April 3rd, 2015

Dear President Lawrence,

It is with great pleasure that we submit our Committee's Report on Fossil Fuel Divestment. As you know, over the past two years there has been increased pressure to address the challenges of climate change that the IPCC detailed in their 2014 reports. Almost all scientists and most policy makers agree that the world needs to reduce its carbon emissions. The divestment movement highlights the need for institutions to rationalize their investment portfolios and pursue a more sustainable set of objectives while meeting risk / return criteria.

Over the past two years, the Brandeis University Exploratory Committee on Fossil Fuel Divestment has met with scores of individuals and professionals within the Brandeis community to understand these issues. We have read numerous reports and talked with professional investment advisors to learn about the challenges of sustainable investing and divestment. We have also consulted with and met with the University Investment Manager, Nicholas Warren. He has advised us on the constraints and investment philosophy of the University.

We have also observed the momentum of the divestment movement across universities and other institutions in the United States. There is clearly pressure for change and a tangible response to the challenges of climate change.

We feel that the University has the opportunity to make a strong statement that is consistent with the social justice mission of Brandeis. Our report outlines a series of options and next steps that we believe are realistic and achievable within the operating constraints of the University.

With many thanks to all who have advised and participated in this effort we humbly submit our Final Report and Recommendations. We look forward to further conversations as the University community contemplates its investment strategies in light of the divestment movement.

Sincerely,

The Committee

Brandeis University's
Exploratory Committee on Fossil Fuel Divestment

Final Report and Recommendations

April 3rd, 2015

<u>TABLE OF CONTENTS</u>

EXECUTIVE SUMMARY

Climate change poses real and immediate threats to human prosperity and the stability of the biosphere. As a steward of our students and the Brandeis community, it is incumbent upon the University to embrace tangible actions that reduce our carbon emissions on campus and in our portfolio. While Brandeis should balance its financial security with the imperatives of confronting climate change, the University must ultimately be guided by its social justice mission. This report responds to the challenges of climate change, the national fossil fuel divestment movement, and our responsibilities as a leading research university preparing global citizens.

Over the past twenty years, the Intergovernmental Panel on Climate Change (IPCC) and a wide variety of leading institutions have published scientific reports regarding the implications of climate change. There is an overwhelming consensus that the Earth is warming and that greenhouse-gas emissions must be curtailed to mitigate serious harm to the environment and society. These gases are *externalities* that are not accounted for in the cost of production or exchange, and are therefore expensive hidden liabilities not recognized by existing global markets. The US-China climate agreement announced by President Obama and Premier Xi Jinping in November 2014 and India's collaboration on reducing emissions are laudable actions by the world's largest carbon emitters; however, international climate negotiations have thus far not significantly mitigated carbon pollution.

Fossil fuels are fundamental to modern civilization and therefore the transition to renewable energy sources will take decades. However, recent studies by energy analysts suggest that with existing technologies the United States could move more rapidly towards a clean energy economy. Several lines of research show that the fossil fuel industry has disseminated denial and doubt about climate change and has impeded the transition to low-carbon energy sources. This delay has real social, environmental, and moral consequences. Divestment seeks to accelerate this clean-energy transition by stigmatizing fossil fuel companies and precipitating a more robust public policy response.

The divestment movement, initiated by the climate-activist organization 350.org, grew in response to the lack of U.S. and international policies on significant emissions reductions. The movement also emerged after scientific and financial reports revealed that fossil fuel companies currently own five times the carbon reserves in their proven assets than scientists warned can be safely combusted. Since the fall of 2012, the campaign for fossil fuel divestiture— encompassing campuses, cities, not-for-profit organizations, religious and financial institutions—has evolved into the fastest growing divestment movement in history. While often considered a symbolic act, divestment has emerged in the U.S. as a significant political action responding to climate change.

President Lawrence commissioned Brandeis University's Exploratory Committee in response to the challenge of divestment and to review the University's strategy in relation to its energy portfolio. The committee was specifically asked to analyze the climate crisis, the social justice aspects of our investments, and alternative investment options.

Brandeis University currently manages its portfolio with a select group of investment managers to achieve above market returns at manageable risk. Over the past fifteen years, a small group of investment professionals at the University have worked with approximately 40 managers to meet its objectives of higher returns with less volatility (Appendix L). Energy investments are an important part of our strategies, both in terms of a hedge against inflation and actual returns. Eliminating fossil fuels from our portfolio could potentially reduce our above market returns by as much as 2%.

Our findings conclude that the University has an opportunity to take significant action on the challenges of climate change and the divestment movement. The options described below can be implemented over the coming years to meet these challenges, while at the same time building a more resilient, ethically consistent and sustainable institution that satisfies its financial objectives.

- Brandeis can divest its entire portfolio of the most polluting fossil fuel firms.[1] A strong divestment commitment would position Brandeis as a leader in tackling climate change.
- The University can instruct its investment managers to divest a portion of its energy portfolio, such as coal firms or high-risk carbon companies.[2]

Alternatively, and/or as complementary actions, Brandeis can consider the following:

- Pursue a more sustainable endowment as measured by comprehensive portfolio metrics. Our investment managers could track the risk and returns of its sustainable portfolio in comparison to more traditional investment options over extended periods of time. This would allow Brandeis to evaluate the risks, returns, and costs of our Socially Responsible Investing (SRI) and Environmental, Social, and Governance (ESG) investment strategies.
- Adjust investment holdings to reduce the "carbon footprint" of the entire or a portion of its portfolio. This can be performed in conjunction with like-minded institutions while maintaining the University's portfolio return targets. Measuring the returns and carbon footprint of our investments would help us evaluate the costs of our sustainable investment goals.
- Actively promote, measure, and encourage reducing the carbon footprint on campus. Provide increased educational opportunities focusing on climate and energy across the curricula in all schools. These initiatives will encourage Brandeisians to be more conscious of their own actions and encourage stronger ecological citizenship.

"Business as usual" is not a responsible option. Choosing not to act on this global issue would represent a failure of the University to live up to its social justice principles. The Brandeis community should lead the educational and political dialogue in addressing the challenges of climate change.

Recommendation

The majority of the Committee advocates that Brandeis strongly considers divesting its holdings in fossil fuel firms. Student consensus and robust faculty concern suggests that continued investment in fossil fuels presents a fundamental tension with Brandeis' proud tradition of social justice.

[1] These firms, the "Carbon Underground 200" (CU 200) consist of the top 100 publicly traded coal companies globally and top 100 oil and gas companies globally, ranked by the potential carbon emissions content of their reported reserves. See Appendix B.

[2] An example of this is the "Sordid Sixteen" list compiled by Swarthmore Mountain Justice. The "Sordid Sixteen" are considered by some to be the most unethical energy investments. See Appendix C.

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UNIVERSITY CHARGE

ANNOUNCING THE FORMATION OF BRANDEIS UNIVERSITY'S EXPLORATORY COMMITTEE ON FOSSIL FUEL DIVESTMENT

Sept. 30, 2013

Dear Members of the Brandeis Community:

I write today to announce the formation of a working group to explore Brandeis's investment strategies as they relate to the fossil fuel divestment movement. The committee includes students, alumni, and members of the faculty and administration.

Over the past year, a number of our community members have become engaged in this movement, sparked by their commitment to sustainability and increasing concerns over the role of fossil fuels in climate change and other social justice issues.

Brandeis University has a lengthy investment policy that states, in part:

"In deciding whether to purchase securities of a particular corporation, the university will in most cases be guided solely by the financial considerations of safety and growth of capital and production of income. Only when the corporation is directly and substantially involved in activities clearly considered by the university community to be contrary to fundamental and widely shared ethical principles should the portfolio managers be instructed to avoid purchase of its securities. . . . Where a corporation's conduct is found to be clearly and gravely offensive to the university community's sense of social justice and where it is found that the exercising of shareholder rights and powers is unlikely to correct the injury, consideration should be given to selling that corporation's securities. Due regard should be given to both positive and negative conduct of the corporation..."

This investment policy allows the university, through our Investment Office and the Investment Committee of the Board of Trustees, to offer guidance to the investment groups that manage our holdings. Bearing this policy in mind, there is quite a lot to consider in examination of the university's investments in fossil fuels. This working group is being brought together to find the most Brandeisian answer to this issue.

The working group will address the goals of:

(a) analyzing the social and environmental justice impacts of the fossil fuel companies in which Brandeis holds investments
(b) modeling and understanding the financial impact of divestiture of the endowment from all or part of the companies analyzed
(c) establishing a list of alternative investment options including investment in socially and environmentally sustainable holdings or funds
(d) addressing a more global objective of reducing the endowment's carbon footprint across each sector of our investment portfolio, utilizing Socrates scores and other Socially Responsible Investments indices

The committee will produce a report of its findings and recommendations to the university, on how it can invest and divest responsibly while strengthening its leadership in the context of climate change and social justice.

The committee, in its proceedings and analyses, will take into account:

- the urgency of the climate crisis and the social and environmental impact of fossil fuels
- the university's commitment in the 1973 Responsible Investor guideline
- the complex and indirect nature of university endowment investments
- the views and the appeals of students and alumni of the university
- the university's commitment to, and leadership on, social justice
- the impact of financial decisions upon the students and university community

An initial meeting of the group was convened in June 2013, with subsequent meetings throughout the summer, and I expect their work will continue well into the school year. Any reports or recommendations from the group will need to be reviewed by the Investment Committee of the Board of Trustees to consider whether a proposal will be advanced to the full board.

Peter Giumette, dean of student financial services, will serve as the chair and facilitator for this group. Committee membership has been selected to include faculty, staff, students, and a member of the Board of Trustees Investment Committee. They all have my thanks and appreciation for taking on this challenging and important subject.

Ricky Rosen '14, Student Union representative
Rohan Bhatia '14
Prof. John Ballantine, IBS
Prof. Eric Olson, Heller
Mike Abrams '15
Rachel Soule '12
Colin Mew '14

Ex Officio
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Ellen de Graffenreid, SVP Communications
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Prof. Dan Perlman, Arts and Sciences and Associate Provost
Nick Warren, Chief Investment Officer
Len Potter '83, Board of Trustees Investment Committee member

Sincerely,

Fred Lawrence

THE CHALLENGE OF CLIMATE CHANGE

The Climate Crisis is Here

Among the several points listed in the charge to this Divestment Committee, President Lawrence asked the Committee to take into account "the urgency of the climate crisis and the social and environmental impact of fossil fuels". The use of the term "climate crisis" in the creation of this committee is not hyperbole, but reflects the widespread concern that anthropocentric climate change is eroding the ecological stability which has grounded the past 10,000 years of human civilization.

A wide range of climate reports from the international community, the U.S. government, global business leaders, and the U.S. military highlight the breadth of concern and consensus of risk. The Committee has been meeting during an extraordinary time for climate science and policy. Three major reports on the social, environmental, and economic impacts of climate change have been released in the past eighteen months:

- Intergovernmental Panel on Climate Change (IPCC). Fifth Assessment Report
- National Academy of Sciences (US) and Royal Society (UK). Climate Change: Evidence and Causes
- U.S. Global Change Research Program. Climate Change Impacts in the United States: The Third National Climate Assessment.

While each report varies in their framework, authors, and emphasis, all three conclude that *climate change—primarily driven by the burning of fossil fuels—constitutes an enormous threat to human prosperity and immediate action is required to reduce human suffering, environmental degradation, and economic costs*.

The IPCC Fifth Assessment report is global in scope and has the greatest diversity of international authorship. We highly recommend that all members of the Brandeis Administration and Board of Trustees read the Summary for Policymakers (Appendix A). While often considered conservative in its findings, the IPCC report is essential reading for those unfamiliar with the most recent research on the pace and consequences of climate change. The fifth in a series of reports spanning over 27 years, the 2014 Assessment's language is stark:

"Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased."

With each iteration of the IPCC report, the language has become more forceful on three key points: climate change is underway, some additional future change is unavoidable, and today's emissions reductions will translate into reduced future harm.

Beyond the IPCC's report, the assessment by the National Academy of Sciences and Royal Society highlights:

- Since the beginning of the Industrial Revolution, atmospheric concentrations of CO_2 have increased by more than 40% and are now higher than previous levels in at least the past 800,000 years

- CO_2 emissions are *accelerating*, with more than half of the increase in CO_2 occurring since 1970
- Since 1900, the global average surface temperature has risen 1.4°F
- 1983 to 2012 was very likely the warmest 30-year period in more than 800 years
- This speed of human-induced warming is ten times faster than the fastest known natural sustained change on a global scale—the end of an ice age.

A recent analysis of over 4,000 peer-reviewed scientific papers revealed that 97.1% of scientists agree that human activities are driving global warming. A consensus has been present since the early 1990s and has only strengthened with time. Despite the politically-driven denial of human-caused climate change, there has not been a debate over the fundamentals of climate change in the scientific community in the last 30 years.

What Risks Do We Face?

Peer-reviewed scientific reports from a wide variety of international, national, and nongovernmental organizations have confirmed that the burning of fossil fuels will only intensify existing negative impacts:

- an increase in Earth's average global temperature resulting in stronger heat waves and droughts
- if the rise of CO_2 remains unchecked, average warming of 7-9° F can be expected by 2100 (NAS)
- "by the middle of this century, the average American will likely see 27 to 50 days over 95°F each year—two to more than three times the average annual number of 95°F days we've seen over the past 30 years." (Risky Business)
- an increase in humidity, leading to more intense rainfall and snowfall events; "Extreme precipitation events…will very likely become more intense and more frequent by the end of this century, as global mean surface temperature increases" (IPCC)
- rapid warming at high latitudes leading to an Arctic Ocean free of ice during the summer months; Since 1978, the yearly minimum Arctic sea ice extent has decreased by more than 40% (NAS)
- retreat of most of the world's mountain ice and snow fields, resulting in water scarcity for billions of the Earth's inhabitants by 2100
- accelerating sea level rise: "The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia."(IPCC)
- acidification of the seas from excessive amounts of CO_2 in the atmosphere, leading to the possible collapse of many fisheries and aquatic ecosystems, most notably coral reefs

Leaders have moved beyond climate change as an academic concern and are now confronting the costs of an increasingly uncertain business environment. Most notable among several important reports by insurance and business leaders, Risky Business: The Economic Risks of Climate Change in the United States, was produced by the Risky Business Project, co-chaired by former New York City Mayor Michael Bloomberg, former U.S. Secretary of the Treasury Henry M. Paulson, Jr., and Thomas F. Steyer, retired founder of Farallon Capital Management LLC. The Risky Business report translates many of these consequences into financial metrics, and lists four especially pertinent to the US economy over the next 5-35 years:

- increased flooding and storm damage to coastal infrastructure and populations, resulting in as much as $3.5 billion in additional yearly costs within the next 15 years

- "If we continue on our current path, by 2050 between $66 billion and $106 billion worth of existing coastal property will likely be below sea level nationwide"
- "some Midwestern and Southern counties could see a decline in yields of more than 10% over the next 5 to 25 years" with a 1-in-20 chance of declining yields exceeding 20%
- "Greenhouse gas-driven changes in temperature will likely necessitate the construction of up to 95 gigawatts of new power generation capacity over the next 5 to 25 years…costing residential and commercial ratepayers up to $12 billion per year"

The authors of Risky Business explicitly stressed that today's business and financial decisions should include consideration of the rising costs of climate change. The authors conclude:

"The fact is that just as the investments and economic choices we made over the past several decades have increased our current vulnerability to climate change, so will the choices we make today determine what our nation looks like in 15 years, at mid-century, and by 2100… *This is not a problem for another day. The investments we make today—this week, this month, this year—will determine our economic future."*

While the Risky Business Project focused on risks within the United States, the impacts of American emissions—representing 26% of the accumulated long-lasting greenhouse gases (from a nation with just 4% of the world's population)—do not stay within our national borders. Our atmosphere is a global commons. When climate-induced changes, like flooding and crop damage, occur to populations in the world's poorest nations, the unequal consequences of climate change become most apparent: *those least responsible for the problem have the least ability to adapt to its consequences*.

Exactly why the poorest nations are more vulnerable to climate change warrants a closer look. In The Distributional Impact of Climate Change on Rich and Poor Countries, the economists Mendelsohn, Dinar and Williams showed that over the next several decades, agriculture is the economic sector most at risk in poor nations. This is because poor nations are often in low latitudes where temperatures are above optimal for most major crops. *The world's poorest countries will suffer disproportionately because they are already so low and hot.*

Similar concerns about the fate of people in low-latitude nations were emphasized by a 2012 World Bank study:

"The projected impacts on water availability, ecosystems, agriculture and human health could lead to large-scale displacement of populations and have adverse consequences for human security and economic and trade systems."

Climate Change is also considered one of the most dangerous threats to American security. Reports prepared by and for the U.S. Department of Defense emphasize the risks of significant population displacements, global instability and the erosion of democratic governance. An important recent contribution is the Military Advisory Board's report: "National Security and the Accelerating Risks of Climate Change". Building on their previous 2007 report, the authors warned: *"the risks we identified are advancing noticeably faster than we anticipated."* They emphasize: "Political posturing and budgetary woes cannot be allowed to inhibit discussion and debate over what so many believe to be a salient national security concern for our nation."

Secretary of Defense Chuck Hagel has furthermore warned that climate change is a "threat multiplier" for the military and United States as a whole, and clarified the exact nature of these risks:

"Rising global temperatures, changing precipitation patterns, climbing sea levels and more extreme weather events will intensify the challenges of global instability, hunger, poverty, and conflict. They will likely lead to food and water shortages, pandemic disease, disputes over refugees and resources, and destruction by natural disasters in regions across the globe."

Considering the United States' active role in the world, climate change threatens to increase the financial, military, and human costs to U.S. citizens. No report has comprehensively tallied these liabilities, so even the costs cited by the Risky Business report might be viewed as conservative.

Beyond military security, social justice, and increasing economic costs, there is an intergenerational dimension to climate change. Our actions today shape the future quality of life for young people, their children, and countless generations to come. *To not act decisively to reduce rising carbon pollution would mean saddling our children and grandchildren with a crushing burden.* "Every year that goes by without a comprehensive public and private sector response to climate change," the authors of Risky Business conclude, "is a year that locks in future climate events that will have a far more devastating effect on our local, regional, and national economies."

The warnings of such highly respected economists, business leaders, and policy makers indicate just how urgent climate change has become over the past five years. The authors of all these various reports, from scientists to financial experts, are hardly prone to alarmism by nature.

All people and institutions with a strong commitment to social justice should take note of these durable findings, specifically since the harshest consequences of climate change will fall on the poorest nations, the poorest people within nations, and our children and grandchildren.

The Imperative and Opportunities of 2ºCelsius

In the 2009 Copenhagen Accord, the vast majority of world leaders agreed to keep warming below 2° Celsius (3.6° F). Many climate scientists—including former NASA Chief Climatologist James Hansen—and world leaders believe 2º C is *too high* as it risks triggering runaway warming. Two degrees Celsius and its corresponding "carbon budget" (see below) should therefore be seen as conservative—the *absolute maximum* of warming that can be permitted.

The full IPCC report also provided a sobering carbon budget, outlining how many gigatons (Gt) of carbon the world can burn before exceeding 2° Celsius and therefore limiting the likelihood of runaway warming and ecosystem collapse. The report notes that human civilization must not burn more than 790 GT of carbon before 2100 if it aims to have a 66% chance of staying below 2º C. In other words, *the world can almost certainly only consume one-third of its proven fossil fuel reserves—leaving the remaining two-thirds in the ground.*

In a 2014 interview with journalist Thomas Friedman, even President Obama admitted, "we can't burn it all."

The supply-side constraints on fossil fuel extraction and consumption has hastened efforts to build a more sustainable economy. Although this energy transition will be among the largest shifts in human history, progressing away from a fossil fuel economy has significant economic, health and environmental benefits. A guiding example is the New Climate Economy, published by the Global Commission on the Economy and Climate, co-chaired by former President of Mexico Felipe Calderón and Sir Nicholas Stern, Chair of Economics and Government at the London School of Economics. The introduction to the New Climate Economy states:

"The next fifteen years will be critical, as the world economy undergoes a deep structural transformation that will determine the future of the world's climate system."

The Risky Business report likewise concludes:

"If we act now, the U.S. can still avoid most of the worst impacts and significantly reduce the odds of costly climate outcomes—but only if we start changing our business and public policy practices today."

Conclusion

Humanity is at a new point in our relationship with the Earth, having become so accustomed to our use of natural resources as to degrade the integrity of our atmosphere. The burning of fossil fuels alters the shape of coastlines, endangers drinking-water supplies, and degrades farmland. We humans, a single species among millions, have the unique power to alter the essentials of world geography. We also have the responsibility to change direction. There is a clear consensus: time and tide wait for no one.

THE LOGIC OF DIVESTMENT

Divestment is a political tactic for inducing social and behavioral change. In recent decades it has been employed to stigmatize industries (tobacco) or sovereign governments (Apartheid South Africa). Divestment might be understood as an extra-ordinary measure available to socially-responsible investors (GSIA 2014; Goodman et al. 2014).

Divestment seeks a response from targeted firms and just as importantly, the general public, Boards of Trustees, and Congress. Divestment campaigns are not intended to financially harm companies. Rather, they seek to change social norms of industries and/or governments. Divestment was not aimed at any one cigarette company; it was a campaign against tobacco. It stigmatized an entire industry, and more importantly changed the smoking habits of an entire population. Success in a divestment campaign is measured as new social and political norms, supported by concurrent laws and regulations.

Our Committee found that divestment gains traction when 1) community members conclude that engagement is ineffective, or 2) the entire business model (basic product or process) of a corporation or industrial sector is viewed by many in the community as socially injurious, or 3) when a company's behavior (deceptive practices) comes to be viewed as unethical.

Brandeis' own statement on responsible investing echoes this view:

"Where a corporation's conduct is found to be clearly and gravely offensive to the University community's sense of social justice and where it is found that the exercising of shareholder rights and powers is unlikely to correct the injury, consideration should be given to selling that corporation's securities."

To our knowledge, Brandeis has participated in politically-targeted divestment campaigns twice in its history. First, it divested from companies doing business in South Africa. Second, it froze future investment from the government of Sudan and companies that were "complicit with Sudan's genocidal practices."

Divestment campaigners seek to attract widespread support, both in terms of number of institutions and total funds divested. Since it is the moral stature of the entities that choose to divest that is most valued, collective action weakens the political capital and moral legitimacy. The evidence shows that *it is through stigma, not direct financial harm to "bad actors"*, that divestment accelerates change (Ansar et al. 2013).

A Brief History of Fossil Fuel Divestment

A brief history reveals how moral and financial arguments for fossil fuel divestment served to support each other and are intertwined. Two pivotal events in 2009 catalyzed the divestment campaign.

First, at the 15th Conference of Parties to the United Nation's Framework Convention on Climate Change, 114 governments affirmed that "climate change is one of the greatest challenges of our time," and signed the Copenhagen Accord. This agreement recognizes that "to prevent dangerous anthropogenic interference with the climate system"—i.e. runaway warming—nations must limit global temperature increase to no more than 2°C (3.6 F). A compromise between developing and developed nations, 2°C constitutes the most significant international metric for combating climate change to date.

Second, based on this global agreement, researchers at Germany's Potsdam Institute for Climate Impact Research published a report on the "Carbon budget" to achieve 2° C in *Nature*. Using estimates of the Earth's "climate sensitivity", Meinshausen et al. (2009) calculated a quantity of greenhouse gases that could be safely emitted. Meinshausen's study group estimated that no more than 565 gigatons (Gt) of CO_2 could be released by 2050 if the world aimed to have a likely chance of not exceeding the 2°C limit. In other words, *most reserves already claimed by large energy corporations would have to stay in the ground*.

In 2011, a group of financial experts—the Carbon Tracker Initiative (CTI)—sought to evaluate the risk premium and possible overvaluation of fossil fuel assets based on scientific arguments that two-thirds of carbon reserves would need to be left unburnt. CTI confirmed that the firms have holdings of enough coal, oil, and natural gas to result in emissions of 2,795 Gt of CO_2 (Leaton et al. 2013). CTI estimates were a way of protecting their clients' financial assets from unforeseen liabilities and risks.

- 2°C – the maximum degree of warming permissible for a stable and safe climate
- 575 Gt –the amount of carbon humanity can burn and remain under 2°C
- 2975 Gt –the carbon in fossil fuel companies' proven reserves, which is primed to be extracted

After reading Carbon Tracker's assessment, climate-activist Bill McKibben wrote a widely-read July 2012 article, "Global Warming's Terrifying New Math," where he introduced these three scientific numbers to the public. Unlike Carbon Tracker, he popularized these numbers for their moral and environmental implications. McKibben argued that the United States and world leaders were unable to agree on action limiting carbon emissions, primarily due to the intransigence of the fossil fuel industry. In his *Rolling Stone* article, McKibben therefore called for a widespread fossil fuel divestment campaign to delegitimize the top carbon-energy firms for warming far beyond the 2°C limit.

Beyond the historical parallels of tobacco and Apartheid, McKibben drew his inspiration most directly from a campaign initiated in 2010 by students at Swarthmore University. After a trip to West Virginia witnessing the impacts of mountaintop coal mining, students from Swarthmore Mountain Justice (SMJ) targeted their University with a divestment campaign. Their campaign emphasized the immorality of continued investment in such destructive behavior.

Inspired by SMJ's strategy and armed with Carbon Tracker's analysis, 350.org launched the "Do The Math" speaking tour in the fall of 2012, and argued that these three simple numbers—2°C, 565 Gt, and 2795 Gt—showed how disconnected the carbon economy had become from Earth's economy.

Recent reports by the International Energy Agency, World Bank, and IMF each verified these numbers and reiterated that humanity should keep two-thirds of known fossil fuel reserves in the ground to ensure a planet habitable for human life.

As of September 2014, "181 institutions and local governments and 656 individuals [collectively] representing over $50 billion in assets have pledged to divest from fossil fuels" (Arabella Advisors, 2014). Over 400 colleges have active campaigns, and the movement has spread to Europe, Australia, and remarkably, South Africa.

The divestment movement, bolstered by prominent individuals and institutions, has grown at an unprecedented pace. Perhaps the most surprising institution to divest from fossil fuels has been the Rockefeller Brothers Fund, the heirs to one of the world's most successful oil businessmen. Citing both moral and economic considerations for the shift, the head of the Fund explained: *"We are quite convinced that if John D. Rockefeller were alive today, as an astute businessman looking out to the future, he would be moving out of fossil fuels and investing in clean, renewable energy."*

The most recent promoter of divestment is The United Nation's governing body on climate change. "We support divestment as it sends a signal to companies, especially coal companies, that the age of 'burn what you like, when you like' cannot continue," said Nick Nuttall, the spokesman for the UN Framework Convention on Climate Change. Similarly, the UN's Special Envoy on Climate Change and former Irish President Mary Robinson cautioned, "There's an injustice in continuing to invest in fossil fuel companies that are part of the problem."

Weighing Divestment Arguments

The Committee has assembled a list of the arguments for divestment to gauge the depth of the movement.

1. Owners are Complicit with Fossil Fuel Assets' Social and Environmental Costs

Advocates contend that owning stock is an endorsement of that business model. To profit from fossil fuels and the unintentional but undeniable changing of the climate makes the University complicit in the costs, consequences, and suffering of global warming. This argument suggests that the University owns both the benefits and the burdens of fossil fuel assets.

"If you own fossil fuels, you own climate change," argues Ellen Dorsey, Executive Director of the $168m Wallace Global Fund. "And it's not just owning their environmental impacts. You own their political impacts too."

The social and environmental costs have been articulated in the section The Challenges of Climate Change. The collective impact of climate change will make our planet less suitable for our children and grandchildren. Archbishop Desmond Tutu (Brandies Honorary Degree recipient, 2000) recently called reducing greenhouse emissions "the human-rights challenge of our time," and has urged investors to embrace divestment. "Move your money out of the problem," he counseled, "and into solutions."

As the divestment movement gains momentum, Brandeis' commitment to sustainability and social justice may be judged on how it chooses to respond to the demands of the divestment movement.

2. Continuing to Invest in Fossil Fuels Threatens Brandeis' Mission and Legitimacy

Institutions of higher education have a commitment to the education and future of their students. They are pillars of civic society in training future professionals, pursuing invaluable research, and leading on important questions of opportunity, equality, and justice. Brandeis defines itself in its mission statement as, "a community of scholars and students united by their commitment to the pursuit of knowledge and its transmission from generation to generation." Such a mission is inherently a long term one. The university therefore concerns itself not only with the needs of the present but also the interests of further generations. Continued investment in carbon extraction poses a significant threat to this future, as the current and future impacts of climate change are creating an increasingly imperiled world.

As environmentalism emerges as a stronger force, universities of all kinds have adopted "green" initiatives—focusing on recycling, energy conservation, and other campus sustainability issues. Yet increasing scientific concern over the climate crisis and unrealized systemic political solutions suggest that such actions are insufficient.

Universities are judged for the social and environmental impacts of their actions—including their invested capital. Sixty-one percent of prospective Brandeis students indicated that they would consider a school's environmental commitment in their decision to apply (in a 2014 Princeton Review survey). Lack of divestment action may also disappoint existing students, alumni, and faculty.

Divestment from fossil fuels gives the university a means of aligning its portfolio with sustainability, especially in parallel with teaching, research, and operations. Brandeis' academic focus on the environment, taught through programs such as Sustainable International Development and Environmental Studies, is an important step forward. However, the Center for Higher Education Research noted that universities must go beyond their curriculums and contribute to the "building of new institutions of civil society, in encouraging and facilitating new cultural values." Brandeis has helped lead in climate change research and preparing students to create a more sustainable world—now it is time for the University to act on the challenge of climate change.

3. The Fossil Fuel Industry has Denied and Delayed Climate Action

Despite overwhelming support within the scientific community (97%), there is still a sizeable population in the United States who argue that climate change is not caused by human activities. A recent report found that while a majority of Americans agreed that the Earth was warming, just 40% believe that human activity is responsible (Appendix D). However, among climate scientists, the certainty that humans are causing recent climate change has been deemed *extremely likely*, defined by the IPCC as having a statistical likelihood of over 95%.

Scholars of public policy, environmental activists, and political leaders eager to rein in carbon emissions have pointed with dismay to the role played by a number of anti-regulatory industry groups, including the American Petroleum Institute, among many others, in cultivating doubt, impugning the motives of climate scientists, and delaying regulatory action (Oreskes and Conway, 2010).

Brulle (2014) published the most comprehensive review yet of these efforts, and identified 110 active "counter climate consensus" groups with annual funding of $900 million, and notes that much of this funding has become increasingly difficult to trace to its source. He explains:

"The climate change counter-movement (CCCM) efforts focus on maintaining a field frame that justifies unlimited use of fossil fuels by attempting to delegitimize the science that supports the necessity of mandatory limits on carbon emissions. To accomplish this goal in the face of massive scientific evidence of anthropogenic climate change has meant the development of an active campaign to manipulate and mislead the public over the nature of climate science and the threat posed by climate change."

The funding of climate denial has lasting effects, creating a politically-charged environment which stifles social cooperation and injures the public trust of science. As an accredited University with strong science programs and an institution that prides itself on forging honest global citizens, Brandeis needs to ask whether investing in fossil fuel companies may be antagonistic to the University's values.

In addition to creating doubt around the severity and sources of climate change, fossil fuel companies are investing billions per year in future exploration when ample evidence suggests that their current reserves already possess more than enough carbon to destabilize the climate. Fossil fuel companies have not attacked the conclusions of the Carbon Tracker report or the science underlying the carbon budget that advises that two-thirds of existing reserves must remain unburnt to stay beneath 2°C. Rather, the industry as a whole, and Exxon Mobil and Shell in particular, argued that rising global demand and a lack of political will meant that their reserves would be extracted and monetized.

"We are confident that none of our hydrocarbon reserves are now or will become 'stranded'", Exxon explained. "We believe producing these assets is essential to meeting growing energy demand worldwide." Likewise Shell responded: "The world will continue to need oil and gas for many decades to come, supporting both demand, and oil and gas prices. As such, we do not believe that any of our proven reserves will become stranded."

Such a response reveals that the carbon majors do not believe citizens and governments possess the political will to impose stringent greenhouse-gas regulations and limit the carbon tap from the supply-side. Thus, to continue to invest in such companies might not only be an endorsement of their dissemination of denial, but also a validation of their dismissal of global democratic governance.

4. The Critical Nature of Energy Investments Over the Next Twenty Years

In addition to its Nobel Prize-winning climate science Assessments, the IPCC has also detailed specific measures necessary for transitioning to a low-carbon global energy infrastructure. Among their recommendations is a profound shift in energy investment. In order to limit global warming to 2°C, the IPCC advises two crucial steps: reducing investment in fossil fuels by $30 billion per year while increasing annual investment in low-carbon sources by $147 billion a year (IPCC, 2014, p. 27).

Carbon-energy firms currently spend 1% of global GDP exploring for fuel reserves that scientists warn must remain unburnt (Caron Tracker, 2013). One percent of global GDP is coincidentally the aggregate investment required for transitioning the world's energy infrastructure to a clean energy future. New extraction and transportation infrastructure projects are a focal point for investor capital. Investment in energy infrastructures is critical because they are capital-intensive, long-term projects that very much determine future energy consumption. Energy systems are socio-technological infrastructures that have tremendous endurance and inertia.

The construction of energy infrastructures is so significant that the IEA has warned that additional fossil fuel projects beyond 2017 risk locking the world's economic system into warming above 2°C. The investments made today— in fossil fuels or low-carbon technologies —will therefore have an outsized effect on the world's ability to reduce carbon pollution. As the Risky Business report concluded, the investments made between 2015 and 2025 will determine much of the world's energy future.

These investments are compounded by the non-linear nature of climate change. If emissions rise too precipitously in the short term, positive feedback loops might drive the climate system into potentially irreversible warming. Therefore, the energy investments made over the next twenty years will do much to determine the severity of the climate crisis.

5. Fossil Fuel Assets May Be Overvalued

The present valuation of fossil fuel reserves without acknowledging the reality of climate change has led to overvaluation of fossil fuel assets. This means that the regulatory action required to address climate change may substantially destabilize the industry's profitability. While the 2014 value of the 1,469 listed oil and gas firms is $4.65 trillion and 275 coal firms are worth $233 billion, carbon asset risk puts these valuations into serious question (Bloomberg New Energy Finance, 2014). The pioneering work of the Carbon Tracker Initiative (CTI), the Oxford University Stranded Assets Programme (OUSAP), and other institutions, have identified and defined the concept of carbon asset risk— the portfolio risk of investing in fossil fuels in the context of climate change.

Carbon asset risk arises most from the threat of a company retaining stranded assets. In the context of upstream energy production, the International Energy Agency (IEA) (2013a) defines stranded assets as "those investments which are made but which, at some time prior to the end of their economic life (as assumed at the investment decision point), are no longer able to earn an economic return, as a result of changes in the market and regulatory environment."

If international communities are committed to limiting warming to 2 °C, then 2/3 to 4/5 of carbon reserves that fossil fuel companies count as assets on their balance sheets will very likely not be monetized. In June 2014, the IEA released an independent analysis projecting that carbon caps strong enough to meet the 2 degrees Celsius threshold could leave nearly $300 billion in stranded fossil fuel investments by 2035.

Concern over investor exposure to overvalued fossil fuel firms precipitated the contemporary divestment movement. In 2013 a group of 75 global investors managing more than $3 trillion of collective assets launched a coordinated effort to spur 45 of the world's top oil, gas, coal and electric power companies to assess the financial risks that climate change poses to their business plans (Ceres, 2013). These efforts call for a reevaluation of fossil fuels' financial risk in the context of stranded assets.

As the Governor of the Bank of England, Mark Carney states, "the vast majority of reserves are unburnable." Carney warns that fossil fuel investors, focused on short-term profits, were not pricing in this reality—a phenomenon he called a "tragedy of horizons." Similarly analysts at HSBC have cautioned that "because of its long-term nature, we doubt the market is pricing in the risk of a loss of value from this issue."

For example in 2013, Storebrand, a Norwegian pension fund, began divesting from companies with a high exposure to coal and oil sands. In 2014 they expanded their divestment even further to include more coal companies. In the words of their head of sustainable investment Christine Tøklep Meisingset: as "climate goals become reality, these resources are worthless financially, but it is also true that they do not contribute to sustainable development in the extent and the pace we want."

In the context of climate change, fossil fuel assets should be reevaluated to reflect the liability they pose to both the Earth and investors.

6. Collective Action is Essential for Mitigating Climate Change

In confronting the challenge of climate change, Brandeis has a clear obligation to reduce its carbon emissions—both on campus and in its investments. Such action is necessary, but perhaps not sufficient. Advocates emphasize that divestment constitutes a collective action that resonates far beyond the confines of the university. As Columbia University Professor of Communications and veteran activist Todd Gitlin argues, "Resonance is the lifeblood of politics." To divest, in short, makes an institution part of a larger movement for social and political change.

Divestment is powerful for its political valence. In stigmatizing the fossil fuel industry, divestment has the potential to be far more effective than just local action. Combating climate change requires a fundamental shift in the global energy economy. History suggests that such a significant shift is only possible when there is momentum from institutional actors for social and political change.

Divestment is more than symbolic. It allows a university's action to produce a significant social statement. As a recent Oxford University study concluded: "In every case we reviewed, divestment campaigns were successful in lobbying for restrictive legislation." Far from merely a "symbolic gesture" these researchers concluded that the "stigmatization process, which the fossil fuel divestment campaign has now triggered, poses the most far-reaching threat to fossil fuel companies and the vast energy value chain."

Divestment is necessary because of the current lack of social and political will. Divestment seeks to change this impasse by creating a tipping point away from the status quo.

In a recent opinion piece, renowned economist Jeffrey Sachs and his wife Lisa Sachs argued that "divestment by leading investors sends a powerful message to the world that climate change is far too dangerous to accept further delays in the transition to a low-carbon future. Divestment is not the only way to send such a message, but it is a potentially powerful one."

The study of history reveals that collective action has been essential in every struggle for social justice and civil rights in this country. Divesting the endowment sends a signal louder than any other that Brandeis demands action on climate change.

7. Fiduciary Responsibility

Bevis Longstreth, commissioner of the SEC under Ronald Reagan, discussed in a 2013 piece called "The Financial Case for Divestment of Fossil Fuel Companies by Endowment Fiduciaries," how fiduciaries of endowments are charged with a duty of care, which is outlined in the American Law Institute's 1991 Restatement of Trusts, Third, Section 227. It states:

"This standard requires the exercise of reasonable care, skill and caution, and is applied to investments not in isolation but in the context of the ...portfolio and as a part of an overall investment strategy, which should incorporate risk and return objectives reasonably suitable to the [purposes of the endowment]."

In this sense, fiduciary responsibility is not a hard line by which trustees judge investments, but the beginning of a conversation; a dialogue about assessing the merits, value, and durability of one's investments. Such responsibility is holistic, thorough, and open-minded. It requires trustees to exercise independent judgment, not follow a formula. Speaking more generally to sustainable investment practices, a 2005 paper by the law firm Freshfields Bruckhaus and Dering concluded that, "integrating

ESG considerations into an investment analysis so as to more reliably predict financial performance, is clearly permissible and is arguably required in all jurisdictions" (Freshfields Bruckhaus Deringer, 2005). With a changing climate, and rapidly shifting financial markets, new modes of analyses and investment are needed.

It is important to note that fiduciaries and lawyers generally emphasize the negatives of taking action, but one should equally weigh the costs of inaction. The Mercer divestment report makes it clear how serious changes in global carbon governance are: "given the risks and opportunities presented by climate change and the rapid introduction of carbon pricing regimes across multiple jurisdictions, trustees have a clear duty to consider climate change risks and relevant laws and policies in making investment decisions when such matters prove to be material" (Mercer, 2013a, p. 4).

The studies presented here demonstrate a clear responsibility on the part of fiduciaries to reevaluate investments in fossil fuels. As Longstreth noted, "An understanding of the standard of care generally applicable to fiduciaries leads easily to the conclusion that divestment of fossil fuel companies on the basis of the financial considerations…is a permissible option." This explains why trustees have the responsibility to thoroughly consider divestment, and if feasible, commit to it.

Conclusion

For many years now, the climate research community has been urging nations everywhere to accelerate de-carbonization, defining 2030- 2040 as the "due date" by which we need to achieve sharp reductions in emissions. Consider the language in the Climate Change Synthesis Report Summary for Policy Makers 2014 by the UN's Intergovernmental Panel on Climate Change (Appendix A):

Substantial emissions reductions over the next few decades can reduce climate risks in the 21st century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the longer term, and contribute to climate-resilient pathways for sustainable development.

The Committee finds that the U.S. should be transitioning off of fossil fuels far more rapidly. As described in the appendix document on clean energy, there is growing consensus that advanced wind turbines and increasingly inexpensive solar technologies are effective enough to meet humanity's growing energy appetite.

The obstacles in the way of speedy progress toward a low-carbon world are not primarily technical or economic in nature, they are mainly political. The current reality of scientific consensus met by doubt and political paralysis is what divestment campaigners seek to change. By divesting, Brandeis can take action that will have significant effects—in terms of steering capital towards needed infrastructure, reducing risk, and using its position of authority as a mechanism for social change and political persuasion.

ACADEMIA AND FOSSIL FUEL DIVESTMENT

Academia's relationship to divestment stems most directly from the anti-Apartheid campaign of the 1970s and 1980s. After facing strong resistance from politicians in Washington D.C.—especially the Reagan administration who viewed support for South Africa through the bipolar lens of the Cold War—activists turned to financial pressure. Beginning in 1977 and escalating in 1983 with the widespread unrest in South Africa, anti-Apartheid activists launched a sustained campaign aimed to deprive the Apartheid regime of both legitimacy and finances. Students eventually pressured 155 American universities—including Brandeis—to divest their endowments from companies supporting the regime. By 1987, roughly 200 companies had withdrawn from South Africa as they were fearful of billions in lost revenue (Coincidentally, this is the same number of publicly-traded companies that Carbon Tracker advises for fossil fuel divestiture).

By 1991, 28 states, 24 counties and 92 cities in the United States had adopted legislation imposing sanctions on South Africa. Activist pressure and financial strain destabilized the regime and probably hastened the transition to a democratic South Africa. Both Nelson Mandela and Desmond Tutu credited the divestment campaign as a key outside pressure tactic during the anti-Apartheid movement. The success of the movement is a primary reason why Desmond Tutu supports fossil fuel divestment as an important tactic to highlight the threat of climate change. While the Apartheid regime is quite different from the fossil fuel industry, the success of the movement is a strong illustration of the influence that academia played in the anti-Apartheid divestment campaign.

The Oxford University report mentioned above, "Stranded Assets and the Fossil Fuel Divestment Campaign", reviewed research by economists and others on the impact of divestment on the legislative process. The report found that "research typically credits divestment by…prominent American universities as heralding a tipping point" in campaigns such as South Africa and tobacco. The Oxford report concluded that divestment has historically constituted a crucial step in galvanizing support for legislation and state action. This same dynamic is certainly possible through fossil fuel divestment, which the authors note has grown faster than any past divestment movement. While only 2% of U.S.-university assets are held in fossil fuel companies, the publicity garnered when institutions divest can be significant. Both advocates and critics of divestment point to academia's leadership role in civil society and their influence in shaping future citizens and leaders.

As of early April 2015, twenty-three U.S. colleges and universities have committed to some form of fossil fuel divestiture. These schools include a large number of private institutions, but also several public universities, and two community colleges. Their endowments range from several million to tens of billions of dollars. Thus far, concerned individuals, communities, cities and counties, religious institutions, colleges and universities have divested over $50 billion from fossil fuels.

Case Studies

In the interest of informing the Board of the range of student activism and actions taken by Universities, four peer institutions—Harvard, Stanford, Boston College and the University of Dayton—are examined here. University responses to date have ranged from no action (Boston College), to reformation of investment criteria (Harvard), to partial divestment (Stanford) and finally to full divestment (Dayton).

Boston College
Student activists began organizing and pressuring Boston College (BC) to divest in December of 2012 and the following year the undergraduate student Senate passed a resolution calling for BC to divest all fossil fuel assets. In the spring of 2013, activists criticized school officials for hosting the CEO of Royal Dutch Shell, arguing that the University was contradicting its Jesuit values. Students emphasized the Catholic Church's strong stance on climate change as a moral issue, and urged administrators to divest the endowment of companies such as Shell. BC activists have participated in a number of rallies and actions coordinated with other Boston-area universities, including Brandeis.

Since the inception of their campaign, the BC administration has rejected any calls for divestment. Administration officials have even rejected making Climate Justice @ Boston College a registered student organization. While the students were granted a meeting with BC President Father Leahy, he informed them that the College would not divest. Tensions continue to rise, and as other institutions take various steps in response to divestment, activists claim they are preparing to escalate their campaign.

Harvard
Over the past three years, a strong fossil fuel divestment movement emerged and grew at Harvard. While first energized by undergraduates, divestment activism currently includes hundreds of law and graduate students, as well as professors and alumni. 72% of Harvard College students voted to divest, and over 1,100 alumni and 65,000 community members have signed in support of divestiture. The City of Cambridge has even issued a proclamation formally congratulating the Divest Harvard campaign for the "important work they undertake to battle climate change."

Since the inception of Divest Harvard, the corporation and its President, Drew Faust Ph.D., have firmly rejected divestment, calling it "political" and not "warranted or wise." Yet pressure continues to mount, and the campaign has already resulted in policy changes to Harvard's investment criteria. Harvard currently holds nearly ~$80 million in fossil fuel stocks out of its $33 billion in total assets.

In April of 2013, 93 faculty signed a letter imploring the University to divest its endowment—the largest university endowment in the world—from the fossil fuel industry as a moral, political, and educational imperative. Since then, the number of faculty signatories has grown to 240. Harvard Faculty for Divestment have held a number of "Teach-Ins" and many have even joined students in fasting to bring awareness to divestment.

