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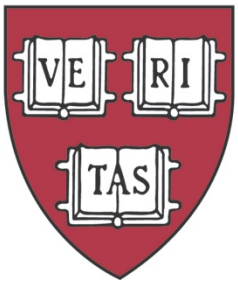

2016-2017 CLIMATE CHANGE TASK FORCE REPORT

CONTENTS

Summary Findings and Recommendations

This document is the Consensus Report of Harvard's Second Climate Change Task Force. The Task Force was convened by President Faust in the fall of 2016 to consider how the University can best contribute to national and international action on climate change by reducing the emissions related to its operations. The Task Force strongly recommends that the University invest in climate change and related research and teaching to the maximum possible extent, but had no mandate to consider how this might best be accomplished. A companion report from the Provost's office reviews challenges and opportunities in the realms of research and teaching.

Since Harvard's First Climate Change Task Force Report was released in 2008, a growing body of scientific evidence has concluded with increasing confidence that human-induced climate change poses a significant and rapidly accelerating risk for society. The principal contributions of Harvard and comparable organizations to that risk is through the greenhouse gas emissions (GHG emissions) from the fossil fuels used to meet our needs for energy services. The climate-related damages associated with these emissions are, however, increasingly understood to be compounded by the damages associated with the other pollutants that are released when fossil fuels are mined and burned. These damages—principally to human and ecological health—are now estimated to be of a magnitude comparable to those currently resulting from climate change at the global scale, though their full extent has not yet been quantified. In the long run, the potentially transformative impact of global climate change will likely swamp all of the other damages associated with energy use. Over the next several decades, however, responsible strategies for managing Harvard's energy use through reductions in our reliance on fossil fuels are likely to contribute not only to reducing the risks of climate change, but also to providing significant additional benefits for human and ecosystem health.

Significant progress has been made over the last ten years in reducing the damaging emissions resulting from efforts to meet Harvard's needs for electricity, heating, and cooling. But Harvard, like most other organizations, has only begun to address so-called "indirect" emissions resulting from its purchase of other goods and services including investment vehicles, food, equipment, and transportation. Preliminary data assembled for the Task Force suggests that these indirect emissions are substantial. Harvard therefore produces more greenhouse gases and other damaging emissions related to energy use than were taken into account by the University when it set its initial 2008 emissions reduction goals.

Several positive developments have also occurred since the 2008 Task Force Report. Harvard has built up an internal organizational capacity to translate University-wide sustainability goals into specific targets, to implement appropriate actions, and to monitor and report performance. The cost of energy produced from low- and zero-emission sources has plummeted. Progress in green building technology and operating practices continues to enable reductions in energy demand associated with Harvard's physical plant. There has emerged an increasingly solid body of theory and evidence on what kinds of off-site investments can lower overall damaging emissions and drive innovation. And though Harvard has over the last ten years harvested much of the "low hanging fruit" for emissions reductions in its physical plant, the "indirect" emissions noted above offer ample and essentially untapped opportunities for reductions driven by our choices regarding travel, food consumption, procurement, and investment. Taking into account the developments summarized above, the Task Force recommends that:

- Harvard's next short-term goal should be to become fossil fuel *neutral* by 2026;
- Harvard's next long-term goal should be to become fossil fuel *free* by 2050.

The remainder of this Report outlines the thinking behind our recommendations and the means by which we believe they can be implemented. Detailed arguments are provided in the Appendices.

1 Background

This Task Force was charged by President Faust in September of 2016 with providing recommendations on the next stage of the University's climate commitment...[including] how the University can best contribute to national and international action on climate change by modeling an institutional pathway in the following five areas:[1]

1. Setting a post-2016 aggressive short-term, science-based GHG emissions reduction goal, consistent with the long-term goal announced in 2008; targeting improvements to district energy supply and building energy demand reduction; defining the best pathway for supporting the development of low-carbon transportation options on our campus and in our region; and integrating planning for climate resiliency with energy and campus planning.
2. Developing a framework that defines the best pathway for supporting the development of on-site renewable energy installations and the purchase of energy from off-campus, large-scale renewable energy projects.
3. Investigating potential approaches to internal energy pricing for Harvard that will more fully account for the social cost of our energy choices including, but extending beyond GHG emissions.
4. Assessing the role of Scope 3 emissions in the University's commitment, with a focus on tracking and reporting emissions associated with food and travel to better educate our community about the impact of these activities and how to address them.
5. Expanding and strengthening living laboratory connections that integrate real-world climate challenges into the classroom learning experience, and that use the campus and the local community to help pilot innovative research and experimentation.

