduction projects in which Harvard should invest. Each individual project might not meet all criteria and the criteria are not yet ranked or prioritized. There are inherent trade-offs to be made when evaluating projects. This is especially true when choosing whether to invest in projects in New England, elsewhere in the United States, or in other countries, and how to make these decisions in a way that is equitable and benefits populations that have been most harmed by fossil fuel pollution.

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The Subcommittee recommends that Harvard develop a portfolio of projects that is local, national, and international and that we include faculty and student involvement in the design and implementation of some projects that relate to areas of research. We also recommend the University continuously evaluate and publicly report the impacts of these projects in order to assure accountability and inform future decisions at Harvard and to enable Harvard to share its experience with other institutions.

Once we agree on the key criteria, we may wish to prioritize individual items and/or set minimum thresholds for the portfolio's incorporation of each of these criteria. The portfolio should be evaluated carefully to ensure that Harvard's participation helps bring about climate and health improvements beyond a baseline (additionality) and that the improvements can be quantified, verified, and attributed to Harvard. See Appendix 3 for background sources.

3.1 Focus on opportunities to experiment, pilot, and study new technologies or strategies. Use the study findings to inform the approach both at Harvard and elsewhere. Harvard can play the unique role of translating the latest research into action by using faculty and student capacities to design and develop innovative projects and inform the global dialogue on how to accelerate a cost-effective transition from a fossil fuel energy system. We should understand that there are possible failure risks associated with innovation and be willing to take these risks to advance promising potential projects. However, if innovation projects fail to deliver anticipated benefits, robust post-hoc evaluation efforts (detailed in 1.4) will allow the University to iteratively adjust purchases and mitigation strategies to ensure that the goal of fossil fuel-neutrality is achieved.

3.2 Include local, national, and global health concerns. We acknowledge the health impacts of Harvard's fossil fuel use on regional/local populations, as well as the global health and societal impacts associated with climate change. We also understand that the New England region has a relatively clean energy system after many years of regional and national air pollution regulation. The overall climate and health benefits from projects could be higher in other communities that are more harmed by fossil fuels today, such as in developing countries where air pollution is a very serious health threat or in communities where coal is a primary fuel source and where there is an outsized health burden on BIPOC communities. For example, recent Harvard research shows that renewable energy projects in some regions of the United States **have health benefits that are estimated to be fourfold** compared to projects in other regions.[vi] The portfolio mix should consider the health and climate benefits per dollar investment made. The implementation committee should also include some local or regional projects in the portfolio to at least partially offset health damages caused by Harvard's fossil fuel in the local community (for example from diesel buses) and from regional electricity production.

3.3 Focus efforts on vulnerable populations who are most harmed by fossil fuel pollution, including addressing environmental injustice. The portfolio should include projects that benefit vulnerable populations in regions where air pollution is a serious public health issue and in communities where there is a known burden of health impact associated with fossil fuel pollution and historical environmental injustice. Environmental injustice is defined in the Lancet Commission on Pollution and Health report as "inequitable exposure of poor, minority, and disenfranchised populations to toxic chemicals, contaminated air and water, unsafe workplaces and other forms of pollution, and the consequent disproportionate burden among these populations of pollution-related disease, often in violation of their human rights".[vii] This outsized health burden due to both the racial and social inequities of historically siting energy facilities near low-income and minority communities and the understanding that

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the impacts of pollution are worse in some communities due to social determinants of health that are unrelated to fossil fuel use.

3.4 Focus on emissions reduction projects that reduce or eliminate the usage of fossil fuel energy sources. This could mean investing in projects that eliminate or reduce fossil fuel generated emissions, such as renewable energy, battery storage, or electric vehicles. The University may also want to proactively test, pilot, and evaluate other innovation opportunities for large-scale GHG reduction projects that don't address fossil fuels, but do align with Harvard's research and teaching mission, and its commitment to make meaningful reductions in addressing climate (e.g., emerging sequestration technologies, agriculture based-emissions). Harvard may decide to pursue innovation opportunities in these areas.

3.5 Ensure that Harvard's participation helps bring about climate and health improvements beyond a baseline (additionality) and that the improvements can be quantified, verified, and attributed to Harvard. The primary means of assuring the validity and credibility of the selected projects will be to play a material role in bringing the projects to fruition. That is, the University will select projects which are not yet on-the-ground and help bring them to life. All projects will use third-party standards and verification methods for both transparency and credibility purposes.