In mid-November, a group of Harvard students, most prominently from Harvard Law School, filed a lawsuit against the college for its continued investment in fossil fuels. The *New York Times* reported that students charged the university with "mismanagement of charitable donations" and the "intentional investment in abnormally dangerous activities." The *Times* notes that a past suit concerning the University's racial diversity hiring policies was ultimately unsuccessful but was influential in pushing Harvard to take action on the issue. Furthermore, the plaintiffs penned a scathing op-ed in the *Boston Globe*.

For all of President Faust's resistance to divestment, there are clear signs that the campaign has changed Harvard's investment guidelines. The University recently became the first in the U.S. to sign on to the United Nations supported "Principles for Responsible Investment," as well as joining the Carbon Disclosure Project's climate change program. While focusing on its research efforts and lowering the University's carbon footprint, Faust recognized that Harvard "has a role to play as a long-term investor," especially in "how we consider material, environmental, social, and governmental factors." In announcing this policy shift, Faust explicitly cited the divestment movement.

Despite the administration's change in investment guidelines, Divest Harvard and its faculty and alumni allies remain committed to full divestment. On March 12th, thirty-four students held a "Sit-In" and occupied Massachusetts Hall, home to the offices of the Harvard administration, for over 24 hours. Following this action, a number of prominent Harvard Alumni—including Nobel Peace Prize recipient Desmond Tutu, Robert F. Kennedy Jr., Todd Gitlin, Former SEC Commissioner Bevis Longstreth, Cornell West, former Colorado Senator Tim Wirth, and Bill McKibben—announced "Harvard Heat Week," a 6-day long series of teach-ins, direct action, and civil disobedience to convince Harvard to divest. This week of action is planned for April 2015.

Stanford

On May 6th, 2014, Stanford University announced it would no longer make direct investments in coal companies and would divest from those which it currently holds. A formal committee concluded that while the intent of the endowment was to maximize returns for the benefit of furthering educational opportunities, investing in coal clearly constituted a practice that created "substantial social injury" and therefore should be excluded. Stanford is thus far the most prominent U.S. University to divest a part of its endowment from fossil fuels.

The move was precipitated by the student-led Fossil Free Stanford, which in addition to other actions, authored a comprehensive report outlining the logic of divestment. "Fossil Free Stanford catalyzed an important discussion, and the university has pursued a careful, research-based evaluation of the issues," said Steven A. Denning, chairman of the Stanford Board of Trustees. Stanford's endowment is currently valued at $21.4 billion.

The University's formal findings cited the IPCC, which has increasingly warned in its five reports (1990– 2014) of the dangers of fossil fuel combustion. Stanford received both praise and criticism for its decision to divest from coal and pressure continues to mount for further action.

In January 2015, some 300 Stanford Faculty—including a former President of the University, two Nobel Laureates, and this year's Field's Medal Winner—signed a letter (Appendix I) to Stanford's President urging full divestment of all fossil fuel stocks. To continue to invest and profit from these companies, they claimed, presented a "Paradox: if a university seeks to educate extraordinary youth so they may achieve the brightest possible future, what does it mean for that university simultaneously to invest in the destruction of that future?"

Dayton

On June 23rd, 2014, the University of Dayton formally announced that it would divest its entire $670 million endowment of fossil fuel investments. Its press release noted that the unanimous decision by the Board of Trustees meant that Dayton was the first Catholic University in the nation to divest. The University plans to divest its assets in phases over the next few years.

The Board's decision appeared to be guided by two dominant concerns: the problematic ethics of investing in fossil fuels and their financial risk. "The tremendous moral imperative to act in accordance with our mission far outweighed any other considerations for divestment," explained the Rev. Martin Solma, a member of the board's investment committee. Yet Thomas Van Dyck, a Senior Vice President for RBC SRI Wealth Management Group—with whom the University consulted—added that the decision also reflected financial concerns with the risks of fossil fuel investments. "Fossil fuel companies have a valuation that assumes every single drop of oil, everything they have in the ground, will be taken out," Dyck said, suggesting that climate policies would prevent these assets from being realized. "It's not only values, but valuation risk associated with owning fossil fuel companies."

Dayton's decision to divest is significant for two dominant reasons. The size of Dayton's $670 million-dollar endowment mirrors Brandeis's own. Similarly, Dayton and Brandeis are both elite, private Universities.

DIVESTMENT AT BRANDEIS

Over a dozen Brandeis students attended 350.org's "Do the Math" event held in Boston in the fall of 2012. Following this, Brandeis's fossil fuel divestment campaign was launched. Brandeis members of Students for a Just and Stable Future (SJSF), a Massachusetts coalition of college climate action groups, coordinated its first meeting for divesting Brandeis. Attendees included, among others, members of the University's main environmental group, Students for Environmental Action (SEA) and several faculty. As one of the lead organizers, Tali Smookler '13, reminded the Committee in an April 2014 email, "We were thinking for ourselves, not just doing 350.org plans….we wanted to see an outcome in line with Brandeis' values." Over the next three months, the Brandeis Fossil Fuel Divestment Campaign began to raise awareness about the cause, meet with university administrators and professors, and worked on passing a Student Union petition in favor of divestment.

Following the January meeting, students from Brandeis SJSF and SEA organized a campus petition drive and managed to place a question about divestment on the spring 2013 election ballot. On April 25th, a strong majority (79%) of students voted to support the petition urging Brandeis University to divest. This overwhelming approval indicated widespread student support for the operative clause of the petition: "We support Brandeis University divesting its endowment from the fossil fuel industry in order to avert further environmental and human rights crises as a result of climate change."

With these results in hand, and with fossil fuel divestment campaigns elsewhere receiving regular coverage in major media, students approached the Brandeis administration, requesting that the school evaluate divesting from fossil fuels. Representatives of the student movement had previously met with Senior Vice President for Students and Enrollment, Andrew Flagel, to discuss divestment. After the success of the petition, a second meeting occurred on April 26th, 2013, in which Dr. Flagel proposed the creation of the Committee to the students. Also attending the meeting were Senior Vice President and Chief of Staff David Bunis, then Senior Vice President for Communications Ellen de Graffenreid, Chief Investment Officer Nicholas Warren, and Associate Professor Dan Perlman.

After deliberating on next steps, President Lawrence announced the formation of a Committee on Divestment on the 30th of Sept. 2013. Since then, Brandeis' chapter of Students for a Just and Stable Future (now chartered as Brandeis Climate Justice) has been supporting the committee process, while also mobilizing Brandeis students to off-campus actions opposed to fossil fuel infrastructure. These included the "Rejection Denied" banner drop in Cambridge in Dec. 2013, a rally against a proposed natural gas plant in Salem in Feb. 2014, the XL Dissent march and direct action at the White House in March 2014, the Walkout for Climate Justice at the Massachusetts State House in March 2014, and the People's Climate March in New York City in Sept. 2014 (Appendix F).

On-campus educational and awareness efforts have continued, including the March 2014 Divest Fest march, the Oct. 2014 "Good News on Climate Change" faculty teach-in, and the Feb. 2014 FACT rally and petition delivery to Provost Lynch. The last of these were collaborations between the undergraduate group Brandeis Climate Justice and the professors of Faculty Against the Climate Threat (FACT), who have thus far collected 145 faculty signatures in support of divestment (Appendix G).

Roughly 70 current Brandeis students attended the People's Climate March, along with a dozen faculty members. New York City, September 21, 2014. Photo by Iona Feldman.

RESPONSIBLE INVESTING

Portfolio Investing Options: Responsible Investing and Reducing Carbon Footprint

The challenges of climate change are very real. The IPCC (2014) underscores the critical impact of increased CO_2 levels on the earth's environment: temperatures, sea levels, weather patterns, arable land, species, and our current living patterns. The assessment warns that temperature increases over 2^oC (3.6^oF) are likely to occur by 2050 if we do not reduce our CO_2 levels by 40-70% over the coming years. The IPCC and climate scientists urge us to reduce our carbon footprint while pursuing sustainable growth policies.

Given the seriousness of CO_2 levels and temperature rise, independent actions are required, especially given the fact that UN climate representatives are quite concerned about the slow progress towards international climate agreements. There continue to be significant political differences among countries and regions regarding economic priorities and implementation of mitigation policies. With inadequate international action, climate advocates feel that everything should be done to reduce our carbon footprint and consumption of fossil fuels.

While the University also has a fiduciary obligation to prudently meet its investment targets to support the community and its students, the social justice mission of Brandeis calls the University to become a more socially-responsible investor (SRI). Brandeis should strive to meet both its investment return target and social justice goals. Divestment and responsible investing represent potentially complementary paths to such goals. Both deserve further examination and consideration.

Brandeis Investment Committee Objectives

Brandeis University has a relatively small endowment in comparison to its more established peer institutions (Appendix L). As a prominent research university, Brandeis strives to build our endowment to support the mission of the school, while also achieving above market returns to help cover the daily operations of the University. To accomplish this, the University's small Investment Office works with a select group of 38 asset managers to achieve the University's investment criteria of above market returns (5%) at lower risk. This is a challenging goal that the Investment Office has often reached over the past 15 years.

The University's managers actively evaluate the opportunities, try to anticipate surprises, and develop hedging options that often call for sophisticated investment tactics. Given the volatility of the market since 2008, this has involved using energy investments (public and private) as both a hedge against inflation and as investments for above market returns (shale oil). Brandeis' endowment professionals have historically relied upon fossil fuel investments because they constitute a significant part of world market capitalization (7-12%).

Given the importance of energy in world markets and its strong correlation with inflation, eliminating fossil fuel investments in our endowment could potentially reduce our portfolio returns. However, not all energy investments are in fossil fuels. The Brandeis Investment Office estimates that full divestment of fossil fuels could reduce annual returns up to 2%, or $18 million. Clearly, this is a significant potential cost that needs to be evaluated carefully in light of the various divestment recommendations.

Other sustainable investment options that are recommended by the Divestment Committee might also involve a significant allocation of time and resources by the University's Investment Office. The carbon footprint of Brandeis' portfolio could be measured and compared with other investment options. This would involve an outside consultant. However, a detailed analysis of the carbon footprint of the endowment would give the University the information it needs to consider the pros and cons of various sustainable investment options.

Options

The Divestment Committee was charged to look at the financial impact of divestment on the portfolio and examine ways of reducing the carbon footprint across the University's investments. Divestment is a strong political statement that despite increasing support might not please everyone. Therefore, Brandeis might also actively pursue alternative responsible investing options. This would involve measuring the University's carbon footprint and other environmental impacts with portfolio return targets. What are the responsible, environmentally-sensitive investment options that meet our return targets and risk profile?

In the investment world, there are a growing number of empirical analyses that show it is possible to reduce the carbon footprint of the portfolio while still meeting investment return targets (market returns not high alphas). For Brandeis, there appear to be two investment options:

- Explore and participate in various socially responsible investment (SRI) or environment, social and government funds (ESG) that have measurable performance metrics and history. (Walden Asset Management, MSCI, Boston Common, Calvert, or other ESG funds). We should actively evaluate the risk/return and socially responsible investment performance of ESG/SRI funds in comparison to broad market indices.
- Traditionally, Brandeis pursues a more active investment strategy working with a select group of fund managers to meet the University's investment criteria of higher alphas (Appendix L). Besides measuring our managers on risk/return performance goals, the University could also request that we measure and track the "carbon footprint," of our investment managers. This might require companies to report ESG information, which would allow us to explore ways of proactively reducing the carbon footprint of our investments while meeting return targets.

Within the financial community there are advocates for environmentally sound investment portfolios. For example, a June 2013 study on divestment produced by the leading global consulting firm, Mercer, recognizes the fiduciary duty of trustees to confront the climate crisis. It cites a 2005 report by British law firm, Freshfields Bruckhaus Deringer, that argues: "integrating ESG considerations into an investment analysis so as to more reliably predict financial performance is clearly permissible and is arguably required in all jurisdictions" (Mercer, 4). Mercer encourages clients, "to consider responsible investment approaches and the proactive management of climate risk" (Mercer, 7). This call for action reflects the severity of the threat presented by climate change and the agency possessed by trustees to confront it with responsible investing.

Given our current investment approach—managers rather than funds—we might work with investment consultants like Trucost to evaluate various responsible investment options (Appendix N). The proposal by Trucost shows how an outside firm would collect data and work with a number of our investment managers to evaluate the risk/returns and ESG tradeoffs of our current investment strategies. In other words, we may find that reducing the "carbon footprint" by 10% generates a minimal decline in returns (0.2%) and no change in volatility.

The challenges of climate change necessitate action even without forceful national and international policies. Responsible investing is a compelling way that Brandeis can achieve a reduction in its "carbon footprint", meet its investment criteria and demonstrate our leadership, while ensuring its commitment to social justice values and stewardship of our planet.

Divestment as a Complementary Tactic

Mercer notes that divestment is "likely to have up-front and recurring costs" (Mercer, 5). Several other reports, produced by reputable financial institutions, discuss the benefits of divestment and the minimal risk to endowment returns presented by divestment. For example, the report entitled Fossil Fuel Divestment: Risks and Opportunities by Impax Asset Management, analyzed four different divestment approaches over a five-year period and determined that: "removing the fossil fuel sector in its entirety and replacing it with 'fossil free' portfolios of energy efficiency, renewable energy, and other alternative energy stocks…would have improved returns" (Impax, 4).

A 2013 report by the Aperio Group revealed that by excluding the 15 most harmful fossil fuel companies a portfolio only increased risk by a negligible 0.0006% (Aperio, 3). Furthermore, entirely excluding the fossil fuel industry from a portfolio increases risk by only 0.0101% (Aperio, 4). Upholding the University's commitment to social justice clearly outweighs such an insignificant risk. The report concludes that although the study performed by Aperio cannot be generalized to all portfolios, it does demonstrate how the financial risk posed by divestment "may be far less significant than presumed". Therefore, it is incumbent upon "anyone on an endowment board," who is considering divestment, to "at least do the math, in this case the investment math" (Aperio, 6).

A study by research firm S&P Capital IQ, discovered that endowments could have significantly benefited from fossil fuel divestment over the past decade. The research firm calculated total returns based on the S&P 500 and revealed that an endowment divested of fossil fuels worth $1 billion would have grown to $2.26 billion over the past decade. Conversely one that did not would have grown to only $2.14 billion. While the 1% variation in returns in small, for Brandeis that extra $119 million could have funded 490 full four-year scholarships, using the current tuition for students who have enrolled after Spring 2012 of $60,750 (Brandeis University, "Tuition and Fees").

Moreover, Bloomberg New Energy Finance forecasts in its White Paper on Divestment that more than $2.8 trillion will be invested in renewable energy in the next 10 years (Bloomberg, 8). Divestment may be an opportunity for the University to cease supporting fossil fuel companies and make above market returns on the emerging renewable energy/efficiency sector.

The Impax report finds that given the growing consensus on the severity of climate change, increased carbon regulation by national governments and international agreements is likely to occur. It continues:

"While many investors may be confident that they can anticipate such regulation and will be able to exit high-carbon investments before their value is significantly eroded, there is considerable uncertainty around the timing and nature of future carbon regulation. Recent history of financial markets suggests that few investors will be able to successfully anticipate any sudden re-pricing and/or stranding of fossil fuel assets that result. Additional considerations should include the falling demand for fossil fuels from the substitution of competing low carbon energy generation such as wind and solar, and from energy efficiency and other technologies, particularly in the industrial, commercial and transportation sectors" (Impax, 8).

Several other reports have been published that contain similar conclusions regarding divestment. Two papers from MSCI and a study by Advisor Partners illustrate the feasibility and profitability of divestment (Appendix O).

These reports show how the University could pursue divestment and meet market return targets. The University has the opportunity to evaluate divestment strategies and responsible investment options to determine the best course of action. A combined strategy of divestment and responsible investment, using the University's "carbon footprint" or the ESG/SRI guidelines as metrics, may prove to be the most financially-productive and environmentally-conscious path at a reasonable cost.

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Climate Change 2014
Synthesis Report
Summary for Policymakers

SPM

Introduction

This Synthesis Report is based on the reports of the three Working Groups of the Intergovernmental Panel on Climate Change (IPCC), including relevant Special Reports. It provides an integrated view of climate change as the final part of the IPCC's Fifth Assessment Report (AR5).

This summary follows the structure of the longer report which addresses the following topics: Observed changes and their causes; Future climate change, risks and impacts; Future pathways for adaptation, mitigation and sustainable development; Adaptation and mitigation.

In the Synthesis Report, the certainty in key assessment findings is communicated as in the Working Group Reports and Special Reports. It is based on the author teams' evaluations of underlying scientific understanding and is expressed as a qualitative level of confidence (from *very low* to *very high*) and, when possible, probabilistically with a quantified likelihood (from *exceptionally unlikely* to *virtually certain*)[1]. Where appropriate, findings are also formulated as statements of fact without using uncertainty qualifiers.

This report includes information relevant to Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC).

SPM 1. Observed Changes and their Causes

Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems. *{1}*

SPM 1.1 Observed changes in the climate system

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen. *{1.1}*

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. The period from 1983 to 2012 was *likely* the warmest 30-year period of the last 1400 years in the Northern Hemisphere, where such assessment is possible (*medium confidence*). The globally averaged combined land and ocean surface temperature data as calculated by a linear trend show a warming of 0.85 [0.65 to 1.06] °C[2] over the period 1880 to 2012, when multiple independently produced datasets exist (Figure SPM.1a). *{1.1.1, Figure 1.1}*

In addition to robust multi-decadal warming, the globally averaged surface temperature exhibits substantial decadal and interannual variability (Figure SPM.1a). Due to this natural variability, trends based on short records are very sensitive to the beginning and end dates and do not in general reflect long-term climate trends. As one example, the rate of warming over

[1] Each finding is grounded in an evaluation of underlying evidence and agreement. In many cases, a synthesis of evidence and agreement supports an assignment of confidence. The summary terms for evidence are: limited, medium or robust. For agreement, they are low, medium or high. A level of confidence is expressed using five qualifiers: very low, low, medium, high and very high, and typeset in italics, e.g., *medium confidence*. The following terms have been used to indicate the assessed likelihood of an outcome or a result: virtually certain 99–100% probability, very likely 90–100%, likely 66–100%, about as likely as not 33–66%, unlikely 0–33%, very unlikely 0–10%, exceptionally unlikely 0–1%. Additional terms (extremely likely 95–100%, more likely than not >50–100%, more unlikely than likely 0–<50%, extremely unlikely 0–5%) may also be used when appropriate. Assessed likelihood is typeset in italics, e.g., *very likely*. See for more details: Mastrandrea, M.D., C.B. Field, T.F. Stocker, O. Edenhofer, K.L. Ebi, D.J. Frame, H. Held, E. Kriegler, K.J. Mach, P.R. Matschoss, G.-K. Plattner, G.W. Yohe and F.W. Zwiers, 2010: Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties, Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland, 4 pp.

[2] Ranges in square brackets or following '±' are expected to have a 90% likelihood of including the value that is being estimated, unless otherwise stated.

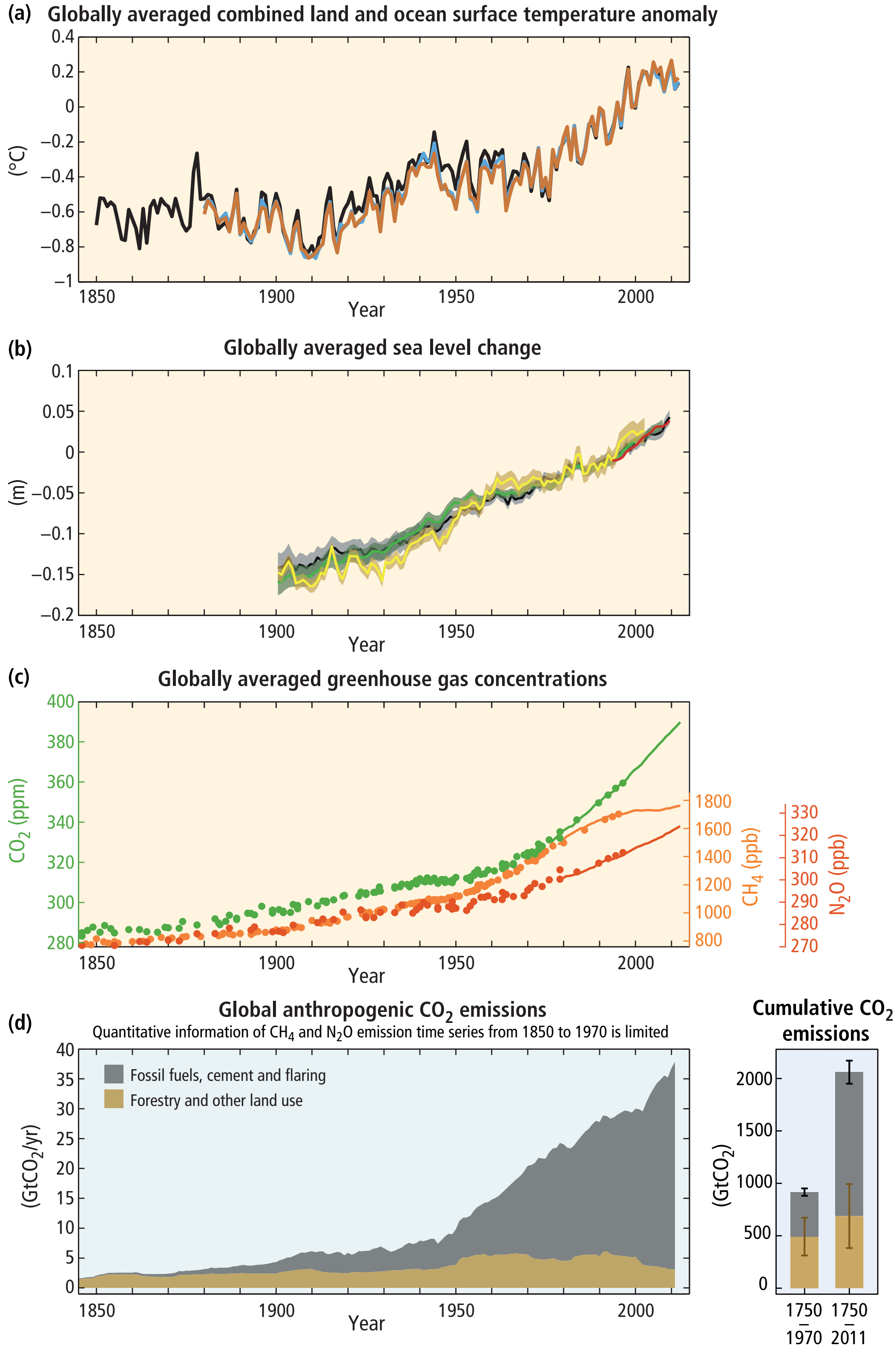

Figure SPM.1 | The complex relationship between the observations (panels a, b, c, yellow background) and the emissions (panel d, light blue background) is addressed in Section 1.2 and Topic 1. Observations and other indicators of a changing global climate system. Observations: **(a)** Annually and globally averaged combined land and ocean surface temperature anomalies relative to the average over the period 1986 to 2005. Colours indicate different data sets. **(b)** Annually and globally averaged sea level change relative to the average over the period 1986 to 2005 in the longest-running dataset. Colours indicate different data sets. All datasets are aligned to have the same value in 1993, the first year of satellite altimetry data (red). Where assessed, uncertainties are indicated by coloured shading. **(c)** Atmospheric concentrations of the greenhouse gases carbon dioxide (CO_2, green), methane (CH_4, orange) and nitrous oxide (N_2O, red) determined from ice core data (dots) and from direct atmospheric measurements (lines). Indicators: **(d)** Global anthropogenic CO_2 emissions from forestry and other land use as well as from burning of fossil fuel, cement production and flaring. Cumulative emissions of CO_2 from these sources and their uncertainties are shown as bars and whiskers, respectively, on the right hand side. The global effects of the accumulation of CH_4 and N_2O emissions are shown in panel c. Greenhouse gas emission data from 1970 to 2010 are shown in Figure SPM.2. *{Figures 1.1, 1.3, 1.5}*

SPM

the past 15 years (1998–2012; 0.05 [–0.05 to 0.15] °C per decade), which begins with a strong El Niño, is smaller than the rate calculated since 1951 (1951–2012; 0.12 [0.08 to 0.14] °C per decade). *{1.1.1, Box 1.1}*

Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010 (*high confidence*), with only about 1% stored in the atmosphere. On a global scale, the ocean warming is largest near the surface, and the upper 75 m warmed by 0.11 [0.09 to 0.13] °C per decade over the period 1971 to 2010. It is *virtually certain* that the upper ocean (0−700 m) warmed from 1971 to 2010, and it *likely* warmed between the 1870s and 1971. *{1.1.2, Figure 1.2}*

Averaged over the mid-latitude land areas of the Northern Hemisphere, precipitation has increased since 1901 (*medium confidence* before and *high confidence* after 1951). For other latitudes, area-averaged long-term positive or negative trends have *low confidence*. Observations of changes in ocean surface salinity also provide indirect evidence for changes in the global water cycle over the ocean (*medium confidence*). It is *very likely* that regions of high salinity, where evaporation dominates, have become more saline, while regions of low salinity, where precipitation dominates, have become fresher since the 1950s. *{1.1.1, 1.1.2}*

Since the beginning of the industrial era, oceanic uptake of CO_2 has resulted in acidification of the ocean; the pH of ocean surface water has decreased by 0.1 (*high confidence*), corresponding to a 26% increase in acidity, measured as hydrogen ion concentration. *{1.1.2}*

Over the period 1992 to 2011, the Greenland and Antarctic ice sheets have been losing mass (*high confidence*), *likely* at a larger rate over 2002 to 2011. Glaciers have continued to shrink almost worldwide (*high confidence*). Northern Hemisphere spring snow cover has continued to decrease in extent (*high confidence*). There is *high confidence* that permafrost temperatures have increased in most regions since the early 1980s in response to increased surface temperature and changing snow cover. *{1.1.3}*

The annual mean Arctic sea-ice extent decreased over the period 1979 to 2012, with a rate that was *very likely* in the range 3.5 to 4.1% per decade. Arctic sea-ice extent has decreased in every season and in every successive decade since 1979, with the most rapid decrease in decadal mean extent in summer (*high confidence*). It is *very likely* that the annual mean Antarctic sea-ice extent increased in the range of 1.2 to 1.8% per decade between 1979 and 2012. However, there is *high confidence* that there are strong regional differences in Antarctica, with extent increasing in some regions and decreasing in others. *{1.1.3, Figure 1.1}*

Over the period 1901 to 2010, global mean sea level rose by 0.19 [0.17 to 0.21] m (Figure SPM.1b). The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia (*high confidence*). *{1.1.4, Figure 1.1}*

SPM 1.2 Causes of climate change

Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are *extremely likely* to have been the dominant cause of the observed warming since the mid-20th century. *{1.2, 1.3.1}*

Anthropogenic greenhouse gas (GHG) emissions since the pre-industrial era have driven large increases in the atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) (Figure SPM.1c). Between 1750 and 2011, cumulative anthropogenic CO_2 emissions to the atmosphere were 2040 ± 310 $GtCO_2$. About 40% of these emissions have remained in the atmosphere (880 ± 35 $GtCO_2$); the rest was removed from the atmosphere and stored on land (in plants and soils) and in the ocean. The ocean has absorbed about 30% of the emitted anthropogenic CO_2, causing ocean acidification. About half of the anthropogenic CO_2 emissions between 1750 and 2011 have occurred in the last 40 years (*high confidence*) (Figure SPM.1d). *{1.2.1, 1.2.2}*

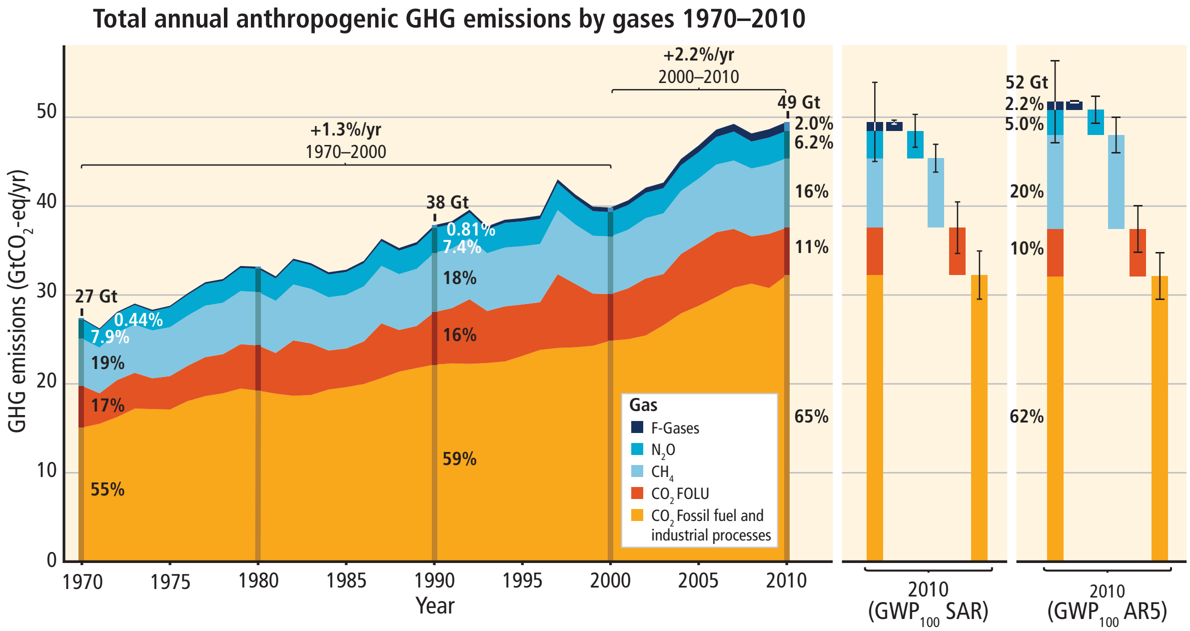

Figure SPM.2 | Total annual anthropogenic greenhouse gas (GHG) emissions (gigatonne of CO_2-equivalent per year, $GtCO_2$-eq/yr) for the period 1970 to 2010 by gases: CO_2 from fossil fuel combustion and industrial processes; CO_2 from Forestry and Other Land Use (FOLU); methane (CH_4); nitrous oxide (N_2O); fluorinated gases covered under the Kyoto Protocol (F-gases). Right hand side shows 2010 emissions, using alternatively CO_2-equivalent emission weightings based on IPCC Second Assessment Report (SAR) and AR5 values. Unless otherwise stated, CO_2-equivalent emissions in this report include the basket of Kyoto gases (CO_2, CH_4, N_2O as well as F-gases) calculated based on 100-year Global Warming Potential (GWP_{100}) values from the SAR (see Glossary). Using the most recent GWP_{100} values from the AR5 (right-hand bars) would result in higher total annual GHG emissions (52 $GtCO_2$-eq/yr) from an increased contribution of methane, but does not change the long-term trend significantly. *{Figure 1.6, Box 3.2}*

Total anthropogenic GHG emissions have continued to increase over 1970 to 2010 with larger absolute increases between 2000 and 2010, despite a growing number of climate change mitigation policies. Anthropogenic GHG emissions in 2010 have reached 49 ± 4.5 $GtCO_2$-eq/yr [3]. Emissions of CO_2 from fossil fuel combustion and industrial processes contributed about 78% of the total GHG emissions increase from 1970 to 2010, with a similar percentage contribution for the increase during the period 2000 to 2010 (*high confidence*) (Figure SPM.2). Globally, economic and population growth continued to be the most important drivers of increases in CO_2 emissions from fossil fuel combustion. The contribution of population growth between 2000 and 2010 remained roughly identical to the previous three decades, while the contribution of economic growth has risen sharply. Increased use of coal has reversed the long-standing trend of gradual decarbonization (i.e., reducing the carbon intensity of energy) of the world's energy supply (*high confidence*). *{1.2.2}*

The evidence for human influence on the climate system has grown since the IPCC Fourth Assessment Report (AR4). It is *extremely likely* that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in GHG concentrations and other anthropogenic forcings together. The best estimate of the human-induced contribution to warming is similar to the observed warming over this period (Figure SPM.3). Anthropogenic forcings have *likely* made a substantial contribution to surface temperature increases since the mid-20th century over every continental region except Antarctica[4]. Anthropogenic influences have *likely* affected the global water cycle since 1960 and contributed to the retreat of glaciers since the 1960s and to the increased surface melting of the Greenland ice sheet since 1993. Anthropogenic influences have *very likely* contributed to Arctic sea-ice loss since 1979 and have *very likely* made a substantial contribution to increases in global upper ocean heat content (0–700 m) and to global mean sea level rise observed since the 1970s. *{1.3, Figure 1.10}*

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[3] Greenhouse gas emissions are quantified as CO_2-equivalent ($GtCO_2$-eq) emissions using weightings based on the 100-year Global Warming Potentials, using IPCC Second Assessment Report values unless otherwise stated. *{Box 3.2}*

[4] For Antarctica, large observational uncertainties result in *low confidence* that anthropogenic forcings have contributed to the observed warming averaged over available stations.

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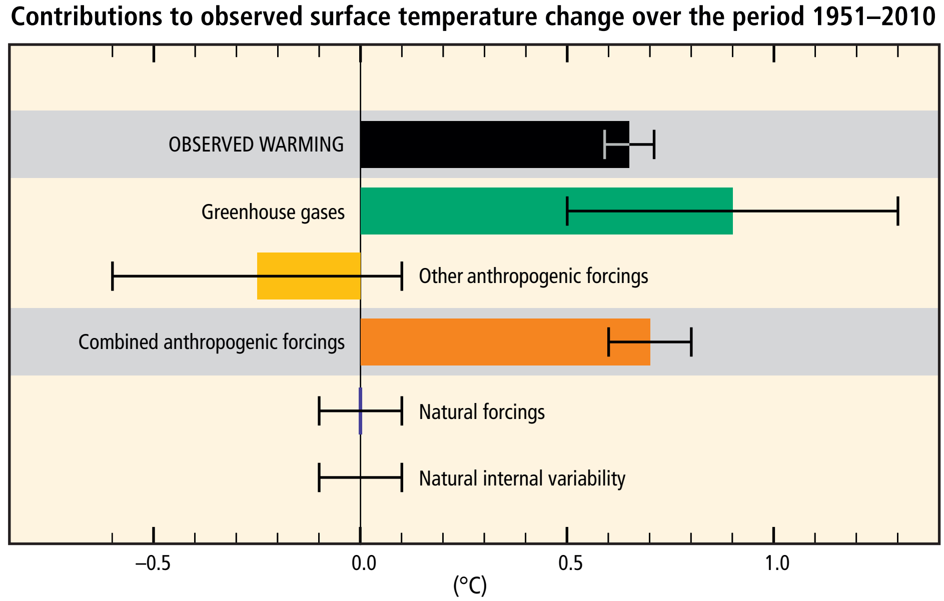

Figure SPM.3 | Assessed *likely* ranges (whiskers) and their mid-points (bars) for warming trends over the 1951–2010 period from well-mixed greenhouse gases, other anthropogenic forcings (including the cooling effect of aerosols and the effect of land use change), combined anthropogenic forcings, natural forcings and natural internal climate variability (which is the element of climate variability that arises spontaneously within the climate system even in the absence of forcings). The observed surface temperature change is shown in black, with the 5 to 95% uncertainty range due to observational uncertainty. The attributed warming ranges (colours) are based on observations combined with climate model simulations, in order to estimate the contribution of an individual external forcing to the observed warming. The contribution from the combined anthropogenic forcings can be estimated with less uncertainty than the contributions from greenhouse gases and from other anthropogenic forcings separately. This is because these two contributions partially compensate, resulting in a combined signal that is better constrained by observations. *{Figure 1.9}*

SPM 1.3 Impacts of climate change

In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate. *{1.3.2}*

Evidence of observed climate change impacts is strongest and most comprehensive for natural systems. In many regions, changing precipitation or melting snow and ice are altering hydrological systems, affecting water resources in terms of quantity and quality (*medium confidence*). Many terrestrial, freshwater and marine species have shifted their geographic ranges, seasonal activities, migration patterns, abundances and species interactions in response to ongoing climate change (*high confidence*). Some impacts on human systems have also been attributed to climate change, with a major or minor contribution of climate change distinguishable from other influences (Figure SPM.4). Assessment of many studies covering a wide range of regions and crops shows that negative impacts of climate change on crop yields have been more common than positive impacts (*high confidence*). Some impacts of ocean acidification on marine organisms have been attributed to human influence (*medium confidence*). *{1.3.2}*

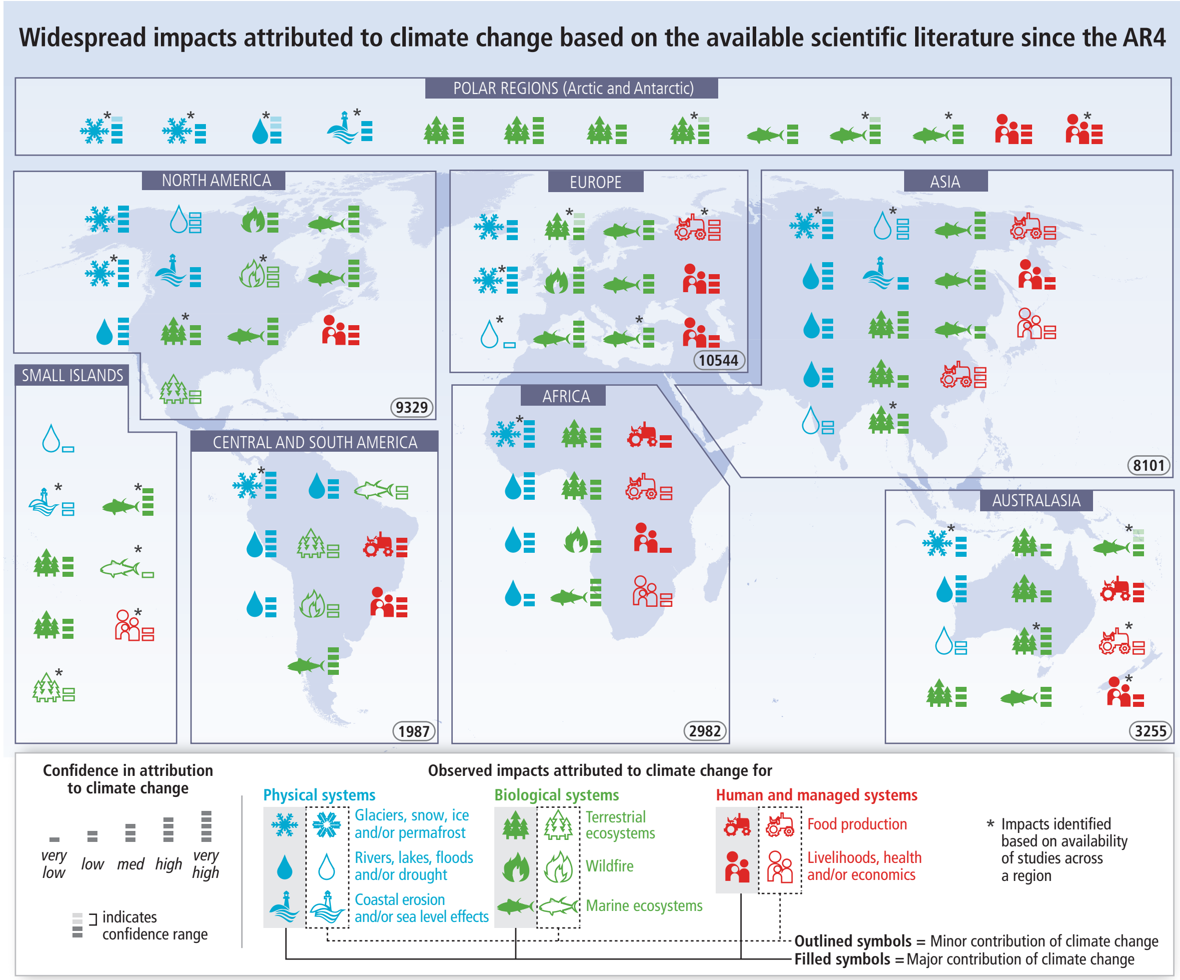

Figure SPM.4 | Based on the available scientific literature since the IPCC Fourth Assessment Report (AR4), there are substantially more impacts in recent decades now attributed to climate change. Attribution requires defined scientific evidence on the role of climate change. Absence from the map of additional impacts attributed to climate change does not imply that such impacts have not occurred. The publications supporting attributed impacts reflect a growing knowledge base, but publications are still limited for many regions, systems and processes, highlighting gaps in data and studies. Symbols indicate categories of attributed impacts, the relative contribution of climate change (major or minor) to the observed impact and confidence in attribution. Each symbol refers to one or more entries in WGII Table SPM.A1, grouping related regional-scale impacts. Numbers in ovals indicate regional totals of climate change publications from 2001 to 2010, based on the Scopus bibliographic database for publications in English with individual countries mentioned in title, abstract or key words (as of July 2011). These numbers provide an overall measure of the available scientific literature on climate change across regions; they do not indicate the number of publications supporting attribution of climate change impacts in each region. Studies for polar regions and small islands are grouped with neighbouring continental regions. The inclusion of publications for assessment of attribution followed IPCC scientific evidence criteria defined in WGII Chapter 18. Publications considered in the attribution analyses come from a broader range of literature assessed in the WGII AR5. See WGII Table SPM.A1 for descriptions of the attributed impacts. *{Figure 1.11}*

SPM 1.4 Extreme events

Changes in many extreme weather and climate events have been observed since about 1950. Some of these changes have been linked to human influences, including a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels and an increase in the number of heavy precipitation events in a number of regions. *{1.4}*

It is *very likely* that the number of cold days and nights has decreased and the number of warm days and nights has increased on the global scale. It is *likely* that the frequency of heat waves has increased in large parts of Europe, Asia and Australia. It is *very likely* that human influence has contributed to the observed global scale changes in the frequency and intensity of daily temperature extremes since the mid-20th century. It is *likely* that human influence has more than doubled the probability of occurrence of heat waves in some locations. There is *medium confidence* that the observed warming has increased heat-related human mortality and decreased cold-related human mortality in some regions. *{1.4}*

There are *likely* more land regions where the number of heavy precipitation events has increased than where it has decreased. Recent detection of increasing trends in extreme precipitation and discharge in some catchments implies greater risks of flooding at regional scale (*medium confidence*). It is *likely* that extreme sea levels (for example, as experienced in storm surges) have increased since 1970, being mainly a result of rising mean sea level. *{1.4}*

Impacts from recent climate-related extremes, such as heat waves, droughts, floods, cyclones and wildfires, reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability (*very high confidence*). *{1.4}*

SPM 2. Future Climate Changes, Risks and Impacts

Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks. *{2}*

SPM 2.1 Key drivers of future climate

Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond. Projections of greenhouse gas emissions vary over a wide range, depending on both socio-economic development and climate policy. *{2.1}*

Anthropogenic GHG emissions are mainly driven by population size, economic activity, lifestyle, energy use, land use patterns, technology and climate policy. The Representative Concentration Pathways (RCPs), which are used for making projections based on these factors, describe four different 21st century pathways of GHG emissions and atmospheric concentrations, air pollutant emissions and land use. The RCPs include a stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0) and one scenario with very high GHG emissions (RCP8.5). Scenarios without additional efforts to constrain emissions ('baseline scenarios') lead to pathways ranging between RCP6.0 and RCP8.5 (Figure SPM.5a). RCP2.6 is representative of a scenario that aims to keep global warming *likely* below 2°C above pre-industrial temperatures. The RCPs are consistent with the wide range of scenarios in the literature as assessed by WGIII[5]. *{2.1, Box 2.2, 4.3}*

Multiple lines of evidence indicate a strong, consistent, almost linear relationship between cumulative CO_2 emissions and projected global temperature change to the year 2100 in both the RCPs and the wider set of mitigation scenarios analysed in WGIII (Figure SPM.5b). Any given level of warming is associated with a range of cumulative CO_2 emissions[6], and therefore, e.g., higher emissions in earlier decades imply lower emissions later. *{2.2.5, Table 2.2}*

[5] Roughly 300 baseline scenarios and 900 mitigation scenarios are categorized by CO_2-equivalent concentration (CO_2-eq) by 2100. The CO_2-eq includes the forcing due to all GHGs (including halogenated gases and tropospheric ozone), aerosols and albedo change.

[6] Quantification of this range of CO_2 emissions requires taking into account non-CO_2 drivers.