The 2016 Task Force membership consisted of faculty, students, and administrators from across the University.[2] The committee met throughout the fall, winter, and spring of 2016–2017, supported by the Office for Sustainability and numerous other experts within and beyond the Harvard community. This document constitutes its consensus findings and recommendations.

1.1 Harvard's Climate Commitments of 2008

In 2008, Harvard University President Drew Faust announced an ambitious program for addressing the challenges of climate change as part of a "broad University commitment to sustainability." The program was anchored in the belief that "energy and environment must be priorities for intellectual inquiry as well as for institutional action." In support of the "intellectual inquiry" component of the program, Harvard pledged to "encourage and support faculty and Schools across the University as they address issues of sustainability in research and teaching." In response to the need for "institutional action" the University committed to "a comprehensive program to reduce Harvard's GHG emissions" on all its properties. That program entailed a "long-term strategy intended to achieve continuous improvement in reducing Harvard's GHG emissions at the maximum practicable rate," with specific goals set on a rolling basis to enable adaptation to new developments. As an initial short-term goal, the University determined "to reduce GHG emissions, including those associated with prospective growth, by 30% below our 2006 baseline, by 2016." In keeping with prevailing best practice, this short-term goal applied to emissions from sources owned and directly emitted by Harvard (Scope 1) and the indirect emissions from energy purchased by Harvard (Scope 2), but—due to lack of reliable data—not to other purchased goods and services such as travel and food (Scope 3). As the means for achieving its goal, the University committed to "a primary emphasis on improvements in our own operations," but acknowledged that some use of quality carbon offsets would be necessary.[3]

1.2 Harvard's Actions in Pursuit of its Climate Commitments, 2008-2017

Harvard has taken a number of actions in pursuit of its 2008 climate commitments. On the research front, the continuing efforts of individual scholars and Harvard's University Center for the Environment were supplemented with support from a new $20 million *Climate Change Solutions Fund* and the *Harvard Global Institute*. Teaching in the area of climate change and sustainability more broadly also expanded, including new courses jointly taught by faculty from across the University. A University-wide Sustainability Plan, adopted in 2014, positioned actions on climate within a broader vision of transforming the campus into a community that enhances the well-being of people and the planet, within and across generations. A campus-wide climate action plan aligned the organization around the common challenge of meeting the aggressive short-term goal.[4]

In 2016, President Faust announced that Harvard had met its 2006–2016 goal of a 30% reduction in Scope 1 and 2 emissions, and had done so despite a 12% growth in the size of its campus.[5] Energy conservation was responsible for a quarter of these reductions. The decarbonization of Harvard's energy supply, both on-site and through the regional grid, was responsible for half of the reductions. Purchased electricity from local renewable energy sources accounted for a fifth.[6]

1.3 The Present Task Force and its Predecessors

The climate commitments Harvard announced in 2008 were based on the work of a University-wide Task Force, charged by President Faust to recommend "an appropriate University-wide GHG emissions reduction goal and a strategy and timeline to achieve that goal." The goals and targets recommended by that Task Force were those ultimately adopted by the University, as noted above. The strategy emphasized the need for an adaptive approach, recommending quadrennial reviews of Harvard's progress in light of continuing advances in research and practice. To this end, an Interim Review was established in 2012 that assessed the University's efforts. This Review affirmed the University should maintain its short-term emissions reduction goal. In light of the Task Force's recognition that off-campus emissions mitigation options would be needed to meet this goal, a faculty-led advisory group was convened in 2015 to evaluate the pros and cons of using complementary mechanisms such as carbon offsets and off-site renewable energy purchases, and to make recommendations on how best to use these as a short-term strategy for meeting the 2006–2016 goal.[7] The present Task Force builds on the work of both of these efforts.

2 Findings: What's Changed Since 2008?

This Task Force began its work by asking what changes have occurred in the world since the 2008 Task Force Report, that might lead us to alter its conclusions and recommendations. Our findings are summarized here, and developed at greater length and with supporting citations in the Appendices to this Report. Broadly, the Task Force found that we now know more about both the problems caused by the burning of fossil fuels and about potential solutions to those problems.