3.6 Evaluate the cost/benefit of all project options, as a primary intent is to accelerate cost-effective, scalable solutions that reduce reliance on fossil fuels. The portfolio must achieve its objectives in a cost-effective manner. While some solutions may be more expensive than others, expensive solutions should be considered when they bring concordant benefits such as research and teaching opportunities or the ability to demonstrate new or innovative approaches whose costs will decrease with such successful demonstrations, particularly compelling health benefits, etc. Health and climate benefits per dollar investment should be considered by the implementation committee when evaluating options.

Recommendation 4: Share knowledge to increase the impact of Harvard's efforts.

4.1 Document and transparently share the University's strategy, progress, and evaluations with others. Use the University's convening power to engage with leading organizations to advance innovation ideas. Harvard should actively work with leading corporate and University partners to improve and evaluate emissions mitigations options, as well as collaborate on innovative ideas. Harvard should disseminate the findings beyond this group, e.g., through publishing Harvard's annual inventory and mitigation efforts and disseminating this information globally, as well as through new academic research publications.

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C. ANALYSIS SUPPORTING THE RECOMMENDATIONS

Pollution from fossil fuel combustion emissions is a leading cause of global premature death.

The Lancet study on pollution and health found that 6.5 million premature deaths are attributed to air pollution each year, much of which can be attributed to fossil fuel combustion.[viii]

In a 2019 study from Harvard T.H. Chan School of Public Health, researchers indicate that climate and health benefits of new renewable energy development are significantly greater in areas of the world where coal is a primary source of electricity. For example, the report found that a wind turbine or solar panel can save 30 times more lives if it is placed in a country where air pollution is a major public health issue than if that same turbine or panel is placed in the U.S., and climate benefits will be about twice as high.[ix]

While the New England region is one of the cleaner electricity grids in the United States, and the United States has some of the strongest air pollution standards in the world, the health impacts of air pollution are still significant. Harvard T.H. Chan School of Public Health research published in 2018 estimated the annual discounted damage of $88/metric ton of carbon dioxide equivalent (MTCDE) for the period 2017-2040 in Massachusetts, with damages about equally split between those mediated by GHGs and those that are the direct impacts of other fossil fuel pollutants (such as SO_x, NO_x and particulates).[x] The preliminary data from this research informed Harvard's 2017 Climate Change Task Force deliberations.

It is also well understood that air pollution does not impact all communities equally. BIPOC communities and lower income communities bear higher health damages even in the same region.[xi]

The negative health impacts of air pollution, extreme weather events, high-heat days, drought, food scarcity issues, increased intensity of diseases, and forced migration mean that climate change – primarily driven by fossil fuel use– is already a leading cause of public health damages, and this will only increase in the future.

Health impacts of fossil fuels can be modeled with sufficient confidence to inform project selection.

While the impacts of GHG emissions are global, the impacts of air pollution are local and are dependent on local conditions, such as population density, weather patterns, population health, and other considerations. For this reason, tracking and neutralizing the air pollutant metrics, the same way the University tracks GHG emissions metrics, will not be an effective strategy for maximizing health benefits.

Harvard T.H. Chan School of Public Health and Harvard John A. Paulson School of Engineering and Applied Sciences researchers, and many other leading researchers, have been developing and

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studying methods for assessing health damages associated with particulate matter and ozone. These methods are widely applied by researchers around the world and used by regulatory agencies such as the U.S. Environmental Protection Agency (EPA). The methods are routine, and a suite of models are available for such purposes.[xii]

The commonly used options to achieve carbon neutrality goals do <u>not</u> consider air pollution health impacts from fossil fuels. Therefore, Harvard will need a different approach to address both climate and health benefits.

The two most commonly used products for achieving carbon neutrality goals are Renewable Energy Certificates (RECs) and carbon offsets, which are two separate markets. A REC represents the verification of 1 MWh of electricity generated from a renewable energy source. A carbon offset represents the verification of 1 metric ton of carbon dioxide (MTCDE) that has been avoided or sequestered as a result of the buyer's intervention.[xiii] Both mechanisms are third-party verified, but with different requirements and different purposes.

Harvard's approach to RECs and fossil fuel-neutrality:

- RECs are measured in MWh, not in GHG emissions. In contrast, Harvard's goal requires the University to offset both GHG emission and health impacts from air pollution (PM2.5, SOx, NOx), so these metrics will need to be calculated and tracked when the University evaluates renewable energy projects. This means Harvard will not follow the more common practice of measuring neutrality for electricity emissions via MWh of renewable electricity.
- Third-party verification of a REC does not include any evaluation of additionality (evidence the project is having an impact beyond a business-as-usual baseline). Therefore, Harvard's goals will require the University to purchase RECs from <u>new projects</u> that are not yet operational in order to have impact beyond business as usual.