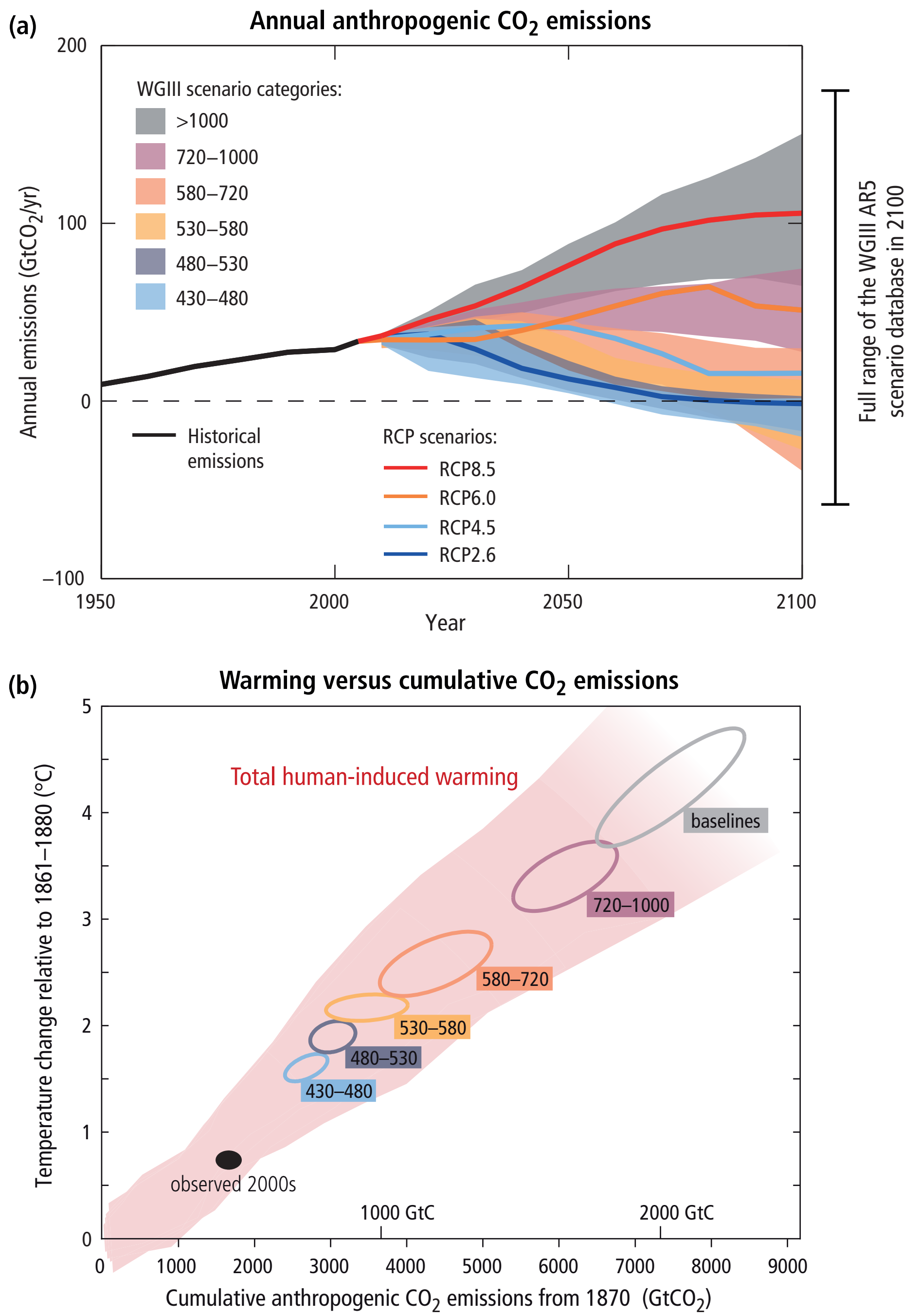

Figure SPM.5 | **(a)** Emissions of carbon dioxide (CO_2) alone in the Representative Concentration Pathways (RCPs) (lines) and the associated scenario categories used in WGIII (coloured areas show 5 to 95% range). The WGIII scenario categories summarize the wide range of emission scenarios published in the scientific literature and are defined on the basis of CO_2-eq concentration levels (in ppm) in 2100. The time series of other greenhouse gas emissions are shown in Box 2.2, Figure 1. **(b)** Global mean surface temperature increase at the time global CO_2 emissions reach a given net cumulative total, plotted as a function of that total, from various lines of evidence. Coloured plume shows the spread of past and future projections from a hierarchy of climate-carbon cycle models driven by historical emissions and the four RCPs over all times out to 2100, and fades with the decreasing number of available models. Ellipses show total anthropogenic warming in 2100 versus cumulative CO_2 emissions from 1870 to 2100 from a simple climate model (median climate response) under the scenario categories used in WGIII. The width of the ellipses in terms of temperature is caused by the impact of different scenarios for non-CO_2 climate drivers. The filled black ellipse shows observed emissions to 2005 and observed temperatures in the decade 2000–2009 with associated uncertainties. *{Box 2.2, Figure 1; Figure 2.3}*

Multi-model results show that limiting total human-induced warming to less than 2°C relative to the period 1861–1880 with a probability of >66%[7] would require cumulative CO_2 emissions from all anthropogenic sources since 1870 to remain below about 2900 $GtCO_2$ (with a range of 2550 to 3150 $GtCO_2$ depending on non-CO_2 drivers). About 1900 $GtCO_2$[8] had already been emitted by 2011. For additional context see Table 2.2. *{2.2.5}*

SPM 2.2 Projected changes in the climate system

Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is *very likely* that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea level to rise. *{2.2}*

The projected changes in Section SPM 2.2 are for 2081–2100 relative to 1986–2005, unless otherwise indicated.

Future climate will depend on committed warming caused by past anthropogenic emissions, as well as future anthropogenic emissions and natural climate variability. The global mean surface temperature change for the period 2016–2035 relative to 1986–2005 is similar for the four RCPs and will *likely* be in the range 0.3°C to 0.7°C (*medium confidence*). This assumes that there will be no major volcanic eruptions or changes in some natural sources (e.g., CH_4 and N_2O), or unexpected changes in total solar irradiance. By mid-21st century, the magnitude of the projected climate change is substantially affected by the choice of emissions scenario. *{2.2.1, Table 2.1}*

Relative to 1850–1900, global surface temperature change for the end of the 21st century (2081–2100) is projected to *likely* exceed 1.5°C for RCP4.5, RCP6.0 and RCP8.5 (*high confidence*). Warming is *likely* to exceed 2°C for RCP6.0 and RCP8.5 (*high confidence*), *more likely than not* to exceed 2°C for RCP4.5 (*medium confidence*), but *unlikely* to exceed 2°C for RCP2.6 (*medium confidence*). *{2.2.1}*

The increase of global mean surface temperature by the end of the 21st century (2081–2100) relative to 1986–2005 is *likely* to be 0.3°C to 1.7°C under RCP2.6, 1.1°C to 2.6°C under RCP4.5, 1.4°C to 3.1°C under RCP6.0 and 2.6°C to 4.8°C under RCP8.5[9]. The Arctic region will continue to warm more rapidly than the global mean (Figure SPM.6a, Figure SPM.7a). *{2.2.1, Figure 2.1, Figure 2.2, Table 2.1}*

It is *virtually certain* that there will be more frequent hot and fewer cold temperature extremes over most land areas on daily and seasonal timescales, as global mean surface temperature increases. It is *very likely* that heat waves will occur with a higher frequency and longer duration. Occasional cold winter extremes will continue to occur. *{2.2.1}*

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[7] Corresponding figures for limiting warming to 2°C with a probability of >50% and >33% are 3000 $GtCO_2$ (range of 2900 to 3200 $GtCO_2$) and 3300 $GtCO_2$ (range of 2950 to 3800 $GtCO_2$) respectively. Higher or lower temperature limits would imply larger or lower cumulative emissions respectively.

[8] This corresponds to about two thirds of the 2900 $GtCO_2$ that would limit warming to less than 2°C with a probability of >66%; to about 63% of the total amount of 3000 $GtCO_2$ that would limit warming to less than 2°C with a probability of >50%; and to about 58% of the total amount of 3300 $GtCO_2$ that would limit warming to less than 2°C with a probability of >33%.

[9] The period 1986–2005 is approximately 0.61 [0.55 to 0.67] °C warmer than 1850–1900. *{2.2.1}*

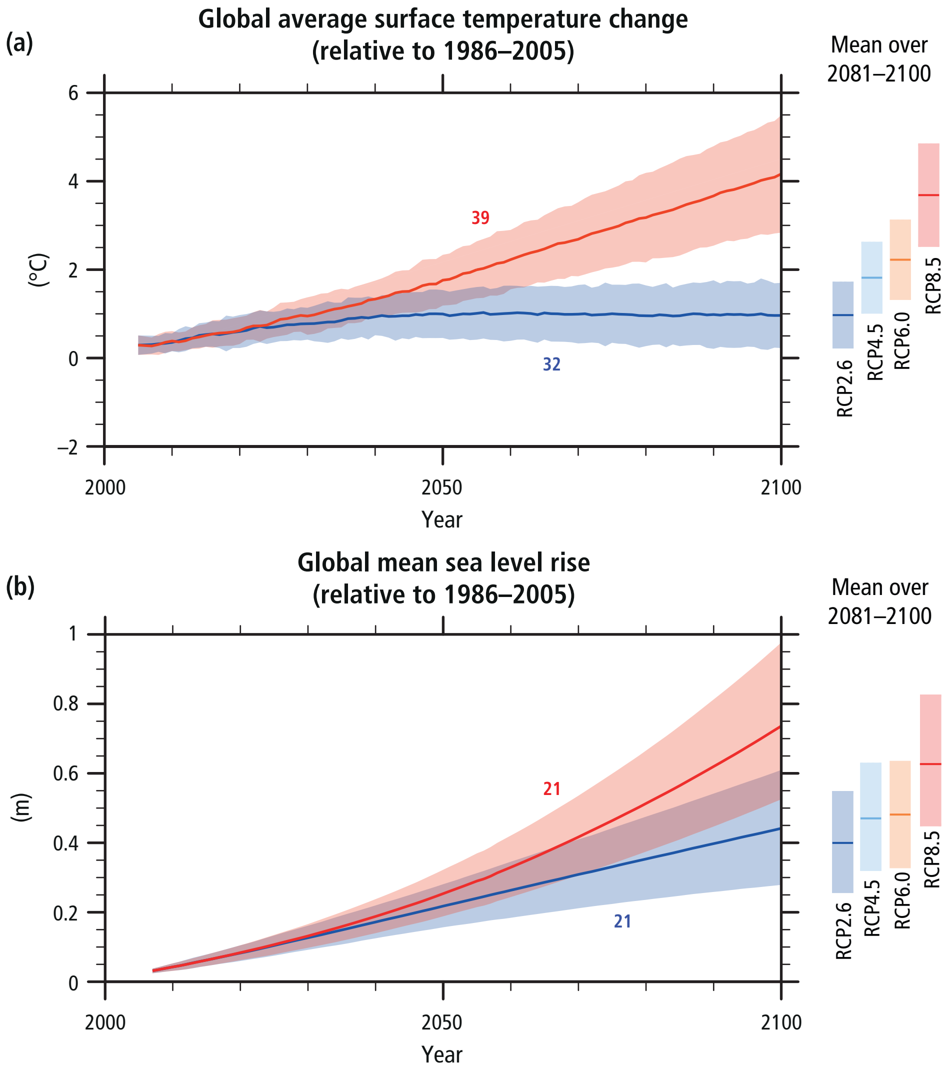

Figure SPM.6 | Global average surface temperature change **(a)** and global mean sea level rise[10] **(b)** from 2006 to 2100 as determined by multi-model simulations. All changes are relative to 1986–2005. Time series of projections and a measure of uncertainty (shading) are shown for scenarios RCP2.6 (blue) and RCP8.5 (red). The mean and associated uncertainties averaged over 2081–2100 are given for all RCP scenarios as coloured vertical bars at the right hand side of each panel. The number of Coupled Model Intercomparison Project Phase 5 (CMIP5) models used to calculate the multi-model mean is indicated. *{2.2, Figure 2.1}*

Changes in precipitation will not be uniform. The high latitudes and the equatorial Pacific are *likely* to experience an increase in annual mean precipitation under the RCP8.5 scenario. In many mid-latitude and subtropical dry regions, mean precipitation will *likely* decrease, while in many mid-latitude wet regions, mean precipitation will *likely* increase under the RCP8.5 scenario (Figure SPM.7b). Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions will *very likely* become more intense and more frequent. *{2.2.2, Figure 2.2}*

The global ocean will continue to warm during the 21st century, with the strongest warming projected for the surface in tropical and Northern Hemisphere subtropical regions (Figure SPM.7a). *{2.2.3, Figure 2.2}*

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[10] Based on current understanding (from observations, physical understanding and modelling), only the collapse of marine-based sectors of the Antarctic ice sheet, if initiated, could cause global mean sea level to rise substantially above the *likely* range during the 21st century. There is *medium confidence* that this additional contribution would not exceed several tenths of a meter of sea level rise during the 21st century.

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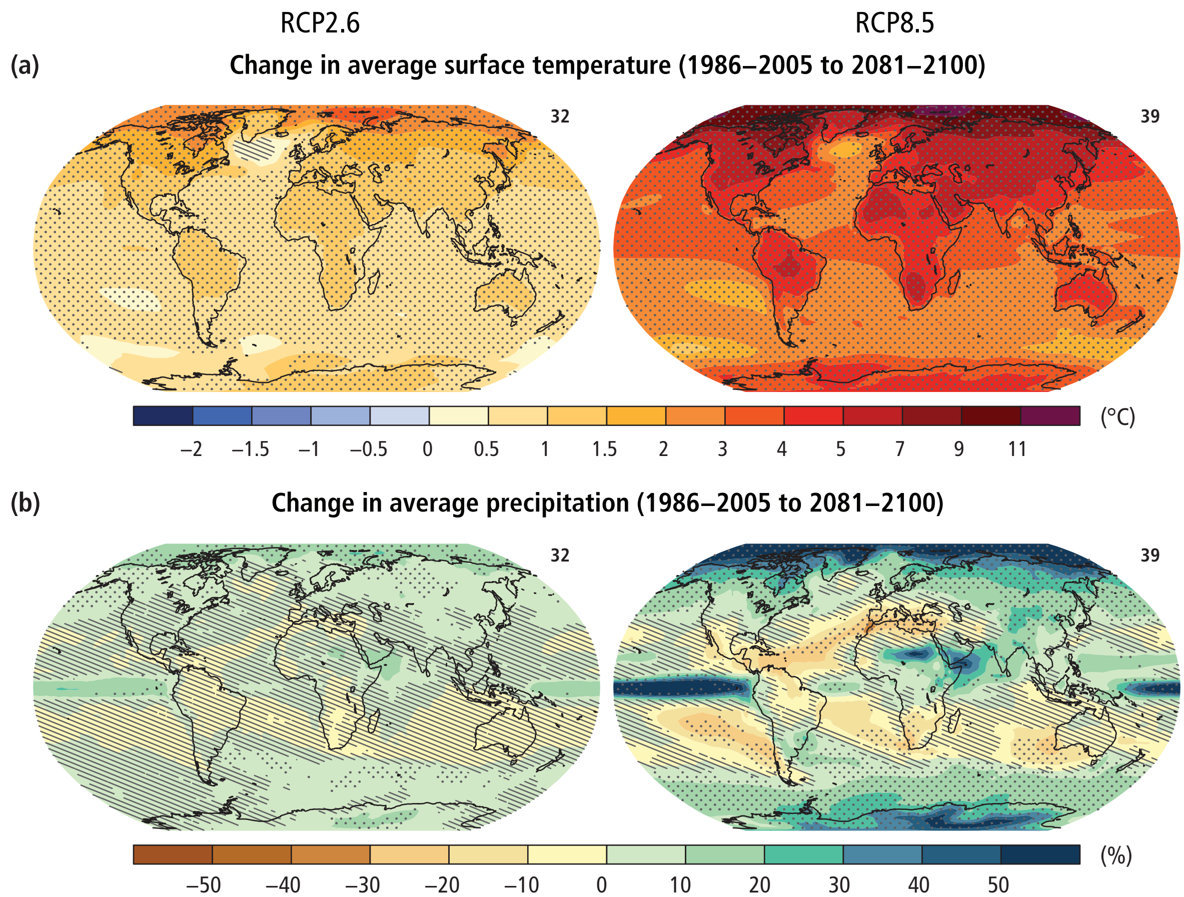

Figure SPM.7 | Change in average surface temperature **(a)** and change in average precipitation **(b)** based on multi-model mean projections for 2081–2100 relative to 1986–2005 under the RCP2.6 (left) and RCP8.5 (right) scenarios. The number of models used to calculate the multi-model mean is indicated in the upper right corner of each panel. Stippling (i.e., dots) shows regions where the projected change is large compared to natural internal variability and where at least 90% of models agree on the sign of change. Hatching (i.e., diagonal lines) shows regions where the projected change is less than one standard deviation of the natural internal variability. *{2.2, Figure 2.2}*

Earth System Models project a global increase in ocean acidification for all RCP scenarios by the end of the 21st century, with a slow recovery after mid-century under RCP2.6. The decrease in surface ocean pH is in the range of 0.06 to 0.07 (15 to 17% increase in acidity) for RCP2.6, 0.14 to 0.15 (38 to 41%) for RCP4.5, 0.20 to 0.21 (58 to 62%) for RCP6.0 and 0.30 to 0.32 (100 to 109%) for RCP8.5. *{2.2.4, Figure 2.1}*

Year-round reductions in Arctic sea ice are projected for all RCP scenarios. A nearly ice-free[11] Arctic Ocean in the summer sea-ice minimum in September before mid-century is *likely* for RCP8.5[12] (*medium confidence*). *{2.2.3, Figure 2.1}*

It is *virtually certain* that near-surface permafrost extent at high northern latitudes will be reduced as global mean surface temperature increases, with the area of permafrost near the surface (upper 3.5 m) projected to decrease by 37% (RCP2.6) to 81% (RCP8.5) for the multi-model average (*medium confidence*). *{2.2.3}*

The global glacier volume, excluding glaciers on the periphery of Antarctica (and excluding the Greenland and Antarctic ice sheets), is projected to decrease by 15 to 55% for RCP2.6 and by 35 to 85% for RCP8.5 (*medium confidence*). *{2.2.3}*

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11 When sea-ice extent is less than one million km^2 for at least five consecutive years.

12 Based on an assessment of the subset of models that most closely reproduce the climatological mean state and 1979–2012 trend of the Arctic sea-ice extent.

There has been significant improvement in understanding and projection of sea level change since the AR4. Global mean sea level rise will continue during the 21st century, *very likely* at a faster rate than observed from 1971 to 2010. For the period 2081–2100 relative to 1986–2005, the rise will *likely* be in the ranges of 0.26 to 0.55 m for RCP2.6, and of 0.45 to 0.82 m for RCP8.5 (*medium confidence*)[10] (Figure SPM.6b). Sea level rise will not be uniform across regions. By the end of the 21st century, it is *very likely* that sea level will rise in more than about 95% of the ocean area. About 70% of the coastlines worldwide are projected to experience a sea level change within ±20% of the global mean. *{2.2.3}*

SPM 2.3 Future risks and impacts caused by a changing climate

Climate change will amplify existing risks and create new risks for natural and human systems. Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development. *{2.3}*

Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems, including their ability to adapt. Rising rates and magnitudes of warming and other changes in the climate system, accompanied by ocean acidification, increase the risk of severe, pervasive and in some cases irreversible detrimental impacts. Some risks are particularly relevant for individual regions (Figure SPM.8), while others are global. The overall risks of future climate change impacts can be reduced by limiting the rate and magnitude of climate change, including ocean acidification. The precise levels of climate change sufficient to trigger abrupt and irreversible change remain uncertain, but the risk associated with crossing such thresholds increases with rising temperature (*medium confidence*). For risk assessment, it is important to evaluate the widest possible range of impacts, including low-probability outcomes with large consequences. *{1.5, 2.3, 2.4, 3.3, Box Introduction.1, Box 2.3, Box 2.4}*

A large fraction of species faces increased extinction risk due to climate change during and beyond the 21st century, especially as climate change interacts with other stressors (*high confidence*). Most plant species cannot naturally shift their geographical ranges sufficiently fast to keep up with current and high projected rates of climate change in most landscapes; most small mammals and freshwater molluscs will not be able to keep up at the rates projected under RCP4.5 and above in flat landscapes in this century (*high confidence*). Future risk is indicated to be high by the observation that natural global climate change at rates lower than current anthropogenic climate change caused significant ecosystem shifts and species extinctions during the past millions of years. Marine organisms will face progressively lower oxygen levels and high rates and magnitudes of ocean acidification (*high confidence*), with associated risks exacerbated by rising ocean temperature extremes (*medium confidence*). Coral reefs and polar ecosystems are highly vulnerable. Coastal systems and low-lying areas are at risk from sea level rise, which will continue for centuries even if the global mean temperature is stabilized (*high confidence*). *{2.3, 2.4, Figure 2.5}*

Climate change is projected to undermine food security (Figure SPM.9). Due to projected climate change by the mid-21st century and beyond, global marine species redistribution and marine biodiversity reduction in sensitive regions will challenge the sustained provision of fisheries productivity and other ecosystem services (*high confidence*). For wheat, rice and maize in tropical and temperate regions, climate change without adaptation is projected to negatively impact production for local temperature increases of 2°C or more above late 20th century levels, although individual locations may benefit (*medium confidence*). Global temperature increases of ~4°C or more[13] above late 20th century levels, combined with increasing food demand, would pose large risks to food security globally (*high confidence*). Climate change is projected to reduce renewable surface water and groundwater resources in most dry subtropical regions (*robust evidence*, *high agreement*), intensifying competition for water among sectors (*limited evidence*, *medium agreement*). *{2.3.1, 2.3.2}*

[13] Projected warming averaged over land is larger than global average warming for all RCP scenarios for the period 2081–2100 relative to 1986–2005. For regional projections, see Figure SPM.7. *{2.2}*

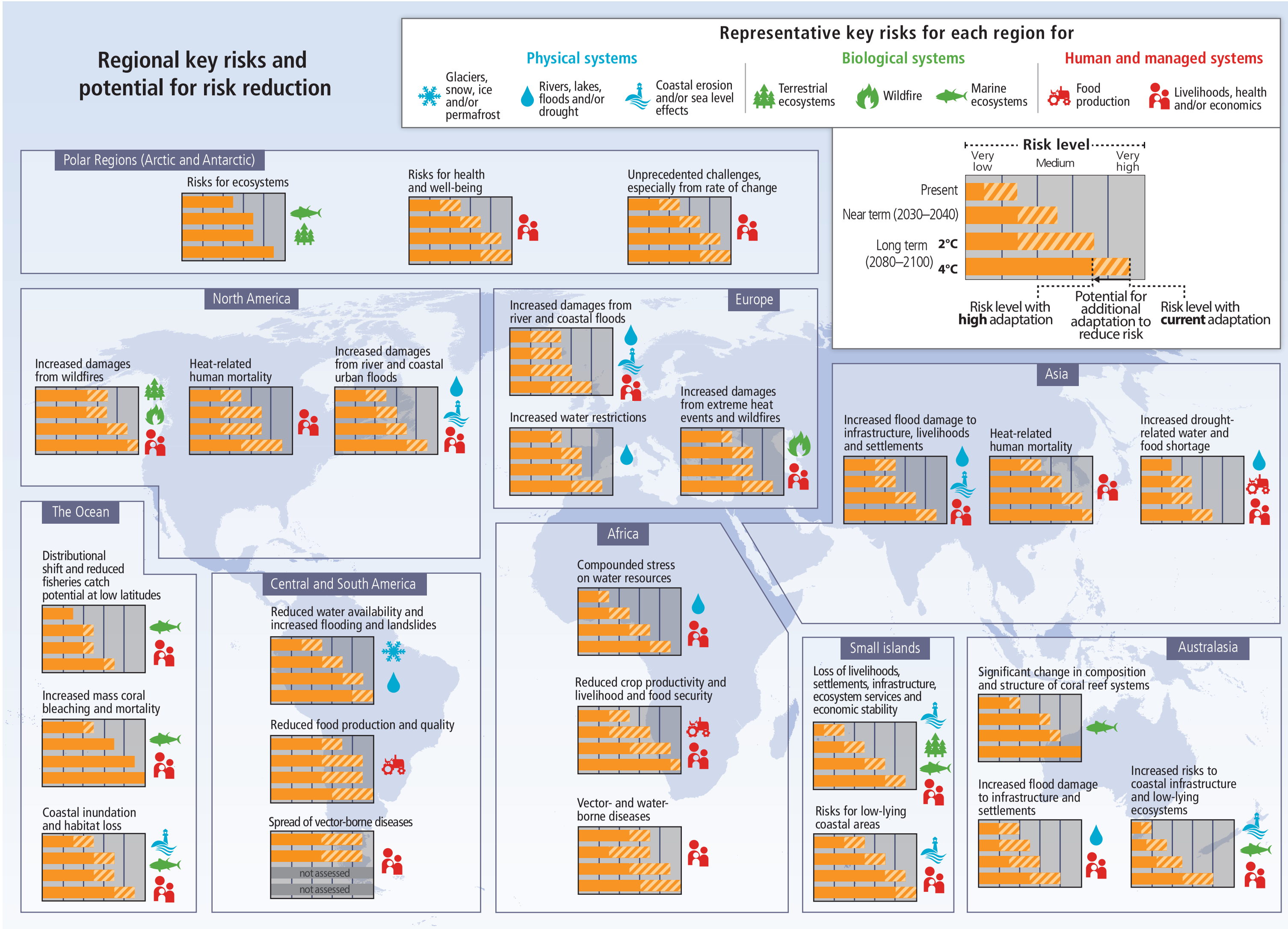

Figure SPM.8 | Representative key risks[14] for each region, including the potential for risk reduction through adaptation and mitigation, as well as limits to adaptation. Each key risk is assessed as very low, low, medium, high or very high. Risk levels are presented for three time frames: present, near term (here, for 2030–2040) and long term (here, for 2080–2100). In the near term, projected levels of global mean temperature increase do not diverge substantially across different emission scenarios. For the long term, risk levels are presented for two possible futures (2°C and 4°C global mean temperature increase above pre-industrial levels). For each timeframe, risk levels are indicated for a continuation of current adaptation and assuming high levels of current or future adaptation. Risk levels are not necessarily comparable, especially across regions. *{Figure 2.4}*

[14] Identification of key risks was based on expert judgment using the following specific criteria: large magnitude, high probability or irreversibility of impacts; timing of impacts; persistent vulnerability or exposure contributing to risks; or limited potential to reduce risks through adaptation or mitigation.

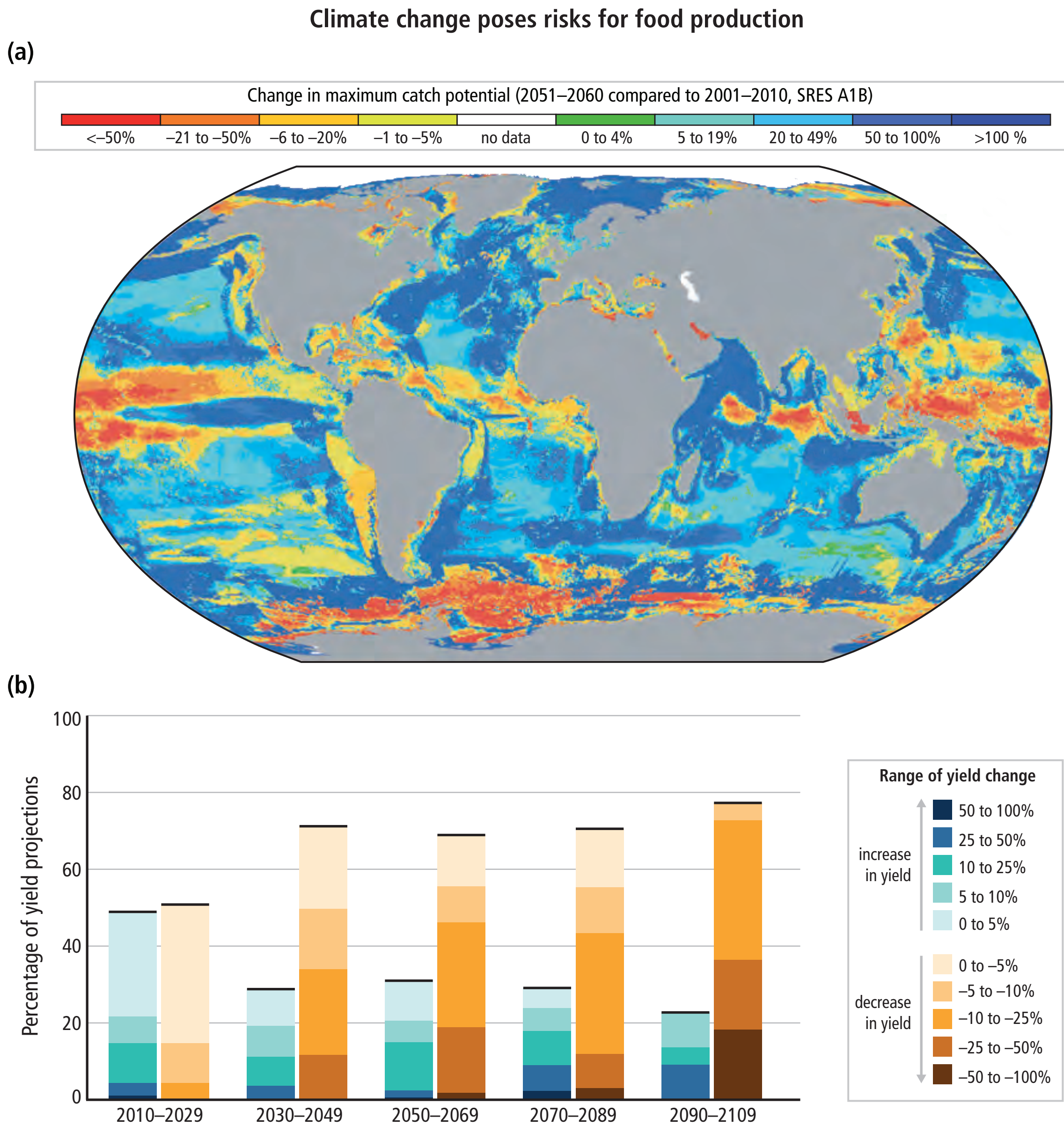

Figure SPM.9 | **(a)** Projected global redistribution of maximum catch potential of ~1000 exploited marine fish and invertebrate species. Projections compare the 10-year averages 2001–2010 and 2051–2060 using ocean conditions based on a single climate model under a moderate to high warming scenario, without analysis of potential impacts of overfishing or ocean acidification. **(b)** Summary of projected changes in crop yields (mostly wheat, maize, rice and soy), due to climate change over the 21st century. Data for each timeframe sum to 100%, indicating the percentage of projections showing yield increases versus decreases. The figure includes projections (based on 1090 data points) for different emission scenarios, for tropical and temperate regions and for adaptation and no-adaptation cases combined. Changes in crop yields are relative to late 20th century levels. *{Figure 2.6a, Figure 2.7}*

Until mid-century, projected climate change will impact human health mainly by exacerbating health problems that already exist (*very high confidence*). Throughout the 21st century, climate change is expected to lead to increases in ill-health in many regions and especially in developing countries with low income, as compared to a baseline without climate change (*high confidence*). By 2100 for RCP8.5, the combination of high temperature and humidity in some areas for parts of the year is expected to compromise common human activities, including growing food and working outdoors (*high confidence*). *{2.3.2}*

In urban areas climate change is projected to increase risks for people, assets, economies and ecosystems, including risks from heat stress, storms and extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, water scarcity, sea level rise and storm surges (*very high confidence*). These risks are amplified for those lacking essential infrastructure and services or living in exposed areas. *{2.3.2}*

Rural areas are expected to experience major impacts on water availability and supply, food security, infrastructure and agricultural incomes, including shifts in the production areas of food and non-food crops around the world (*high confidence*). *{2.3.2}*

Aggregate economic losses accelerate with increasing temperature (*limited evidence, high agreement*), but global economic impacts from climate change are currently difficult to estimate. From a poverty perspective, climate change impacts are projected to slow down economic growth, make poverty reduction more difficult, further erode food security and prolong existing and create new poverty traps, the latter particularly in urban areas and emerging hotspots of hunger (*medium confidence*). International dimensions such as trade and relations among states are also important for understanding the risks of climate change at regional scales. *{2.3.2}*

Climate change is projected to increase displacement of people (*medium evidence, high agreement*). Populations that lack the resources for planned migration experience higher exposure to extreme weather events, particularly in developing countries with low income. Climate change can indirectly increase risks of violent conflicts by amplifying well-documented drivers of these conflicts such as poverty and economic shocks (*medium confidence*). *{2.3.2}*

SPM 2.4 Climate change beyond 2100, irreversibility and abrupt changes

Many aspects of climate change and associated impacts will continue for centuries, even if anthropogenic emissions of greenhouse gases are stopped. The risks of abrupt or irreversible changes increase as the magnitude of the warming increases. *{2.4}*

Warming will continue beyond 2100 under all RCP scenarios except RCP2.6. Surface temperatures will remain approximately constant at elevated levels for many centuries after a complete cessation of net anthropogenic CO_2 emissions. A large fraction of anthropogenic climate change resulting from CO_2 emissions is irreversible on a multi-century to millennial timescale, except in the case of a large net removal of CO_2 from the atmosphere over a sustained period. *{2.4, Figure 2.8}*

Stabilization of global average surface temperature does not imply stabilization for all aspects of the climate system. Shifting biomes, soil carbon, ice sheets, ocean temperatures and associated sea level rise all have their own intrinsic long timescales which will result in changes lasting hundreds to thousands of years after global surface temperature is stabilized. *{2.1, 2.4}*

There is *high confidence* that ocean acidification will increase for centuries if CO_2 emissions continue, and will strongly affect marine ecosystems. *{2.4}*

It is *virtually certain* that global mean sea level rise will continue for many centuries beyond 2100, with the amount of rise dependent on future emissions. The threshold for the loss of the Greenland ice sheet over a millennium or more, and an associated sea level rise of up to 7 m, is greater than about 1°C (*low confidence*) but less than about 4°C (*medium confidence*) of global warming with respect to pre-industrial temperatures. Abrupt and irreversible ice loss from the Antarctic ice sheet is possible, but current evidence and understanding is insufficient to make a quantitative assessment. *{2.4}*

Magnitudes and rates of climate change associated with medium- to high-emission scenarios pose an increased risk of abrupt and irreversible regional-scale change in the composition, structure and function of marine, terrestrial and freshwater ecosystems, including wetlands (*medium confidence*). A reduction in permafrost extent is *virtually certain* with continued rise in global temperatures. *{2.4}*

SPM 3. Future Pathways for Adaptation, Mitigation and Sustainable Development

Adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change. Substantial emissions reductions over the next few decades can reduce climate risks in the 21st century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the longer term and contribute to climate-resilient pathways for sustainable development. *{3.2, 3.3, 3.4}*

SPM 3.1 Foundations of decision-making about climate change

Effective decision-making to limit climate change and its effects can be informed by a wide range of analytical approaches for evaluating expected risks and benefits, recognizing the importance of governance, ethical dimensions, equity, value judgments, economic assessments and diverse perceptions and responses to risk and uncertainty. *{3.1}*

Sustainable development and equity provide a basis for assessing climate policies. Limiting the effects of climate change is necessary to achieve sustainable development and equity, including poverty eradication. Countries' past and future contributions to the accumulation of GHGs in the atmosphere are different, and countries also face varying challenges and circumstances and have different capacities to address mitigation and adaptation. Mitigation and adaptation raise issues of equity, justice and fairness. Many of those most vulnerable to climate change have contributed and contribute little to GHG emissions. Delaying mitigation shifts burdens from the present to the future, and insufficient adaptation responses to emerging impacts are already eroding the basis for sustainable development. Comprehensive strategies in response to climate change that are consistent with sustainable development take into account the co-benefits, adverse side effects and risks that may arise from both adaptation and mitigation options. *{3.1, 3.5, Box 3.4}*

The design of climate policy is influenced by how individuals and organizations perceive risks and uncertainties and take them into account. Methods of valuation from economic, social and ethical analysis are available to assist decision-making. These methods can take account of a wide range of possible impacts, including low-probability outcomes with large consequences. But they cannot identify a single best balance between mitigation, adaptation and residual climate impacts. *{3.1}*

Climate change has the characteristics of a collective action problem at the global scale, because most GHGs accumulate over time and mix globally, and emissions by any agent (e.g., individual, community, company, country) affect other agents. Effective mitigation will not be achieved if individual agents advance their own interests independently. Cooperative responses, including international cooperation, are therefore required to effectively mitigate GHG emissions and address other climate change issues. The effectiveness of adaptation can be enhanced through complementary actions across levels, including international cooperation. The evidence suggests that outcomes seen as equitable can lead to more effective cooperation. *{3.1}*

SPM 3.2 Climate change risks reduced by mitigation and adaptation

Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread and irreversible impacts globally (*high confidence*). Mitigation involves some level of co-benefits and of risks due to adverse side effects, but these risks do not involve the same possibility of severe, widespread and irreversible impacts as risks from climate change, increasing the benefits from near-term mitigation efforts. *{3.2, 3.4}*

Mitigation and adaptation are complementary approaches for reducing risks of climate change impacts over different timescales (*high confidence*). Mitigation, in the near term and through the century, can substantially reduce climate change impacts in the latter decades of the 21st century and beyond. Benefits from adaptation can already be realized in addressing current risks, and can be realized in the future for addressing emerging risks. *{3.2, 4.5}*

Five Reasons For Concern (RFCs) aggregate climate change risks and illustrate the implications of warming and of adaptation limits for people, economies and ecosystems across sectors and regions. The five RFCs are associated with: (1) Unique and threatened systems, (2) Extreme weather events, (3) Distribution of impacts, (4) Global aggregate impacts, and (5) Large-scale singular events. In this report, the RFCs provide information relevant to Article 2 of UNFCCC. *{Box 2.4}*

Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread and irreversible impacts globally (*high confidence*) (Figure SPM.10). In most scenarios without additional mitigation efforts (those with 2100 atmospheric concentrations

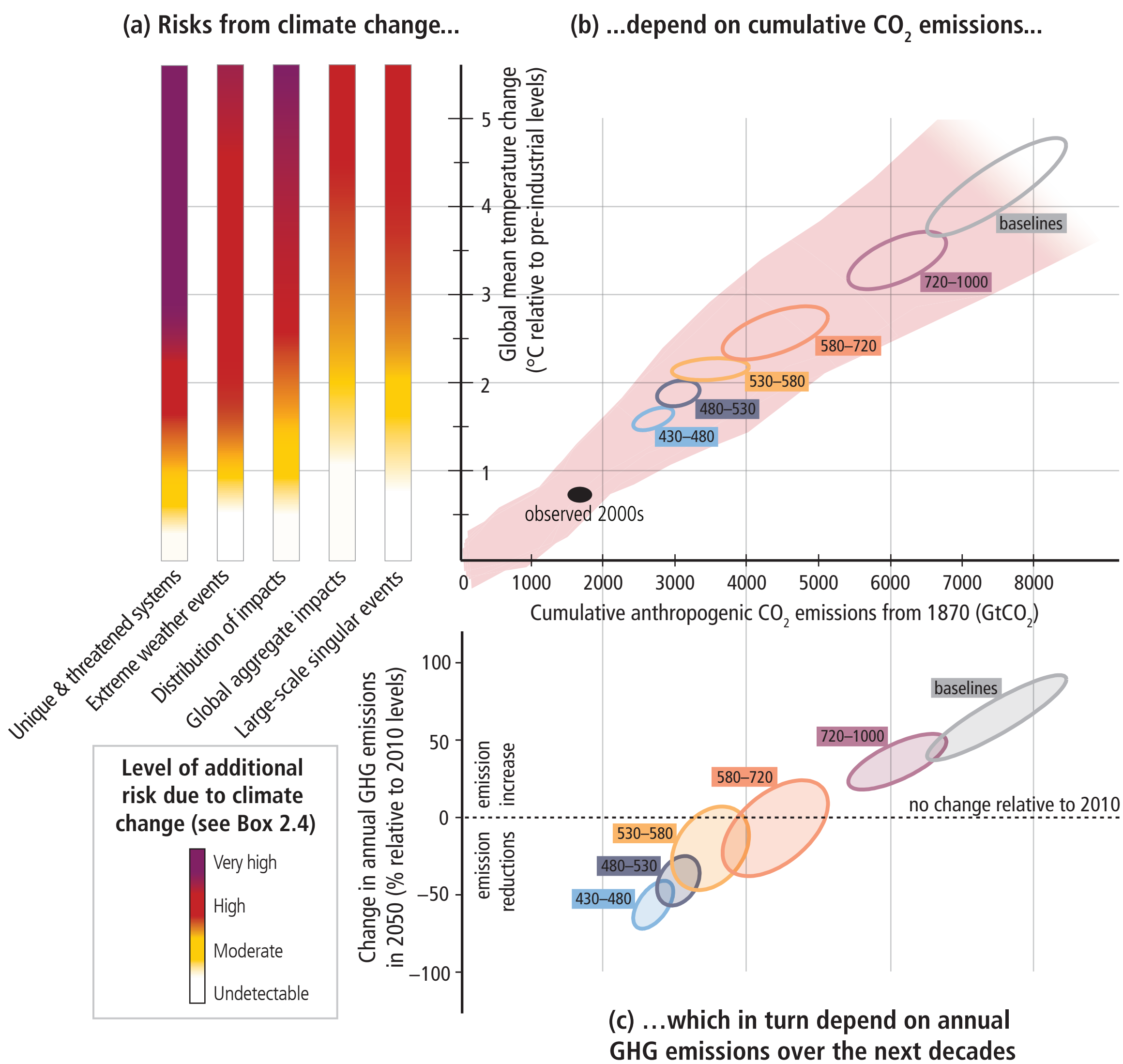

Figure SPM.10 | The relationship between risks from climate change, temperature change, cumulative carbon dioxide (CO_2) emissions and changes in annual greenhouse gas (GHG) emissions by 2050. Limiting risks across Reasons For Concern **(a)** would imply a limit for cumulative emissions of CO_2 **(b)** which would constrain annual GHG emissions over the next few decades **(c)**. **Panel a** reproduces the five Reasons For Concern *{Box 2.4}*. **Panel b** links temperature changes to cumulative CO_2 emissions (in $GtCO_2$) from 1870. They are based on Coupled Model Intercomparison Project Phase 5 (CMIP5) simulations (pink plume) and on a simple climate model (median climate response in 2100), for the baselines and five mitigation scenario categories (six ellipses). Details are provided in Figure SPM.5. **Panel c** shows the relationship between the cumulative CO_2 emissions (in $GtCO_2$) of the scenario categories and their associated change in annual GHG emissions by 2050, expressed in percentage change (in percent $GtCO_2$-eq per year) relative to 2010. The ellipses correspond to the same scenario categories as in Panel b, and are built with a similar method (see details in Figure SPM.5). *{Figure 3.1}*

>1000 ppm CO_2-eq), warming is *more likely than not* to exceed 4°C above pre-industrial levels by 2100 (Table SPM.1). The risks associated with temperatures at or above 4°C include substantial species extinction, global and regional food insecurity, consequential constraints on common human activities and limited potential for adaptation in some cases (*high confidence*). Some risks of climate change, such as risks to unique and threatened systems and risks associated with extreme weather events, are moderate to high at temperatures 1°C to 2°C above pre-industrial levels. *{2.3, Figure 2.5, 3.2, 3.4, Box 2.4, Table SPM.1}*

Substantial cuts in GHG emissions over the next few decades can substantially reduce risks of climate change by limiting warming in the second half of the 21st century and beyond. Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond. Limiting risks across RFCs would imply a limit for cumulative emissions of CO_2. Such a limit would require that global net emissions of CO_2 eventually decrease to zero and would constrain annual emissions over the next few decades (Figure SPM.10) (*high confidence*). But some risks from climate damages are unavoidable, even with mitigation and adaptation. *{2.2.5, 3.2, 3.4}*

Mitigation involves some level of co-benefits and risks, but these risks do not involve the same possibility of severe, widespread and irreversible impacts as risks from climate change. Inertia in the economic and climate system and the possibility of irreversible impacts from climate change increase the benefits from near-term mitigation efforts (*high confidence*). Delays in additional mitigation or constraints on technological options increase the longer-term mitigation costs to hold climate change risks at a given level (Table SPM.2). *{3.2, 3.4}*

SPM 3.3 Characteristics of adaptation pathways

Adaptation can reduce the risks of climate change impacts, but there are limits to its effectiveness, especially with greater magnitudes and rates of climate change. Taking a longer-term perspective, in the context of sustainable development, increases the likelihood that more immediate adaptation actions will also enhance future options and preparedness. *{3.3}*

Adaptation can contribute to the well-being of populations, the security of assets and the maintenance of ecosystem goods, functions and services now and in the future. Adaptation is place- and context-specific (*high confidence*). A first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability (*high confidence*). Integration of adaptation into planning, including policy design, and decision-making can promote synergies with development and disaster risk reduction. Building adaptive capacity is crucial for effective selection and implementation of adaptation options (*robust evidence, high agreement*). *{3.3}*

Adaptation planning and implementation can be enhanced through complementary actions across levels, from individuals to governments (*high confidence*). National governments can coordinate adaptation efforts of local and sub-national governments, for example by protecting vulnerable groups, by supporting economic diversification and by providing information, policy and legal frameworks and financial support (*robust evidence*, *high agreement*). Local government and the private sector are increasingly recognized as critical to progress in adaptation, given their roles in scaling up adaptation of communities, households and civil society and in managing risk information and financing (*medium evidence*, *high agreement*). *{3.3}*

Adaptation planning and implementation at all levels of governance are contingent on societal values, objectives and risk perceptions (*high confidence*). Recognition of diverse interests, circumstances, social-cultural contexts and expectations can benefit decision-making processes. Indigenous, local and traditional knowledge systems and practices, including indigenous peoples' holistic view of community and environment, are a major resource for adapting to climate change, but these have not been used consistently in existing adaptation efforts. Integrating such forms of knowledge with existing practices increases the effectiveness of adaptation. *{3.3}*

Constraints can interact to impede adaptation planning and implementation (*high confidence*). Common constraints on implementation arise from the following: limited financial and human resources; limited integration or coordination of governance; uncertainties about projected impacts; different perceptions of risks; competing values; absence of key adaptation leaders and advocates; and limited tools to monitor adaptation effectiveness. Another constraint includes insufficient research, monitoring, and observation and the finance to maintain them. *{3.3}*

Greater rates and magnitude of climate change increase the likelihood of exceeding adaptation limits (*high confidence*). Limits to adaptation emerge from the interaction among climate change and biophysical and/or socio-economic constraints. Further, poor planning or implementation, overemphasizing short-term outcomes or failing to sufficiently anticipate consequences can result in maladaptation, increasing the vulnerability or exposure of the target group in the future or the vulnerability of other people, places or sectors (*medium evidence, high agreement*). Underestimating the complexity of adaptation as a social process can create unrealistic expectations about achieving intended adaptation outcomes. *{3.3}*