2.1 The Problem

Climate change: *Scientists have become even more confident that human-induced climate change poses a significant and growing risk for society* since Harvard's First Climate Change Task Force Report was released in 2008. Annual emissions of greenhouse gases have continued to rise, as have their concentrations in the atmosphere. Through the greenhouse effect, this has resulted in a significant accrual of heat in the earth system, i.e. in global warming. Each of the last three years has

been Earth's hottest year since global instrumental records became available in the late 19th century, and the last decade contains nine of the hottest ten years on record. As a result, sea ice cover reached historic lows in 2016, and the melting of both the Greenland and Antarctic ice sheets continues to accelerate. Sea level rise has brought increased coastal flooding. Current greenhouse gas concentrations already build-in further warming, loss of ice, and sea level rise, and continued emissions will exacerbate the magnitude of these changes. The potential for crossing "tipping points" in the global climate system raises the specter of even more rapid and essentially irreversible changes.[8]

Social damages: *The devastating climate-related damages that are likely to be associated with GHG emissions are increasingly understood to be compounded by the damages associated with the other pollutants and waste products that are also released when fossil fuels are mined and burned*. Climate change will impose increasingly serious damages almost everywhere. But it will be the most difficult to cope with in regions that are already the hottest and/or that have limited resources for adaptation. Moreover, it constitutes an existential threat to low-lying regions, ecosystems, and ways of life. Closer to home, Boston has been identified as one of cities in the United States, and indeed in the world, most vulnerable to flooding associated with climate change.[9] The regional impacts of climate change on our transportation systems, utility systems, and access to hospitals and critical care facilities are likely to be substantial and systemic.

The use of carbon-based fuels to meet our energy needs results in the release of not only greenhouse gases, but also other damaging pollutants and wastes. In 2012, for example, energy-related air pollution was associated with seven million deaths worldwide, about half from ambient pollution due to fossil fuel use, and about half from household pollution due to inefficient combustion of various carbon-based fuels. These damage pathways interact: climate change can exacerbate the human and ecological health risks associated with pollutants by changing where and when they are distributed and their exposure pathways. Global estimates for the current monetized damages resulting from fossil fuel use suggest that the impacts of greenhouse gases and of other pollutants are roughly comparable in size, though it is widely acknowledged that there are many additional costs that remain unquantified but are likely substantial. In the longer run, climate change impacts are likely to grow and dominate all other impacts. But, over the next several decades, the impacts on health are such that appropriately designed reductions in fossil fuel use can possibly double the reductions in social damages that are counted when considering climate change alone. Moreover, those benefits would be more or less evenly distributed between the global effects associated with climate change mitigation and the local reduction of damages that result from lesser exposure to other fossil fuel pollutants. For Harvard, the combined damages due to emissions resulting from its current use of fossil fuels are *at least* $25 million per year, of which perhaps three quarters is due to climate change and the rest to health effects of other pollutants. These combined damages are equal to approximately a quarter of the University's annual energy budget. We emphasize that this numerical estimate reflects only the damages that are currently well understood and monetizable. Total damages are surely much higher.[10]

Emissions: *Harvard and similar "service" organizations are now known to emit significantly more greenhouse gas and other fossil fuel emissions than were attributed to them at the time of the 2008 Task Force Report.* This is because reliable estimates were not available a decade ago for Scope 3 emissions: those released by others in providing goods and services purchased by the organization (other than purchased energy, which is captured as Scope 2 emissions). Such emissions were therefore not generally included in organizations' emission budgets or in their commitments for emissions reductions. Recently, however, progress in the development of accounting methods and data collection has begun to illuminate the magnitude of Scope 3 emissions. For Harvard, significant contributors to Scope 3 emissions, for which reasonably reliable data are available, include food, commuting, and air travel (by far the largest). Other contributors that are likely to be significant, but for which reliable data

is not yet available, include investments, "upstream" energy emissions (i.e. leaked methane, mining damage), and non-food procurement.

There is as yet no widely accepted methodology for measuring either the carbon footprint or the climate-related risks inherent in an investment portfolio. Currently, Harvard Management Company (HMC), the entity responsible for managing Harvard's investments, does not attempt to estimate either. However, HMC routinely engages with select portfolio companies on environmental, sustainability, and governance (ESG) risks, encouraging them to take action and to make disclosures on climate change. Harvard University was the first university endowment in the U.S. to become a signatory to the United Nations Principles for Responsible Investment (PRI). As a signatory, HMC is committed to implementing the PRI's Six Principles in their management of the University's endowment and related financial assets. HMC reports to the PRI on an annual basis regarding its implementation of the Six Principles across asset classes. The resulting transparency report is published by the PRI. Harvard is also a signatory to the CDP's climate change program. The CDP, formerly known as the Carbon Disclosure Project, is an international non-profit organization that works with governments, public companies, and institutional investors to drive environmental disclosure and performance of publicly listed companies.