Harvard's approach to carbon offsetting projects and fossil fuel-neutrality:

- Carbon offset projects do require additionality tests in order to be verified by a third-party, so it is less critical that offset purchases be from new projects, but the University will need to carefully consider projects to ensure that the projects have an impact beyond baseline and that the projects can be quantified, verified, and attributed to Harvard.
- When evaluating carbon offsets projects, Harvard's strategy to be fossil fuel-neutral means the portfolio of projects will include projects that eliminate the harm from fossil fuels when offsetting the fossil fuel energy sources used to run our campus (from heating, cooling, electricity, and transportation sources).
- This is not always common practice, as about half of the voluntary carbon offsets (those not for regulatory requirements) issued from 2005-2017 were not related to fossil fuels (see Appendix 3, Exhibit 3 for a list of voluntary offset project types).[xiv] An entity could achieve a carbon-neutral goal by investing in enough forestry offsets or industrial gas offsets to avoid or sequester the amount of GHG emissions that result from their electricity or energy use each year. However, if this electricity/energy is produced by fossil fuels – especially coal or oil – then the health damages from air pollutants will continue to result in premature death and social damages, even as the organization (or city, or company) achieves carbon neutrality.

The markets for voluntary procurement of renewable energy and carbon offsets are large and growing, and there is a need for evidence-based research to better inform the policies and protocols that drive and measure voluntary purchases. Again, this is how Harvard can distinguish itself from other climate actors. It is how we can contribute to both our mission as a higher education institution and to the deployment of meaningful solutions to climate change.

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FURTHER BACKGROUND READING

2016-2017 Harvard Climate Change Task Force Report

https://green.harvard.edu/sites/green.harvard.edu/files/2016-2017HarvardClimateChangeTaskForceReport.pdf

Harvard's first-generation climate goal of a 30% absolute reduction in GHG emissions (2006-2016) was largely achieved through on-campus energy supply changes and energy reduction in Harvard's built environment.

Harvard Sustainability Plan and **Harvard Sustainability Website**

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APPENDIX 1

Subcommittee on Fossil Fuel-Neutral by 2026: Renewable Energy and Offsetting Mechanisms (formerly PCS 2026 Subcommittee).

Membership

- Henry Lee (**co-chair**), Jassim M. Jaidah Family Director of the Environment and Natural Resources Program (HKS); Faculty Co-Chair of the Sustainability Science Program (HKS); Senior Lecturer in Public Policy (HKS)
- Mike Toffel (**co-chair**), Senator John Heinz Professor of Environmental Management (HBS); Faculty Chair of the HBS Business and Environment Initiative (HBS)
- Zak Gingo, Associate Dean for Physical Resources and Planning (FAS)
- Heather Henriksen, Managing Director and chief sustainability officer (OFS)
- Abby Mayer, MPP/MBA candidate (HKS/HBS)
- Jaclyn Olsen (OFS Subcommittee lead), Associate Director (OFS)
- Forest Reinhardt, John D. Black Professor of Business Administration (HBS); Head of the Business, Government, and the International Economy unit (HBS); Faculty Chair of the Asia-Pacific Research Center (HBS); Chair of the Executive Education in the Asia-Pacific Region (HBS)
- Lauren Bloomberg (OFS staff support), Sustainability Manager (OFS)

Advisors:

- Jonathan Buonocore, Research Scientist (Harvard T.H. Chan School of Public Health)
- Elsie Sunderland, Gordon McKay Professor of Environmental Chemistry (SEAS); Faculty Associate in the Harvard University Center for the Environment, Harvard Center for Risk Analysis (Harvard T.H. Chan School of Public Health), and the Department of Earth and Planetary Sciences (FAS)
- Ari Bernstein, Interim Director of The Center for Climate, Health, and the Global Environment (C-CHANGE) at Harvard T.H. Chan School of Public Health, Boston Children's Hospital pediatrician, and an Assistant Professor of Pediatrics at Harvard Medical School.

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APPENDIX 2

Updates related to climate science after Harvard's fossil fuel-free and fossil fuel-neutral goals were announced in February 2018.

Climate Change, driven primarily by fossil fuels, is a public health imperative and the urgency to act has increased. Since February 2018, when Harvard announced its second-generation goals, the urgency to act quickly to reduce global GHG emissions has only increased.