Significant co-benefits, synergies and trade-offs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions (*very high confidence*). Increasing efforts to mitigate and adapt to climate change imply an increasing complexity of interactions, particularly at the intersections among water, energy, land use and biodiversity, but tools to understand and manage these interactions remain limited. Examples of actions with co-benefits include (i) improved energy efficiency and cleaner energy sources, leading to reduced emissions of health-damaging, climate-altering air pollutants; (ii) reduced energy and water consumption in urban areas through greening cities and recycling water; (iii) sustainable agriculture and forestry; and (iv) protection of ecosystems for carbon storage and other ecosystem services. *{3.3}*

Transformations in economic, social, technological and political decisions and actions can enhance adaptation and promote sustainable development (*high confidence*). At the national level, transformation is considered most effective when it reflects a country's own visions and approaches to achieving sustainable development in accordance with its national circumstances and priorities. Restricting adaptation responses to incremental changes to existing systems and structures, without considering transformational change, may increase costs and losses and miss opportunities. Planning and implementation of transformational adaptation could reflect strengthened, altered or aligned paradigms and may place new and increased demands on governance structures to reconcile different goals and visions for the future and to address possible equity and ethical implications. Adaptation pathways are enhanced by iterative learning, deliberative processes and innovation. *{3.3}*

SPM 3.4 Characteristics of mitigation pathways

There are multiple mitigation pathways that are *likely* to limit warming to below 2°C relative to pre-industrial levels. These pathways would require substantial emissions reductions over the next few decades and near zero emissions of CO_2 and other long-lived greenhouse gases by the end of the century. Implementing such reductions poses substantial technological, economic, social and institutional challenges, which increase with delays in additional mitigation and if key technologies are not available. Limiting warming to lower or higher levels involves similar challenges but on different timescales. *{3.4}*

Without additional efforts to reduce GHG emissions beyond those in place today, global emissions growth is expected to persist, driven by growth in global population and economic activities. Global mean surface temperature increases in 2100 in baseline scenarios—those without additional mitigation—range from 3.7°C to 4.8°C above the average for 1850–1900 for a median climate response. They range from 2.5°C to 7.8°C when including climate uncertainty (5th to 95th percentile range) (*high confidence*). *{3.4}*

Emissions scenarios leading to CO_2-equivalent concentrations in 2100 of about 450 ppm or lower are *likely* to maintain warming below 2°C over the 21st century relative to pre-industrial levels[15]. These scenarios are characterized by 40 to 70% global anthropogenic GHG emissions reductions by 2050 compared to 2010[16], and emissions levels near zero or below in 2100. Mitigation scenarios reaching concentration levels of about 500 ppm CO_2-eq by 2100 are *more likely than not* to limit temperature change to less than 2°C, unless they temporarily overshoot concentration levels of roughly 530 ppm CO_2-eq

[15] For comparison, the CO_2-eq concentration in 2011 is estimated to be 430 ppm (uncertainty range 340 to 520 ppm)

[16] This range differs from the range provided for a similar concentration category in the AR4 (50 to 85% lower than 2000 for CO_2 only). Reasons for this difference include that this report has assessed a substantially larger number of scenarios than in the AR4 and looks at all GHGs. In addition, a large proportion of the new scenarios include Carbon Dioxide Removal (CDR) technologies (see below). Other factors include the use of 2100 concentration levels instead of stabilization levels and the shift in reference year from 2000 to 2010.

before 2100, in which case they are *about as likely as not* to achieve that goal. In these 500 ppm CO_2-eq scenarios, global 2050 emissions levels are 25 to 55% lower than in 2010. Scenarios with higher emissions in 2050 are characterized by a greater reliance on Carbon Dioxide Removal (CDR) technologies beyond mid-century (and vice versa). Trajectories that are *likely* to limit warming to 3°C relative to pre-industrial levels reduce emissions less rapidly than those limiting warming to 2°C. A limited number of studies provide scenarios that are *more likely than not* to limit warming to 1.5°C by 2100; these scenarios are characterized by concentrations below 430 ppm CO_2-eq by 2100 and 2050 emission reduction between 70% and 95% below 2010. For a comprehensive overview of the characteristics of emissions scenarios, their CO_2-equivalent concentrations and their likelihood to keep warming to below a range of temperature levels, see Figure SPM.11 and Table SPM.1. *{3.4}*

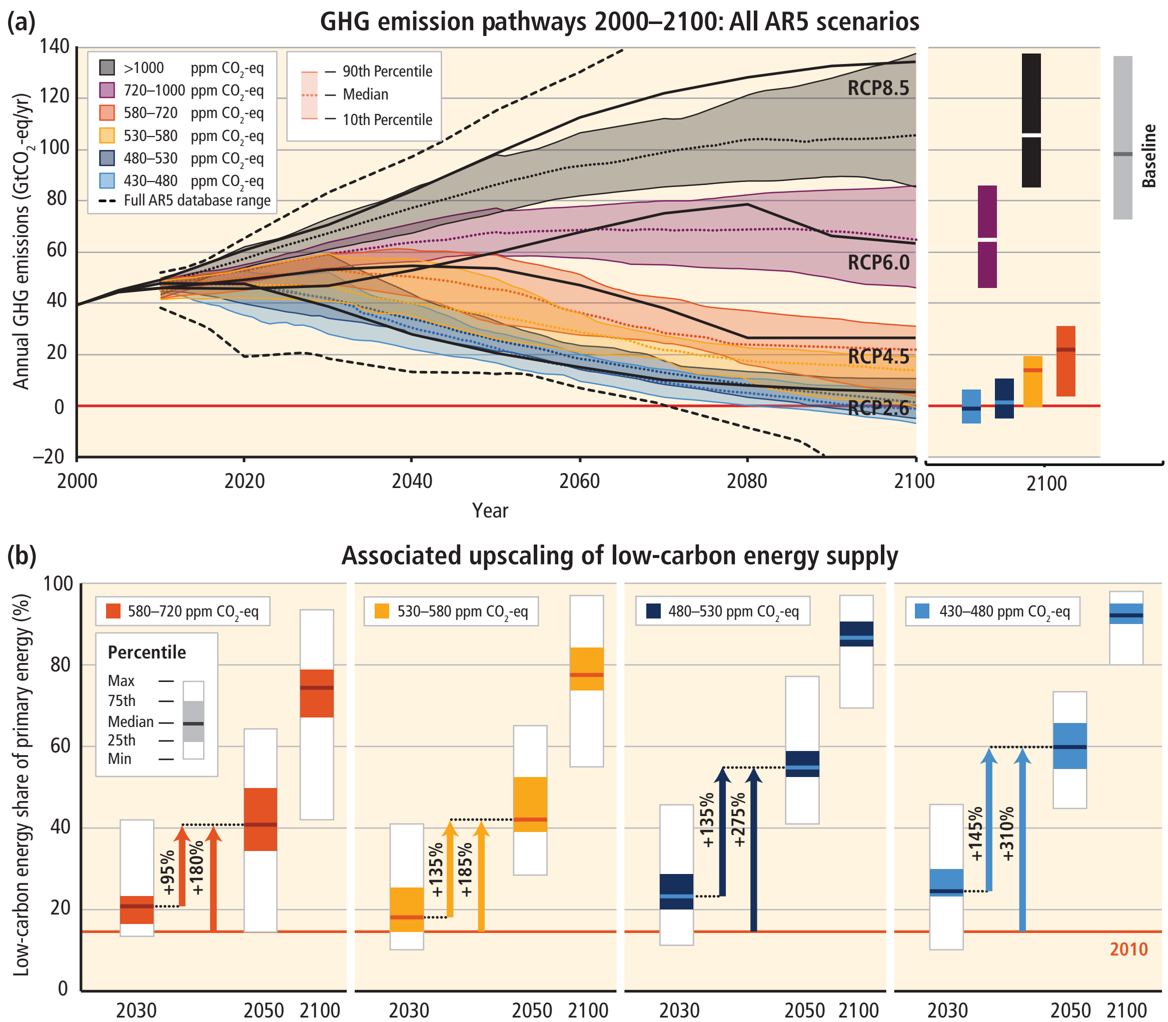

Figure SPM.11 | Global greenhouse gas emissions (gigatonne of CO_2-equivalent per year, $GtCO_2$-eq/yr) in baseline and mitigation scenarios for different long-term concentration levels **(a)** and associated upscaling requirements of low-carbon energy (% of primary energy) for 2030, 2050 and 2100 compared to 2010 levels in mitigation scenarios **(b)**. *{Figure 3.2}*

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Table SPM.1 | Key characteristics of the scenarios collected and assessed for WGIII AR5. For all parameters the 10th to 90th percentile of the scenarios is shown [a]. *{Table 3.1}*

<table>
<tr><th rowspan="2">CO_2-eq Concentrations in 2100 (ppm CO_2-eq) [f]

Category label (conc. range)</th><th rowspan="2">Subcategories</th><th rowspan="2">Relative position of the RCPs [d]</th><th colspan="2">Change in CO_2-eq emissions compared to 2010 (in %) [c]</th><th colspan="4">Likelihood of staying below a specific temperature level over the 21st century (relative to 1850–1900) [d, e]</th></tr>
<tr><th>2050</th><th>2100</th><th>1.5°C</th><th>2°C</th><th>3°C</th><th>4°C</th></tr>
<tr><td><430</td><td colspan="8">Only a limited number of individual model studies have explored levels below 430 ppm CO_2-eq [j]</td></tr>
<tr><td>450
(430 to 480)</td><td>Total range [a, g]</td><td>RCP2.6</td><td>−72 to −41</td><td>−118 to −78</td><td>More unlikely than likely</td><td>Likely</td><td rowspan="6">Likely</td><td rowspan="8">Likely</td></tr>
<tr><td rowspan="2">500
(480 to 530)</td><td>No overshoot of 530 ppm CO_2-eq</td><td></td><td>−57 to −42</td><td>−107 to −73</td><td rowspan="6">Unlikely</td><td>More likely than not</td></tr>
<tr><td>Overshoot of 530 ppm CO_2-eq</td><td></td><td>−55 to −25</td><td>−114 to −90</td><td>About as likely as not</td></tr>
<tr><td rowspan="2">550
(530 to 580)</td><td>No overshoot of 580 ppm CO_2-eq</td><td></td><td>−47 to −19</td><td>−81 to −59</td><td rowspan="3">More unlikely than likely [i]</td></tr>
<tr><td>Overshoot of 580 ppm CO_2-eq</td><td></td><td>−16 to 7</td><td>−183 to −86</td></tr>
<tr><td>(580 to 650)</td><td>Total range</td><td rowspan="2">RCP4.5</td><td>−38 to 24</td><td>−134 to −50</td></tr>
<tr><td>(650 to 720)</td><td>Total range</td><td>−11 to 17</td><td>−54 to −21</td><td rowspan="2">Unlikely</td><td>More likely than not</td></tr>
<tr><td>(720 to 1000) [b]</td><td>Total range</td><td>RCP6.0</td><td>18 to 54</td><td>−7 to 72</td><td rowspan="2">Unlikely [h]</td><td>More unlikely than likely</td></tr>
<tr><td>>1000 [b]</td><td>Total range</td><td>RCP8.5</td><td>52 to 95</td><td>74 to 178</td><td>Unlikely [h]</td><td>Unlikely</td><td>More unlikely than likely</td></tr>
</table>

Notes:

[a] The 'total range' for the 430 to 480 ppm CO_2-eq concentrations scenarios corresponds to the range of the 10th to 90th percentile of the subcategory of these scenarios shown in Table 6.3 of the Working Group III Report.

[b] Baseline scenarios fall into the >1000 and 720 to 1000 ppm CO_2-eq categories. The latter category also includes mitigation scenarios. The baseline scenarios in the latter category reach a temperature change of 2.5°C to 5.8°C above the average for 1850–1900 in 2100. Together with the baseline scenarios in the >1000 ppm CO_2-eq category, this leads to an overall 2100 temperature range of 2.5°C to 7.8°C (range based on median climate response: 3.7°C to 4.8°C) for baseline scenarios across both concentration categories.

[c] The global 2010 emissions are 31% above the 1990 emissions (consistent with the historic greenhouse gas emission estimates presented in this report). CO_2-eq emissions include the basket of Kyoto gases (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) as well as fluorinated gases).

[d] The assessment here involves a large number of scenarios published in the scientific literature and is thus not limited to the Representative Concentration Pathways (RCPs). To evaluate the CO_2-eq concentration and climate implications of these scenarios, the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) was used in a probabilistic mode. For a comparison between MAGICC model results and the outcomes of the models used in WGI, see WGI 12.4.1.2, 12.4.8 and WGIII 6.3.2.6.

[e] The assessment in this table is based on the probabilities calculated for the full ensemble of scenarios in WGIII AR5 using MAGICC and the assessment in WGI of the uncertainty of the temperature projections not covered by climate models. The statements are therefore consistent with the statements in WGI, which are based on the Coupled Model Intercomparison Project Phase 5 (CMIP5) runs of the RCPs and the assessed uncertainties. Hence, the likelihood statements reflect different lines of evidence from both WGs. This WGI method was also applied for scenarios with intermediate concentration levels where no CMIP5 runs are available. The likelihood statements are indicative only *{WGIII 6.3}* and follow broadly the terms used by the WGI SPM for temperature projections: likely 66–100%, more likely than not >50–100%, about as likely as not 33–66%, and unlikely 0–33%. In addition the term more unlikely than likely 0–<50% is used.

[f] The CO_2-equivalent concentration (see Glossary) is calculated on the basis of the total forcing from a simple carbon cycle/climate model, MAGICC. The CO_2-equivalent concentration in 2011 is estimated to be 430 ppm (uncertainty range 340 to 520 ppm). This is based on the assessment of total anthropogenic radiative forcing for 2011 relative to 1750 in WGI, i.e., 2.3 W/m^2, uncertainty range 1.1 to 3.3 W/m^2.

[g] The vast majority of scenarios in this category overshoot the category boundary of 480 ppm CO_2-eq concentration.

[h] For scenarios in this category, no CMIP5 run or MAGICC realization stays below the respective temperature level. Still, an *unlikely* assignment is given to reflect uncertainties that may not be reflected by the current climate models.

[i] Scenarios in the 580 to 650 ppm CO_2-eq category include both overshoot scenarios and scenarios that do not exceed the concentration level at the high end of the category (e.g., RCP4.5). The latter type of scenarios, in general, have an assessed probability of *more unlikely than likely* to stay below the 2°C temperature level, while the former are mostly assessed to have an *unlikely* probability of staying below this level.

[j] In these scenarios, global CO_2-eq emissions in 2050 are between 70 to 95% below 2010 emissions, and they are between 110 to 120% below 2010 emissions in 2100.

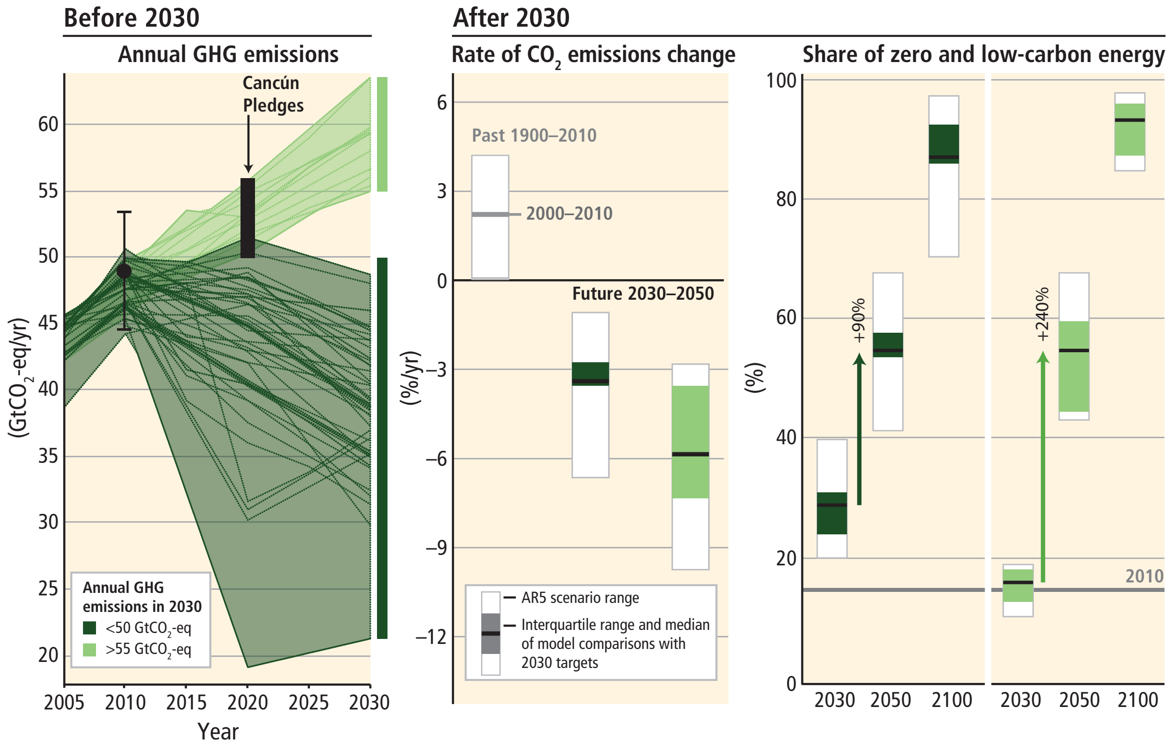

Figure SPM.12 | The implications of different 2030 greenhouse gas (GHG) emissions levels for the rate of carbon dioxide (CO_2) emissions reductions and low-carbon energy upscaling in mitigation scenarios that are at least *about as likely as not* to keep warming throughout the 21st century below 2°C relative to pre-industrial levels (2100 CO_2-equivalent concentrations of 430 to 530 ppm). The scenarios are grouped according to different emissions levels by 2030 (coloured in different shades of green). The left panel shows the pathways of GHG emissions (gigatonne of CO_2-equivalent per year, $GtCO_2$-eq/yr) leading to these 2030 levels. The black dot with whiskers gives historic GHG emission levels and associated uncertainties in 2010 as reported in Figure SPM.2. The black bar shows the estimated uncertainty range of GHG emissions implied by the Cancún Pledges. The middle panel denotes the average annual CO_2 emissions reduction rates for the period 2030–2050. It compares the median and interquartile range across scenarios from recent inter-model comparisons with explicit 2030 interim goals to the range of scenarios in the Scenario Database for WGIII AR5. Annual rates of historical emissions change (sustained over a period of 20 years) and the average annual CO_2 emission change between 2000 and 2010 are shown as well. The arrows in the right panel show the magnitude of zero and low-carbon energy supply upscaling from 2030 to 2050 subject to different 2030 GHG emissions levels. Zero- and low-carbon energy supply includes renewables, nuclear energy and fossil energy with carbon dioxide capture and storage (CCS) or bioenergy with CCS (BECCS). [Note: Only scenarios that apply the full, unconstrained mitigation technology portfolio of the underlying models (default technology assumption) are shown. Scenarios with large net negative global emissions (>20 $GtCO_2$-eq/yr), scenarios with exogenous carbon price assumptions and scenarios with 2010 emissions significantly outside the historical range are excluded.] *{Figure 3.3}*

Mitigation scenarios reaching about 450 ppm CO_2-eq in 2100 (consistent with a *likely* chance to keep warming below 2°C relative to pre-industrial levels) typically involve temporary overshoot[17] of atmospheric concentrations, as do many scenarios reaching about 500 ppm CO_2-eq to about 550 ppm CO_2-eq in 2100 (Table SPM.1). Depending on the level of overshoot, overshoot scenarios typically rely on the availability and widespread deployment of bioenergy with carbon dioxide capture and storage (BECCS) and afforestation in the second half of the century. The availability and scale of these and other CDR technologies and methods are uncertain and CDR technologies are, to varying degrees, associated with challenges and risks[18]. CDR is also prevalent in many scenarios without overshoot to compensate for residual emissions from sectors where mitigation is more expensive (*high confidence*). *{3.4, Box 3.3}*

Reducing emissions of non-CO_2 agents can be an important element of mitigation strategies. All current GHG emissions and other forcing agents affect the rate and magnitude of climate change over the next few decades, although long-term warming is mainly driven by CO_2 emissions. Emissions of non-CO_2 forcers are often expressed as 'CO_2-equivalent emissions', but the choice of metric to calculate these emissions, and the implications for the emphasis and timing of abatement of the various climate forcers, depends on application and policy context and contains value judgments. *{3.4, Box 3.2}*

[17] In concentration 'overshoot' scenarios, concentrations peak during the century and then decline.

[18] CDR methods have biogeochemical and technological limitations to their potential on the global scale. There is insufficient knowledge to quantify how much CO_2 emissions could be partially offset by CDR on a century timescale. CDR methods may carry side effects and long-term consequences on a global scale.

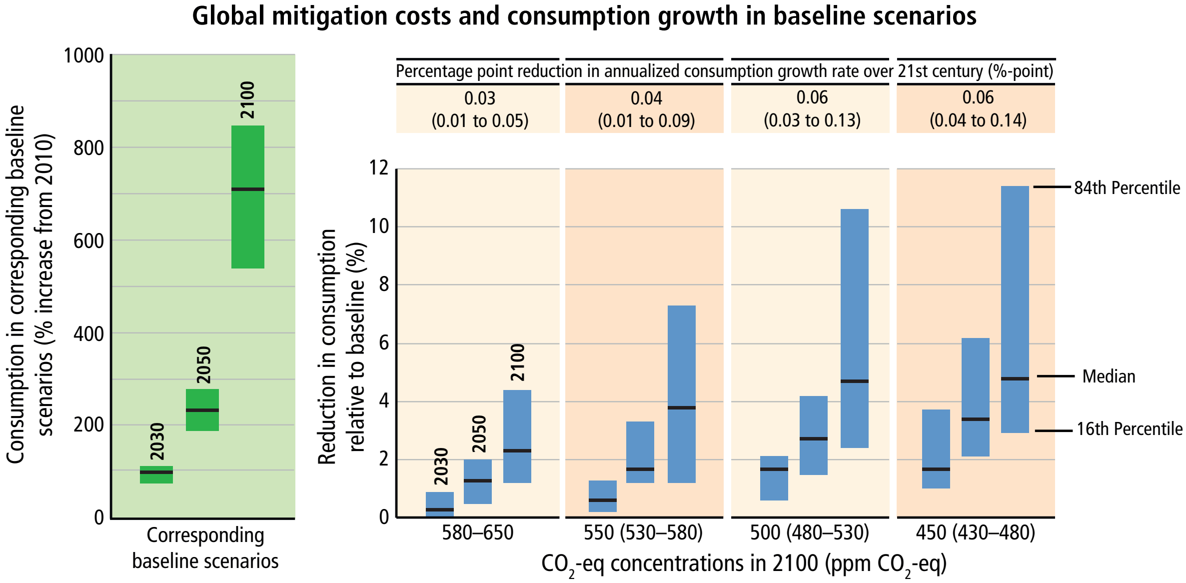

Figure SPM.13 | Global mitigation costs in cost-effective scenarios at different atmospheric concentrations levels in 2100. Cost-effective scenarios assume immediate mitigation in all countries and a single global carbon price, and impose no additional limitations on technology relative to the models' default technology assumptions. Consumption losses are shown relative to a baseline development without climate policy (left panel). The table at the top shows percentage points of annualized consumption growth reductions relative to consumption growth in the baseline of 1.6 to 3% per year (e.g., if the reduction is 0.06 percentage points per year due to mitigation, and baseline growth is 2.0% per year, then the growth rate with mitigation would be 1.94% per year). Cost estimates shown in this table do not consider the benefits of reduced climate change or co-benefits and adverse side effects of mitigation. Estimates at the high end of these cost ranges are from models that are relatively inflexible to achieve the deep emissions reductions required in the long run to meet these goals and/or include assumptions about market imperfections that would raise costs. *{Figure 3.4}*

Delaying additional mitigation to 2030 will substantially increase the challenges associated with limiting warming over the 21st century to below 2°C relative to pre-industrial levels. It will require substantially higher rates of emissions reductions from 2030 to 2050; a much more rapid scale-up of low-carbon energy over this period; a larger reliance on CDR in the long term; and higher transitional and long-term economic impacts. Estimated global emissions levels in 2020 based on the Cancún Pledges are not consistent with cost-effective mitigation trajectories that are at least *about as likely as not* to limit warming to below 2°C relative to pre-industrial levels, but they do not preclude the option to meet this goal (*high confidence*) (Figure SPM.12, Table SPM.2). *{3.4}*

Estimates of the aggregate economic costs of mitigation vary widely depending on methodologies and assumptions, but increase with the stringency of mitigation. Scenarios in which all countries of the world begin mitigation immediately, in which there is a single global carbon price, and in which all key technologies are available have been used as a cost-effective benchmark for estimating macro-economic mitigation costs (Figure SPM.13). Under these assumptions mitigation scenarios that are *likely* to limit warming to below 2°C through the 21st century relative to pre-industrial levels entail losses in global consumption—not including benefits of reduced climate change as well as co-benefits and adverse side effects of mitigation—of 1 to 4% (median: 1.7%) in 2030, 2 to 6% (median: 3.4%) in 2050 and 3 to 11% (median: 4.8%) in 2100 relative to consumption in baseline scenarios that grows anywhere from 300% to more than 900% over the century (Figure SPM.13). These numbers correspond to an annualized reduction of consumption growth by 0.04 to 0.14 (median: 0.06) percentage points over the century relative to annualized consumption growth in the baseline that is between 1.6 and 3% per year (*high confidence*). *{3.4}*

In the absence or under limited availability of mitigation technologies (such as bioenergy, CCS and their combination BECCS, nuclear, wind/solar), mitigation costs can increase substantially depending on the technology considered. Delaying additional mitigation increases mitigation costs in the medium to long term. Many models could not limit *likely* warming to below 2°C over the 21st century relative to pre-industrial levels if additional mitigation is considerably delayed. Many models could not limit *likely* warming to below 2°C if bioenergy, CCS and their combination (BECCS) are limited (*high confidence*) (Table SPM.2). *{3.4}*

Table SPM.2 | Increase in global mitigation costs due to either limited availability of specific technologies or delays in additional mitigation [a] relative to cost-effective scenarios [b]. The increase in costs is given for the median estimate and the 16th to 84th percentile range of the scenarios (in parentheses) [c]. In addition, the sample size of each scenario set is provided in the coloured symbols. The colours of the symbols indicate the fraction of models from systematic model comparison exercises that could successfully reach the targeted concentration level. *{Table 3.2}*

Mitigation cost increases in scenarios with limited availability of technologies [d] *[% increase in total discounted* [e] *mitigation costs (2015–2100) relative to default technology assumptions]*					**Mitigation cost increases due to delayed additional mitigation until 2030** *[% increase in mitigation costs relative to immediate mitigation]*	
2100 concentrations (ppm CO_2-eq)	no CCS	nuclear phase out	limited solar/wind	limited bioenergy	medium term costs (2030–2050)	long term costs (2050–2100)
450 (430 to 480)	138% (29 to 297%) 4	7% (4 to 18%) 8	6% (2 to 29%) 8	64% (44 to 78%) 8	44% (2 to 78%) 29	37% (16 to 82%) 29
500 (480 to 530)	not available (n.a.)	n.a.	n.a.	n.a.		
550 (530 to 580)	39% (18 to 78%) 11	13% (2 to 23%) 10	8% (5 to 15%) 10	18% (4 to 66%) 12	15% (3 to 32%)	16% (5 to 24%)
580 to 650	n.a.	n.a.	n.a.	n.a.		

Symbol legend—fraction of models successful in producing scenarios (numbers indicate the number of successful models)	
: all models successful	: between 50 and 80% of models successful
: between 80 and 100% of models successful	: less than 50% of models successful

Notes:

[a] Delayed mitigation scenarios are associated with greenhouse gas emission of more than 55 $GtCO_2$-eq in 2030, and the increase in mitigation costs is measured relative to cost-effective mitigation scenarios for the same long-term concentration level.

[b] Cost-effective scenarios assume immediate mitigation in all countries and a single global carbon price, and impose no additional limitations on technology relative to the models' default technology assumptions.

[c] The range is determined by the central scenarios encompassing the 16th to 84th percentile range of the scenario set. Only scenarios with a time horizon until 2100 are included. Some models that are included in the cost ranges for concentration levels above 530 ppm CO_2-eq in 2100 could not produce associated scenarios for concentration levels below 530 ppm CO_2-eq in 2100 with assumptions about limited availability of technologies and/or delayed additional mitigation.

[d] No CCS: carbon dioxide capture and storage is not included in these scenarios. Nuclear phase out: no addition of nuclear power plants beyond those under construction, and operation of existing plants until the end of their lifetime. Limited Solar/Wind: a maximum of 20% global electricity generation from solar and wind power in any year of these scenarios. Limited Bioenergy: a maximum of 100 EJ/yr modern bioenergy supply globally (modern bioenergy used for heat, power, combinations and industry was around 18 EJ/yr in 2008). EJ = Exajoule = 10^{18} Joule.

[e] Percentage increase of net present value of consumption losses in percent of baseline consumption (for scenarios from general equilibrium models) and abatement costs in percent of baseline gross domestic product (GDP, for scenarios from partial equilibrium models) for the period 2015–2100, discounted at 5% per year.

Mitigation scenarios reaching about 450 or 500 ppm CO_2-eq by 2100 show reduced costs for achieving air quality and energy security objectives, with significant co-benefits for human health, ecosystem impacts and sufficiency of resources and resilience of the energy system. *{4.4.2.2}*

Mitigation policy could devalue fossil fuel assets and reduce revenues for fossil fuel exporters, but differences between regions and fuels exist (*high confidence*). Most mitigation scenarios are associated with reduced revenues from coal and oil trade for major exporters (*high confidence*). The availability of CCS would reduce the adverse effects of mitigation on the value of fossil fuel assets (*medium confidence*). *{4.4.2.2}*

Solar Radiation Management (SRM) involves large-scale methods that seek to reduce the amount of absorbed solar energy in the climate system. SRM is untested and is not included in any of the mitigation scenarios. If it were deployed, SRM would entail numerous uncertainties, side effects, risks and shortcomings and has particular governance and ethical implications. SRM would not reduce ocean acidification. If it were terminated, there is *high confidence* that surface temperatures would rise very rapidly impacting ecosystems susceptible to rapid rates of change. *{Box 3.3}*

SPM 4. Adaptation and Mitigation

Many adaptation and mitigation options can help address climate change, but no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales and can be enhanced through integrated responses that link adaptation and mitigation with other societal objectives. *{4}*

SPM 4.1 Common enabling factors and constraints for adaptation and mitigation responses

Adaptation and mitigation responses are underpinned by common enabling factors. These include effective institutions and governance, innovation and investments in environmentally sound technologies and infrastructure, sustainable livelihoods and behavioural and lifestyle choices. *{4.1}*

Inertia in many aspects of the socio-economic system constrains adaptation and mitigation options (*medium evidence, high agreement*). Innovation and investments in environmentally sound infrastructure and technologies can reduce GHG emissions and enhance resilience to climate change (*very high confidence*). *{4.1}*

Vulnerability to climate change, GHG emissions and the capacity for adaptation and mitigation are strongly influenced by livelihoods, lifestyles, behaviour and culture (*medium evidence, medium agreement*). Also, the social acceptability and/or effectiveness of climate policies are influenced by the extent to which they incentivize or depend on regionally appropriate changes in lifestyles or behaviours. *{4.1}*

For many regions and sectors, enhanced capacities to mitigate and adapt are part of the foundation essential for managing climate change risks (*high confidence*). Improving institutions as well as coordination and cooperation in governance can help overcome regional constraints associated with mitigation, adaptation and disaster risk reduction (*very high confidence*). *{4.1}*

SPM 4.2 Response options for adaptation

Adaptation options exist in all sectors, but their context for implementation and potential to reduce climate-related risks differs across sectors and regions. Some adaptation responses involve significant co-benefits, synergies and trade-offs. Increasing climate change will increase challenges for many adaptation options. *{4.2}*

Adaptation experience is accumulating across regions in the public and private sectors and within communities. There is increasing recognition of the value of social (including local and indigenous), institutional, and ecosystem-based measures and of the extent of constraints to adaptation. Adaptation is becoming embedded in some planning processes, with more limited implementation of responses (*high confidence*). *{1.6, 4.2, 4.4.2.1}*

The need for adaptation along with associated challenges is expected to increase with climate change (*very high confidence*). Adaptation options exist in all sectors and regions, with diverse potential and approaches depending on their context in vulnerability reduction, disaster risk management or proactive adaptation planning (Table SPM.3). Effective strategies and actions consider the potential for co-benefits and opportunities within wider strategic goals and development plans. *{4.2}*

Table SPM.3 | Approaches for managing the risks of climate change through adaptation. These approaches should be considered overlapping rather than discrete, and they are often pursued simultaneously. Examples are presented in no specific order and can be relevant to more than one category. *{Table 4.2}*

Overlapping Approaches	Category	Examples
Vulnerability & Exposure Reduction through development, planning & practices including many low-regrets measures	Human development	Improved access to education, nutrition, health facilities, energy, safe housing & settlement structures, & social support structures; Reduced gender inequality & marginalization in other forms.
	Poverty alleviation	Improved access to & control of local resources; Land tenure; Disaster risk reduction; Social safety nets & social protection; Insurance schemes.
	Livelihood security	Income, asset & livelihood diversification; Improved infrastructure; Access to technology & decision-making fora; Increased decision-making power; Changed cropping, livestock & aquaculture practices; Reliance on social networks.
	Disaster risk management	Early warning systems; Hazard & vulnerability mapping; Diversifying water resources; Improved drainage; Flood & cyclone shelters; Building codes & practices; Storm & wastewater management; Transport & road infrastructure improvements.
	Ecosystem management	Maintaining wetlands & urban green spaces; Coastal afforestation; Watershed & reservoir management; Reduction of other stressors on ecosystems & of habitat fragmentation; Maintenance of genetic diversity; Manipulation of disturbance regimes; Community-based natural resource management.
	Spatial or land-use planning	Provisioning of adequate housing, infrastructure & services; Managing development in flood prone & other high risk areas; Urban planning & upgrading programs; Land zoning laws; Easements; Protected areas.
Adaptation including incremental & transformational adjustments	Structural/physical	***Engineered & built-environment options***: Sea walls & coastal protection structures; Flood levees; Water storage; Improved drainage; Flood & cyclone shelters; Building codes & practices; Storm & wastewater management; Transport & road infrastructure improvements; Floating houses; Power plant & electricity grid adjustments.
		Technological options: New crop & animal varieties; Indigenous, traditional & local knowledge, technologies & methods; Efficient irrigation; Water-saving technologies; Desalinisation; Conservation agriculture; Food storage & preservation facilities; Hazard & vulnerability mapping & monitoring; Early warning systems; Building insulation; Mechanical & passive cooling; Technology development, transfer & diffusion.
		Ecosystem-based options: Ecological restoration; Soil conservation; Afforestation & reforestation; Mangrove conservation & replanting; Green infrastructure (e.g., shade trees, green roofs); Controlling overfishing; Fisheries co-management; Assisted species migration & dispersal; Ecological corridors; Seed banks, gene banks & other *ex situ* conservation; Community-based natural resource management.
		Services: Social safety nets & social protection; Food banks & distribution of food surplus; Municipal services including water & sanitation; Vaccination programs; Essential public health services; Enhanced emergency medical services.
	Institutional	***Economic options***: Financial incentives; Insurance; Catastrophe bonds; Payments for ecosystem services; Pricing water to encourage universal provision and careful use; Microfinance; Disaster contingency funds; Cash transfers; Public-private partnerships.
		Laws & regulations: Land zoning laws; Building standards & practices; Easements; Water regulations & agreements; Laws to support disaster risk reduction; Laws to encourage insurance purchasing; Defined property rights & land tenure security; Protected areas; Fishing quotas; Patent pools & technology transfer.
		National & government policies & programs: National & regional adaptation plans including mainstreaming; Sub-national & local adaptation plans; Economic diversification; Urban upgrading programs; Municipal water management programs; Disaster planning & preparedness; Integrated water resource management; Integrated coastal zone management; Ecosystem-based management; Community-based adaptation.
	Social	***Educational options***: Awareness raising & integrating into education; Gender equity in education; Extension services; Sharing indigenous, traditional & local knowledge; Participatory action research & social learning; Knowledge-sharing & learning platforms.
		Informational options: Hazard & vulnerability mapping; Early warning & response systems; Systematic monitoring & remote sensing; Climate services; Use of indigenous climate observations; Participatory scenario development; Integrated assessments.
		Behavioural options: Household preparation & evacuation planning; Migration; Soil & water conservation; Storm drain clearance; Livelihood diversification; Changed cropping, livestock & aquaculture practices; Reliance on social networks.
Transformation	Spheres of change	***Practical***: Social & technical innovations, behavioural shifts, or institutional & managerial changes that produce substantial shifts in outcomes.
		Political: Political, social, cultural & ecological decisions & actions consistent with reducing vulnerability & risk & supporting adaptation, mitigation & sustainable development.
		Personal: Individual & collective assumptions, beliefs, values & worldviews influencing climate-change responses.

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SPM 4.3 Response options for mitigation

Mitigation options are available in every major sector. Mitigation can be more cost-effective if using an integrated approach that combines measures to reduce energy use and the greenhouse gas intensity of end-use sectors, decarbonize energy supply, reduce net emissions and enhance carbon sinks in land-based sectors. *{4.3}*

Well-designed systemic and cross-sectoral mitigation strategies are more cost-effective in cutting emissions than a focus on individual technologies and sectors, with efforts in one sector affecting the need for mitigation in others (*medium confidence*). Mitigation measures intersect with other societal goals, creating the possibility of co-benefits or adverse side effects. These intersections, if well-managed, can strengthen the basis for undertaking climate action. *{4.3}*

Emissions ranges for baseline scenarios and mitigation scenarios that limit CO_2-equivalent concentrations to low levels (about 450 ppm CO_2-eq, *likely* to limit warming to 2°C above pre-industrial levels) are shown for different sectors and gases in Figure SPM.14. Key measures to achieve such mitigation goals include decarbonizing (i.e., reducing the carbon intensity of) electricity generation (*medium evidence, high agreement*) as well as efficiency enhancements and behavioural changes, in order to reduce energy demand compared to baseline scenarios without compromising development (*robust evidence, high agreement*). In scenarios reaching 450 ppm CO_2-eq concentrations by 2100, global CO_2 emissions from the energy supply sector are projected to decline over the next decade and are characterized by reductions of 90% or more below 2010 levels between 2040 and 2070. In the majority of low-concentration stabilization scenarios (about 450 to about 500 ppm CO_2-eq, at least *about as likely as not* to limit warming to 2°C above pre-industrial levels), the share of low-carbon electricity supply (comprising renewable energy (RE), nuclear and carbon dioxide capture and storage (CCS) including bioenergy with carbon dioxide capture and storage (BECCS)) increases from the current share of approximately 30% to more than 80% by 2050, and fossil fuel power generation without CCS is phased out almost entirely by 2100. *{4.3}*

Direct CO_2 emissions by major sectors, and non-CO_2 emissions, for baseline and mitigation scenarios

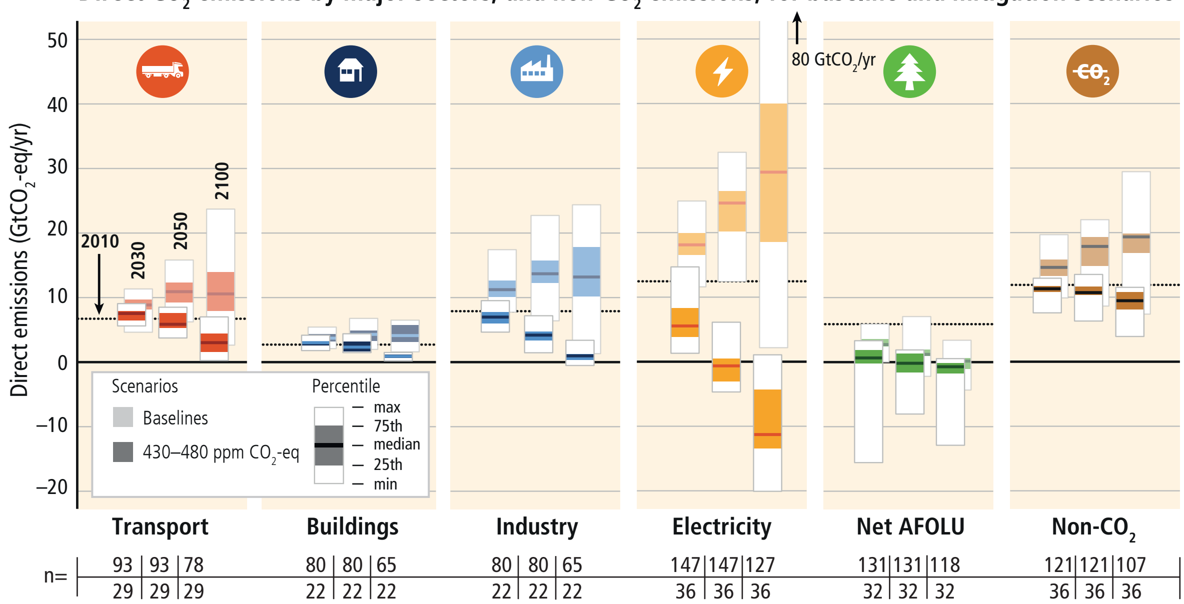

Figure SPM.14 | Carbon dioxide (CO_2) emissions by sector and total non-CO_2 greenhouse gases (Kyoto gases) across sectors in baseline (faded bars) and mitigation scenarios (solid colour bars) that reach about 450 (430 to 480) ppm CO_2-eq concentrations in 2100 (*likely* to limit warming to 2°C above pre-industrial levels). Mitigation in the end-use sectors leads also to indirect emissions reductions in the upstream energy supply sector. Direct emissions of the end-use sectors thus do not include the emission reduction potential at the supply-side due to, for example, reduced electricity demand. The numbers at the bottom of the graphs refer to the number of scenarios included in the range (upper row: baseline scenarios; lower row: mitigation scenarios), which differs across sectors and time due to different sectoral resolution and time horizon of models. Emissions ranges for mitigation scenarios include the full portfolio of mitigation options; many models cannot reach 450 ppm CO_2-eq concentration by 2100 in the absence of carbon dioxide capture and storage (CCS). Negative emissions in the electricity sector are due to the application of bioenergy with carbon dioxide capture and storage (BECCS). 'Net' agriculture, forestry and other land use (AFOLU) emissions consider afforestation, reforestation as well as deforestation activities. *{4.3, Figure 4.1}*

Near-term reductions in energy demand are an important element of cost-effective mitigation strategies, provide more flexibility for reducing carbon intensity in the energy supply sector, hedge against related supply-side risks, avoid lock-in to carbon-intensive infrastructures, and are associated with important co-benefits. The most cost-effective mitigation options in forestry are afforestation, sustainable forest management and reducing deforestation, with large differences in their relative importance across regions; and in agriculture, cropland management, grazing land management and restoration of organic soils (*medium evidence, high agreement*). *{4.3, Figures 4.1, 4.2, Table 4.3}*

Behaviour, lifestyle and culture have a considerable influence on energy use and associated emissions, with high mitigation potential in some sectors, in particular when complementing technological and structural change (*medium evidence, medium agreement*). Emissions can be substantially lowered through changes in consumption patterns, adoption of energy savings measures, dietary change and reduction in food wastes. *{4.1, 4.3}*

SPM 4.4 Policy approaches for adaptation and mitigation, technology and finance

Effective adaptation and mitigation responses will depend on policies and measures across multiple scales: international, regional, national and sub-national. Policies across all scales supporting technology development, diffusion and transfer, as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation and mitigation. *{4.4}*

International cooperation is critical for effective mitigation, even though mitigation can also have local co-benefits. Adaptation focuses primarily on local to national scale outcomes, but its effectiveness can be enhanced through coordination across governance scales, including international cooperation: *{3.1, 4.4.1}*

- The United Nations Framework Convention on Climate Change (UNFCCC) is the main multilateral forum focused on addressing climate change, with nearly universal participation. Other institutions organized at different levels of governance have resulted in diversifying international climate change cooperation. *{4.4.1}*

- The Kyoto Protocol offers lessons towards achieving the ultimate objective of the UNFCCC, particularly with respect to participation, implementation, flexibility mechanisms and environmental effectiveness (*medium evidence, low agreement*). *{4.4.1}*

- Policy linkages among regional, national and sub-national climate policies offer potential climate change mitigation benefits (*medium evidence, medium agreement*). Potential advantages include lower mitigation costs, decreased emission leakage and increased market liquidity. *{4.4.1}*

- International cooperation for supporting adaptation planning and implementation has received less attention historically than mitigation but is increasing and has assisted in the creation of adaptation strategies, plans and actions at the national, sub-national and local level (*high confidence*). *{4.4.1}*

There has been a considerable increase in national and sub-national plans and strategies on both adaptation and mitigation since the AR4, with an increased focus on policies designed to integrate multiple objectives, increase co-benefits and reduce adverse side effects (*high confidence*): *{4.4.2.1, 4.4.2.2}*

- National governments play key roles in adaptation planning and implementation (*robust evidence, high agreement*) through coordinating actions and providing frameworks and support. While local government and the private sector have different functions, which vary regionally, they are increasingly recognized as critical to progress in adaptation, given their roles in scaling up adaptation of communities, households and civil society and in managing risk information and financing (*medium evidence, high agreement*). *{4.4.2.1}*

- Institutional dimensions of adaptation governance, including the integration of adaptation into planning and decision-making, play a key role in promoting the transition from planning to implementation of adaptation (*robust evidence,* *high agreement*). Examples of institutional approaches to adaptation involving multiple actors include economic options (e.g., insurance, public-private partnerships), laws and regulations (e.g., land-zoning laws) and national and government policies and programmes (e.g., economic diversification). *{4.2, 4.4.2.1, Table SPM.3}*

- In principle, mechanisms that set a carbon price, including cap and trade systems and carbon taxes, can achieve mitigation in a cost-effective way but have been implemented with diverse effects due in part to national circumstances as well as policy design. The short-run effects of cap and trade systems have been limited as a result of loose caps or caps that have not proved to be constraining (*limited evidence, medium agreement*). In some countries, tax-based policies specifically aimed at reducing GHG emissions—alongside technology and other policies—have helped to weaken the link between GHG emissions and GDP (*high confidence*). In addition, in a large group of countries, fuel taxes (although not necessarily designed for the purpose of mitigation) have had effects that are akin to sectoral carbon taxes. *{4.4.2.2}*

- Regulatory approaches and information measures are widely used and are often environmentally effective (*medium evidence, medium agreement*). Examples of regulatory approaches include energy efficiency standards; examples of information programmes include labelling programmes that can help consumers make better-informed decisions. *{4.4.2.2}*

- Sector-specific mitigation policies have been more widely used than economy-wide policies (*medium evidence, high agreement*). Sector-specific policies may be better suited to address sector-specific barriers or market failures and may be bundled in packages of complementary policies. Although theoretically more cost-effective, administrative and political barriers may make economy-wide policies harder to implement. Interactions between or among mitigation policies may be synergistic or may have no additive effect on reducing emissions. *{4.4.2.2}*

- Economic instruments in the form of subsidies may be applied across sectors, and include a variety of policy designs, such as tax rebates or exemptions, grants, loans and credit lines. An increasing number and variety of renewable energy (RE) policies including subsidies—motivated by many factors—have driven escalated growth of RE technologies in recent years. At the same time, reducing subsidies for GHG-related activities in various sectors can achieve emission reductions, depending on the social and economic context (*high confidence*). *{4.4.2.2}*

Co-benefits and adverse side effects of mitigation could affect achievement of other objectives such as those related to human health, food security, biodiversity, local environmental quality, energy access, livelihoods and equitable sustainable development. The potential for co-benefits for energy end-use measures outweighs the potential for adverse side effects whereas the evidence suggests this may not be the case for all energy supply and agriculture, forestry and other land use (AFOLU) measures. Some mitigation policies raise the prices for some energy services and could hamper the ability of societies to expand access to modern energy services to underserved populations (*low confidence*). These potential adverse side effects on energy access can be avoided with the adoption of complementary policies such as income tax rebates or other benefit transfer mechanisms (*medium confidence*). Whether or not side effects materialize, and to what extent side effects materialize, will be case- and site-specific, and depend on local circumstances and the scale, scope and pace of implementation. Many co-benefits and adverse side effects have not been well-quantified. *{4.3, 4.4.2.2, Box 3.4}*

Technology policy (development, diffusion and transfer) complements other mitigation policies across all scales, from international to sub-national; many adaptation efforts also critically rely on diffusion and transfer of technologies and management practices (*high confidence*). Policies exist to address market failures in R&D, but the effective use of technologies can also depend on capacities to adopt technologies appropriate to local circumstances. *{4.4.3}*

Substantial reductions in emissions would require large changes in investment patterns (*high confidence*). For mitigation scenarios that stabilize concentrations (without overshoot) in the range of 430 to 530 ppm CO_2-eq by 2100[19], annual investments in low carbon electricity supply and energy efficiency in key sectors (transport, industry and buildings) are projected in the scenarios to rise by several hundred billion dollars per year before 2030. Within appropriate enabling environments, the private sector, along with the public sector, can play important roles in financing mitigation and adaptation (*medium evidence, high agreement*). *{4.4.4}*

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[19] This range comprises scenarios that reach 430 to 480 ppm CO_2-eq by 2100 (*likely* to limit warming to 2°C above pre-industrial levels) and scenarios that reach 480 to 530 ppm CO_2-eq by 2100 (without overshoot: *more likely than* not to limit warming to 2°C above pre-industrial levels).