Including estimates of Scope 3 activities in Harvard's accounts leads us to conclude that the emissions resulting from the full scope of Harvard's operational practices are at least 50% higher than those addressed in Harvard's 2008 Task Force Report and climate commitment. Combining this new estimate of emissions with our new understanding of the health costs of fossil fuel emissions suggests that the damages due to all (i.e. Scope 1, 2, and 3) emissions resulting from Harvard's current use of fossil fuels are plausibly as much as $30-40 million per year, or up to 40% of the University's annual energy budget. Again, this numerical estimate reflects only the damages that are currently well known and that can be monetized. Total damages are surely higher.[11]

2.2 Possible Solutions

Demand: *Harvard's demand for energy used in its buildings has been significantly reduced through improvements in technical and operational efficiency. But, reducing Scope 3 emissions and planned growth in the physical footprint of the campus remain as major challenges.* Harvard has implemented more than 1,600 energy conservation projects over the last decade, resulting in a 7% reduction in net building energy use (20% excluding the impact of growth). But these projects, by and large, have addressed the "low hanging fruit." Further reductions, while still cost-effective over time, may require significantly higher capital costs or different financing and planning structures. Current estimates suggest that implementing building efficiency improvements (retro-commissioning, ventilation upgrades, and some envelope upgrades) will deliver roughly 10% additional reduction in emissions relative to the 2006 baseline in the next ten years, *exclusive of campus growth*. But the campus is expected to grow between 5% and 10% over the next decade. Aside from Harvard's *Green Building Standards*, mechanisms are not currently in place to assure that the University's overall goals for reductions in damaging emissions are taken into account when expansions of the campus are considered. Moreover, while there are certainly "low hanging fruit" for reducing Scope 3 emissions, inventories continue to be incomplete and the specific actions that might be most effective at reducing these emissions remain to be identified.[12]

Supply: *The costs of renewable energy continue to fall. At the same time, Harvard's ability to take advantage of regional nuclear power sources will almost certainly diminish.* From 2008 to 2016 the New England region benefitted from a switch from fuel oil to natural gas. Nationally, the cost of wind fell approximately 50%, while over the same period the cost of solar has dropped by more than 80%. Several experts believe that these rates of progress imply that it is entirely possible that the U.S.

electricity grid will be at least 80% fossil fuel free by 2050, and possibly even cleaner. Harvard has taken advantage of these trends, with the last ten years seeing 18 solar projects, plus solar thermal and geothermal installations, installed on campus. The University has also achieved substantial emissions reductions through changes in its district energy system, including fuel-switching from fuel oil to natural gas, the installation of combined heat and power systems, and other utility efficiency upgrades. Together, these changes were responsible for half of the University's reductions in GHG emissions relative to the 2006 baseline. That said, it will be challenging to achieve further reductions in the short term, considering that the physical plant does not need major capital improvements over the next decade. The Pilgrim Nuclear Power Plant—from which the regional electric grid that Harvard uses receives a significant amount of its "clean" power supply—is due to go off line in 2019. Harvard is an urban campus without expansive roof space or land for larger on-site solar installations: additional on-site solar with current technology could only deliver an additional 1% reduction in total emissions. We expect that the regional electric grid will continue to decarbonize, but that the rate at which it does so will depend on the rate of reduction in the cost of renewable energy in New England, on advances in biofuels and in the storage and distribution of electricity, and on regulatory reforms over which Harvard has only limited influence.[13]

Complementary mechanisms and off-site emissions reductions: *A variety of mechanisms are available through which organizations can complement their on-site emissions reductions with off-site purchases that either help other organizations to reduce their emissions or that stimulate the development and deployment of low-emission energy systems.* As reviewed by Harvard's Complementary Mechanisms Advisory Group, these options include carbon offsets, renewable energy procurement, and carbon allowances.[14] The general understanding of the potential and pitfalls of these options has matured significantly in recent years, although these markets are continuing to evolve and there are still risks and concerns with some of these options and the claims that organizations make when using them. An extensive body of research in economics suggests that as these markets mature they are likely to be a critically important driver of technological change. Historical analysis suggests that major technological shifts such as the transition to a fossil fuel-based energy system are driven both by advances in "supply"—that is, in the underlying science and/or technology—and by significant expansions in demand. Strong demand signals help to shape advances in supply not only by highlighting the kinds of problems that need to be solved, but also by stimulating the flow of investment into the field. Current information suggests that the University could purchase high-quality complementary mechanisms sufficient to offset all of its current Scope 1 and 2 emissions at a cost of approximately 2-5% of its total annual energy spending, i.e. $2-5 million per year on top of Harvard's current $100 million annual energy budget. In spring 2017, the University launched a new cross-disciplinary, graduate-level Climate Solutions Living Lab Course to evaluate potential criteria and new models for off-campus reduction mechanisms in support of fossil fuel neutrality goals.[15]