On August 9, 2021 the Intergovernmental Panel on Climate Change (IPCC) released the first report from the Sixth Assessment that is currently underway. The report is from Working Group 1 and is called "Climate Change 2021: The Physical Science Basis." The report "addresses the most up-to-date physical understanding of the climate system and climate change, bringing together the latest advances in climate science, and combining multiple lines of evidence from paleoclimate, observations, process understanding, and global and regional climate simulations."

A November 2019 report of the "Lancet Countdown on health and climate change" states that "a business-as-usual trajectory will result in a fundamentally altered world, with the indicators described providing a glimpse of the implications of this pathway. **The life of every child born today will be profoundly affected by climate change. Without accelerated intervention, this new era will come to define the health of people at every stage of their lives."**[xv]

In October 2018, the IPCC released a special report on the implications of 1.5 degrees C of warming. Professor John Holdren, Teresa and John Heinz Professor of Environmental Policy at HKS, wrote the following summary of the key findings in this report.

"An October 2018 report issued by the IPCC—the first to take a serious look at the implications and feasibility of limiting warming to 1.5 degrees C, was commissioned by the parties to the United Nations Framework Convention on Climate Change at their 2015 meeting in Paris at the urging of low-lying island states and other countries already being seriously impacted by climate change at the then-current level of about 1.0 degrees C. While the IPCC is prohibited by its charter from offering policy recommendations, the new report makes clear that the climate-related impacts to be expected at a level of 1.5 degrees C, while much larger than current impacts, are dramatically smaller than those expected at 2.0 degrees C. The new report predicts that, absent far more aggressive, global, emission-reduction efforts than any underway to date, the earth will soar through the 1.5 degree C mark as early as 2030, accompanied by significant increases in all the classes of impacts already being felt today, and will be heading for 2.0 degrees C and more. It makes clear that the challenges for adaptation grow rapidly with rising temperature and that irreversible and unmanageable impacts are already likely at 1.5 degrees C and practically a certainty at 2.0 degrees. The even worse news, stressed in earlier IPCC reports although not in this one, is that the world is actually heading for 3-4 degrees C unless global emissions-reduction ambitions (and success) are ramped up well beyond what was agreed in Paris in 2015. **The bottom line of the report is that the damages of business-as-usual emissions are even worse that we thought, and that efforts to radically and quickly reduce emissions are even more valuable than we thought."**

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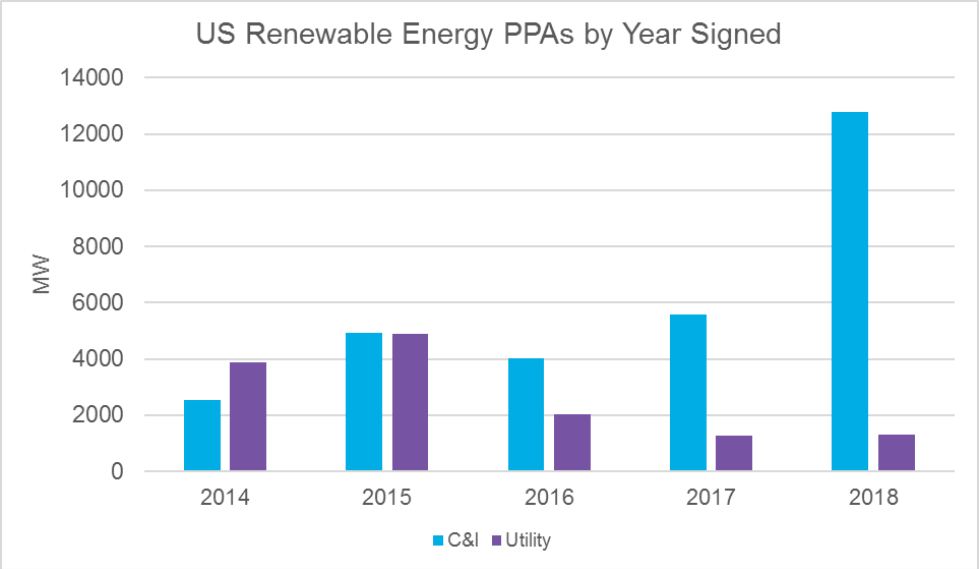
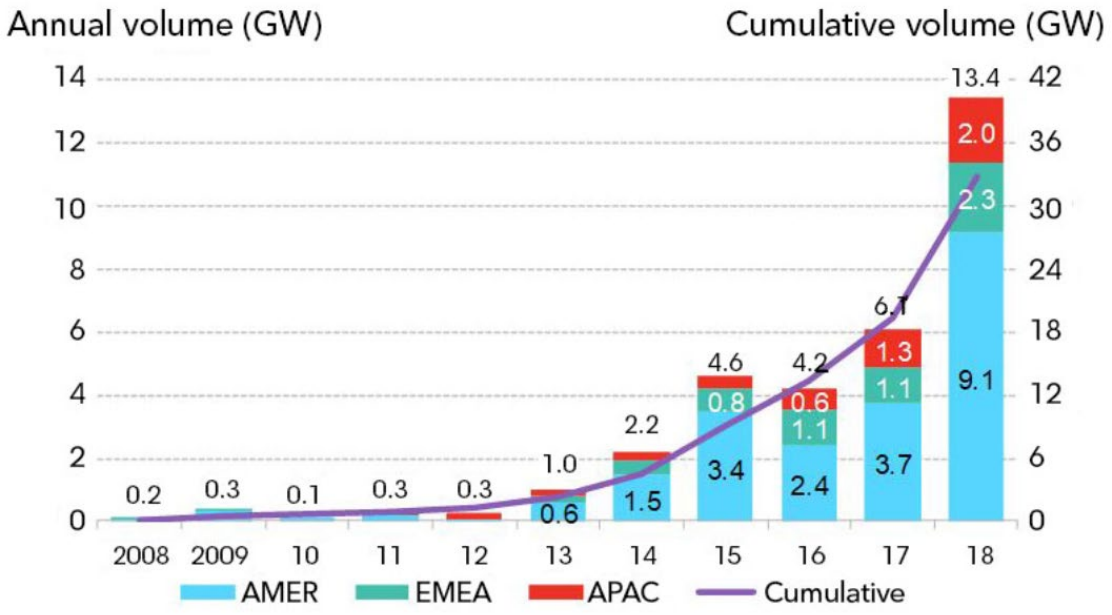
APPENDIX 3