Financial resources for adaptation have become available more slowly than for mitigation in both developed and developing countries. Limited evidence indicates that there is a gap between global adaptation needs and the funds available for adaptation (*medium confidence*). There is a need for better assessment of global adaptation costs, funding and investment. Potential synergies between international finance for disaster risk management and adaptation have not yet been fully realized (*high confidence*). *{4.4.4}*

SPM 4.5 Trade-offs, synergies and interactions with sustainable development

Climate change is a threat to sustainable development. Nonetheless, there are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through integrated responses (*high confidence*). Successful implementation relies on relevant tools, suitable governance structures and enhanced capacity to respond (*medium confidence*). *{3.5, 4.5}*

Climate change exacerbates other threats to social and natural systems, placing additional burdens particularly on the poor (*high confidence*). Aligning climate policy with sustainable development requires attention to both adaptation and mitigation (*high confidence*). Delaying global mitigation actions may reduce options for climate-resilient pathways and adaptation in the future. Opportunities to take advantage of positive synergies between adaptation and mitigation may decrease with time, particularly if limits to adaptation are exceeded. Increasing efforts to mitigate and adapt to climate change imply an increasing complexity of interactions, encompassing connections among human health, water, energy, land use and biodiversity (*medium evidence, high agreement*). *{3.1, 3.5, 4.5}*

Strategies and actions can be pursued now which will move towards climate-resilient pathways for sustainable development, while at the same time helping to improve livelihoods, social and economic well-being and effective environmental management. In some cases, economic diversification can be an important element of such strategies. The effectiveness of integrated responses can be enhanced by relevant tools, suitable governance structures and adequate institutional and human capacity (*medium confidence*). Integrated responses are especially relevant to energy planning and implementation; interactions among water, food, energy and biological carbon sequestration; and urban planning, which provides substantial opportunities for enhanced resilience, reduced emissions and more sustainable development (*medium confidence*). *{3.5, 4.4, 4.5}*

The Carbon Underground 200™

Rank	Coal Companies	Coal Gt CO_2	Rank	Oil and Gas Companies	Oil Gt CO_2	Gas Gt CO_2	Total O&G Gt CO_2
1	Coal India	57.722	1	Gazprom	6.248	37.292	43.540
2	Shenhua Group	31.523	2	Rosneft	10.059	1.979	12.039
3	Adani Enterprises	25.383	3	PetroChina	4.884	3.693	8.577
4	Shanxi Coking Company	18.445	4	ExxonMobil	4.143	4.038	8.181
5	BHP Billiton	13.469	5	Lukoil	5.666	1.280	6.946
6	Anglo American	12.985	6	BP	4.203	2.197	6.400
7	Inner Mongolia Yitai Coal	12.223	7	Petrobras	4.676	0.674	5.350
8	Datang Intl. Power	12.206	8	Royal Dutch Shell	2.140	2.332	4.473
9	China National Coal	12.071	9	Chevron	2.545	1.591	4.137
10	Peabody Energy	11.469	10	Total	2.130	1.683	3.813
11	Glencore Xstrata	10.453	11	Novatek	0.387	3.391	3.777
12	Datong Coal Industry	10.281	12	ConocoPhillips	1.661	1.069	2.730
13	Yanzhou Coal Mining	9.799	13	Tatneft	2.622	0.067	2.689
14	Public Power Corp (DEH)	9.339	14	ENI	1.418	1.142	2.561
15	Exxaro Resources	8.793	15	ONGC	1.449	0.703	2.152
16	Yangquan Coal Industry	7.298	16	Statoil	1.012	0.928	1.939
17	Mechel	6.739	17	Sinopec	1.204	0.367	1.571
18	Arch Coal	6.530	18	CNOOC	1.155	0.366	1.521
19	Alpha Natural Resources	5.482	19	BG	0.593	0.664	1.257
20	Mitsubishi	4.738	20	Occidental	0.950	0.303	1.253
21	Vale	4.401	21	Apache	0.586	0.461	1.047
22	Rio Tinto	4.338	22	Canadian Natural Resources	0.780	0.200	0.980
23	EVRAZ	4.235	23	Anadarko Petroleum	0.450	0.454	0.904
24	Raspadskaya	4.084	24	BHP Billiton	0.345	0.552	0.897
25	Asia Resource Minerals	3.181	25	Devon Energy	0.379	0.515	0.894
26	UC RUSAL	3.081	26	Chesapeake Energy	0.293	0.596	0.889
27	Neyveli Lignite	3.035	27	Bashneft	0.876	0.000	0.876
28	Pingdingshan Tianan Coal	3.023	28	Inpex	0.393	0.369	0.762
29	Cloud Peak Energy	2.881	29	Ecopetrol	0.580	0.157	0.737
30	Sasol	2.731	30	EOG Resources	0.392	0.258	0.650
31	Severstal	2.726	31	Suncor Energy	0.596	0.041	0.636
32	AGL Energy	2.704	32	Marathon Oil	0.473	0.151	0.624
33	Tata Steel	2.679	33	Hess	0.485	0.125	0.610
34	Teck Resources	2.603	34	Imperial Oil	0.561	0.027	0.587
35	Kuzbass Fuel	2.504	35	Encana	0.089	0.479	0.568
36	Polyus Gold	2.294	36	Energi Mega Persada	0.020	0.537	0.557
37	Energy Ventures	2.184	37	BASF	0.159	0.294	0.453
38	Whitehaven Coal	2.055	38	Repsol	0.182	0.265	0.446
39	Banpu	2.040	39	OMV	0.260	0.152	0.413
40	RWE	1.943	40	Noble Energy	0.141	0.271	0.412
41	Consol Energy	1.887	41	Woodside Petroleum	0.058	0.334	0.392
42	W H Soul Pattison	1.850	42	Pioneer Natural Resources	0.270	0.120	0.390
43	Resource Generation	1.818	43	Linn Energy	0.218	0.163	0.381
44	Bayan Resources	1.806	44	Cenovus Energy	0.309	0.053	0.362
45	Churchill Mining	1.745	45	YPF	0.235	0.121	0.356
46	NTPC	1.740	46	Range Resources	0.090	0.261	0.352
47	Adaro Energy	1.607	47	PTT	0.111	0.228	0.339
48	Nacco Industries	1.557	48	Husky Energy	0.212	0.122	0.334
49	Idemitsu Kosan	1.530	49	EQT	0.001	0.326	0.327
50	Alliance Resource Partners	1.475	50	Continental Resources	0.238	0.073	0.311

The Carbon Underground 200™

Rank	Coal Companies	Coal Gt CO_2	Rank	Oil and Gas Companies	Oil Gt CO_2	Gas Gt CO_2	Total O&G Gt CO_2
51	Huolinhe Opencut Coal Ind	1.387	51	Talisman Energy	0.111	0.199	0.310
52	Coalspur Mines	1.380	52	KazMunaiGas EP	0.298	0.000	0.298
53	Mitsui	1.366	53	JX Holdings	0.271	0.000	0.271
54	Golden Energy Mines	1.354	54	WPX Energy	0.069	0.188	0.258
55	Coal of Africa	1.339	55	Santos	0.033	0.204	0.237
56	Novolipetsk Steel	1.288	56	SK Innovation	0.226	0.000	0.226
57	Wesfarmers	1.094	57	QEP Resources	0.078	0.143	0.220
58	Tata Power	1.062	58	Southwestern Energy	0.000	0.219	0.219
59	Magnitogorsk Iron & Steel	1.046	59	Consol Energy	0.000	0.218	0.218
60	Sherritt International	1.012	60	Cabot Oil & Gas	0.010	0.201	0.212
61	Kazakhmys	0.998	61	SandRidge Energy	0.134	0.077	0.211
62	New World Resources	0.972	62	Newfield Exploration	0.112	0.096	0.207
63	Mongolian Mining	0.903	63	Murphy Oil	0.144	0.062	0.206
64	Itochu	0.878	64	Dragon Oil	0.159	0.044	0.203
65	Westmoreland	0.864	65	Freeport-McMoRan	0.155	0.028	0.183
66	Cockatoo Coal	0.851	66	Maersk Group	0.174	0.000	0.174
67	Shanxi Meijin Energy	0.784	67	Concho Resources	0.116	0.057	0.173
68	Jizhong Energy Resources	0.742	68	Ultra Petroleum	0.008	0.162	0.169
69	Bandanna Energy	0.731	69	Denbury Resources	0.139	0.026	0.166
70	Polo Resources	0.726	70	GDF SUEZ	0.045	0.117	0.162
71	Allete	0.723	71	MEG Energy	0.155	0.000	0.155
72	CLP Holdings	0.696	72	Whiting Petroleum	0.139	0.012	0.151
73	Aspire Mining	0.670	73	RWE	0.037	0.111	0.148
74	Walter Energy	0.641	74	MOL	0.084	0.061	0.146
75	Aquila Resources	0.627	75	Crescent Point Energy	0.135	0.010	0.145
76	Coal Energy	0.614	76	Polish Oil & Gas	0.036	0.108	0.144
77	China Resources Power	0.567	77	Mitsui	0.048	0.095	0.142
78	Indika Inti	0.485	78	Penn West Petroleum	0.111	0.029	0.140
79	ArcelorMittal	0.464	79	Pacific Rubiales Energy	0.104	0.028	0.132
80	FirstEnergy	0.458	80	Oil India	0.073	0.059	0.132
81	Black Hills Corp	0.431	81	Cimarex Energy	0.062	0.068	0.130
82	Wescoal Holdings	0.430	82	Energen	0.082	0.044	0.126
83	Grupo Mexico	0.420	83	TAQA	0.065	0.055	0.121
84	African Rainbow Minerals	0.379	84	Oil Search	0.028	0.088	0.117
85	Shanxi Coal Intl Energy	0.376	85	ARC Resources	0.044	0.065	0.109
86	Capital Power	0.367	86	Canadian Oil Sands	0.109	0.000	0.109
87	PTT Public	0.359	87	Genel Energy	0.105	0.000	0.105
88	Lanhua	0.338	88	SM Energy	0.057	0.045	0.102
89	Fortune Minerals	0.328	89	Sasol	0.004	0.085	0.089
90	Cardero Resources	0.323	90	National Fuel Gas	0.018	0.071	0.088
91	Zhengzhou Coal Ind & Elec	0.319	91	Tullow Oil	0.080	0.008	0.088
92	Steel Authority of India	0.307	92	Pengrowth Energy	0.051	0.037	0.088
93	Jindal Steel & Power	0.301	93	Xcite Energy	0.084	0.001	0.085
94	Shougang Fushan Resources	0.299	94	Vermilion Energy	0.069	0.013	0.082
95	Jingyuan CE	0.297	95	Peyto E&D	0.009	0.070	0.079
96	Stanmore Coal	0.287	96	Quicksilver Resources	0.017	0.061	0.077
97	Prophecy Coal	0.272	97	Petroceltic International	0.026	0.050	0.077
98	Marubeni	0.265	98	Forest Oil	0.026	0.050	0.076
99	Cliffs Natural Resources	0.247	99	Tourmaline Oil	0.009	0.065	0.074
100	NSSMC	0.237	100	Bonavista Energy	0.027	0.045	0.072

APPENDIX C: THE SORDID SIXTEEN

Alpha Natural Resources

ANR is the third-largest coal producer in the U.S., producing approximately 126 million tons of coal from approximately 150 active mines in Virginia, West Virginia, Kentucky, Pennsylvania, and Wyoming. ANR is currently the single largest company using mountaintop removal,[31] a particularly invasive method of coal mining that directly correlates with high rates of cancer, birth defects, and poverty.[32] In 2010, ANR received 1,453 notices of violations — over 4 a day — from the Mine Safety and Health Administration (MSHA) for breaches of health or safety standards that could cause a serious injury.[33] ANR is also responsible for the 2010 Upper Big Branch explosion, which resulted in the deaths of 29 miners.

Arch Coal

Arch is the second-largest coal producer in the U.S.[34] Arch is currently in a court battle to build the Spruce No. 1 mine, which would be the largest mountaintop removal mine in the U.S.[35] In 2009, the company spent over $2.32 million on lobbying efforts, and has also developed the Arch Coal Political Action Committee, which is a substantial donor to West Virginia politicians.[36]

Cabot Oil & Gas

Cabot Oil & Gas Corporation is a natural gas exploration and production company based in Houston. The company has been cited for numerous spills of toxic hydrofracking fluids in northeastern PA. Cabot had 412 violations on 213 wells drilled in the Marcellus Shale region from 2008-2011, roughly 2 violations per well.[37] EPA tests of well water in the area show dangerous levels of arsenic, glycols, barium, and other carcinogens.[38] These wells are also the site of the famous images of families lighting their tap water on fire.

Chesapeake Energy

Chesapeake is, in its own words, “the second-largest producer of natural gas, a Top 15 producer of oil and natural gas liquids and the most active driller of new wells in the U.S.”[39] While natural gas is often touted as a cleaner alternative to coal, recent studies show that high levels of methane released through hydrofracking result in greater overall greenhouse gas emissions for natural gas than for coal.[40] In 2011, Chesapeake was implicated in 141 health and safety violations in Pennsylvania alone. Chesapeake was fined $565,000 in February 2012 for previous violations that resulted in contamination of local waterways. In May of 2011, Chesapeake was fined $1.09 million.[41]

Chevron

Chevron is a U.S. based multinational energy company that is active in over 180 countries. It is considered one of the 6 “supermajor” oil companies in the world and is one of the largest 5 corporations in the U.S.[42] It has a long history of ethical violations, excerpted here. In 1950, it was one of three companies responsible for buying streetcar systems nationwide and replacing them with bus systems to increase petroleum sales. The three companies were charged and convicted for conspiracy.[43] Chevron is responsible for sickening local residents and damaging forests and rivers in Ecuador by dumping 18 billion gallons of toxic formation water into the rainforest with no remediation.[44] Its Richmond, CA refinery has bypassed wastewater treatment and released 11 million

[31] Rainforest Action Network and the Sierra Club, “Policy and Practice: 2011 Report Card on Banks and Mountaintop Removal: Executive Summary,” April 2011, http://www.ran.org/sites/default/files/ran_mtr_reportcard_2011_exec_summary.pdf.

[32] http://ilovemountains.org/the-human-cost

[33] Alpha Natural Resources, “2010 Form 10-K,” p 254-257, http://alnr.client.shareholder.com/secfiling.cfm?filingID=1140361-11-12105&CIK=1301063.

[34] Arch Coal, “Start Here Arch Coal, Inc. 2010 Annual Report,” p 40-42, 12 December 2010, http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9ODYxOTN8Q2hpbGRJRD0tMXxUeXBlPTM=&t=1.

[35] http://blogs.wvgazette.com/coaltattoo/2012/03/23/breaking-judge-overturns-epa-veto-of-spruce-mine-permit/

[36] “Annual Lobbying by Arch Coal,” OpenSecrets.org, accessed 1 August 2011,

[36]http://www.opensecrets.org/lobby/clientsum.php?id=D000019258&year=2011.

[37] Staaf, Erika. “Risky Business: An analysis of Marcellus Shale gas drilling violations in Pennsylvania, 2008-2011.”http://pennenvironmentcenter.org/sites/environment/files/reports/Risky%20Business%20Violations%20Report_0.pdf

[38] https://www.propublica.org/article/years-after-evidence-of-fracking-contamination-epa-to-supply-drinking-water

[39] http://www.chk.com/Pages/default.aspx

[40]http://www.sustainablefuture.cornell.edu/news/attachments/Howarth-EtAl-2011.pdf

[41] http://www.polluterwatch.com/chesapeake-energy

[42] Fortune 500, 2010 “America’s Largest Corporations” CNNmoney.com.

[43] Chomsky, Noam (1999). Year 501: the Conquest Continues. South End Press.

[44] “60 Minutes: Amazon Crude”. 3 May 2009. cbsnews.com.http://www.cbsnews.com/stories/2009/05/01/60minutes/main4983549_page2.shtml

pounds of toxic materials into the environment.[45] Chevron may have paid for Nigerian military forces to commit human rights abuses, such as shooting protesters from helicopters.[46] Chevron is also responsible for a large oil spill off the coast of Brazil in 2011.[47]

ConocoPhillips

ConocoPhillips is a U.S. multinational energy company and one of the six "supermajor" oil companies. It is operating in over 40 countries worldwide. Within the U.S., it is the second-largest refiner of oil, and the 13th worst corporate air polluter.[48] ConocoPhillips' Trainer Oil Refinery is the second-largest industrial polluter in Delaware County. A 2006 Swarthmore study found that this facility released over 138 tons of nitrate compounds into the Delaware River each year, putting area infants at greater risk of "Blue Baby Disease." The study also found that ConocoPhillips emits substantial amounts of napthalane, an airborne toxicant, from this same facility.[49]

Dominion Resources

Dominion Resources is a power and energy company headquartered in Richmond, Virginia. In 2010, pollution from Dominion's coal-fired power plants contribute to 332 deaths, 519 heart attacks, 5,528 asthma attacks, and 205 cases of chronic bronchitis per year.[50] Dominion also recently received approval from the U.S. Department of Energy to export natural gas from its Cove Point Liquefied Natural Gas terminal.[51] This move to export natural gas belies industry and governmental assurances that increased natural gas exploration will result in U.S. energy independence.

Duke Energy

Duke is a utility based in Charlotte, North Carolina. Duke will soon be the largest utility in the U.S., pending approval of a merger with Progress Energy.[52] In 2010, pollution from Duke and Progress' coal plants caused 1,248 deaths, 1,887 heart attacks, 20,511 asthma attacks, and 758 cases of chronic bronchitis per year.[53] The company has also been implicated in numerous ethics scandals and is a major contributor to political candidates.[54]

Exelon

Exelon is a utility based in Chicago but with a significant presence in greater Philadelphia. Exelon owns the Eddystone Station coal-fired power plant in Crum Lynne, PA. A 2006 Swarthmore study found that Eddystone Station releases nearly one ton of arsenic, one ton of lead, and 200 tons of sulfuric and hydrochloric acids into the atmosphere each year.[55] Eddystone Station also releases 162 pounds of mercury per year, more than all but two other power plants in the U.S. All of these contaminants have significant health effects for residents of Delaware County, with the impacts concentrated on the low-income and majority black residents of Chester.[56]

ExxonMobil

ExxonMobil, formerly Rockefeller's Standard Oil, is a U.S. multinational oil and gas corporation, and is the second-largest company in the world. Exxon has refineries in 21 countries, producing 6.3 million barrels a day, making in the largest refiner in the world. It is the largest "supermajor" oil company. The Exxon Valdez Spill in 1989, the second-largest spill in U.S. history, spilled 11 million gallons of crude oil. The company continues to suffer environmental mishaps; in July 2011, oil spilled from an ExxonMobil pipeline running from Silver Tip to Billings, Montana. The spill leaked 750 to 1,000 barrels of oil into the Yellowstone River in the 30 minutes before it was shut down.[57] Exxon allegedly assisted human rights violations in Indonesia by giving aid to the

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[45] "StandingUpToBigOil." Making Contact: produced by National Radio Project. 14 December 2010.
[46] Egelko, Bob (August 15, 2007). "Chevron can be sued for attacks on Nigerians, U.S. judge rules". The San Francisco Chronicle.
[47] "Chevron Takes Responsibility for Brazil Oil Spill, May Face $51M Fine." Fox News. 11 Nov 2011.
[48] "Toxic 100 Air Polluters Detailed Company Reports." Political Economy Research Institute.
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Indonesian military to torture and murder opposition.[58] 90% of scientists who deny climate change are connected with Exxon, and are often the direct recipients of Exxon funding.[59]

Halliburton

Halliburton is one of the world's largest natural gas companies, with operations in over 70 countries. Halliburton invented hydraulic fracturing, and is indirectly responsible for its recent expansion; the "Halliburton Loophole," passed in 2005 at the behest of former CEO Dick Cheney, removed the EPA's authority to regulate the practice.[60] In addition to numerous environmental disasters caused by fracking, Halliburton also shares culpability for the 2010 Deepwater Horizon explosion and oil spill. The National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling found that Halliburton used an unstable sealant on the well, helping cause the worst oil spill in U.S. history.[61]

Hess

Hess is a New York-based oil company that explores, produces, transports, and refines crude oil and natural gas in the U.S. and around the world. Hess is responsible for spilling 163,000 gallons of kerosene into the Hudson River in 1990 and for spilling 2.5 million gallons of crude oil into the Gowanus Canal in 1976, the largest spill on record at that time.[62] Hess currently has to pay $1.1 million in fines for having over 100 violations at various gas stations and their major storage facility in Brooklyn.[63] In 2008, Hess also had to pay $422 million in a settlement over water contamination; public water providers from 17 states filed a suit over drinking water contamination.[64]

Occidental Petroleum

Occidental is an oil and gas exploration and production corporation operating in the United States, the Middle East, North Africa, and South America. It is the fourth largest U.S. oil and gas company. Hooker Chemicals, later purchased by Occidental, was responsible for disposing chemical waste in the Love Canal beginning in the 1940s. The waste site was later the site of a school and residential community that experienced high instances of health problems; Occidental was eventually forced to pay $129 million in restitution for the damage done.[65] In 2007, indigenous Peruvians filed a lawsuit against Occidental demanding that they clean up and pay reparations for environmental damage caused over the course of three decades of dumping chemical byproducts (totaling 9 billion barrels) into local watersheds that were sources of drinking water and fish.[66]

Patriot Coal

Patriot is a St. Louis-based coal extraction company. It is the second-largest practitioner of mountaintop removal in the U.S.[67] In 2010, Patriot was found in contempt of court for selenium pollution at two mountaintop removal sites in West Virginia.[68] From 2000 to 2010, Patriot Coal had nearly 3,000 "significant" violations from the Mine Safety and Health Administration, one death on the job, and close to $10 million in fines.[69] Patriot Coal is a member of and contributor to the National Mining Association, which since 1997 has spent over $40 million lobbying against issues such as clean air, clean energy and green jobs, and for carbon capture and storage.[70]

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Peabody Energy

Peabody is the largest private-sector coal company in the world. In the U.S., it owns 20 coal mining operations in Wyoming, Colorado, Arizona, New Mexico, Illinois, and Indiana. In 2010, it averaged nine daily safety violations from the Mine Safety and Health Administration.[71] In addition to its U.S. operations, Peabody is rapidly expanding into China, where it has plans to develop several enormous surface mines.[72] Peabody spent almost $6.6 million on lobbying in 2010[73] and in the first 5 months of 2011 the company spent $3.7 million, including on a bill aimed at preventing the EPA from taking action relating to greenhouse gas emissions to address climate change.[74] In 2007, the Kentucky state legislature passed a law that will provide approximately $300 million in incentives to Peabody to build a coal gasification plant in that state.[75]

Range Resources

Range is a natural gas company based in Fort Worth, Texas, but with major operations in southwestern Pennsylvania. Range's operations in PA have led to skyrocketing levels of water-borne and aerial carcinogens.[76] As of May 2010, Range had made over $200,000 in fines to the state for regulatory violations.[77] Range has also engaged in campaigns of intimidation against communities who threaten to pass unfavorable zoning regulations. A company spokesman stated on record that the company employs Army-trained counterinsurgency experts to deal with angry local populations.[78]

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NUMBERS, FACTS AND TRENDS SHAPING THE WORLD

FOR RELEASE JUNE 26, 2014

Beyond Red vs. Blue: The Political Typology

Fragmented Center Poses Election Challenges for Both Parties

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RECOMMENDED CITATION: Pew Research Center, June, 2014, “Beyond Red vs. Blue: The Political Typology”

Section 7: Global Warming, Environment and Energy

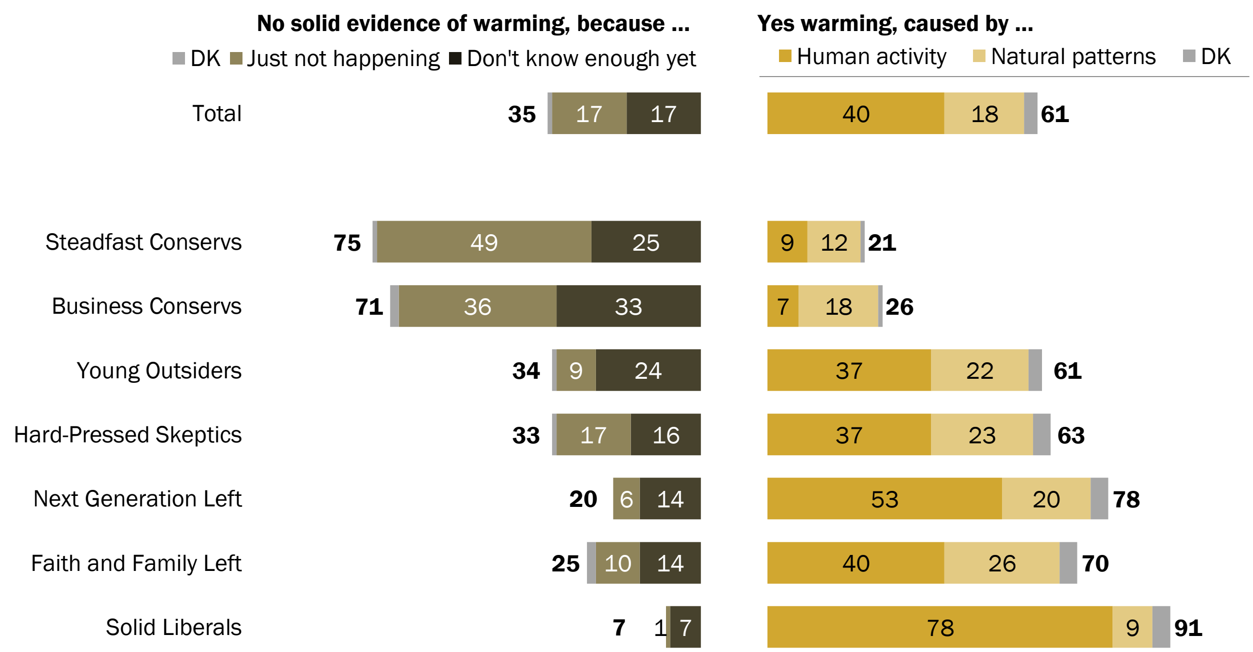
Opinions about the environment and energy sharply divide the typology groups, with the two predominantly Republican groups – Steadfast Conservatives and Business Conservatives – standing out for their skepticism of global warming and relatively low support for environmental protection. The other typology groups generally express pro-environmental views, and majorities in these groups say the average temperature on Earth has increased over the past few decades. However, most typology groups also favor building the Keystone XL pipeline, with the notable exception of Solid Liberals.

Views of Global Warming

Overall, 61% of the public say there is solid evidence that the average temperature on Earth has been getting warmer over the past few decades, while 35% say there is not solid evidence that the Earth is warming.

Steadfast and Business Conservatives Say No Solid Evidence of Global Warming

% who say…



2014 Political Typology. QC57/QC58a-b. Subgroups may not add to NETs because of rounding.

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Among those who say the Earth is warming, most say it is caused by human activity (40% of the public), while fewer say it is because of natural patterns in the Earth's environment (18%).

Those who do not believe there is solid evidence the Earth is warming are divided, with as many saying they "just don't know enough yet" (17% of the public) as "it's just not happening" (also 17%).

Wide majorities of Steadfast Conservatives (75%) and Business Conservatives (71%) say there is not solid evidence the Earth is warming – the only two typology groups with a majority who hold this view. Nearly half of Steadfast Conservatives (49%) say warming is not happening at all, while 25% say not enough is yet known. Business Conservatives are divided, with about as many saying it is not happening (36%) as say that not enough is yet known (33%).

Majorities of Young Outsiders (61%) and Hard-Pressed Skeptics (63%) say there is solid evidence the Earth is warming. However, just 37% of each group says that the Earth is getting warmer as a result of human activity.

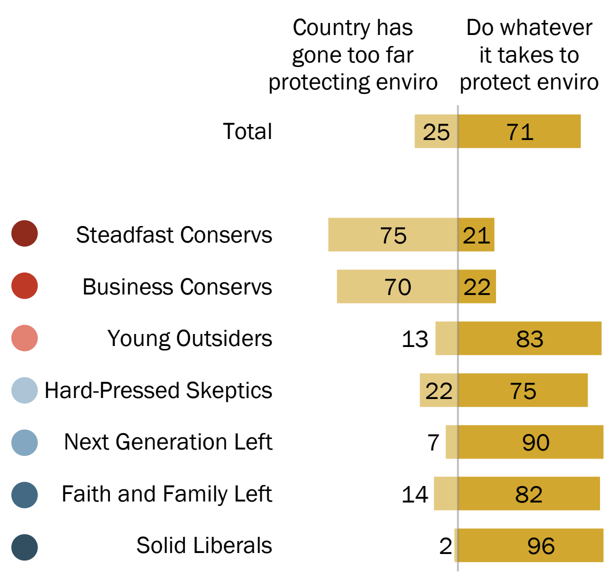
Broad majorities of the Next Generation Left (78%) and Faith and Family Left (70%) say that the average temperature on Earth has been getting warmer over the past few decades. The Next Generation Left, however, are somewhat more likely than the Faith and Family Left to say warming is the result of human activity (53% vs. 40%).

An overwhelming majority (91%) of Solid Liberals say the Earth is warming, and fully 78% say it is because of human activity – by far the highest percentage among typology groups.

Alongside doubts about global warming, 75% of Steadfast Conservatives and 70% of Business Conservatives say the country has gone too far in its efforts to protect the environment. Less than a quarter of each group say the country should do whatever it takes to protect the environment.

Stark Divide Between Conservatives and Other Groups in Views of Environment

% who say ...



2014 Political Typology. Q50q.

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There is a stark divide between these two groups and the other typology groups: Clear majorities of the five other groups – including 96% of Solid Liberals and 83% of Republican-leaning Young Outsiders – say that the country should do whatever it takes to protect the environment.

Environmental protection draws more support in principle than when the issue of potential costs is raised. Among the public, 71% say the country "should do whatever it takes to protect the environment."

But a smaller majority (56%) says "stricter environmental laws and regulations are worth the cost." Nearly four-in-ten (39%) say tougher environmental laws and regulations cost too many jobs and hurt the economy.

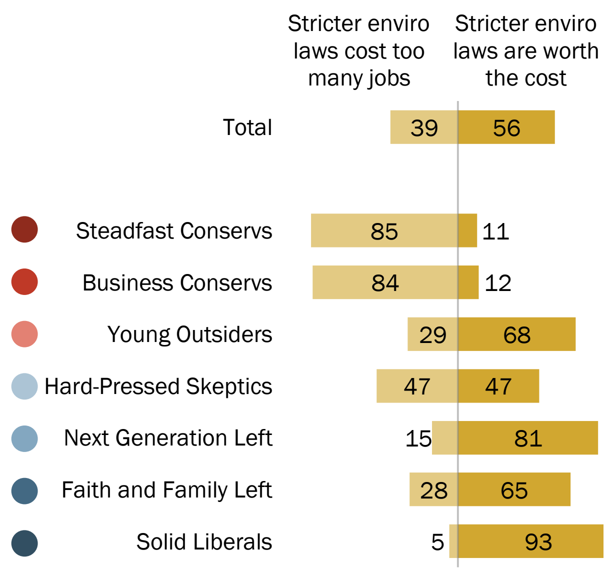
Among Hard-Pressed Skeptics, the most financially-strapped typology group, 75% favor the country doing whatever is necessary to protect the environment. But as many say stricter environmental laws hurt the economy as say they are worth the cost (47%). A similar pattern is evident, to a lesser extent, among the Faith and Family Left and the Young Outsiders; about two-thirds in each of these groups say stricter environmental regulations are worth the cost, though larger majorities (around eight-in-ten) say the country should do whatever is necessary to protect the environment.

By comparison, Solid Liberals and the Next Generation Left are broadly supportive of environmental laws and regulations; most Solid Liberals (93%) and those in the Next Generation Left (81%) say stricter environmental laws are worth the economic costs.

And overwhelming majorities of both Steadfast (85%) and Business Conservatives (84%) say that stricter environmental regulations cost too many jobs and hurt the economy.

Hard-Pressed Skeptics Split Over Costs of Environmental Protection

% who say ...



2014 Political Typology. Q50r.

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Most Prioritize Alternative Energy, But Keystone Draws Broad Support

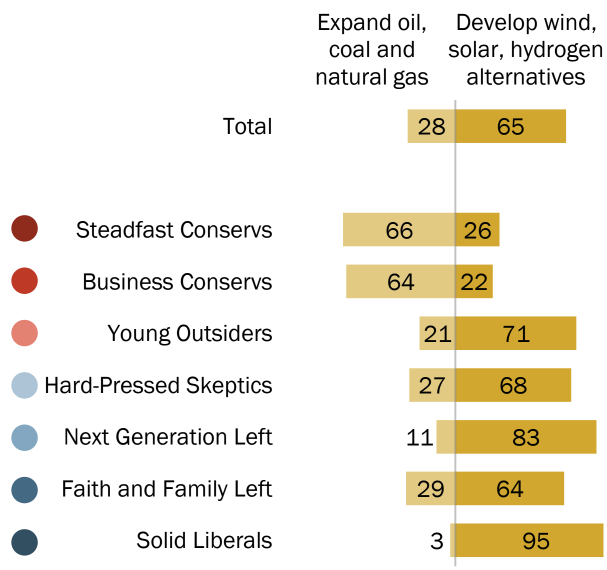
When it comes to policies to address the country's energy supply, 65% say the more important priority should be developing alternative sources such as wind, solar and hydrogen technology; fewer than half as many (28%) say the priority should be on expanding exploration and production of oil, coal and natural gas.

Here again, the two most conservative typology groups are an exception. About two-thirds of Steadfast Conservatives (66%) and Business Conservatives (64%) say it is more important for the country to focus on expanded production of oil, coal and natural gas than on developing alternatives such as wind, solar and hydrogen technology.

Majorities of all other groups prioritize the development of alternative energy sources over expanding exploration of fossil fuels. Solid Liberals (95%) and the Next Generation Left (83%) are the two groups most likely to back development of alternative sources of energy. They are joined in this view by 71% of Young Outsiders, 68% of Hard-Pressed Skeptics and 64% of the Faith and Family Left.

Alternative Energy Widely Supported, Except by Conservative Groups

% who say ...



2014 Political Typology. QB107.

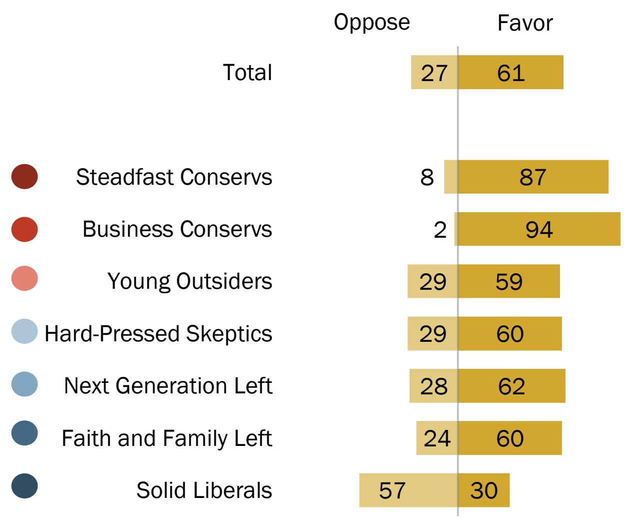
PEW RESEARCH CENTER

While most groups prioritize developing alternative sources of energy over the expanded production of oil, coal and natural gas, the Keystone XL pipeline is broadly supported. Six of the seven typology groups support building the Keystone XL pipeline, including the Next Generation Left, which has pro-environmental views on most measures.

Solid Liberals are the only group in which a majority opposes the pipeline, which would transport oil from Canada's oil sands to refineries in Texas. By nearly two-to-one (57%-30%), Solid Liberals oppose construction of the pipeline.

Business Conservatives are nearly unanimous in their support for building the Keystone XL pipeline (94%-2%); and almost nine-in-ten Steadfast Conservatives (87%) also back construction.

Solid Liberals Only Group to Oppose Building Keystone XL Pipeline



2014 Political Typology. QC128.

PEW RESEARCH CENTER

Somewhat smaller majorities of Young Outsiders (59%), Hard-Pressed Skeptics (60%), the Faith and Family Left (60%) and the Next Generation Left (62%) support building the Keystone pipeline.

A Transition to Clean Energy: Pace, Benefits, and Co-Benefits

There are clear economic and social benefits to continued fossil fuel use, but the advantages of consuming fossil fuels are rapidly being outweighed by their negative social, environmental, and climate impacts. As the following discussion shows, opinions about the pace of change needed—and that is politically possible—are starkly different depending on the perspective of the observer. In general, fossil fuel company executives see no significant energy transition taking place on the near-term (decades) horizon, while many clean energy CEOs, energy researchers, and climate activists believe that existing technology can and must be employed quickly. Among this latter group there exists a strong consensus that emissions must be reduced by 2030, with 2050 as a target year for reductions in the range of 80% of current rates. Both groups acknowledge that new technologies, better performance, and reduced costs are needed, especially in energy storage and vehicle drive trains. But the most important result to report about the pace of change, based on our study over the last two years, is our realization that the obstacles to moving more quickly toward a clean energy future are more political in nature than they are technical.

Energy Company Perspectives

The fossil fuel industry is diverse, and we do not claim here to comprehensively review industry perspectives on the world's energy future. As the examples given here show, though, some of the world's largest energy companies continue to reassure their investors that the transition to a clean energy economy is many years away, and there is little financial risk to their business model of accelerating extraction and combustion.

In a 2014 analysis, ExxonMobil predicted that although energy from renewable sources will continue to grow, fossil energy demand overall will grow even faster, with the result that renewable sources will represent a mere 5% of global energy production by 2040. As a result annual global emissions will increase from about 30 billion tons (GT) of CO_2 per year today to 35 GT by 2030, at which point emissions will plateau and begin to gradually decline.

Other fossil fuel companies, particularly Shell, have been more forthcoming about the risks of climate change, calling for much more vigorous energy research and new policies to steer the world toward a low-carbon future. In a September 2014 speech, Shell CEO Ben Van Beurden called climate change a significant threat and praised carbon cap-and-trade schemes, among other measures he identified to curb emissions. But he appears to be either unaware or dismissive of studies outlining ways the world could move much more quickly off of fossil fuels, as described below. And in a February 2015 speech Mr. Van Beurden predicts that oil demand will continue to grow for at least two decades, and calls for additional exploration to find new oil deposits:

"… the need for new supply could be as high as 5 million barrels a day, year after year until at least 2030.This amount of supply cannot be delivered by OPEC or shale oil producers in the US alone. It will need to come from new and challenging areas, and has to be supported by an oil price that justifies huge investments."

Climate Implications

"Huge investments" in new oil fields and decades more of growth in emissions are not compatible with ensuring that the global average temperature not rise by more than 2°C. For that limit not to be exceeded, one group of climate researchers has estimated that the atmosphere can hold no more than an additional 550 to 600 GT of CO_2 (Meinshausen et al. 2009). This means that the ExxonMobil global prediction, for all fossil fuels, of 30 to 35 GT of CO_2 emitted per year, results in a timeline of about 18 years before the atmosphere can hold no more. At that point emissions would have to somehow fall abruptly to zero. The

IPCC has recently increased the "allowable carbon budget" estimate upwards to 825 GT of CO_2 (IPCC 2013), but the implication remains unchanged: *clean energy sources must begin to play a much greater role, and much more quickly, than these industry leaders project.* The world may have to yield somewhat on its 2°C target, but this quick bit of math should serve to explain why for many climate activists and researchers, nations must pick up the pace, and dramatically so.

Is a Clean Energy Transition Possible with Existing Technology?

There is a remarkably optimistic consensus emerging among climate and energy scholars, that an orderly transition to a world reliant on renewable power sources is now possible. Two peer-reviewed studies demonstrating how feasible a truly clean energy economy has become include Jacobson et al. (2013) and Budischak et al. (2013). The Jacobson study considers just New York State as a case example, and shows how all energy demand, including for vehicles, could be met by renewable sources with today's technology. That team has recently launched a website that provides results of similar analyses for all fifty states.

Budischak et al. (2013) take as their case example the unified portion of the US electric grid known as the PJM Interconnection, that serves millions of people from Illinois to New Jersey and south to Virginia. These authors consider only current electricity demand, not fuels used for home heating or transportation, and they focus on minimizing costs instead of simply matching generation to electricity use.

Both reports find that sharp reductions in emissions are possible now, through rapid installation of wind and solar (and some hydro) power devices. Readers are referred to the papers for details. These authors do not claim that all technological barriers have been overcome. Budischak et al. (2013) expressed surprise, however, at their discovery that storage of electricity—often cited as a technology that must be dramatically improved before significant reliance on wind and solar energy is possible—proved to be largely unnecessary in the area of the USA they studied. The wind resource proved to be so reliable, given their large study area, that storage rarely needed to be called upon.

It is worthwhile in this context to consider the challenges being encountered by a nation like Denmark, where a nearly unanimous consensus aims to end the combustion of all fossil fuels by 2050. Already Denmark has reached a 40% renewable penetration and will likely reach 50% in less than five more years, by 2020. Transportation remains the sector with the least forward progress, and in a recent NY Times interview, the Danish Climate Minister Rasmus Helveg Petersen observed "we need longer range and lower prices before this becomes a good option….technology needs to save us here." As both Jacobson and Budishak demonstrate though, and Denmark proves daily, the largest obstacles to advancing far down the road toward a cleaner energy economy are not technical in nature. Where political will exists, dramatic progress can be made with existing technology.

Co-Benefits of Pioneering a Fully Clean Energy System

A transition to clean energy, led by the US and other advanced nations, would not just slow climate change, it would have two distinct co-benefits. First, it would facilitate a similar transition in the developing world. Pioneering truly clean energy systems would give an industrial nation like the US the moral authority to insist that this transition occur elsewhere. At least as important, by overcoming economic, engineering, and environmental obstacles, we would pave the way for effective policies in, and technology transfer to, poorer nations throughout the world.

This co-benefit of rapid action should be particularly compelling for all aware of the extent of global energy poverty. Extreme energy poverty limits the flourishing of some two to three billion people, depending on how such poverty is defined (Bazilian and Pielke 2013). Meanwhile, the industrialized nations have literally “burned through” the atmospheric commons available to hold carbon emissions. People throughout the developing world must be allowed to develop their own energy-rich economies, but a major and sustained role for fossil fuels in that process is no longer an acceptable option. Much of the increased energy demand cited by the leaders of major fossil fuel companies assumes that fossil energy is the only source available to lift today’s poorest people out of energy poverty. But if clean energy grids can work in developed nations like the U.S., with our very large per capita energy use, they could certainly do a great deal of good in places where energy demand is currently low.