Institutions: *The institutional context within which solutions for climate and related energy problems will be sought has entered a period of extreme flux.* While the global Paris Agreement on climate change went into effect on November 4, 2016, just days later, national elections in the U.S. produced a new administration that called into question continued U.S. support for the Agreement. That said, many nations, states, cities, firms, and universities are moving ahead with aggressive emissions reduction plans. For example, Norway has declared a carbon neutral goal by 2030, and California and Massachusetts have set emissions reduction goals of 80% below 1990 levels by 2050. Locally, both Cambridge and Boston signed the Metro Mayors Climate Mitigation Commitment that "by 2050, we commit that the region will achieve Net Zero/Carbon-Free status." Cambridge has also adopted a goal of 100% "clean and renewable energy" citywide by 2035. Cambridge and Boston have both initiated climate resiliency planning, including vulnerability studies and publicly available detailed mapping and analysis of sea level rise, extreme heat, and other impacts expected in the region. And, perhaps most significantly for Harvard, leading private organizations such as Google have already

achieved 100% renewable energy goals, and have inspired coalitions like the RE100 comprised of almost 100 companies who have committed to 100% renewable energy goals. Locally, Partners Healthcare recently announced a goal of net carbon positive by 2025, and they further committed to sourcing 100% of their energy from renewable sources. Among top universities, Cornell has pledged climate neutrality by 2035, the University of California system has committed to carbon neutrality by 2025, while Stanford has already reduced their carbon emissions by 68%. Looking forward, Harvard's efforts to reduce its own emissions are likely to get less help from federal government initiatives in the near future than they did during the 2006-2016 period, but the University is likely to have many opportunities for emissions reduction partnerships with other "local" actors from the public and private sector. Finally, the need for independent universities to develop and deploy their capacity for teaching, research, and leadership in the climate and energy space has never been greater.[16]

3 Recommendations

In formulating its recommendations, the Task Force sought to identify measures that would:

- be based on the latest research;
- build on our unique expertise and capacity as an institution whose primary mission is research and teaching;
- develop and adopt approaches that can be used as models by our surrounding communities and the world at large, to address more effectively the challenges of climate change and related energy pollution issues, and
- provide leadership by having Harvard "walk its talk" on these challenges and the opportunities for dealing with them.

The Task Force makes the following recommendations:

3.1 Problem Framing

A comprehensive approach to managing the damages of energy use: *Harvard should broaden its response to concerns over climate change to address more comprehensively the damages associated with its energy choices.* In practice, this means crafting a University strategy for reducing its use of fossil fuels. Focusing on the multiple impacts of fossil fuel use suggests that the damages inflicted on society by the University's use of those fuels may well be double or more what was assumed in the Harvard's initial 2008 Task Force Report, and that the motivations for reducing our reliance on fossil fuels may be correspondingly larger. We believe that this wider framing not only reflects the latest science, but also significantly increases the moral imperative to act to reduce fossil fuel usage.

3.2 Short-term Goal for Reducing Damages Resulting from Harvard's Energy Use

Fossil fuel *neutral* by 2026: *As its next short-term goal, Harvard should become fossil fuel neutral by 2026.* By "fossil fuel neutral" we mean that the University should complement its aggressive reductions of its own emissions with off-campus investments in projects that can offset the campus's remaining emissions. Efforts to achieve this goal should take place on two fronts.

First, *Harvard should intensify its current policy of pushing first and hardest on what can be done on campus to reduce our own fossil fuel use.* Over the last ten years, Harvard has significantly increased the efficiency with which energy is used on campus, but it should be possible to further reduce energy demand on the *existing* campus by at least 10% over the next ten years. Since the campus is expected to grow by 5% to 10% over the next ten years, net on-campus energy demand reduction efforts will be lessened or negated by the addition of new square footage. It is therefore vitally

important that the University continue to invest in on-campus reductions to the maximum feasible extent. Targeted efforts to reduce emissions that fall under Scope 3 should also play an important role in this effort.

Second, as noted above, conservative estimates suggest that our annual purchase of approximately $100 million of energy services is causing at least $25 million worth of annual damages, primarily through impacts on climate and human health. We believe this to be unacceptable, particularly given our finding that the University is in a position to invest at reasonable cost in off-campus projects that can bring our net emissions to zero. In the short term, reducing to zero Harvard's reliance on fossil fuels to meet its energy needs is likely to be prohibitively expensive. But, by thoughtfully participating in off-campus projects that replace fossil fuel-generated energy or that reduce demand for it, and by conducting rigorous research that can support the further development of the offset markets, Harvard can join those leading institutions that have signaled their commitment to mitigating the harm they are causing through a reliance on fossil fuels, and simultaneously play an important role in accelerating the development of a fossil fuel free economy. The use of these off-campus investments should decrease with time consistent with the long-term goal recommended below.