Exhibit 1: US Renewable Energy PPAs by Year Signed



Source: Bloomberg New Energy Finance Data Hub, https://www.bnef.com/core/data-hubs/29/85?tab=U.S.%20Utility%20PPA

Exhibit 2: Global Corporate PPAs for renewable energy volumes from 2008-2018.



Source: BloombergNEF. Note: Data in this report is through 2018. Onsite PPAs not included.

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Exhibit 3: Forest Trends Report Categories of Voluntary Carbon Offset Projects.

Table 1. Categories of Voluntary Carbon Projects, 2008-2018[3]

Project Categories	Projects with Issued Offsets	Volume of Offsets Issued in $MtCO_2e$ (2005 - Present)[4]	New Projects[5]
Agriculture – modifying agricultural practices to reduce emissions by switching to no-till farming, reducing chemical fertilizer use, etc.	87	6.7	1
Chemical Processes and Industrial Manufacturing – modifying industrial processes to emit fewer greenhouse gases.	72	63.5	0
Energy Efficiency and Fuel Switching – improving energy efficiency or switching to cleaner fuel sources.	633	127.9	8
Forestry and Land Use – managing forests, soil, grasslands, and other land types to avoid releasing carbon and/or increasing the amount of carbon the land absorbs.	170	95.3	3
Household Devices – distributing cleaner-burning stoves or water purification devices to reduce or eliminate the need to burn wood (or other inefficient types of energy).	161	23.4	0
Renewable Energy – installing solar, wind, and other forms of renewable energy production.	611	61.9	2
Transportation – increasing access to public and/or alternative transportation (like bicycling) and reducing emissions from private transportation like cars and trucks.	43	1.1	0
Waste Disposal – reducing methane emissions from landfills or wastewater, often by collecting converting it to usable fuel.	238	57.5	0

Source: Kelley Hamrick, et al., "State of the Voluntary Carbon Markets 2017," (Washington, DC: Forest Trends Association, 2017), 4, https://www.forest-trends.org/wp-content/uploads/2017/07/doc_5591.pdf

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[ii] [ii] Landrigan, Philip J, "The Lancet Commission on pollution and health." The Lancet. 2017 October. 1-41. https://www.thelancet.com/commissions/pollution-and-health

[iii] Landrigan, Philip J, "The Lancet Commission on pollution and health." The Lancet. 2017 October. 1-41. https://www.thelancet.com/commissions/pollution-and-health

[iv] The Clean Air Act requires EPA to set National Ambient Air Quality Standards (NAAQS) for six common air pollutants: particulate matter, photochemical oxidants (including ozone), carbon monoxide, sulfur oxides, nitrogen oxides, and lead. These pollutants are found all over the U.S. They can harm your health and the environment, and cause property damage. https://www.epa.gov/criteria-air-pollutants

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