A second co-benefit for us right here at home is that this transition would truly clear the air. In the US today, in spite of extraordinary reductions via tough government regulation in particulates, ozone, and other conventional pollutants over the last half century, several studies (see Caiazzo et al. 2013 and references therein) have converged around a range of 90,000 to as many as 362,000 premature deaths of Americans, per year, from air pollution. As noted by NASA (2014),

“In fact, about 142 million people still live in areas in the United States with unhealthy levels of air pollution, according to the EPA. Also, high levels of air pollution remain an issue in many other parts of the world, according to the global view from satellites.”

Remarkably, in the paper by Jacobson et al. (2013) cited above, the health benefits of their selected case would be so significant as to fully pay for the transition in just 17 years – *from health benefits alone.* Recent incremental improvements in air quality in the New York City region have likely extended the favorable “pay back” time they discovered, but the point holds: improved human health will be a significant co-benefit associated with an end to the age of combustion. That this is demonstrably true in the United States makes it all the more urgent for India, China, and other highly-polluted nations.

Other co-benefits to leaving behind the fossil-fuel age include an end to events like the Deepwater Horizon Oil Spill of 2010; oil train derailments and explosions; excessive water use and risk of groundwater pollution from hydraulic fracturing; harm to land and streams from surface coal mining; spills of coal ash waste, among many others.

SUMMARY and implications for divestment

The forecasts of the major fossil fuel companies cited here are logical given the sheer amount of energy currently used around the world, and the observed growth in demand for energy as population grows and people escape from poverty. Perhaps most significantly though, there remains a lack of serious progress in global climate negotiations, and this must also be reassuring to major energy companies. At the same time though, we find that the studies of Jacobson et al. (2013) and Budischak et al. (2013) are not much discussed by political leaders, but neither have they been seriously debunked. Meanwhile the warnings of climate scientists are becoming increasingly urgent, extreme weather events that are at least partly attributable to climate change are occurring at greater frequency, and with their use of social media, activists demanding change are able to share new research findings and organize protests more quickly than ever. National energy policies and the pace of international negotiations are subject to political pressure, and political pressure can build quickly in today’s world. The current divestment campaign should be recognized as one element of a larger political effort to force world leaders to greatly pick up the pace.

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Climate Activism at Brandeis

Brandeis Community, Waltham Clergy, and Waltham Citizen Activists, on the Moody Street Bridge. "STEP IT UP" Campaign day, May of 2007.Photo by Eric Olson.

Brandeis students power the speaker system with pedal-cranked generators at the Moving Earth Climate Rally, Boston, September 2011. Photo by Eric Olson.

Forward on Climate, National Mall Rally in Washington, DC, February 17th, 2013. Numerous Brandeis students and some faculty attended. Photo by Eric Olson.

Fast in solidarity with Filipino climate diplomat Yeb Saño, during Warsaw Climate Change Conference in wake of Typhoon Haiyan. November 18, 2013. Picture by Rohan Bhatia.

Rejection Denied, Weeks Footbridge, Cambridge/Boston, December 8, 2013. Brandeis Climate Justice regularly collaborates with other Boston area campus divestment campaigns.

Only the Best for Salem: Rally against the Proposed Natural Gas Plant, February 8, 2014, Brandeis Students regularly turn for protests against fossil fuel infrastructure and in support of a transition to renewable energy in Massachusetts, such as at this march in Salem. Photo by Iona Feldman.

XL Dissent, Washington DC, March 3, 2014. Brandeis Students were well represented among the 398 arrested at this direct action in front of the White House.

Global Divestment Day march to deliver faculty petition to Provost Lynch, February 12 2015. Photo by Iona Feldman.

"Most of the things worth doing in the world had been declared impossible before they were done."
"Publicity is justly commended as a remedy for social and industrial diseases."
Louis Brandeis

February 12, 2015

Provost Lisa Lynch, President Fred Lawrence, and members of the Board of Trustees of Brandeis University:

Scientists are showing us that the climate crisis is threatening life on Earth as we know it, and that it demands immediate and transformative actions by individuals, governments, businesses, and organizations. As highly respected institutions of knowledge production and transmission, universities are perfectly positioned to lead the way. As a world-class academic institution of scientific and economic research and as a champion for social justice Brandeis University is called upon to act.

The extent and urgency of the crisis has become clearer with the release of the most recent Intergovernmental Panel on Climate Change report,[1] which outlines the ongoing effects and future threats of climate change, including: scarcity of food and fresh water; extreme weather events; ocean acidification; sea level rise; loss of biodiversity; areas becoming uninhabitable; and mass human migration, conflict and violence. In response, the American Association for the Advancement of Science has issued this dire warning: "the wellbeing of people of all nations [is] at risk."[2]

Brandeis is a highly regarded partner in the global health community. As our colleagues at Harvard wrote in April of 2014: "The World Health Organization estimated in 2005 that climate change caused some 150,000 deaths worldwide each year. The heads of the American College of Physicians and the Royal College of Physicians of London in 2009 joined leaders of medical colleges from 12 other countries in calling climate change 'the biggest global health threat of the 21st century.'"[3]

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[1] *Climate Change 2014: Impacts, Adaptation, and Vulnerability*, IPCC WGII AR5 Summary Statement for Policymakers,
http://ipcc-wg2.gov/AR5/images/uploads/IPCC_WG2AR5_SPM_Approved.pdf.
[2] *What We Know* (2014), AAAS, http://whatweknow.aaas.org/get-the-facts/.
[3] http://www.harvardfacultydivest.com/open-letter-new.

The billions of dollars in pledges demanded by poor countries in the Southern hemisphere to prepare for climate change mitigation make unequivocally clear that climate change is already a global social justice crisis. Brandeis has been training leaders in sustainable international development for many years. Our graduates are fighting around the world at the forefront of the battle for climate justice. We therefore ask our administration and the Board of Trustees to join us in taking bold action to support them and protect the integrity of our mission.

Fossil fuel companies are spending millions of dollars on attacking and undermining scientists and their discoveries. Because the science behind climate change, though extremely complex, is also clear: Greenhouse gas emissions from burning fossil fuels such as coal, oil, and gas are responsible for increasing the average temperature on the planet. 2014 was yet again the hottest year on record. Only if two thirds of the existing fossil fuel resources remain in the ground do we have a chance to prevent catastrophic, irreversible tipping points. Our work in the name of “Truth Even Unto its Innermost Parts” vehemently rejects the systematic dissemination of misinformation. Brandeis must take a stand in support of science and scientists everywhere.

Fossil fuel interests will not stop their unrelenting drive to burn their fuel stocks. We must find strategies to induce them to stop obstructing alternatives. As one step in this effort, the undersigned faculty members, together with the Brandeis Climate Justice student organization, urge those in charge of the endowment to remove all financial investments from fossil fuel interests. In signing this petition we join hundreds of distinguished faculty colleagues at Harvard University, Stanford University, Boston University, Massachusetts Institute of Technology, and many others around the world. 229 members of Harvard University’s faculty signed on to the letter to president Drew Faust, originally published in April 2014, in which they write: “Our University invests in the fossil fuel industry: this is for us the central issue. We now know that fossil fuels cause climate change of unprecedented destructive potential. We also know that many in this industry spend large sums of money to mislead the public, deny climate science, control legislation and regulation, and suppress alternative energy sources.”[4] We agree. 300 members of the faculty at Stanford University wrote in January 2015: “to remain invested in oil and gas companies presents us with a paradox: if a university seeks to educate extraordinary youth so they may achieve the brightest possible future, what does it mean for that university simultaneously to invest in the destruction of that future?”[5] We agree. Collective action can make a difference. If enough institutions divest, this will put political pressure, if not economic pressure, on companies to change their business model.

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[4] See http://www.harvardfacultydivest.com/open-letter-new.

[5] See http://www.theguardian.com/environment/interactive/2015/jan/11/stanford-fossil-fuel-divestment-letter)

There is ample evidence to suggest that careful divestment from fossil fuels will result in no significant financial hardships for institutions.[6] Furthermore, since the true costs of greenhouse gas emissions are currently not taken into account in determining fossil fuel companies' stock prices, investing in them is becoming increasingly risky. This phenomenon is known as the 'carbon bubble'.[4] There is a long history of responsible investors who redirected investments away from socially unacceptable enterprises, and Brandeis has taken action before to disengage financially from reprehensible activities (i.e., divesting from Apartheid South Africa).[5]

In addition to doing everything we can to promote climate-friendly alternatives and eco-intelligence right here on our campus, we must stop profiting from fossil fuel extraction and invest our endowment in sustainable alternatives instead.

We ask you to join us in this very urgent effort.

Faculty Against the Climate Threat (FACT)

SIGNED

#	Date	Name	Title	Department/School
1.	1/25/15	Sabine von Mering	Prof.of German and WGS	GRALL/WGS/CGES
2.	1/26/15	Judith Herzfeld	Prof. of Biophysical Chemistry	Chemistry
3.	1/26/15	Ellen Wright	Assistant Prof of Psychology	Psychology
4.	1/26/15	Malcolm Watson	Prof. of Psychology	Psychology
5.	1/26/15	Neil Simister	Assoc.Prof. Biology	Biology
6.	1/26/15	Paul Miller	Assoc. Prof. of Biology	Biology
7.	1/26/15	Leslie Zebrowitz	Professor of Psychology	Psychology
8.	1/26/15	Lawrence Wangh	Professor of Biology	Biology
9.	1/26/15	Mark Adler	Professor of Mathematics	Math
10.	1/26/15	Rachel Woodruff	Lecturer in Biology	Biology
11.	1/26/15	Jim Bensinger	Prof. of Physics	Physics
12.	1/26/15	Matthew Fraleigh	Assoc. Prof. of E. Asian Lit. and Culture	GRALL/COML/EAS
13.	1/26/15	James Mandrell	Assoc.Prof. of Hispanic Studies,COML	ROMS
14.	1/26/15	Sophia Malamud	Assoc.Prof. of Language and Linguistics	Computer Science
15.	1/26/15	Maria Miara	Lecturer in Biology	Biology
16.	1/26/15	Timothy Hickey	Prof. of Computer Science	Computer Science
17.	1/26/15	Paul Monsky	Prof. of Mathematics	Mathematics
18.	1/26/15	Matthew Headrick	Assistant Prof. of Physics	Physics

[6] For example, see: Patrick Geddes (Chief Financial Officer, Aperio Group), *Do the Investment Math: Building a Carbon-Free Portfolio* (2013). aperiogroup.com/system/files/documents/building_a_carbon_free_portfolio.pdf.

19. 1/26/15	David Buchsbaum	Prof. of Mathematics (Emeritus)	Mathematics
20. 1/26/15	Sarah Lamb	Prof. of Anthropology	Anth, WGS, SAS, HSSP, PRS
21. 1/26/15	Anita Hannig	Assistant Prof. of Anthro	Anth, HSSP, WGS
22. 1/26/15	Elizabeth Ferry	Prof. of Anthropology	Anth, LALS, WGS
23. 1/26/15	Donald Hindley	Professor of Politics	Pol, EAS, LALS
24. 1/26/15	Mary Baine Campbell	Professor of English	COML, WGSS, MVL
25. 1/26/15	Gordon Fellman	Prof. of Sociology	Soc, PAX. IMES
26. 1/26/15	Ann O. Koloski-Ostrow	Prof. of Classical Studies	CLAS, ANTH, FA, ITAL, WGS
27. 1/27/15	Jane A. Hale	Assoc. Prof. Emer.French. & COML	ROMS
28. 1/27/15	Peter Conrad	Professor of Sociology	Sociology, HSSP
29. 1/27/15	Ana Villalobos	Asst. Prof of Sociology	Sociology
30. 1/27/15	William Flesch	Professor of English	English
31. 1/27/15	Laura Quinney	Professor of English	English
32. 1/27/15	Patrick Gamsby	Lecturer in Philosophy	Philosophy/HOID
33. 1/27/15	Gary Jefferson	Professor of Economics	Economics/IBS/EAS
34. 1/27/15	Mark Hulliung	Professor of History	History
35. 1/27/15	Jody Hoffer Gittell	Professor	Heller School
36. 1/27/15	Nader Habibi	Prof. of the Economics of the Middle East	Economics, IBS
37. 1/27/15	Janet McIntosh	Assoc. Prof. of Anthropology	Anth
38. 1/27/15	James Lackner	Professor of Physiology	Psychology/Volen Ctr
39. 1/27/15	Marya Lowry	Assoc. Prof of Theater	Creative Arts/Theater
40. 1/27/15	Christopher Frost	Lecturer in Fine Arts	Dept. of Fine Arts
41. 1/27/15	Sue Lanser	Professor of Comp Lit, English, WGS	Humanities
42. 1/27/15	Caren Irr	Professor of English	ENG, ENVS, FTIM
43. 1/27/15	Paul Morrison	Professor of English	Humanities
44. 1/27/15	Leonard Muellner	Professor of Classical Studies	Classics/Humanities
45. 1/27/15	Brian Donahue	Assoc. Prof. Am. Environmental Studies	ENVS, AMST
46. 1/27/15	Jennifer Gutsell	Asst. Professor	Psychology/ Volen
47. 1/27/15	Carmen Sirianni	Professor of Sociology and Public Policy	Sociology, Heller
48. 1/27/15	Nina Kammerer	Senior Lecturer	Heller
49. 1/27/15	Dawn Skorczewski	Professor of English	English
50. 1/27/15	Laura Miller	Assoc. Professor of Sociology	Sociology
51. 1/27/15	David Cunningham	Prof. of Sociology & Social PolicySOC/SJSP	
52. 1/28/14	Erica Harth	Prof. Emerita	ROMS
53. 1/27/15	Talinn Grigor	Assoc. Prof. of Fine Arts	FA
54. 1/27/15	Elizabeth Merrick	Senior Scientist and Lecturer	Heller
55. 1/27/15	Thomas A. King	Assoc. Prof. of English & WGS	ENG, WGS, SQS, CAST
56. 1/27/15	Jonathan Anjaria	Asst. Professor of Anthropology	Anth
57. 1/27/15	Yukimi Nakano	Lecturer in Japanese	GRALL
58. 1/28/15	Dian Fox	Prof.,Hispanic Studies and WGS	ROMS, WGS
59. 1/28/15	Melissa Stimell	Professor of the Practice	Legal Studies
60. 1/28/15	Daniel Kryder	Assoc. Professor	Politics
61. 1/28/15	Charles C. Chester	Lecturer	Environmental Studies
62. 1/28/15	David Sherman	Assistant Professor	English
63. 1/28/15	Karen Klein	Assoc. Prof Emerita	English & Humanities
64. 1/28/15	Irina Dubinina	Assoc. Professor of Russian	GRALL
65. 1/29/15	Harleen Singh	Associate Professor	GRALL, WGS, SAS
66. 1/29/15	Hisae Fujiwara	Assistant Professor of JPAN	GRALL

67. 1/29/15	Tory Fair	Associate Professor	Fine Arts
68. 1/30/15	Tatjana Meschede	Scientist/Senior Lecturer	Heller
69. 1/30/15	Dominic Hodgkin	Professor	Heller
70. 1/30/15	Seth Coluzzi	Assistant Professor	Music
71. 1/31/15	Raymond Knight	Professor	Psychology
72. 2/1/15	Ellen Kellman	Assistant Professor	NEJS
73. 2/5/15	Stephen Whitfield	Professor	American Studies
74. 2/5/15	Faith Smith	Assoc Professor	AAAS,ENG,LALS,WGS
75. 2/5/15	Dmitry Kleinbock	Professor	Mathematics
76. 2/5/15	Joseph Assan	Assist. Prof.Political Economy of Sustainable Development	Heller
77. 2/5/15	Janet Boguslaw	Senior Scientist and Lecturer	Heller
78. 2/6/15	Peter Kalb	Assoc Professor	Fine Arts
79. 2/6/15	Sandra Venner	Fellow	Heller
80. 2/6/15	Larry Bailis	Associate Professor	Heller
81. 2/6/15	Aida Yuen Wong	Associate Professor	Fine Arts/EAS/GRALL
82. 2/6/15	Karen V. Hansen	Professor	Sociology & WGS
83. 2/6/15	Gannit Ankori	Professor of Fine Art	Fine Arts
84. 2/6/15	David Powelstock	Assoc. Prof.	GRALL
85. 2/6/15	Lawrence Simon	Professor of International Development	Heller School
86. 2/7/15	Bernadette Brooten	Professor	NEJS/WGS/PRS/CLAS
87. 2/7/15	Daniel Stepner	Professor of the Practice	Music Dept.
88. 2/7/15	Stephen Dowden	Professor of German	GRALL/COML
89. 2/7/15	Mike Coiner	Associate Professor	Economics
90. 2/7/15	John Plotz	Professor	English
91.2/7/15	Gina Turrigiano	Professor	Biology/Neuroscience
92. 2/7/15	Ira Gessel	Professor	Mathematics
93. 2/2/15	Michael Hagan	Associate Professor	Physics
94. 2/7/15	Sacha Nelson	Professor	Biology/Neuroscience
95. 2/7/15	Albion Lawrence	Associate Professor	Physics
96. 2/7/15	Tsipis Judith	Professor	Biology
97. 2/7/15	Ari Ofengenden	Assistant Professor	NEJS
98. 2/7/15	Azadeh Samadani	Assistant Professor	Physics
99. 2/7/15	Xiaodong Liu	Assistant Professor	Psychology
100. 2/7/15	Daniel Bergstresser	Associate Professor	IBS
101. 2/7/15	James Morris	Associate Professor	Biology
102. 2/7/15	Lotus Goldberg	Associate Professor, Lang & Linguistics	Computer Science
103. 2/8/15	David H. Roberts	Professor of Astrophysics	Physics
104. 2/8/15	Laura Goldin	Professor of the Practice	Environmental Studies
105. 2/8/15	Joe Cunningham	Professor	Psychology
106. 2/8/15	Olivier Bernardi	Assistant Professor	Mathematics
107. 2/8/15	Eugene Sheppard	Associate Professor	NEJS
108. 2/8/15	Silvia Arrom	Professor Emeritus	Hist/Latin Amer. Studies
109. 2/9/15	Melissa Kosinski-Collins	Associate Professor	Biology
110. 2/9/15	Greg Childs	Assistant Professor	History
111. 2/9/15	Kanan Makiya	Professor	NEJS/Crown
112. 2/9/15	Marion Howard	Assoc. Professor of the Practice	Heller
113. 2/9/15	Alain Lempereur	Professor	Heller
114. 2/9/15	Joshua Ellsworth	Lecturer	Heller

115. 2/9/15	Fernando J. Rosenberg	Associate Professor	ROMS
116. 2/9/15	Jonathan Unglaub	Associate Professor	FA
117. 2/9/15	Douglas Theobald	Associate Professor	Biochemistry
118 2/9/15	Martine Voiret	Senior Lecturer.	ROMS
119. 2/9/15	Ellen Smith	Assoc. Professor & Dir.,	Hornstein Program
120. 2/9/15	Joseph M. Wardwell	Assoc. Professor & Dir.	Fine Arts
121. 2/9/15	Marya R. Levenson	Professor of the Practice	Education
122. 2/9/25	Kelley Ready	Senior Lecturer	Heller/SID
123. 2/10/15	Mari Fitzduff	Professor	Heller/Coex
124. 2/10/15	Susan Holcombe	Professor Emerita of the Practice	Heller School
125. 2/10/15	Stan Wallack	Professor; Exec. Dir. Schneider Inst.	Heller School
126. 2/10/15	Gregory Freeze	Professor	History Dept.
127. 2/10/15	ChaeRan Freeze	Associate Professor	NEJS
128. 2/10/15	Cheryl L Walker	Associate Professor	Classical Studies
129. 2/11/15	Sarah Mead	Professor of the Practice	Music
130. 2/11/15	Jennifer Cleary	Senior Lecturer	Theater Arts
131. 2/13/15	Richard Gaskins	Professor	AMST, LGLS
132. 2/13/15	Wendy Cadge	Professor	Sociology & WGS
133. 2/14/15	Raj Sampath	Assistant Professor	Heller School
134. 2/16/15	John Wardle	Professor	Physics
135. 2/15/17	Hermann Wellenstein	Associate Professor	Physics
136. 2/22/15	Joyce Antler	Professor	American Studies
137. 3/14/15	Leonard Saxe	Professor	Hornstein/Heller
138. 3/16/15	Govind Sreenivasan	Associate Professor	History Dept.
139. 3/17/15	Rebecca Torrey	Assistant Professor	Mathematics
140. 3/17/15	Timothy Street	Assistant Professor	Biochemistry
141. 3/31/15	Marc Weinberg	Adjunct Assistant Professor	English
142. 3/31/15	John Lisman	Professor	Biology
143. 3/31/15	Ramie Targoff	Professor	English/MCH
144. 3/31/15	Berislav Marusic	Assistant Professor	Philosophy
145. 4/1/15	James Haber	Professor	Biology

Institutional Responses

The programs, activities and degrees at Brandeis University are constantly changing and developing to reflect the interest and needs of students. Just as buildings are repeatedly renovated and enhanced with state-of-the-art technologies, so do the programs and degree opportunities expand to provide the necessary skills and knowledge that students will need to be successful in an ever-changing world. Increased awareness of climate change and natural-resource depletion has sparked new interest in environmental sustainability. In response a number of classes, degree specializations, and activities have been added to the Brandeis community. The following is a list of just some of those new opportunities. It is worth noting that concerns of a changing planet have penetrated every area of the Brandeis community.

School Organizations

The **Brandeis Sustainability Fund** provides grants, advice and support to any undergraduate student for their projects promoting sustainability. Projects that receive funding could relate to energy efficiency, green buildings, waste management, renewable energy purchases, greening student events, and so much more. The money in this fund is for you to implement your ideas on how to make our community less ecologically destructive and more sustainable.

Brandeis Climate Justice (BCJ)is the Student Union chartered name of the fossil fuel divestment campaign. Beginning as an initiative of SEA, the campaign quickly became an independent organization. However, it was not until February 1, 2015 that Brandeis Climate Justice officially became are recognized and chartered club within the undergraduate Student Union. BCJ is committed to mobilizing student support for climate justice issues on campus and off. Its primary focus remains the divestment movement but BCJ has collaborated with other student groups to raise awareness about water issues in Israel-Palestine, natural gas plants and fracking in New England, and labor issues at Brandeis University. BCJ is also active in the Massachusetts coalition of campus climate justice organizations known as Students for a Just and Stable Future.

Net Impact is a nonprofit organization that empowers individuals to use their careers to drive organizational change in the workplace and the world. The Net Impact chapter at Brandeis University is an outlet for MBA students who want to use their degrees for social good. This year, Brandeis's Net Impact chapter focused on social enterprise development and corporate social responsibility. In these events, they discussed business's roles and obligations around climate change. Specifically, they debated if becoming environmentally sustainable can benefit both the business and the community.

Students for Environmental Action

Students for Environmental Action (SEA) is a community working to make Brandeis and the world a more healthy, just, and sustainable place. They work on a variety of initiatives throughout the year, and plan events that allow the Brandeis community to connect with the natural world.

Cholmondeley's Coffee House
Cholmondeley's (Chum's) is Brandeis' student run coffee house and late-night snack bar. Among other things, it is currently working to provide more local and organic food to the menu. Chum's has been an important meeting space and forum for students working on various political and social causes. It was an early supporter of the fossil fuel divestment campaign on campus and was the "official headquarters" of the movement during the referendum process.

HellerSAVE Ecological Working Group
HellerSAVEis made up of graduate students at the Heller School for Social Policy and Management who are dedicated to issues of the environment and conservation. Many of their sponsored events shed light on the negative role of climate change in vulnerable communities around the globe. In addition their conservation efforts at Brandeis have resulted in a successful Heller-wide composting project and yearly clothing swap.

Majors and Degree Programs

Environmental Studies Program (BA)
The Environmental Studies Program prepares students to tackle critical issues such as global climate change, shrinking natural resources, and health effects from toxic exposure. Students are educated through rigorous coursework, hands-on learning experience, and direct work with the local community. Among many of the program's activities, students contribute to a monthly blog. http://blogs.brandeis.edu/environmentalstudies/

International Business School Sustainability Specialization
The specialization incorporates instruction in issues ranging from social development and environmental improvement to economic development and corporate governance. Students learn and apply current economic models to formulate essential conclusions about socially responsible business plans. This specialization is available for all MA, MBA, MSF and PhD students.

Heller School for Social Policy and Management MA Sustainable International Development, Conservation and Development Specialization
The goal of the Sustainable International Development Master's Degree Program is to provide a holistic and innovative professional curriculum that will equip students with practical skills in project and program planning and implementation, monitoring and evaluation, and organizational management. The degree program offers a second year specialization in Conservation and Development for students wishing to further their knowledge in the complex relationships between communities and the environmental world around them.

Classes

Although there are many classes on campus addressing the issue of climate change within class curriculums, there are several classes…

- Atmospheric Civics & Diplomacy: World Politics of Air Pollution, Ozone Depletion, and Climate Change
- Conservation Biology

- Environmental Movements: Organizations, Networks, and Partnerships
- Food and Farming in America
- Fundamentals of Environmental Challenges
- Greening the Ivory Tower: Improving Environmental Sustainability of Brandeis and Community
- Human/Nature: European Perspectives on Climate Change
- Life on a Changing Planet
- Nature, Culture, Power: Anthropology of Environment
- Solving Environmental Challenges: The Role of Chemistry
- Environmental History
- Investing in Energy: From Fossil Fuels to Clean Energy
- Threats to Development
- Sustainable Cities and Communities

Faculty and Administration

American College and University: President's Climate Commitment
In 2007 President Fredrick Lawrence signed the President's Climate Commitment making environmental sustainability a priority for the University. This action included a detailed Climate Action Plan, which was written to help guide the university towards its various sustainability goals.

Sustainability Initiative
The Campus Sustainability Initiative is charged with reducing Brandeis' environmental and climate change impact. The initiative is a collaborative effort between many departments, offices, and academic disciplines and student groups. The initiative has made great stride in establishing community-wide recycling and composting programs. In addition they have created programs to help the university reach its commitment of carbon neutrality by 2050.

Faculty Against the Climate Threat (FACT)
On February 2nd, 2015 faculty and several active student groups rallied to celebrate Global Divestment Day. The final action of this event was the presentation to Brandeis administration the FACT Petition signed by 130 Brandeis Faculty members asking the university to divest from fossil fuels.

Stanford University
Faculty Letter in Support of Fossil Fuel Divestment

January 11, 2015

Dear President Hennessy and the Stanford Board of Trustees,

We the undersigned, faculty of Stanford University, acknowledge the urgency of the scientific community's warning that the burning of fossil fuels puts our world at risk. To prevent wide-spread ecological collapse we must limit global warming to 2 degrees Celsius. Scientific consensus indicates that to stay within this 2-degree margin, we must cap carbon dioxide emissions at 565 gigatons. Because companies currently own fossil-fuel holdings sufficient to produce 2795 gigatons of carbon dioxide, the risk is clear: 2795 gigatons is five times the scientifically designated limit. In short, for companies to exploit these holdings—as they must, to turn a profit—would mean raising atmospheric carbon dioxide to cataclysmic levels.

Many of these fossil-fuel companies are publicly traded and investor-owned, supported in large part by institutional investors like Stanford. Professor James Engell of Harvard writes: "The fossil-fuel companies are decent investments *only* under two assumptions: first, the oil and gas and coal they own in the ground *shall* be sold and burned. Second, they *shall* continue to find more oil and gas and coal and *shall* sell that to be burned, too. Any investor in them must *want* this to happen, and any investor is putting up money to *make* this happen with all deliberate speed."

We honor the May 2014 decision of the Stanford Board of Trustees to divest from coal, setting a precedent of responsibility and integrity commensurate with the University's role in the world. Sixty-five percent of all carbon holdings are in coal reserves, and this significant act of divestment is proof of the university's resolve to act to counter climate disruption. This resolve must now encompass the reality that, once coal is taken out of the equation, the remaining 35% reserves in oil and gas holdings still represent 978 gigatons of carbon, or nearly double the 565 gigaton cap. The urgency and magnitude of climate change call not for partial solutions, however admirable; they demand the more profound and thorough commitment embodied in divestment from all fossil-fuel companies.

The alternative—for Stanford to remain invested in oil and gas companies—presents us with a paradox: If a university seeks to educate extraordinary youth so they may achieve the brightest possible future, what does it mean for that university simultaneously to invest in the destruction of that future? Given that the university has signaled its awareness of the dangers posed by fossil fuels, what are the implications of Stanford's making only a partial confrontation with this danger? In working with our students we encourage the clarity necessary to confront complex realities and the drive to carry projects through to completion. For Stanford's investment policies to be congruent with the clarity and drive in its classrooms, the university must divest from all fossil-fuel companies. To this end we respectfully ask President Hennessy and the Board of Trustees to recognize the need for comprehensive divestment from fossil fuels. When it comes to the future our students will live to see, there is a scientifically documented, morally clear, technologically innovative *right thing to do*: divest from fossil fuels and reinvest in a sustainable future.

Sincerely yours,

1. Elizabeth Tallent
Professor of English and Creative Writing

2. Donald Kennedy
President Emeritus of Stanford University
Bing Professor of Environmental Science and Policy, Emeritus
Senior Fellow, Woods Institute for the Environment

3. Roger Kornberg
Mrs. George A. Winzer Professor in Medicine
Nobel Prize in Chemistry, 2006

4. Douglas Osheroff
J. G. Jackson and C. J. Wood Professor of Physics, Emeritus
Nobel Prize in Physics, 1996

5. Maryam Mirzakhani
Professor of Mathematics
Fields Medal, 2014

6. David Palumbo-Liu
Louise Hewlett Nixon Professor, and Professor of Comparative Literature

7. Terry Root
Professor, by courtesy, of Biology
Senior Fellow, Woods Institute for the Environment

8. Debra Satz
Marta Sutton Weeks Professor of Ethics in Society
Professor of Philosophy, and, by courtesy, of Political Science

9. Mark Jacobson
Professor of Civil and Environmental Engineering
Senior Fellow, Precourt Institute for Energy
Senior Fellow, Woods Institute for the Environment

10. Charles Steele
Professor of Mechanical Engineering and of Aeronautics and Astronautics, Emeritus

To view all 369 faculty signatures, visit http://www.stanfordfacultydivest.org/letter.html

Faculty Open Letter

Original Signatories: 93
Current Signatories: *240*
Faculty of Harvard University to the President and Fellows

April 10, 2014

Our University invests in the fossil fuel industry: this is for us the central issue. We now know that fossil fuels cause climate change of unprecedented destructive potential. We also know that many in this industry spend large sums of money to mislead the public, deny climate science, control legislation and regulation, and suppress alternative energy sources.

We are therefore disappointed in the statements on divestment made by President Faust on October 3, 2013 and April 7, 2014. They appear to misconstrue the purposes and effectiveness of divestment. We believe that the Corporation is making a decision that in the long run will not serve the University well. Our sense of urgency in signing this Letter cannot be overstated. Humanity's reliance on burning fossil fuels is leading to a marked warming of the Earth's surface, a melting of ice the world over, a rise in sea levels, acidification of the oceans, and an extreme, wildly fluctuating, and unstable global climate. These physical and chemical changes, some of which are expected to last hundreds, if not thousands, of years are already threatening the survival of countless species on all continents. And because of their effects on food production, water availability, air pollution, and the emergence and spread of human infectious diseases, they pose unparalleled risks to human health and life.

The World Health Organization estimated in 2005 that climate change caused some 150,000 deaths worldwide each year. The heads of the American College of Physicians and the Royal College of Physicians of London in 2009 joined leaders of medical colleges from 12 other countries in calling climate change "the biggest global health threat of the 21st century."

Divestment is an act of ethical responsibility, a protest against current practices that cannot be altered as quickly or effectively by other means. The University either invests in fossil fuel corporations, or it divests. If the Corporation regards divestment as "political," then its continued investment is a similarly political act, one that finances present corporate activities and calculates profit from them.

The only way to remain "neutral" in such circumstances is to bracket ethical principles even while being deeply concerned about consequences. Slavery was once an investment issue, as were apartheid and the harm caused by smoking.

In the past, the University did divest from certain industries on ethical grounds. Harvard's leadership—initiated by faculty, students, and alumni—is credited with making campaigns against apartheid and smoking far more effective.

* * *

Financially, no evidence exists that planned divestment would damage Harvard. As awareness grows that burning known fossil fuel reserves will accelerate climate change to a catastrophic degree, and as fossil fuel consumption moderates, planned divestment will, in fact, strengthen the portfolio of the University. A number of studies, including one by S&P Capital IQ, demonstrate that over the last ten years, for example, an endowment reflecting the S&P 500 without targeted fossil fuel companies would have outpaced one with them. Moreover, study of fossil fuel divestment suggests it need not lower the overall value of investors' holdings, and that "those that commit to divestment should consider re-directing investment to renewable energy alternatives" (Atif Ansar, Ben Caldecott, James Tilbury, "Stranded assets and the fossil fuel divestment campaign: what does divestment mean for the valuation of fossil fuel assets?" Smith School of Enterprise and the Environment, University of Oxford, 2013, pp. 71-72).

Recent pronouncements from authoritative quarters support our call for action. Christiana Figueres, Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC) states that the "continued and dangerous rise in greenhouse gases . . . is in large part the direct result of past investments in . . . fossil fuels." She warns that "institutional investors who ignore climate risk face being increasingly seen as blatantly in breach of their fiduciary duty." (January 15, 2014)

World Bank President Jim Yong Kim, Harvard Medical School graduate, and former Professor and Chairman of HMS's Department of Global Health and Social Medicine, even includes divestment as a legitimate tactic: "The good news is that there is action we all can take . . . we can divest and tax that which we don't want, the carbon that threatens development gains over the last 20 years." He goes on to urge: "Be the first mover. Use smart due diligence. Rethink what fiduciary responsibility means in this changing world." (January 24, 2014)

* * *

If any doubt remains about long-term plans of fossil fuel corporations, consider the signature statement of the American Petroleum Institute: "a secure energy future for generations to come." API corporations are determined to produce more of the same "for generations": more fossil fuel extraction, more sales, more denial or evasion of science. Coal companies, similarly, proclaim plans to continue mining for hundreds of years.

* * *

The aim of divestment is not to drive these corporations out of business. It was never the intention of Harvard's South African or tobacco related divestments to eliminate industries.

Instead, divestment aims to expose corporate attitudes and change corporate behavior. And indeed, the most comprehensive study of divestment to date, published by the Smith School of Enterprise and the Environment at the University of Oxford and cited above, indicates that past divestment strategies forced changes in corporate behavior, government regulation, legal statues, and even share prices, that would not otherwise have been accomplished.

* * *

It seems self-contradictory to argue that Harvard owns a very small percentage of shares in a group of stocks (shares that, moreover, represent a small percentage of its own holdings) yet can nevertheless exert greater influence on corporate behavior by retaining rather than selling that stock as protest. If Harvard were a major shareholder, that argument might make sense, but Harvard is not.

The President and Fellows are working assiduously to reduce the University's greenhouse emissions, while maintaining investments that promote their increase locally and worldwide. The President and Fellows are right to be concerned about the "troubling inconsistency" of these investments.

* * *

As the statements of October 3, 2013 and April 7, 2014 indicate, the Harvard Corporation wishes to influence corporate behaviors in the fossil fuel and energy sectors. We therefore ask:

How, exactly, will the University "encourage" fossil fuel corporations in "addressing pressing environmental imperatives"? Will Harvard initiate or support shareholder resolutions? Will it divest from coal companies? Will it ask questions at shareholder meetings? Will it set standards analogous to the Sullivan Principles? Will it conduct private meetings?

In short, how long will Business As Usual continue?

The questions in this section are not rhetorical. They require answers.

* * *

We know that fossil fuel use must decrease. To achieve this goal, not only must research and education be pursued with vigor, pressure must also be exerted. If there is no pressure, then grievous harm due to climate change will accelerate and entrench itself for a span of time that will make the history of Harvard look short.

We the undersigned are faculty and officers of the University, many with knowledge and research in climate science, energy, business management, ethics, and the effects of climate change on health, prosperity, and biodiversity. Many are alumni and donors. We appeal to our colleagues, fellow alumni, and donors to join us in signing this statement, as an act of conscience and fiscal responsibility, and in asking the Corporation to divest, as soon as possible, its holdings in fossil fuel corporations.

Signed:

James G. Anderson
Philip S. Weld Professor of Atmospheric Chemistry
Department of Chemistry & Chemical Biology

———

David Armitage
Lloyd C. Blankfein Professor of History
Faculty of Arts and Sciences

———

Carmen Arnold-Biucchi
Damarete Curator of Ancient Coins, Division of Asian and Mediterranean Art
Harvard Art Museum
Lecturer on the Classics
Faculty of Arts and Sciences
President of the INC

———

Alberto Ascherio
Professor of Epidemiology and Nutrition
Harvard School of Public Health

———

Elizabeth Bartholet
Morris Wasserstein Professor of Law
Harvard Law School

———

Melissa Bartick
Assistant Professor of Medicine
Harvard Medical School

———

Soha Bayoumi
Lecturer, Department of the History of Science
Faculty of Arts and Sciences

Jason Beckfield
Professor of Sociology
Faculty of Arts and Sciences

Janet Beizer
Professor of Romance Languages and Literatures
Faculty of Arts and Sciences

Eugene Beresin
Professor of Psychiatry
Harvard Medical School

Lisa Berkman
Thomas Cabot Professor of Public Policy and Epidemiology
Harvard School of Public Health

To see all 240 signatories, visit: http://www.harvardfacultydivest.com/open-letter-new

Confronting climate change

APRIL 7, 2014

Cambridge, Mass.

Dear Members of the Harvard Community,

Worldwide scientific consensus has clearly established that climate change poses a serious threat to our future—and increasingly to our present. Universities like ours have produced much of the research supporting that consensus, as well as many of the emerging ideas helping us to begin confronting that challenge. Yet we have far more work ahead to chart the path from societies and economies fundamentally dependent on fossil fuels to a system of sustainable and renewable energy. We must devote ourselves to enabling and accelerating that transition—by developing the technologies, policies and practices that would make it possible—if we are to mitigate the damage that rising greenhouse gas levels are inflicting on the planet.

Harvard has a vital leadership role to play in this work. As a university, it has a special obligation and accountability to the future, to the long view needed to anticipate and alter the trajectory and impact of climate change. Harvard also possesses the wide range of capacities across fields and disciplines that must be mobilized and conjoined in order to create effective solutions. Ideas, innovation, discovery and rigorous independent thought will serve as indispensable elements in combating the climate threat; these are the special province of universities.

Already we support research at the vanguard of energy and climate science—from new technologies for energy storage, to solar ovens to reduce pollution in the developing world, to an “artificial leaf” that mimics photosynthesis to produce renewable fuel, to give just three examples. Our faculty are deeply engaged as well in informing the development of law andpolicy to advance sustainability and to address the hazards of climate change worldwide, from advancing climate agreements, to fashioning legal frameworks for regulating shale extraction, to designing models for sustainable businesses. The Harvard University Center for the Environment engages more than 200 faculty sharing their insights and their commitment to these urgent issues. And our educational programs, with some 250 courses across the University focusing on aspects of environmental sustainability, will prepare leaders with the insight and foresight to safeguard our environment in the years and decades to come.

Harvard has the opportunity and the responsibility to help create the path to a sustainable future. We can and must galvanize the deep commitment of students, faculty, staff and alumni to work together to move us closer to a world founded on renewable energy. Today I would like to highlight three areas in which we are focusing special attention as part of our obligation to our planet and our collective future.

*

First, and at the heart of our mission as a university, is research. Our research across Harvard—in climate science, engineering, law, public health, policy, design and business—has an unparalleled capacity to accelerate the progression from nonrenewable to renewable sources of energy. The Harvard Campaign has identified energy and environment as a priority, and we have already raised $120 million to support activities in this area. As part of this broader campaign focus, I intend to catalyze the aspects of that research specifically focused on shaping and accelerating the transition to a sustainable energy system.

I challenge our talented and dedicated faculty and students to identify how their efforts can propel societies and individuals along this path. And I challenge our alumni and friends to assist me in raising $20 million for a fund that will seed and spur innovative approaches to confronting climate change, as an element of our broader campaign efforts in energy and environment. To launch this new Climate Change Solutions Fund, I will immediately make available $1 million in grants to be allocated at the outset of the coming academic year. (Please see here for further information on this fund and the application process.)

*

Second, Harvard must model an institutional pathway toward a more sustainable future. We have the opportunity to serve as a living laboratory for strategies and initiatives that reduce energy consumption and greenhouse gas (GHG) emissions in the ways we live and work. In 2008, the University set an ambitious goal of achieving a 30 percent reduction in our GHG emissions from our 2006 baseline by 2016, including growth. Thanks to the leadership of our GHG reduction executive committee and our Office for Sustainability, and the dedicated efforts of individuals across Harvard, we have so far achieved a reduction of 21 percent, when we include the effects of growth and renovation in our physical plant, and 31 percent, when we do not. (For details on how we have joined as One Harvard to accomplish this, please see here.)

As we recognize our remarkable progress, we must also recommit to the work ahead. I have accepted the recommendations of the task force empaneled to review Harvard'sprogress toward its GHG reduction goal. Co-chaired by Jeremy Bloxham, Dean of Science in the Faculty of Arts and Sciences; Robert S.

Kaplan, Professor of Management Practice at Harvard Business School; and Katie Lapp, Executive Vice President, the task force has proposed, and I have agreed, to the following:

- We will continue to explore and exhaust all on-campus efficiency and reduction projects to the maximum extent possible.
- We recognize, as we did when we set our goal in 2008, that even after our aggressive on-campus efficiency efforts, a gap will likely remain to achieve our goal of 30 percent reduction (including growth) by 2016, requiring us to explore complementary mechanisms, including offsets. We will establish an advisory group of faculty, students and staff to evaluate and recommend complementary off-campus emissions reduction options that are additive and real.
- We will create a sustainability committee led by senior faculty to shape the next generation of sustainability solutions and strategy on our campus.

*

Third, in addition to our academic work and our greenhouse gas reduction efforts, Harvard has a role to play as a long-term investor. Last fall, I wrote on behalf of the Corporation to affirm our judgment that divestment from the fossil fuel industry would not be wise or effective as a means for the University to advance progress towards addressing climate change. I also noted that, with the arrival of a first-ever vice president for sustainable investing at Harvard Management Company, we would strengthen our approach to how we consider material environmental, social and governance factors as we seek robust investment returns to support our academic mission.

Today I am pleased to report that we have decided to become a signatory to two organizations internationally recognized as leaders in developing best-practice guidelines for investors and in driving corporate disclosure to inform and promote sustainable investment.

Specifically, Harvard's endowment will become a signatory to the United Nations-supported Principles for Responsible Investment (PRI). The PRI joins together a network of international investors working to implement a set of voluntary principles that provide a framework for integrating environmental, social and governance factors into investment analysis and ownership practices aligned with investors' fiduciary duties. Harvard Management Company will manage Harvard's endowment consistent with these principles.

In addition, we will become a signatory to the Carbon Disclosure Project's (CDP) climate change program. The CDP is an international nonprofit organization that works with investors to request that portfolio companies account for and disclose information on greenhouse gas emissions, energy use and carbon risks associated with their business activities in order to increase transparency and encourage action.

Both these significant steps underscore our growing efforts to consider environmental, social and governance issues among the many factors that inform our investment decision-making, with a paramount concern for how the endowment can best support the academic aspirations and educational opportunities that define our distinctive purposes as a university.

*

As we take these steps forward—supporting innovative research focused on climate change solutions, reducing our own carbon footprint, advancing our commitments as a long-term investor—we should also step back and see the bigger picture. In the broad domain of energy and environment, as in many other fields, people at Harvard make extraordinary contributions, in myriad ways, to generating the knowledge, ideas and tools that in time can help society's most complex and intractable problems seem amenable to effective solutions. Ultimately, Harvard will contribute to confronting climate change not through presidential pronouncements, and not through a sudden burst of eureka moments, but through the steadfast, unrelenting commitment of faculty, students, staff and alumni who train their minds on hard questions, combine their imagination with rigorous analysis and convert their insights into effective action.

Whatever your own particular academic interests, I hope you will take the time to learn more about our collective efforts in energy and environment, highlighted here and elsewhere. More than that, whatever part of Harvard you inhabit, I hope you will count yourself among the thousands of people across the University who increasingly embrace a concern for environmental sustainability as an integral part of our academic work, our institutional practices and our daily lives.