3.3 Long-term Goal for Reducing Damages Resulting from Harvard's Energy Use

Fossil fuel free by 2050: *As its next long-term goal, Harvard should become fossil fuel free by 2050*. By "fossil fuel free" we mean that the University should commit to relying completely on fossil fuel free sources to meet its needs for energy services to heat, cool, and power the facilities under its control (i.e. 100% non-fossil sourcing for energy produced by Harvard owned facilities [Scope 1] and for energy purchased by Harvard [Scope 2]). By 2050, Harvard should also strive to purchase externally provided services (Scope 3 activities such as food, travel, and investments) that rely as little on fossil fuels as feasible. This goal is consistent with the global emissions targets that the best available research suggest must be met if we are to avoid a dangerous 2 degrees Celsius of warming. We also believe it to be feasible, given the long-term trends in supply and demand cited earlier in this Report.

We recommend that both short- and long-term goals be rigorously reviewed on a periodic basis to ensure that the University is making appropriate progress against them, and that they are still the best goals to be pursuing. We expand on this idea below.

3.4 Fostering Research, Analysis, and Outreach

Harvard should conduct a number of follow-up activities to deepen and extend its response to the operational challenges of reducing damages associated with its use of energy. These activities should capitalize on the University's central strengths as a research and teaching institution. Each of the activities we recommend below has the potential both to improve Harvard's own operations and emissions, and to provide models for more effective responses across society. In principle, most could be conducted by an individual researcher, an ad-hoc task group, or as a classroom-related activity. We recommend that an individual from the faculty or administration be asked to take on each task, and to recommend an appropriate modality for implementing it. Further thoughts from the Task Force on how and why these various activities could be undertaken are provided in the Implementation section below and in Appendices to this Report.

1. **Scope 3 emissions:** An initiative should be launched immediately to develop the means for better estimating and tracking Scope 3 emissions, in order to lay the foundation for Scope 3 emissions reduction targets. Harvard should work with researchers to establish clear, research-backed baselines as to the magnitude of these emissions within the next two years, focusing particularly on

commuting, air travel, food, and the University's financial investments. The University should set preliminary targets for the reduction of these priority Scope 3 emissions and should develop initial action plans for reducing such emissions as soon as possible, consistent with the short-term goals noted above. These options might include introducing a truly integrated social cost of carbon, investing in technology such as advanced teleconferencing, and/or implementing a range of behavioral or procurement interventions. Harvard should also establish guidelines for transparent public GHG emissions disclosure from our top suppliers. Related to Harvard's investments, opportunities for addressing the damaging emissions associated with our investments should be considered in coordination with the Harvard Management Company. All Scope 3 emissions reduction targets should be reviewed during the next quadrennial review of Harvard's climate commitment.

2. **Social damages of fossil fuel use**: Harvard should seek to assist in the development of an integrated approach for calculating the full damages of fossil fuel use. This should include at least GHG emissions, pollutant releases into air and water, other atmospheric emissions, and "upstream" emissions due to the full lifecycle of fuel use including extraction, processing, transport, storage, and disposal prior to combustion. Existing frameworks are fragmented and inadequate for providing useful estimates of the full social damages of fossil fuel use. An improved methodology would help both Harvard's work and that of many others.[17]

3. **Off-site emissions reductions**: Harvard should further refine and extend the work of Harvard's 2015 Complementary Mechanisms Advisory Group to ensure that Harvard's investments both reduce fossil fuel usage and its associated damage cost effectively, and that they accelerate global progress towards a fossil free tomorrow. This work could include both a research effort devoted to improving our collective understanding of the ways in which offsets markets can be strengthened and brought to scale, and on the ground investment devoted to understanding the evolving opportunities available to reduce emissions off campus in support of fossil fuel neutral goals.

4. **Resilience**: We recommend the creation of an initiative that could further assess the vulnerability of Harvard's campus to climate change, and to develop options for increasing the University's resilience in the face of such threats.

5. **Communications**: Explore the options for significantly increasing Harvard's ability to communicate effectively to the broader global community with respect to the University's on-going work exploring the implications of energy choices for social and environmental well-being and the ways in which these can be managed.

6. **Living labs and regional collaboration**: Explore options for better integrating Harvard's teaching and research on energy, climate, and health issues with action on campus and by partners in the surrounding regions. The new course offered at the Harvard Law School, looking at off-campus reduction mechanisms in support of fossil fuel neutral goals, provides an encouraging model. The new Campus Sustainability Innovation Fund, which supports students researching solutions to real-world challenges, is another.[18]

4 Implementation

4.1 Impose a Surcharge on Fossil Fuel Use

1. *We recommend the imposition of a surcharge on all fossil fuels used to power the campus (i.e. on all fossil fuels responsible for Scope 1 and 2 emissions).* The purpose of this surcharge would be two-fold: to discourage use of fossil fuels to meet the campus's energy needs,[19] and to raise the funds to help achieve the fossil fuel neutrality goal outlined above. Our current estimates suggest that completely offsetting all of Harvard's emissions this year would cost in the region of $2-5 million. We recommend this surcharge be phased in gradually and in accord with the financial constraints facing the University. The size of the surcharge should be reviewed periodically.

4.2 Invest in Supplemental Operating Capacity

Harvard should invest in the additional operational capacity required to realize these recommendations in practice. We believe that it will be important to complement existing capacity in two areas in which the capabilities that are required to make progress are significantly different from those that already exist on the campus.

1. *Identify and access additional capacity to support the development and implementation of projects that reduce the demand for energy across the campus.* The Office for Sustainability and the operations units at Harvard's various Schools already provide significant support to the University's efforts to achieve its climate, energy, and sustainability goals. But we believe that the prospects for demand reduction on campus could be advanced significantly if the operations departments at the various Schools could be given more support in identifying and executing projects. New techniques and methodologies are continuously emerging to assist organizations in reducing energy use—some of them from researchers on the Harvard campus—and we believe that it is critical that every School be given access to the leading edge of practice. We recommend that the University consider identifying resources that could be made available to the various Schools to support them in identifying, financing, and implementing demand reduction projects. The University should also evaluate transportation options that could further reduce the fossil fuel intensity of the campus. We believe that such a move could have significant positive benefits, and would be highly feasible while the cost of capital remains at such historic lows.

2. *Identify and access capacity to support Harvard's investment in off-campus emissions reductions.* Investing off-campus to reduce fossil fuel emissions is—of course!—something that must be approached with caution. It is essential that Harvard invest only in bona fide, high-quality projects that will lead to demonstrable reductions in fossil fuel use, while simultaneously having the potential to accelerate the transition to a fossil fuel free economy. We recommend that Harvard develop a mechanism to supplement the University's existing expertise in this area with access to the knowledge currently being generated by leading participants in this space. At the same time, Harvard should charter a faculty committee with deep expertise in the full range of off-site emissions reduction opportunities, including offsets markets and renewable energy systems to provide supplementary advice and guidance. In combination, we believe this will enable Harvard to make the best possible investments while simultaneously generating scholarly research that can augment efforts in this area across many institutions.

4.3 Provide for the Periodic Review of Progress Against These Recommendations

1. *Harvard should establish a standing senior level Sustainability Executive Committee* made up of faculty, senior administrators, and students to oversee Harvard's implementation of the goals and strategies adopted by the University in response to this Report. The Committee would periodically review Harvard's actions in this space and their implications for the University's energy, climate, and sustainability goals. It would provide input on, and approve recommendations from, the

Working Groups and Task Forces identified in this Report. The Committee would also periodically evaluate the effectiveness of Harvard's policies and practices relating to areas that have significant impact on the goals and activities adopted in response to this Report, including major capital projects, transportation planning, and energy supply planning. The Office for Sustainability should support the work of the Committee, continuing its central roles in implementation of Harvard's energy, climate, and sustainability strategies, serving as a vital convening and facilitation resource to Harvard's Schools and departments, and ensuring continual improvement of the University's strategy in line with industry best practices. Additional resources should be found or raised to match the scope of the University's commitment. A comprehensive, University-wide implementation plan should be developed with continual review of progress on an annual and quadrennial basis.

2016–2017 Climate Change Task Force Membership

Faculty Membership

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6. Ian J. Miller (FAS), Professor of History
7. Elsie M. Sunderland (SEAS/ChanSPH), Thomas D. Cabot Associate Professor of Environmental Science and Engineering
8. Michael Toffel (HBS), Senator John Heinz Professor of Environmental Management and Faculty Chair of the HBS Business and Environment Initiative

School and Central Administration Membership

1. Katie Lapp, Executive Vice President [Co-Chair]
2. Patricia Byrne, Executive Dean, Harvard Divinity School
3. Heather Henriksen, Director, Office for Sustainability
4. Thomas Hollister, Vice President for Finance and Chief Financial Officer
5. Andrew O'Brien, Chief of Operations, Harvard Business School
6. Russ Porter, Administrative Dean for Science, Faculty of Arts & Sciences
7. Meredith Weenick, Vice President for Campus Services