Sincerely,
Drew Faust

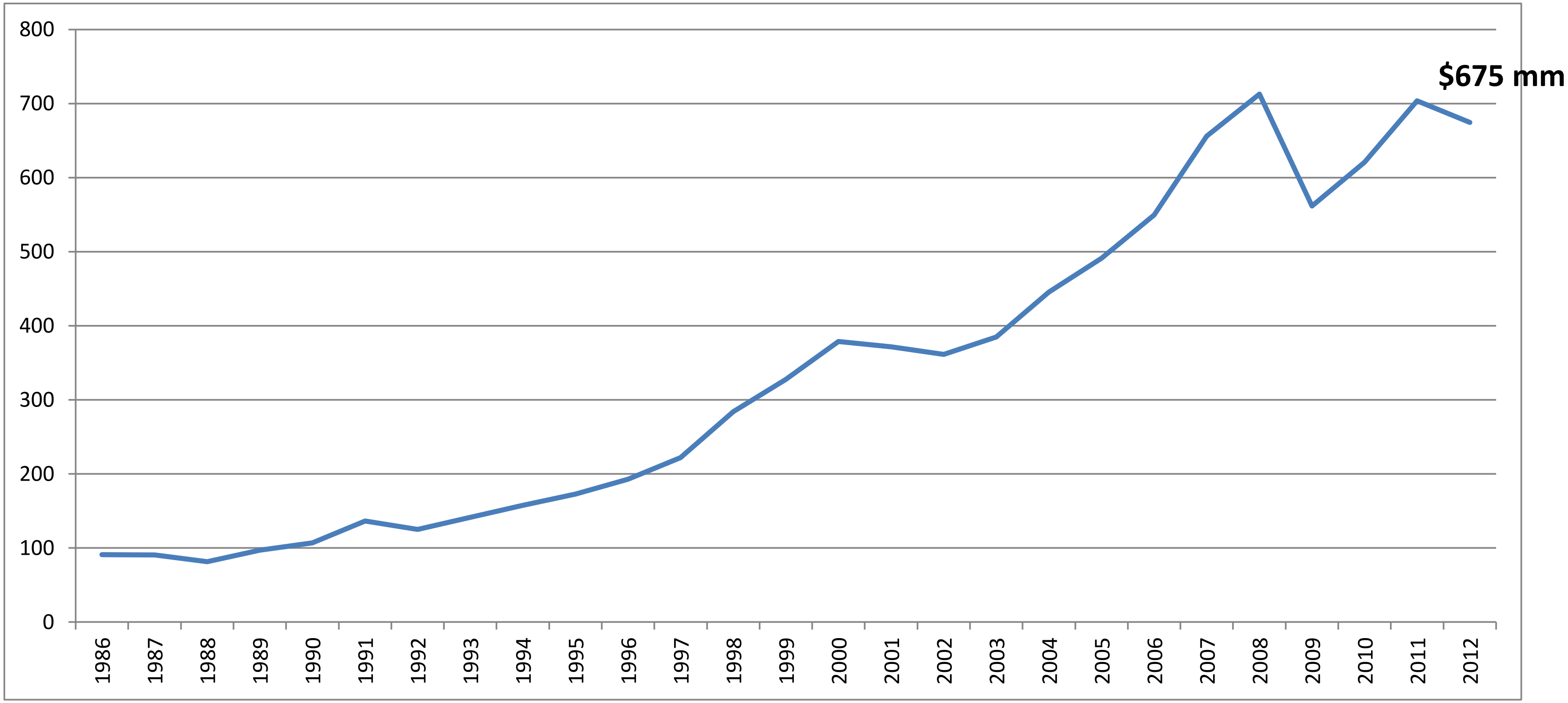
General Endowment Information

Data as of June 30, 2012

Change in Endowment Value

nominal $s in millions

Fiscal Years, June 30



NOTE: Endowment value is estimated to be $762 mm on June 30, 2013

How has the endowment grown?

All values adjusted for inflation into June 30, 2012 dollars

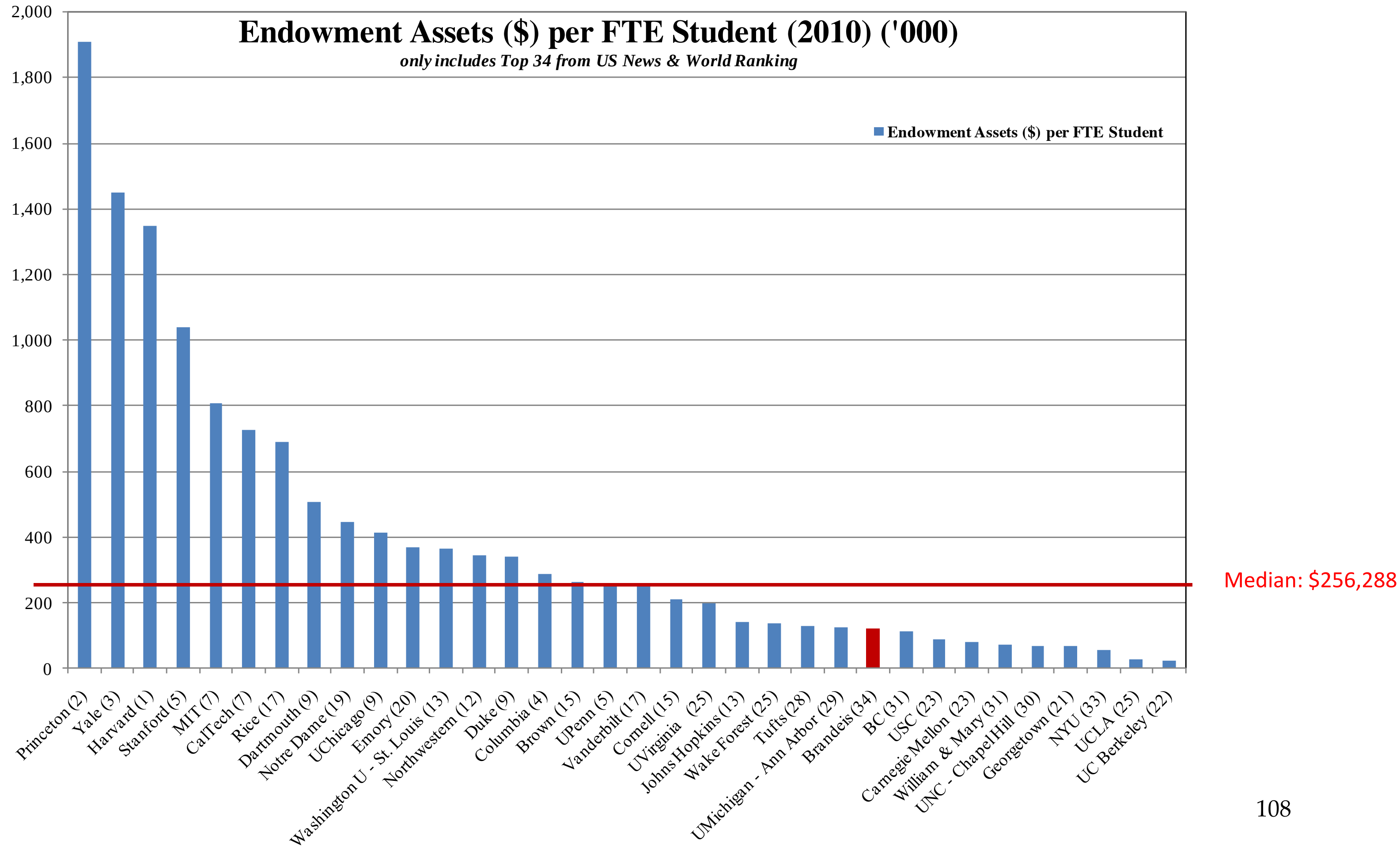
Gifts drive growth in endowment.

Investment performance supports spending and preserves real endowment value.

2012 Endowment Value	$	675
1989 Endowment Value	$	180
Growth		495
From Gifts		466
From Performance (over spending)		28
Increase in Value	$	495
Cumulative Spending 1990 to 2012	$	687

Endowment Per Student Relative to Peers

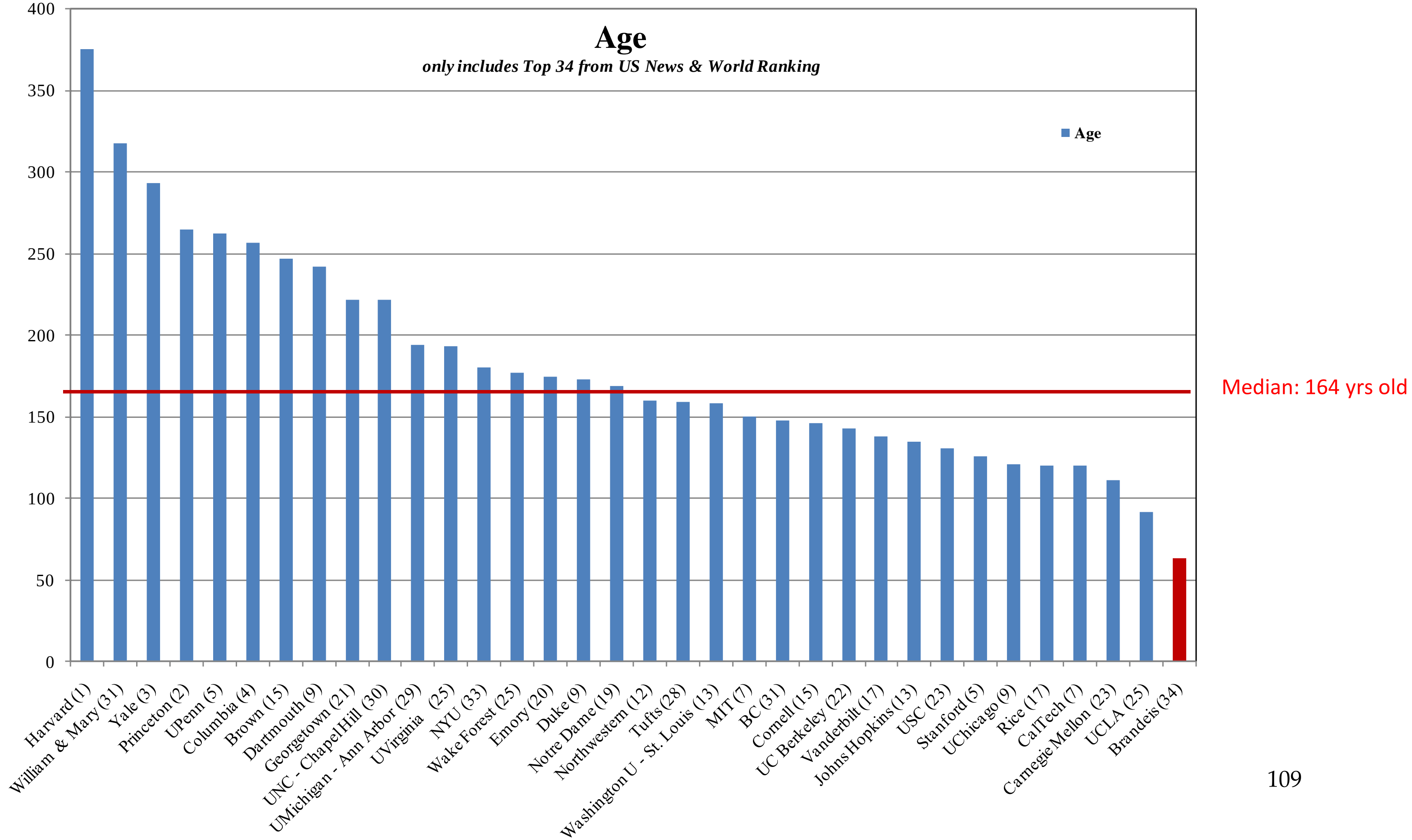
•Brandeis would need to raise $642 mm to match the median endowment per student of peers



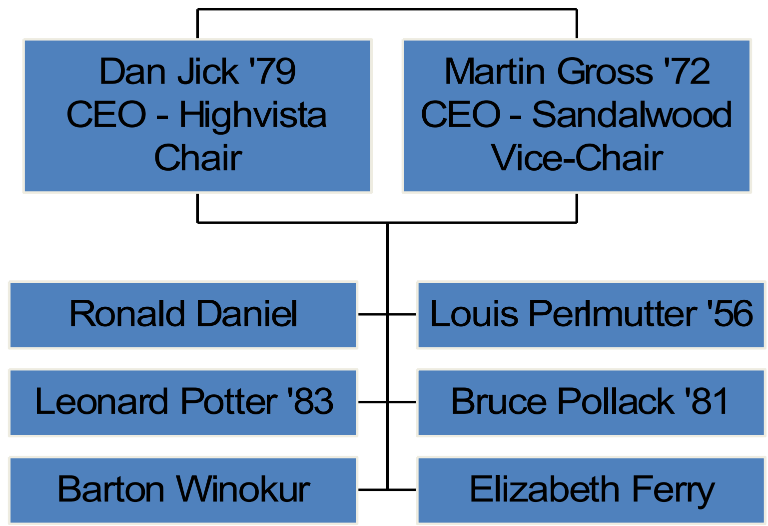
Source: Cambridge Associates

Age Relative to Peers

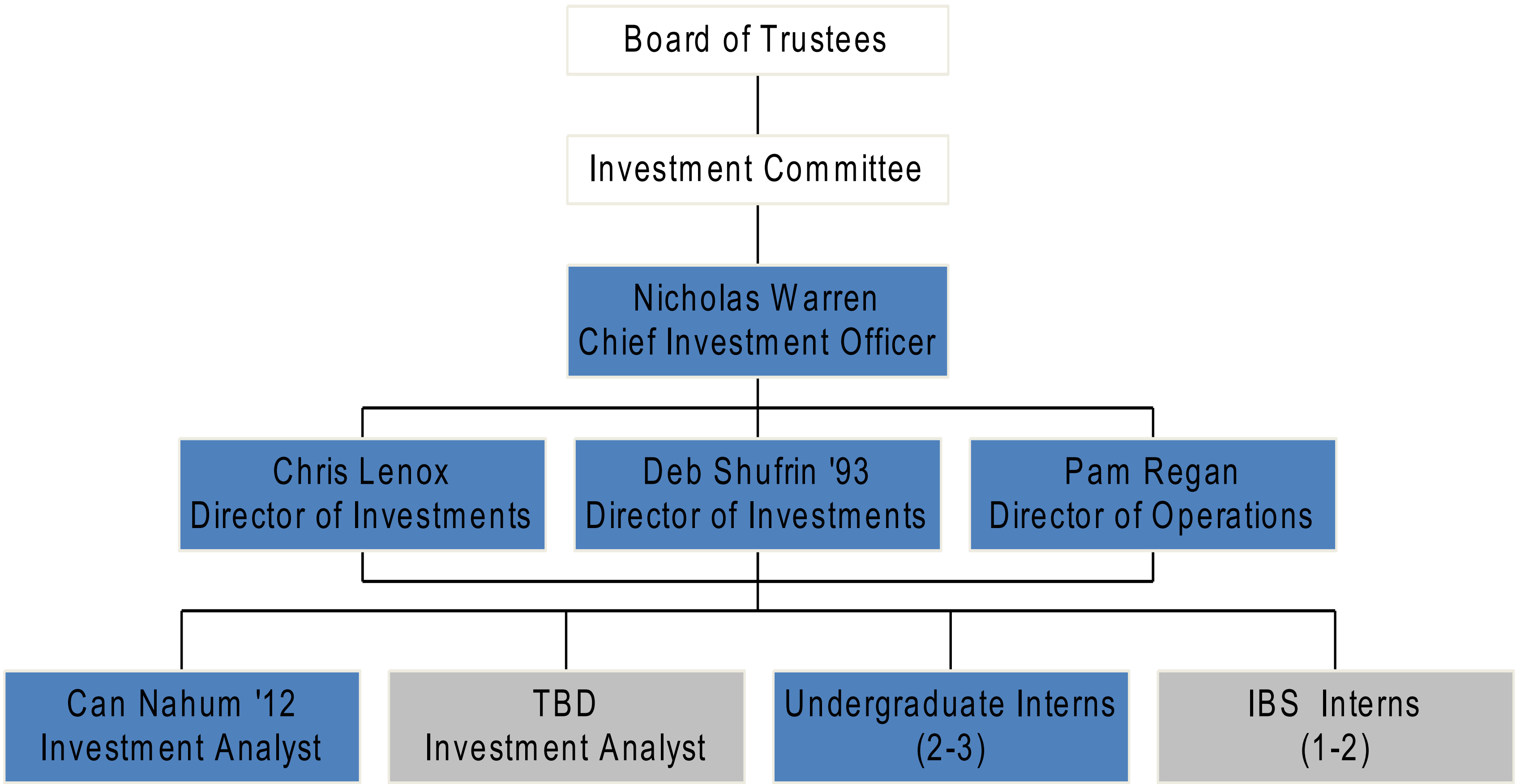
•Brandeis is dependent on young alumni and friends for donations. As most original alumni are still living, Brandeis does not enjoy the benefit of estate bequests.



Investment Committee



Investment Oversight



Overview

- Objective

  Support a spending rate that is sufficient to maintain the *real* value of future spending, taking into account the appropriate investment risk level for Brandeis

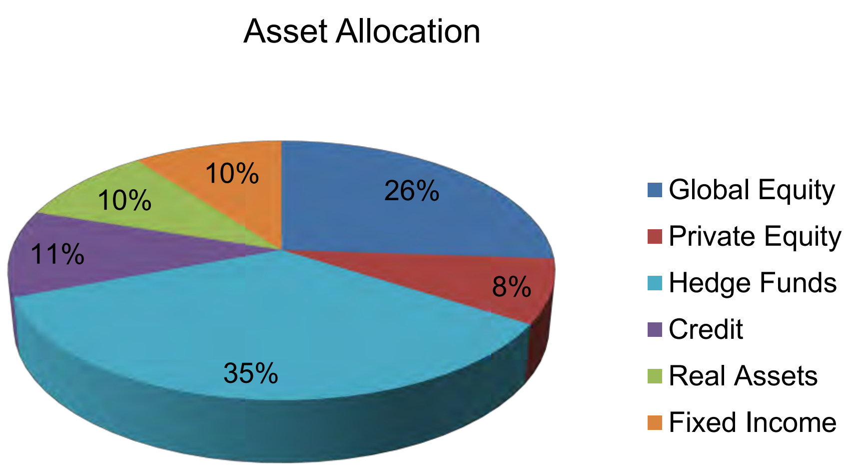
- Spending Rule: 5% of a trailing 3-year average

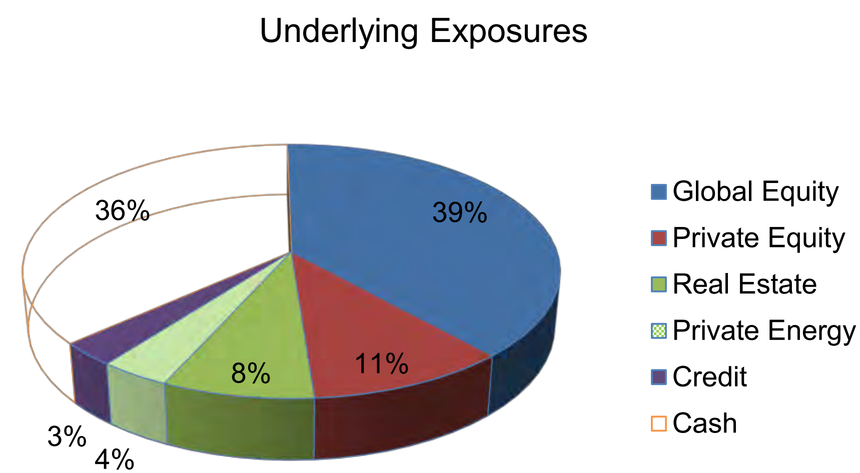
- Expected Real Return: 5%
- Expected Volatility: 12%

- The Endowment provides 12% of the University budget

Asset Allocation and Exposures

9/30/2012





	Sept. Acutal	Policy
Global Equity	26%	28%
Private Equity	8%	8%
Hedge Funds	35%	35%
Credit	11%	10%
Real Assets	10%	10%
Fixed Income	10%	10%

	Sept. Acutal Net
Global Equity	39%
Private Equity	11%
Real Estate	8%
Private Energy	4%
Credit	3%
Cash	36%

NOTE: Long 96%, Short 33% (excludes 7% sovereign debt short)

Number of Managers by Asset Class

Global Equity	4
Private Equity	9
Hedge Funds	10
Credit	4
Real Assets	11
Fixed Income	0
TOTAL	38

Fiscal Year Annualized Performance

As of June 30, 2012

	1 Year	3 Year	5 Year
Brandeis Performance	-1.0%	9.5%	2.2%
Preliminary Peer Performance Data			
NACUBO Mean	-0.3%	10.4%	1.5%
Cambridge Associates			
25th Percentile	0.8%	11.1%	1.9%
Median	-1.0%	10.3%	1.1%
75th Percentile	-2.1%	9.3%	0.4%
Benchmarks			
S&P 500	5.4%	16.4%	0.2%
70/20/10 Benchmark*	1.9%	10.9%	0.9%
5% Real	6.7%	7.1%	8.3%

Source: NACUBO, Cambridge Associates

Current FYTD '13 Return through October is 3.3% versus the S&P 500 return of 4.4%, and the 70/20/10 Benchark of 3.8%

*70% Public Equity (50% S&P 500, 50% MSCI ACWI), 20% Cash, 10% 10-Yr Treasuries

Annual Returns

Fiscal Years ending June 30

Fiscal Year	Brandeis	S&P 500
1998	15.6	30.2
1999	10.4	22.8
2000	13.2	7.2
2001	-3.4	-14.8
2002	-2.5	-18.0
2003	5.6	0.3
2004	15.6	19.1
2005	9.5	6.3
2006	11.1	8.6
2007	18.3	20.6
2008	2.4	-13.1
2009	-17.0	-26.2
2010	13.9	15.6
2011	16.8	30.7
2012	-1.0	5.5

Cumulative	167.6	103.6

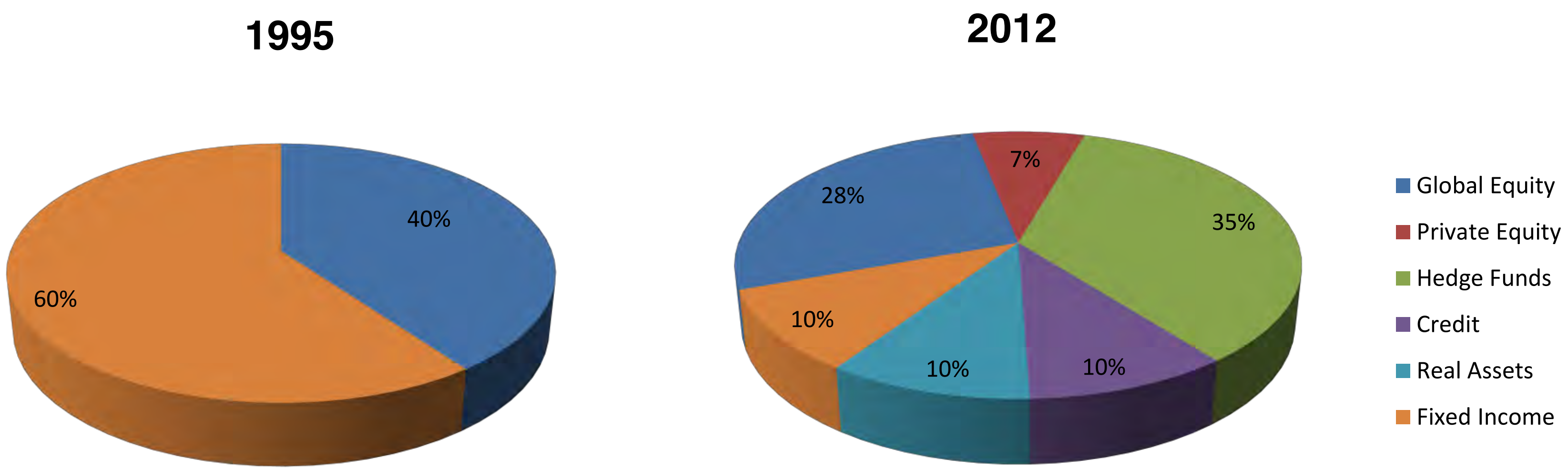
Standard Deviation	9.8	17.7

Recent Manager Hires

January 11, 2011 to December 31, 2012

New Commitments	Committed
Long/Short: European Small Cap	$17 mm
U.S. Real Estate: Distressed	$6.8 mm
U.S. Real Estate: Retail	$10 mm
Private Equity: U.S. Energy (re-up)	$10 mm
Private Equity: Global Energy (re-up)	$6.5 mm
Venture Capital: Fund of Funds	$20 mm
Long/Short: Healthcare	$20 mm
Private Equity: U.S. Energy	$10 mm
Long-Only: Biotechnology	$20 mm
Long-Only: U.S. Energy (Pending)	$20 mm
TOTAL	$140.3 mm
Implied Annual Turnover	10%

Policy Portfolio Over Time



	1995	2012	
	Policy	Policy	September Actual
Global Equity	40%	28%	26%
Private Equity		8%	8%
Hedge Funds		35%	35%
Credit		10%	11%
Real Assets		10%	10%
Fixed Income	60%	10%	10%

How We Invest

Core Principles

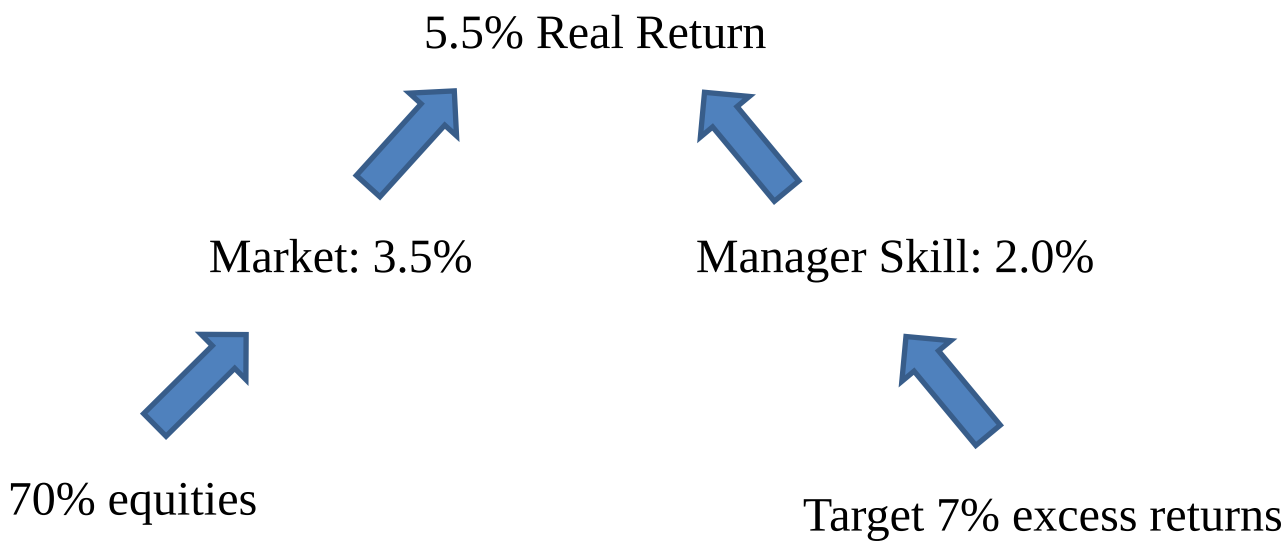
- **Target 5.5% real return**
- Diversified 70% equity exposure approach
- Deep research
- **Concentrated portfolio of 40 managers**
- Low manager turnover (4-6 managers/year)
- **High alpha**
- Focus on three alpha sources: fix it, large inefficiencies, real growth
- Long-term horizon – 5+ years
- **Robust portfolio – multi-economic scenario portfolio**
- Understand Brandeis specific advantages/disadvantages
- Be humble, know what you don’t know, dig deep, have fun

Potential costs associated with divestment

- **Smaller opportunity set of managers leads to lower excess returns**
- **Reduced inflation protection**
- **Limited staff resources due to small endowment**

Smaller Manager Opportunity Set

Anatomy of our target return



- Given our fiscal situation we are currently spending 6%. This adds additional importance to our search for high alpha managers.

Note: Fixed income real return today is -0.4% versus +0.5% historically

Managers versus individual equities

- Brandeis does not own individual equities
- The investment office looks for managers
- The subset of managers that would meet full compliance with energy divestment criteria is small
- If we divest, we could probably only achieve a market return with our investments
- To achieve a level of returns equal to our spending, we would have to take more risk. This would increase spending volatility, require us to decrease our spending rate, decrease the likelihood of maintaining the real value of endowment, make the endowment extremely vulnerable to inflationary and deflationary environments.

How hard is it to find managers

- Ability to generate 7% gross excess return is extremely rare; academic studies have not been able to find anyone who has done this consistently
- Pursuit of 7% excess returns requires great patience and humility which are not common characteristics of humans, and even rarer among professional investors.
- We spend 4500 hours a year looking for 5 new managers (4 months of work for each)
- Ex: We have met over 100 real estate managers and hired 2

Reduced Inflation Protection

Robust portfolio concept

- Two large risks we design the portfolio to survive
  - Inflation
  - Deflation

- For inflation we own energy and real estate

- For deflation we own government bonds, and keep equity exposure to the minimum required

- Equity does poorly in both inflationary and deflationary scenarios (both risks are at elevated levels today)

Inflation Hedging Assets

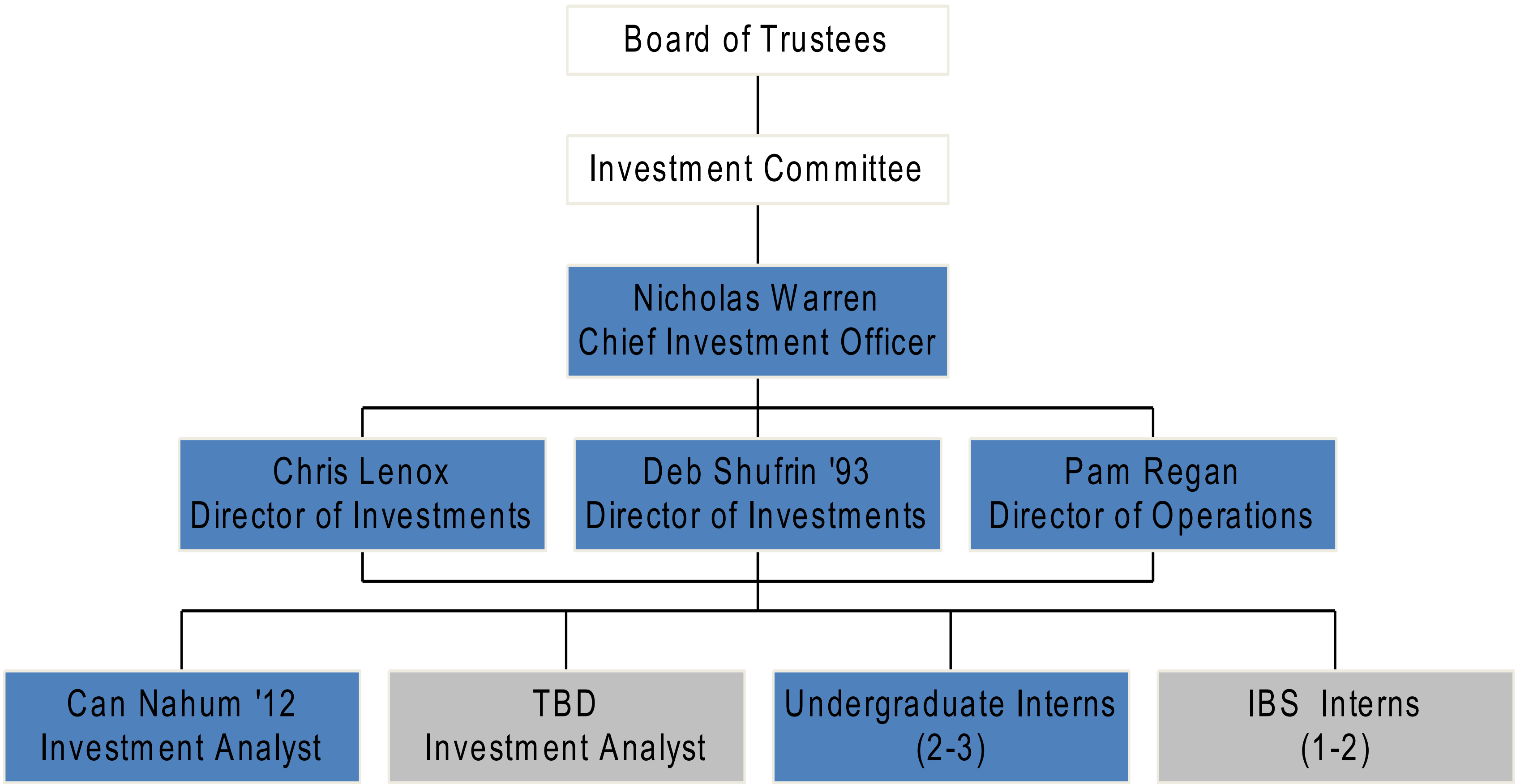
- Energy: Oil and Natural Gas <u>(by far the best)</u>
  - During severe, unexpected inflation, oil has been one of best hedges – it is a global commodity and most of consumption is non-discretionary
  - We can buy barrels in the ground for which we earn a normal equity return to produce. In addition, we get a cheap call option on a sustained increase in energy prices.
  - Massive reserves in the US and Canada allow us to access in politically stable environments – little risk to changes in our property rights
- Gold & TIPs
  - Gold and TIPs have negative real returns unless there is severe unexpected inflation, making them very costly hedges.
  - Gold in the ground is difficult to produce, and costs are almost unpredictable. Gold reserves tend to be in politically unstable countries.
- Real estate (second best)
  - The link between inflation and real estate returns exists but is more tenuous
  - Supply and demand imbalances can swamp inflation protection benefits
  - Perceptions of real estate as a bond substitute can distort prices
  - Highly fragmented industry with high fees and poor capital discipline
- Other: Mining, Agriculture, Timber, Power Production, Infrastructure

Brandeis' Energy Investments

- 10% energy exposure – would like it to be higher
  - 3.2% held by non-dedicated energy managers
  - 2.6% in one public energy manager
    - Small E&P companies that are nearing cash flow inflection points
  - 4.2% in three private energy managers
    - New capital is focused on buying existing conventional reserves that have been undermanaged and are being sold by families or companies that need capital for drilling unconventional wells

Limited Staff Resources

Investment Oversight



Summary

Potential costs associated with divestment

- **Smaller opportunity set of managers leads to lower excess returns**
  - To achieve higher return, need to take greater market risk
    - a) Higher risk increases volatility of spending putting greater stresses on the University during bad economic scenarios
    - b) Increased chance of not meeting expected return which would decrease the real endowment value
    - c) Lower spending rate needed to offset increased risk
    - d) Increased sensitivity to inflation and deflation risks
  - Or have to simply lower spending to match return at current risk

- **Reduced inflation protection**
  - Double trouble: 1) less protection if we do face inflation, and 2) increased losses due to more market risk

- **Divestment research consumes limited staff resources – small endowment**

Brandeis University as a Responsible Investor
General Guideline Adopted by the Board of Trustees
April 1973

Society supports the achievement of these missions [the university mission] by conferring great privileges on university communities. Exemption from income and property taxes, and tax deductibility to the donor for gifts made to universities, are among the important - even crucial - privileges conferred upon universities by the society in which they function. It follows that the energies and funds of a university should be devoted mainly to its primary missions and goals and not diverted to other causes such as official promotion of particular political or social views.

It further follows that capital funds received in support of a university's missions and goals should be invested primarily with a view to financial considerations such as safety and growth of capital and production of income, thereby producing further funds to support and advance such missions and goals. The need for productive economic employment of funds is particularly acute in the present inflationary period of rapidly rising costs.

Even though it is concluded that attempting to pass judgment upon or to influence the conduct of business corporations with regard to the social consequences of their activities is not among a university's primary missions, it does not follow that the university should ignore the ethical implications of the investment of its capital funds in various corporate enterprises. Indeed, we believe a university has the ethical responsibility to exercise such power as it has as an investor in ways designed to prevent or correct social injury caused by corporations in which it invests. Nevertheless, it must be recognized that there are difficult practical problems associated with attempts by a university to exercise this ethical responsibility, among which are the following:

A. A university's power to influence corporate action, while not negligible, is nevertheless quite limited. The amount of funds available to Brandeis University's portfolio managers is too small to cause economic detriment to a corporation by deciding to refuse to buy its stock, or by deciding to sell its stock, if already owned. A university's power of moral persuasion greatly exceeds its economic power as a buyer and seller of securities; if effectiveness is a criterion by which the university's attempts to influence corporate action are to be judged, it is believed that such activities as the voting of proxies, and communication with management to urge upon it various courses of action or inaction (perhaps with accompanying publicity), are much more promising fields of action that the refusal to buy or hold securities.

B. Particularly difficult would be the question of deciding which companies to "reward" or "praise" by buying their securities and which to "punish" or "censure" by selling or refusing to buy their securities. There is probably no company which will not at some time be engaged in an activity which is offensive to some people, and the larger the company the more likely this is to be the case. It is difficult enough to reach agreement on what particular policies are "good" or "bad"; the difficulty is greatly compounded when it becomes necessary to further decide whether, considering a corporation's activities as a whole, it should be "praised" or "censured." This compounded problem is largely avoided if the university concentrates its efforts on influencing specified activities rather than making the judgment on the corporation as a whole, which would be implicit in a decision to purchase or sell its securities on the grounds of social acceptability of its overall performance.

C. There are some questions on which the university community may be deeply divided. To attempt to adopt an official university position favoring one or the other side on such a question would tend to impair the university's capacity to carry out its educational mission, both because of the distraction and diversion of energies caused by attempting to resolve the question and because of the derogation from academic freedom, which is implicit in the university's taking an official position on controversial issues. Consistent with its ethical responsibilities as an investor, the university can and should avoid taking a position on corporate responsibility questions of this sort.

D. The problem of obtaining sufficient information to reach informed decisions is greater than it might first appear. At any given time, the university is likely to own securities of many corporations. Merely reviewing the proxy statements of these corporations without attempting to be informed on aspects of their activities, which are not the subject of proxy statement proposals, will involve a considerable commitment of time and effort.

With the foregoing factors in mind the Investment Committee of the Board of Trustees proposes the following guidelines in discharging its ethical responsibilities related to investment in corporate enterprises:

RECOMMENDED GUIDELINES

1. <u>The University as an Initial Investor</u>

In deciding whether to purchase securities of a particular corporation, the university will in most cases be guided solely by the financial considerations of safety and growth of capital and production of income. Only when the corporation is directly and substantially involved in activities clearly considered by the university community to be contrary to fundamental and widely shared ethical principles should the portfolio managers be instructed to avoid purchase of its securities.

2. <u>The University as a Continuing Investor</u>

a. The university should exercise its ethical responsibilities as an investor primarily through the voting of its shares on propositions presented in corporate proxy statements. The university may also wish to make formal or informal representations to management concerning the corporation's activities. Only in exceptional cases, where it is found that the corporation's activities are gravely offensive to the university's sense of social justice, should the university consider initiating formal corporate action such as the proposing of matters for inclusion in a proxy statement, or initiating or joining in shareholder litigation.

b. When the university finds that a corporation in which it owns securities is directly and substantially involved in activities causing social injury, it will vote its shares in favor of propositions, which it considers likely to change such activities or to mitigate the social injury, which they cause, and against propositions, which it believes will have the opposite effect. Written representations may be made to management where appropriate, and other shareholder action may be initiated under circumstances referred to in paragraph A. In deciding whether to take shareholder action, the university should give due consideration to whether the company acting alone has power and responsibility to correct the injury, or whether correction could be made more appropriately through the enactment of new laws and regulations. The university should refrain from taking action on, or should vote against, proxy proposals involving social or political matters which are unrelated to the business of the particular corporation, and should refrain from voting on proposals which are likely to cause deep divisions within the university community.

c. Where a corporation's conduct is found to be clearly and gravely offensive to the university community's sense of social justice and where it is found that the exercising of shareholder rights and powers is unlikely to correct the injury, consideration should be given to selling that corporation’s securities. Due regard should be given to both positive and negative conduct of the corporation in such areas as:

(i) hiring, employment and pension practices;
(ii) relationships with oppressive governments;
(iii) product safety and consumer health;
(iv) extent and nature of military contracts;
(v) conservation and environmental pollution;
(vi) participation in charitable, educational and cultural life of the community.

In considering whether a sale should be made, the economic effect of such a sale on the university's portfolio should be a relevant, but not necessarily controlling, consideration.

TRUCOST PORTFOLIO FOOTPRINTS

Efficiently measuring the most critical natural capital risks

DIVYA MANKIKAR
VP BUSINESS DEVELOPMENT, NORTH AMERICA
TRUCOST

NATURAL CAPITAL METRICS FOR INVESTORS

TRUCOST

The world's most comprehensive data on
corporate environmental impacts

- Greenhouse Gases
- Air Pollutants
- Water
- Land and Water Pollutants
- Waste
- Natural Resource Usage

NATURAL CAPITAL METRICS FOR INVESTORS

TRUCOST

THE TRUCOST ENVIRONMENTAL REGISTER

93% coverage of global markets by market cap.

4,500 companies and their supply chains researched annually by Trucost analysts

$2.7 trillion investment funds analyzed

12 years Trucost has been researching, standardizing and validating the world's most comprehensive natural capital data

"Trucost's global environmental impact data has enabled us to truly integrate climate change analysis into our investment process. The quantitative data is fed into our mainstream investment decision making process enabling risk management, portfolio footprinting, sector and stock level analysis and the simulation of climate change strategies across asset classes "

AXA INVESTMENT MANAGERS
redefining / investment solutions

PORTFOLIO FOOTPRINTS

Leveraging the **Trucost Environmental Register** and **your holdings' data**, we help you understand the carbon, water and/or waste footprint of your portfolio.

We can compare that footprint to the financial benchmark (e.g. S&P 500, Russell 1000) your portfolio is being tracked against in a fast, cost-efficient manner, enabling you to:

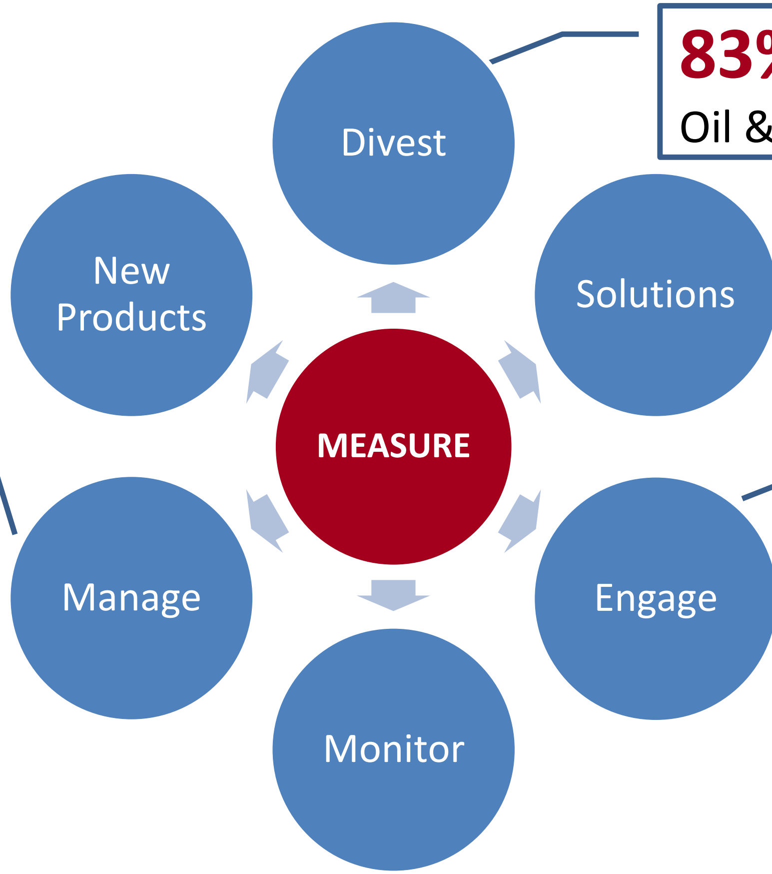
- **Identify** sectors or firms that are lending greater environmental risk to the investment strategy
- **Analyze** the decision-making of external managers with objective, standardized environmental performance data
- **Communicate** your management of environmental issues to stakeholders / UN PRI

DEVELOPING A STRATEGY

Conducting a portfolio footprint is the first step and enables you to consider other strategies to reduce risk and find opportunity through integrating natural capital data in investment decisions.