Student Membership

1. Emily Broas (HBS/HKS)
2. Aldis Elfarsdottir (College)
3. Piers MacNaughton (ChanSPH)
4. Charlotte Wagner (SEAS)

END

5 Appendices

[1] The full text of the charge to the 2016–2017 Task Force is provided in Appendix 1 of this Report.
[2] The full list of members of the 2016–2017 Task Force and support staff is provided in Appendix 2 of this Report.
[3] Drew Faust, "Statement on the Report of the Harvard Greenhouse Gas Taskforce," *Harvard University Office of the President*, 2008, http://www.harvard.edu/president/speech/2008/statement-on-report-harvard-greenhouse-gas-task-force.
[4] Richard D. McCullough, Energy and Environment: Research at Harvard University, *Office of the Vice Provost for Research*, 2017; Harvard University Center for the Environment, "Harvard Speaks on Climate Change," 2017, http://climatechange.environment.harvard.edu/; Colin Durrant, "Support for seven from president's climate fund," *Harvard Gazette*, February 11, 2015, http://news.harvard.edu/gazette/story/2015/02/support-for-seven-from-presidents-climate-fund/; Alvin Powell, "Harvard creates Global Institute," *Harvard Gazette*, October 15, 2015, http://news.harvard.edu/gazette/story/2015/10/harvard-creates-global-institute/; Harvard Office for Sustainability, "Harvard University Sustainability Plan," *green.harvard.edu*, October 22, 2014, https://green.harvard.edu/campaign/our-plan.
[5] Colin Durrant, "Curbing carbon on campus," *Harvard Gazette*, December 8, 2016, http://news.harvard.edu/gazette/story/2016/12/harvard-achieves-greenhouse-gas-reduction-goal/.
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[9] Tran Viet Duc, "Which Coastal Cities Are at Highest Risk of Damaging Floods? New Study Crunches the Numbers," *The World Bank*, August 19, 2013, accessed October 2016, http://www.worldbank.org/en/news/feature/2013/08/19/coastal-cities-at-highest-risk-floods.
[10] WHO, "Climate Change Impacts," *WHO*, accessed March 2017, http://www.who.int/phe/health_topics/outdoorair/databases/en/; Joel Blum, Celia Chen, Charles Driscoll, John Evans, Philippe Grandjean, James Hammitt, and Elsie Sunderland, "Benefits of Regulating Hazardous Air

Pollutants from Coal and Oil-Fired Utilities in the United State," *Environmental Science & Technology* 50, no. 5: 2117-2120. For further details see Appendix 5.

[11] For further details see Appendix 12,13, and 5.

[12] Harvard University's net campus energy reduction from FY 2006-2016 is 10% (23% excluding the impact of growth). The net campus energy reduction number includes equipment upgrades in the district energy systems. For further details see Appendix 15.

[13]Alexander E. MacDonald, Christopher T. M. Clack, Anneliese Alexander, Adam Dunbar, James Wilczak, and Yuanfu Xie**,** "Future cost-competitive electricity systems and their impact on US CO2 emissions," *Nature Climate Change*, Vol 6, May 2016: 526-531; National Renewable Energy Laboratory, "Renewable Electricity Futures Study, Golden, CO: *National Renewable Energy Laboratory*, 2012, http://www.nrel.gov/analysis/re_futures/; David Abel and John R. Ellement, "Closing date set for Pilgrim nuclear power plant," *The Boston Globe*, April 14, 2016, https://www.bostonglobe.com/2016/04/14/pilgrim-nuclear-power-plant-close-may/FRXGHcfMrk3nSngdYueMML/story.html.

[14] **Carbon offsets**, emission reductions generated from project-based activities (e.g. landfill gas) and **carbon allowances**, permits issued by a government under a cap-and-trade program, are both tradable carbon pricing instruments. **Renewable Energy Certificates (RECs)**, an environmental commodity created when one (net) megawatt hour of electricity is generated and supplied to the grid from an eligible renewable energy resource, are a tradable unit in the renewable energy market; Harvard University, "Report of the Complementary Mechanisms Advisory Group," 2015. Available upon request from the Office for Sustainability.

[15] Rebecca Henderson and Richard Newell, eds., "Accelerating Energy Innovation: Insights from Multiple Sectors," Chicago and London: NBER and the University of Chicago Press, 2011. For further details see Appendix 20.

[16] For further details see Appendix 21.

[17] National Research Council, "Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide," Washington, DC: National Academies Press, 2017, https://doi.org/10.17226/24651; National Research Council, "Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use," Washington, DC: National Academies Press, 2010, https://doi.org/10.17226/12794.

[18] For further details see Appendix 19 and 26.

[19] Xavier Labandeira, Jose Labeaga, and Xiral Lopez, "A Meta Analysis on the Price Elasticity of Energy Demand, Energy Policy," Vol 102, March 2017: 549-568.