83% revenue at risk for Oil & Gas firms, for example

0.1 - 83% revenue at risk across world's largest Oil & Gas companies due to externalities



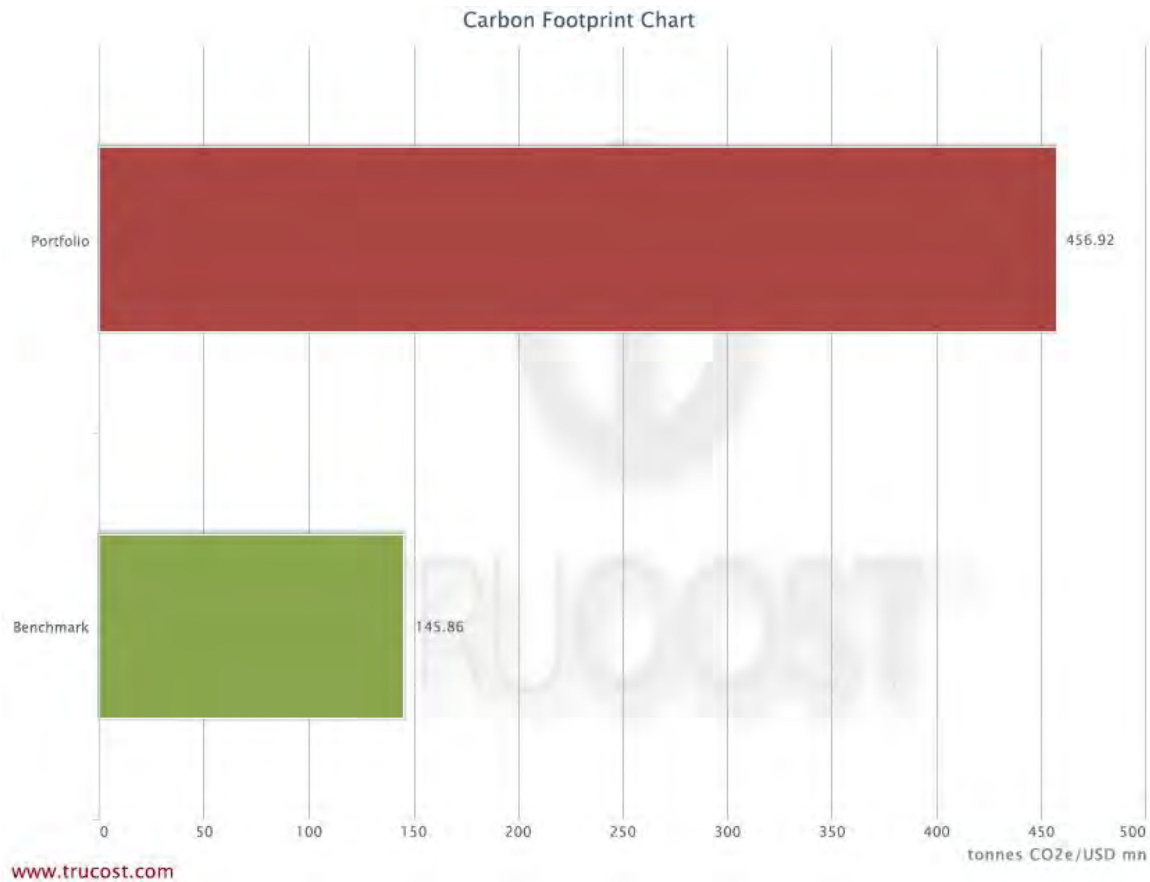
60% world's largest Oil & Gas companies do not disclose on Scope 1 emissions

INTEGRATING NATURAL CAPITAL INTO INVESTMENT DECISION-MAKING

ICB Super Sector	Portfolio (tCO2e/$mn)	Benchmark (tCO2e/$mn)
Construction & Materials	1,936.34	95.14
Basic Resources	1,416.97	265.41
Travel & Leisure	993.32	151.88
Food & Beverage	931.67	192.42
Chemicals	448.68	199.13
Real Estate	423.49	56.19
Technology	290.68	22.55
Industrial Goods & Services	233.06	56.73
Insurance	225.45	3.47
Automobiles & Parts	148.12	49.41
Telecommunications	124.51	31.15
Retail	69.04	38.43
Healthcare	54	43.39
Personal & Household Goods	44.98	59.76
Banks	23.69	8.52
Utilities	0	692.26
Oil & Gas	0	339.25
Media	0	18.91
Financial Services	0	6.39

INTEGRATING NATURAL CAPITAL INTO INVESTMENT DECISION-MAKING

Fossil Free Portfolio: 456.92 tonnes CO_2/$mn
Benchmark Portfolio: 145.96 tonnes CO_2/$mn



APPENDIX N

INTEGRATING NATURAL CAPITAL INTO INVESTMENT DECISION-MAKING

SELECTING AND EVALUATING MANAGERS

Portfolio Audits: Select and evaluate managers by permitting you to quantify the environmental performance of their funds in comparison to a benchmark and each other.

Mutual fund name (Ticker)	Carbon footprint (tCO_2e/ US$ million revenue)	ESG rating	Total returns[11] (% rank in peer group[10])				Risk		Gross expense ratio[11]	Inception date[11]
			1-YR	3-YR	5-YR	Since inception[11]	Alpha[11]	Alpha % rank[10]		
Large Cap Growth										
Calvert Social Investment Equity (CSIEX)	94	ESG-4	13.39 (37)	-5.42 (16)	0.29 (37)	6.35	4.55	19	1.28	24/8/87
Parnassus (PARNX)	95	ESG-4	17.23 (10)	-4.48 (9)	2.72 (8)	8.65	8.72	3	1.00	27/12/84
Fidelity Contrafund (FCNTX)	153	ESG-0	16.42 (14)	-5.30 (14)	3.05 (6)	11.98	3.40	30	1.02	17/5/67
American Funds Growth Fund of America (AGTHX)	366	ESG-0	10.39 (68)	-8.51 (57)	0.83 (27)	13.52	1.02	66	0.76	30/11/73
Responsible Group Average	95		15.31	-4.95	1.51		6.64	11	1.14	
Traditional Group Average	260		13.41	-6.91	1.94		2.21	48	0.89	
Peer Group Median Mutual Fund/ETF[10]			12.00	-8.10	-0.35					
Index: Russell 1000 Growth			13.62	-6.91	0.38					

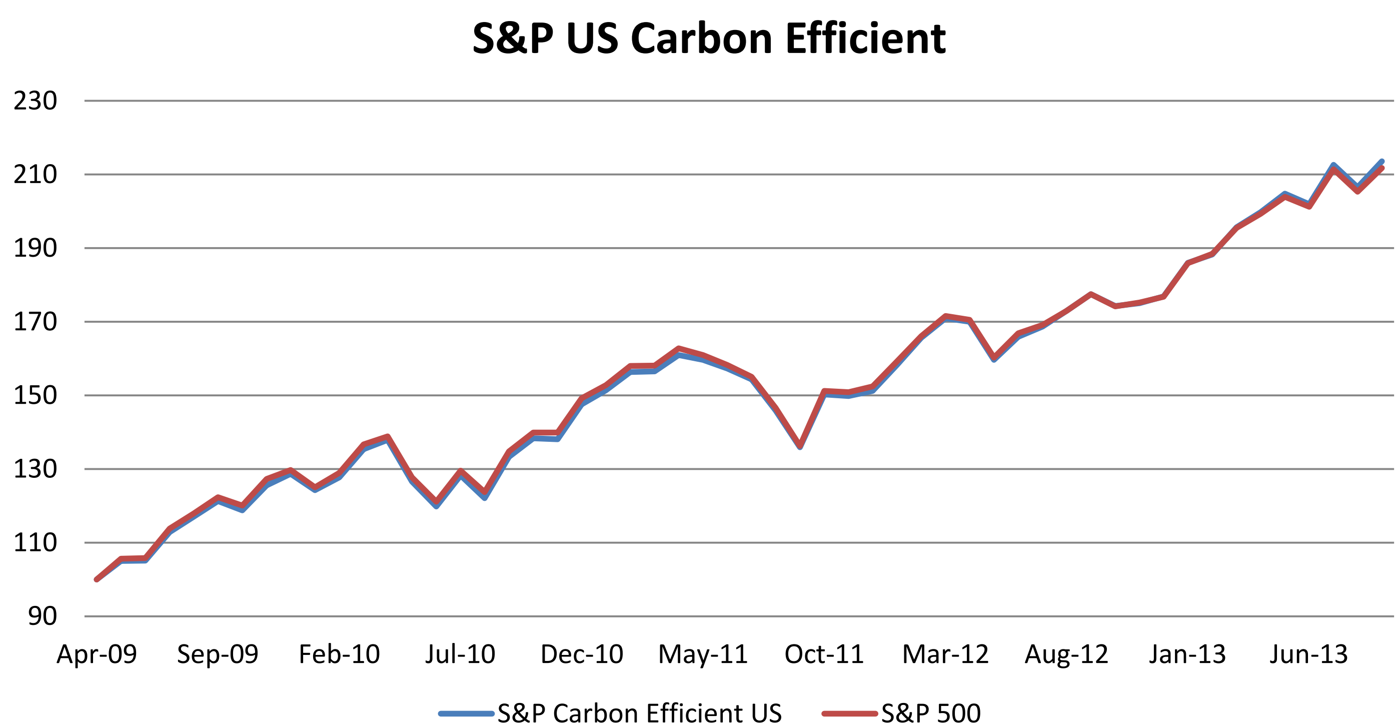
[1] TRUCOST. Carbon Footprints, Performance And Risk Of U.S. Equity Mutual Funds: Trucost And RLP Capital Study On The Effects Of Environmental, Social And Governance (ESG) Analysis (Nov 2010)

OPPORTUNITY

The index is composed of a subset of constituents in the S&P 500 with a relatively low Carbon Footprint, calculated by Trucost.

Date of inception: Apr-09

Compound annualised growth rate: +18.37%
Tracking Error: 0.051%



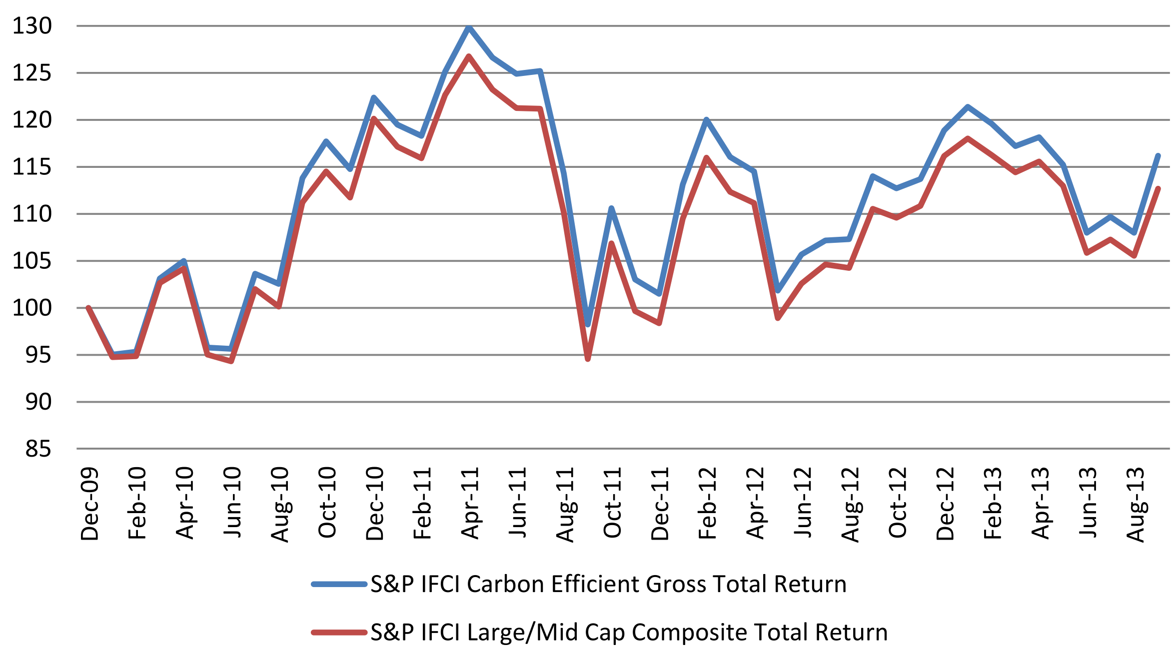
OPPORTUNITY

The S&P/IFCI Carbon Efficient Index measures the performance of investable emerging market companies with relatively low carbon emissions, calculated by Trucost, while closely tracking the returns of the S&P/IFCI LargeMidCap Index.

Date of inception: Dec-09

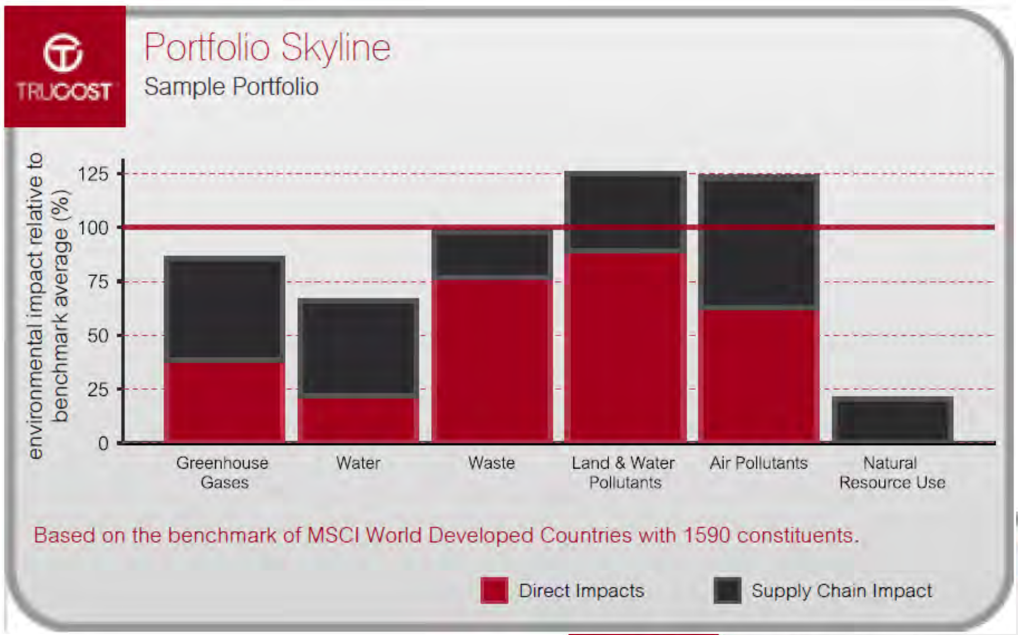
Compound annualised growth rate: +3.99%
Tracking Error: 0.09%

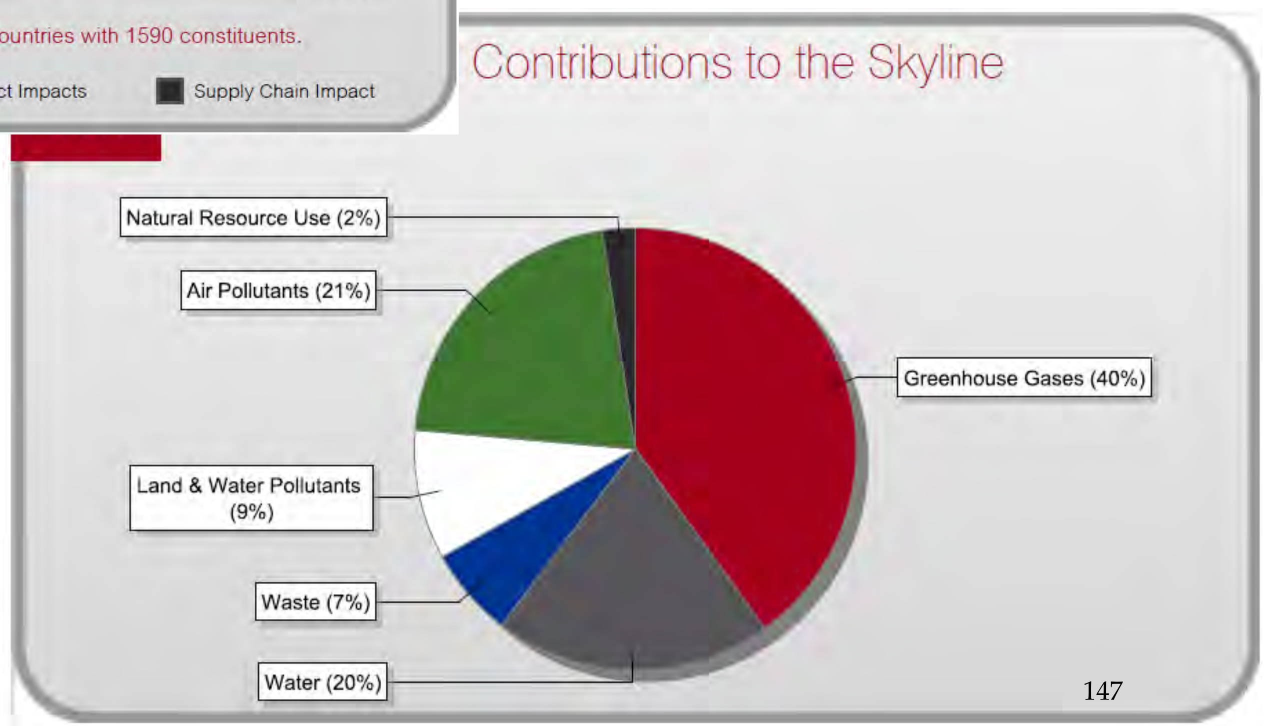
S&P IFCI Carbon Efficient Index



Example Outputs from a Portfolio Footprint

Understanding your exposure – Portfolio level + Environmental Risks

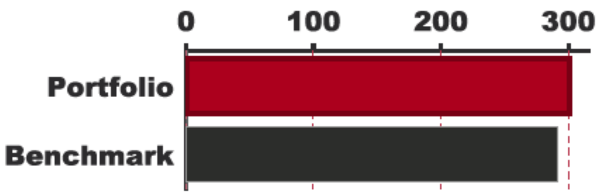




Example Outputs from a Portfolio Footprint

Understanding your exposure – Portfolio Level + Carbon Risks

The carbon footprint of the portfolio is 301.07 compared to the benchmark which is 291.50.



The portfolio is 3. 28% more carbon intensive than its benchmark, S&P 500.

Summary of Stock and Sector Allocation Effects

Portfolio

	Sector Weighting		Carbon Intensity (tCO2e/$mn revenue)		Carbon Footprint Attribution		
	Portfolio	Benchmark	Portfolio	Benchmark	Sector Allocation	Stock Selection	Total Effect
Banks	26.24 %	25.51 %	14.52	14.32	-0.31 %	-0.01 %	-0.32 %
Basic Resources	26.20 %	25.54 %	1,045.82	917.00	-0.38 %	-7.00 %	-7.37 %
Chemicals	0.62 %	1.55 %	500.28	616.25	1.55 %	0.27 %	1.82 %
Construction & Materials	2.78 %	2.55 %	461.79	304.47	0.02 %	-3.87 %	-3.85 %
Financial Services	3.80 %	4.49 %	16.50	18.17	-1.58 %	0.01 %	-1.57 %
Food & Beverage	4.11 %	1.79 %	288.10	227.75	0.61 %	-1.00 %	-0.40 %
Healthcare	2.03 %	3.28 %	49.87	55.49	-0.38 %	0.04 %	-0.35 %
Industrial Goods & Services	6.66 %	4.55 %	172.32	160.09	0.92 %	-0.38 %	0.54 %
Insurance	2.92 %	2.41 %	6.65	5.70	0.41 %	-0.02 %	0.39 %
Media	1.96 %	1.32 %	63.71	38.94	0.10 %	-0.16 %	-0.06 %
Oil & Gas	3.64 %	6.10 %	522.52	481.80	-0.58 %	-0.67 %	-1.25 %
Personal & Household Goods	0.45 %	0.26 %	21.96	47.76	-0.04 %	0.05 %	0.01 %
Real Estate	1.13 %	6.05 %	131.76	130.89	-1.18 %	-0.00 %	-1.18 %
Retail	7.05 %	7.46 %	69.16	91.09	-0.57 %	1.52 %	0.95 %

Example Outputs from a Portfolio Footprint

Understanding your exposure – Stock Level + Carbon Risks

Company Breakdown

Portfolio

Company details	Weighting – Portfolio	Weighting – Benchmark	Carbon Apportioned – Tonnes CO2e	Carbon Apportioned – % of Portfolio's Total Carbon Apportioned	Carbon Intensity (tCO2e/$mn)	Carbon Footprint Contribution (%)*	Footprint Rank in Benchmark Sector **	Data Source ***
Media	**1.96 %**	**1.32 %**	**619**	**0.41 %**	**64**	**1.55 %**		
Company 1078746	1.23 %	0.23 %	489	0.32 %	67	1.15 %	6 / 7	TC
Company 1328849	0.42 %	0.08 %	1	0.00 %	18	0.01 %	3 / 7	TC
Company 1408844	0.06 %	0.08 %	9	0.01 %	71	0.02 %	7 / 7	TC
Company 1462740	0.26 %	0.06 %	119	0.08 %	55	0.36 %	5 / 7	TC
Oil & Gas	**3.64 %**	**6.10 %**	**12,580**	**8.30 %**	**523**	**-3.70 %**		
Company 1337740	1.88 %	1.20 %	3,773	2.49 %	1,642	-2.04 %	16 / 18	ENV*
Company 1344740	0.66 %	0.19 %	8,175	5.40 %	398	-1.37 %	11 / 18	ENV*
Company 1388841	0.18 %	0.17 %	109	0.07 %	276	0.01 %	4 / 18	TC
Company 1717241	0.93 %	2.46 %	523	0.35 %	617	-0.18 %	15 / 18	ENV*
Personal & Household Goods	**0.45 %**	**0.26 %**	**66**	**0.04 %**	**22**	**0.56 %**		
Company 1882743	0.45 %	0.14 %	66	0.04 %	22	0.56 %	1 / 3	ENV*
Real Estate	**1.13 %**	**6.05 %**	**252**	**0.17 %**	**132**	**0.21 %**		
Company 1019252	0.04 %	0.05 %	2	0.00 %	42	0.01 %	1 / 17	TC
Company 1268843	0.11 %	0.16 %	8	0.01 %	65	0.02 %	5 / 17	TC
Company 1278841	0.23 %	0.42 %	8	0.00 %	65	0.02 %	4 / 17	TC
Company 1398748	0.19 %	0.38 %	122	0.08 %	219	0.03 %	16 / 17	ENV*
Company 1528849	0.09 %	0.07 %	10	0.01 %	65	0.02 %	6 / 17	TC
Company 1570745	0.44 %	2.40 %	93	0.06 %	114	0.10 %	12 / 17	ENV*
Company 1588847	0.04 %	0.06 %	10	0.01 %	88	0.02 %	11 / 17	TC

"In an environment where governments are increasingly taxing and regulating GHG emissions, which has a real financial impact on businesses, there is a growing investor appetite for products that can capitalize on carbon-efficiency.

For further information please contact us:

Divya Mankikar
Vice President, North America
Divya.Mankikar@Trucost.com
(646) 812-5208

Brandeis University

Trucost proposal for measuring carbon exposure of Brandeis' endowment through portfolio footprints

Data and tools to link financial and environmental performance

April 2014

Trucost helps organizations understand the economic consequences of their natural capital dependencies, in order to identify investment risk and opportunity, today and tomorrow.

Contents

Understanding your request

YOUR REQUEST

Brandeis University Endowment

The Brandeis endowment supports the mission of Brandeis University. As a research university, Brandeis is dedicated to the advancement of the humanities, arts and social, natural and physical sciences. The endowment's mission is to support this goal financially by meeting an investment objective is maximize risk-adjusted returns over a long-term horizon.

The Challenge

- The endowment must meet aggressive financial targets, incorporating risk management across its investments to maintain its **long-term viability.** Climate change poses risk to **all sectors** the endowment is invested in as underlined in the most recent IPCC report. Portfolio managers and external stakeholders are aware the endowment has exposure to environmental risk which also impacts financial viability.
- In addition, members of Brandeis' community have expressed concern for the Endowment's investment in fossil fuel firms and become active in engaging the endowment managers to divest from certain firms and sectors.
- Brandeis is interested in understanding the specific, quantified environmental risks to its endowment in order to create a benchmark against which to consider any proposed changes to the current investment thesis.
- Brandeis has approached Trucost for insight and support in measuring the equity investments' exposure to carbon with a view towards potentially integrating carbon risk in the due diligence and portfolio management in the future.

OUR RESPONSE

The Proposal and Objectives

Trucost's data and tools can meet the dual objectives of:

- Measuring exposure to carbon
- Supporting informed, scientifically robust communication with engaged stakeholders

The objective of these two items is to support Brandeis:

- To communicate the difference in risk between its endowments' equity investments and the broader market
- To translate carbon considerations into meaningful, financial terms of relevance to mainstream portfolio managers
- To demonstrate how investment-grade carbon data can be leveraged in decisions about multiple investment strategies

Project Process

Trucost proposes achieving these objectives by:

- Conducting portfolio footprints of the relevant equity investments to inform internal strategy
- Supporting Brandeis in communicating the benefits of its strategy to stakeholders, leveraging the footprint reports

Timescales for delivery:

- Timeframes will be refined after further discussion of the proposed approach through discussions with Brandeis, but draft timelines have been proposed.

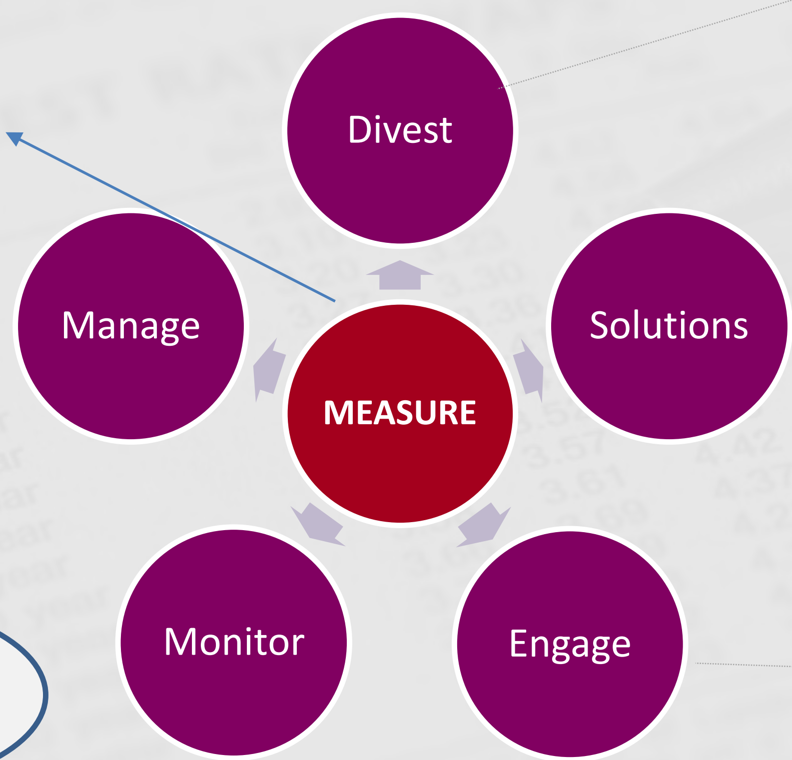
Project Objective and Value to Brandeis

Measuring Brandeis' exposure to carbon in its endowment

OBJECTIVE	**Trucost will support Brandeis University' strategy in measuring, reducing and communicating the exposure of its funds to carbon externalities.**
VALUE TO Brandeis University	• Working with Trucost, Brandeis can understand the environmental and financial benefits of its strategies in quantitative terms. • Brandeis can source environmental data from the largest possible universe, as Trucost data goes beyond publicly reported data to engage companies and model impacts where disclosure is unavailable. • Brandeis will be able address carbon concerns across its equity investments. Impact Reduction: Leverage Investment Grade, Quantitative Data; Use Data Easily Integrated into Existing Tools; Hedge Carbon Exposure Reputation: Respond to Stakeholder Pressure; Improve in Peer Ranking of Responsible Endowments
TRUCOST METHODOLOGY	Trucost will footprint Brandeis University's aggregate equity funds, and if desired support the integration of quantified, natural capital metrics into portfolio management.

Developing A Strategy

Conducting a portfolio footprint is the first step and enables you to consider other strategies to reduce risk and find opportunity through integrating natural capital data in investment decisions.



Up to 83% revenue at risk for the world's largest Oil & Gas firms from carbon emissions

Invest in companies best positioned for a low carbon economy

60% world's largest Oil and Gas companies do not disclose Scope 1 carbon emissions[156]

We can help here too in strategy review, development & guidance

Develop Strategy: quantify impact - Divest, Engage, Hedge, Invest in Solutions?
Communicate Strategy: to stakeholder & engage with your managers
Monitor Progress: assess annually progress against your strategy

Trucost Portfolio Footprints

Leveraging the **Trucost Environmental Register** and **your holdings' data**, we help you measure the carbon, water and/or waste footprint of your portfolio.

We can compare that footprint to the financial benchmark (e.g. S&P 500, Russell 1000) your portfolio is being tracked against in a fast, cost-efficient manner, enabling you to:

- **Identify** sectors or firms that are lending greater environmental risk to the investment strategy
- **Analyze** the decision-making of external managers with objective, standardized environmental performance data
- **Communicate** your management of environmental issues to stakeholders / UN PRI

High level project approach

3 weeks

Stage 1: 3 weeks

Carbon Footprint of Brandeis University's aggregate equity holdings

Stage 2: 2 weeks

Carbon footprint of Brandeis' endowment at the manager level

Total project time: 5 weeks

Detailed project approach

Stage 1

Brandeis will send the aggregate holdings through to Trucost.

Trucost will then match the holdings to the Trucost Environmental Register and quantify the carbon footprint of Brandeis's fund with regard to:

- Total carbon footprint of the fund vs. footprint of the benchmark
- The footprint, ranking within sector and source of carbon data for each firm within the fund
- The performance of the endowment vs the benchmark due to sector and stock allocation decisions
- The top contributors to the footprint who do not disclose on their carbon footprint
- This research process covers the firms that overlap between the Trucost Environmental Register and Brandeis' equity holdings.

- 8-10 page Portfolio Carbon Footprint including written and graphical description of each of the analytic items described above

(see accompanying sample report)

Stage 2

Trucost will analyze trends across managers to create a Key Findings Report

Trucost will quantify the carbon footprint of Brandeis' endowment with regard to:

- Total carbon footprint of each manager fund vs. the aggregate holdings
- The footprint, ranking within sector and source of carbon data for each firm within manager's portfolio
- Qualitative review of managers' engagement on climate change through participation in related dialogue, investor associations and shareholder resolutions

---

- Portfolio Carbon Footprint report similar to Stage 1, but conducted for each manager's portfolio
- 3-5 page Key Findings Report - Executive Summary for CIO and Administration

Stage 1: Carbon Footprint Analysis

TRUCOST

Carbon footprint of aggregate Brandeis equity holdings

- Trucost will conduct research starting from Brandeis' aggregate equity holdings across funds in order to measure the total carbon exposure of equity investments of those firms already within Trucost's Environmental Register. This process will allow Brandeis to understand the context for the specific divestment request that has been made and answer the question:

  "What is our total exposure to carbon and where does it arise from?"

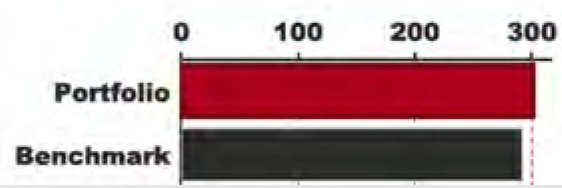
- To answer this question and provide context, Trucost will quantify the carbon footprint of Brandeis' equity investments with regard to:
  - Total carbon footprint vs. footprint of the benchmark (ex. Russell 1000, MSCI World)
  - The footprint, ranking within sector and source of carbon data for each firm within the aggregate holdings
  - The performance of the aggregate holdings vs the benchmark due to sector and stock allocation decisions
  - The top contributors to the footprint that do not disclose on their carbon footprint

Deliverables:

- The results will be disclosed through our standard carbon footprint report and a webinar to discuss the findings. Sample outputs are in the following slides, and a full sample is attached in an accompanying document.

- Optional Extra: **Stage 2:** Trucost can also break the results out by manager or fund, and provide a Key Findings report looking into trends across decision-makers and whether particular manager's decisions are more carbon-efficient or more engaged with companies on climate change.

Sample deliverable - Task 1: Portfolio Footprint



The portfolio is 3.28% more carbon intensive than its benchmark, R 1000.

Summary of Stock and Sector Allocation Effects

Portfolio

	Sector Weighting		Carbon Intensity (tCO2e/A$mn revenue)		Carbon Footprint Attribution		
	Portfolio	Benchmark	Portfolio	Benchmark	Sector Allocation	Stock Selection	Total Effect
Banks	26.24 %	25.51 %	14.52	14.32	-0.31 %	-0.01 %	-0.32 %
Basic Resources	26.20 %	25.54 %	1,045.82	917.00	-0.38 %	-7.00 %	-7.37 %
Chemicals	0.62 %	1.55 %	500.28	616.25	1.55 %	0.27 %	1.82 %
Construction & Materials	2.78 %	2.55 %	461.79	304.47	0.02 %	-3.87 %	-3.85 %
Financial Services	3.80 %	4.49 %	16.50	18.17	-1.58 %	0.01 %	-1.57 %
Food & Beverage	4.11 %	1.79 %	288.10	227.75	0.61 %	-1.00 %	-0.40 %
Healthcare	2.03 %	3.28 %	49.87	55.49	-0.38 %	0.04 %	-0.35 %
Industrial Goods & Services	6.66 %	4.55 %	172.32	160.09	0.92 %	-0.38 %	0.54 %
Insurance	2.92 %	2.41 %	6.85	5.70	0.41 %	-0.02 %	0.39 %
Media	1.86 %	1.32 %	63.71	38.94	0.10 %	-0.16 %	-0.06 %
Oil & Gas	3.64 %	6.10 %	522.52	481.80	-0.58 %	-0.67 %	-1.25 %
Personal & Household Goods	0.45 %	0.26 %	21.96	47.76	-0.04 %	0.05 %	0.01 %
Real Estate	1.13 %	6.05 %	131.76	130.89	-1.16 %	-0.00 %	[illegible]
Retail	7.05 %	7.46 %	69.16	91.09	-0.57 %	1.52 %	0.95 %
Technology	0.07 %	0.12 %	18.31	21.53	-0.03 %	0.00 %	-0.03 %
Telecommunications	4.96 %	2.91 %	59.19	56.68	1.11 %	-0.05 %	1.06 %
Travel & Leisure	3.90 %	1.83 %	259.28	552.51	-0.89 %	5.52 %	4.63 %
Utilities	1.48 %	2.27 %	637.93	862.69	2.79 %	0.89 %	3.68 %
Total	**100.00 %**	**100.00 %**	**301.07**	**291.50**	**1.56 %**	**-4.84 %**	**-3.28 %**

THI

- Trucost's portfolio carbon footprints provide a quantitative assessment of the carbon risk associated with portfolios
- Carbon risk is assessed at an absolute level, and relative to a benchmark
- Footprinting identifies the key sectors and stocks that are contributing to the portfolio's carbon risk

Sample deliverable - Task 1: Portfolio Footprint

TRUCOST

Largest Contributors to Portfolio's Carbon Footprint

Company Name*	Holding (US$ mn)	Carbon Apportioned Tonnes	Carbon Apportioned (%)	Carbon Intensity (tCO2e/US$mn)	Carbon Footprint Contribution (%)*	Footprint Rank in Benchmark sector**	Data Source***
Company 1561645	6.632	25,887	17.09%	1,342	-13.79 %	32 / 38	ENV*
Company 1411944	105.664	22,309	14.73%	882	-10.21 %	29 / 39	ENV*
Company 1096249	9.154	11,167	7.37%	[illegible]	-8.44 %	35 / 39	OTH*
Company 1361944	44.488	13,097	8.65%	1,057	-6.94 %	[illegible]	ENV*
Company 1412745	7.224	10,454	6.90%	1,087	-5.09 %	13 / 14	ENV*
Company 1051643	2.469	6,415	4.24%	877	-2.82 %	7 / 8	OTH*
Company 1789744	1.982	4,788	3.16%	1,090	-2.31 %	31 / 38	ENV*
Company 1387740	14.444	2,773	2.49%	1,842	-2.04 %	16 / 18	ENV*
Company 1108840	1.877	3,018	1.99%	3,750	-1.84 %	14 / 14	AR*
Company 1344740	5.051	8,175	5.40%	398	-1.37 %	11 / 18	ENV*
Total	**199.205**	**109,083**	**72.01%**		**-52.25 %**		

Company Reporting Assessment

Portfolio

Company Name*	Holding (US$ mn)	Carbon Apportioned Tonnes	Carbon Apportioned (%)	Carbon Intensity (tCO2e/US$mn)	Carbon Footprint Contribution (%)*	Footprint Rank in Benchmark sector**	Data Source***
Company 1177643	5.735	2,031	1.34%	365	-0.25 %	11 / 14	PRE
Company 1808848	1.540	291	0.19%	306	-0.05 %	2 / 5	PRE
Company 1233258	0.321	93	0.06%	429	-0.02 %	12 / 39	TC
Company 1193153	0.922	45	0.03%	423	-0.01 %	11 / 39	TC
Company 1503681	0.543	3	0.01%	388	-0.00 %	9 / 33	TC
Total	**7.059**	**2,464**	**1.63%**		**-0.32 %**		

- Full transparency of company data sources used
- Identifies engagement opportunities to enhance shareholder value, focusing either on largest contributors to the footprint, or poor disclosers
- Can also be used to model potential impacts on carbon risk from stock changes in the portfolio (e.g. scenario analysis)

PRI Principles for Responsible Investment

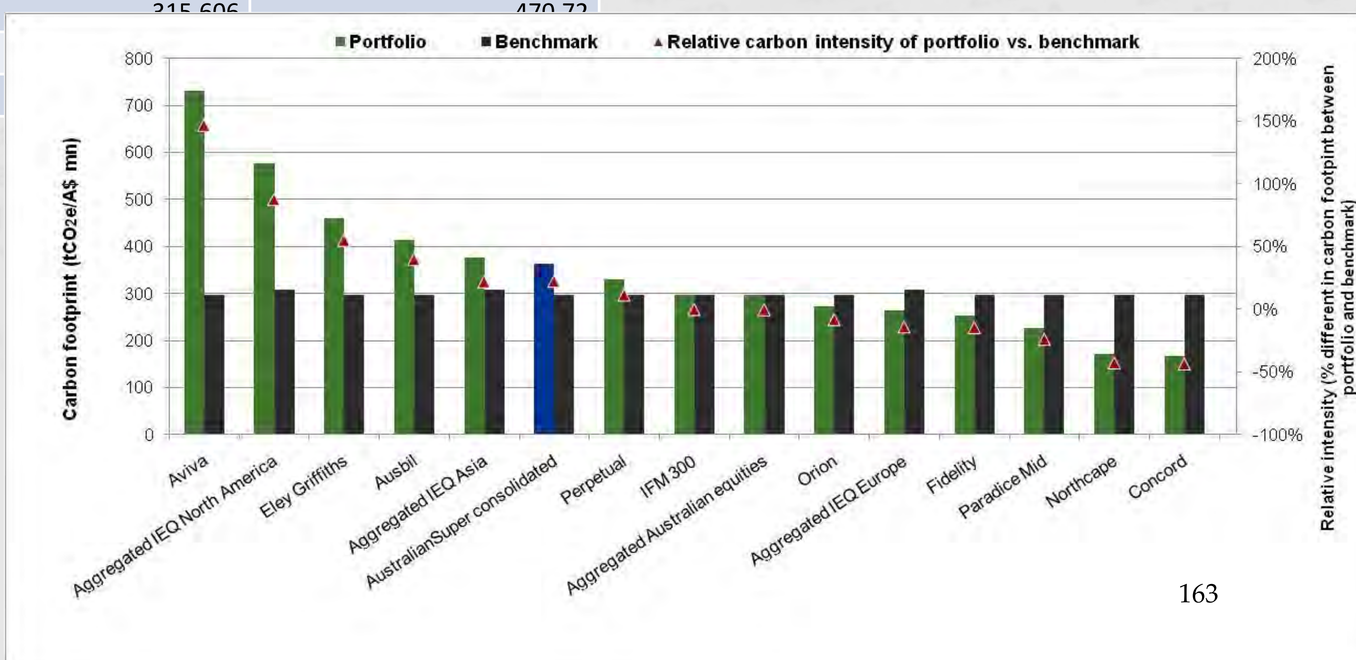
UN-backed PRI Principle 6: We will each report on our activities and progress towards implementing the UN Principles

Stage 2: Optional Extra – Manager Comparison

TRUCOST

Portfolio/ Benchmark	GHG emissions allocated to holdings (tCO_2e)*	Carbon footprint (tonnes of CO_2e/$Mn)*
Portfolio 1	54,637	167.44
Portfolio 2	19,939	170.31
Portfolio 3	19,828	225.69
US Holdings	53,887	253.80
Emerging Market Holdings	121,146	272.36
Aggregated	4,499,486	362.95
Portfolio 4	709,392	375.24
MSCI AW Benchmark	2,615,677	433.55
Portfolio 5	315,606	470.72
EM Benchmark	[illegible]	[illegible]
Portfolio 6	[illegible]	[illegible]

Breakout of Different Manager's carbon performance relative to benchmark



Your investment

PROJECT		
PROJECT STAGE	**ACTIVITIES**	**TOTAL PRICE**
1	Stage 1 – Carbon Footprint of Brandeis's endowment	$18,000
2	Stage 2 – Comparison of endowment's footprint at manager-level	$7,500 per manager
TOTAL PROJECT COSTS		**Dependent on number of managers selected**

Discount	10% discount if two stages are purchased together.	Dependent on number of managers selected

Terms and Conditions: The budget is based on an average daily rate of $1,500, reflecting the composition of the assignment team in terms of experience and expertise. There will be no charge for meetings conducted in New York area, but travel outside will be charged at cost and agreed upon before incurred. The proposal is valid for 60 days from the date of this letter. The quoted fees apply for the duration of the engagement.

Contact us

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VP Business Development,
North America

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E-Mail: divya.mankikar@trucost.com

PROPOSAL GUARANTEE
The charges contained within this proposal are guaranteed for four weeks from the date of this proposal and are submitted on the basis of Trucost's Terms and Conditions of Business. These can be found at: http://www.trucost.com/termsandconditions

Proposed team

ROLE IN PROJECT: Account Manager
DIVYA MANKIKAR, VP BUSINESS DEVELOPMENT, NORTH AMERICA

Divya joined Trucost in 2012 from Patagonia Sur, where she worked as General Manager of Carbon Offsets. Prior to this Divya evaluated renewable energy projects for the InterAmerican Development Bank, and conducted clean tech equity analysis at KLD Research and Analytics and Walden Asset Management. Divya also has Master's degrees in energy and environmental analysis from Boston University, international human rights law from Tufts University's Fletcher School, and an International MBA from IE Business School in Spain.

ROLE IN PROJECT: Project Manager
JAMES SALO, SENIOR VP, NORTH AMERICA

Based in Boston, James is the senior member responsible for Trucost's research efforts in North America and coordinates Trucost's Advisory Panel. James has been the research lead in projects such as Newsweek's Green Rankings, Carbon Counts USA, Carbon Risks and Opportunities in the S&P 500 and Carbon Counts Asia 2007. James holds a Doctor of Philosophy from Oxford University's Centre of the Environment , and a BA and an MA in Environmental Science and Policy from Clark University.

Client testimonials

RBS The Royal Bank of Scotland

"We worked with Trucost to carry out an analysis of the generation mix of the energy companies we lend to and their greenhouse gas emissions. We have also implemented a range of policies and procedures to ensure we take account of social and environmental risks when lending to customers."

HERMES

"Trucost's ability to dig out the data about the environmental consequences of production is absolutely second to none anywhere in the globe."

AXA INVESTMENT MANAGERS

"Trucost's global environmental impact data has enabled us to truly integrate climate change analysis into our investment process. The quantitative data is fed into our mainstream investment decision making process enabling risk management, portfolio footprinting, sector and stock level analysis and the simulation of climate change strategies across asset classes."

"Trucost's quantitative work highlighted that applying a 'green' filter to our current investments could actually add value and generate extra returns."

Appendix 1: Features of Trucost data

NATURAL CAPITAL METRICS	*Standard*: carbon and other Greenhouse Gas (GHG) emissions, water use, resource dependency, air/land/water pollutants, waste *Financial*: externality valuation ($), impact ratio (proxy for potential contingent resource liability), profit at risk *Customized:* commodity flows, environmental benefits, region specific analysis, legislation impact, forward looking scenario analysis
DISCLOSURE METRICS	We research the environmental reporting of 4,500 companies globally on an annual basis and provide a disclosure metric for each natural capital impact.
ADVANCED ENVIRONMENTAL PROFILING TOOL	Where companies do not disclose natural capital data, we complete the data gaps with advanced econometric modelling which converts business information related to activities and revenues into detailed natural capital metrics.
HISTORY	Time series data available (typically 5-10 years)
NUMBER OF COMPANIES	*Standard:* ~4,500 listed companies (representing 93% of global markets by market capitalization) *Customized:* Trucost can incorporate additional company analysis based on business activities and revenue for any company, irrespective of size or listing.
INDICES COVERED	MSCI World, S&P 500, MSCI Emerging Markets, MSCI Europe, STOXX Europe 600, S&P/IFCI LargeMidCap, MSCI Asia Ex-Japan, FTSE All-Share, Nikkei 225, Topix 150, Bovespa, ASX 200, CAC 40, SMI, KOSPI, IBEX, AEX and FTSE MIB.
ASSET CLASSES COVERED	Equities, fixed income, commodities, private equity, infrastructure and property.
GHG PROTOCOL SCOPES (1, 2, 3) COVERED	ALL Scopes (covering operation impacts, fuel use and supply chain impacts)
INFORMATION SOURCES	We research, standardize and validate company disclosed data (via environmental reports, financial reports, websites) and Carbon Disclosure Project (CDP) responses (Trucost is a CDP Gold Partner). We also engage directly with companies to verify our research and collect the latest non-disclosed data.
ECONOMIC VALUATIONS	We provide natural capital data in financial terms using environmental cost analysis derived from academic literature enabling you to understand potential financial impacts and integrate natural capital risk into traditional financial metrics.
VERIFICATION	We have developed a robust verification process which includes independent analyst quality checks, identification of data outliers and sector level comparisons. We also engage directly with companies as part of our research process to verify our assessments.
DELIVERY OPTIONS	We offer data subscriptions as well as custom cuts of data. These can be delivered via analytical software tools, customized spreadsheets or FTP transfer. Thematic research and customized analysis is also available in report form.
INVESTMENT PLATFORMS	Our data is also available via FactSet and Style Research platforms.

Client testimonials

PRI

"The United Nations backed Principles for Responsible Investment (PRI) and the United Nations Environment Programme Finance Initiative (UNEP FI) commissioned Trucost to calculate the cost of global environmental damage and examine why this is important to the economy, capital markets, companies and institutional investors."

Environment Agency

"Trucost footprints of our active equity funds against their benchmarks give us a fresh perspective on risk, stock selection and sector exposures. The analysis helps us track external fund manager performance against environmental criteria, identify companies for engagement and address financially material risks and opportunities linked to our investments."

MERCER

"Pension fund trustees should address the financial risk posed by climate change and other environmental issues as part of their fiduciary duty to manage risk and maximise investment returns in their portfolios."

McKinsey&Company

"With the help of Trucost, we have assessed how the price of a common basket of CPG goods might change if it were to reflect the costs of its environmental impact in terms, for example, of carbon emissions and water use that are currently unpriced in most cases."

Our credentials

TRUCOST

UNEP Finance Initiative
Changing finance, financing change

PRI

wbcsd

defra
Department for Environment Food and Rural Affairs

Bank of America Merrill Lynch

ASN BANK

Legal & General

STANDARD & POOR'S

UBS

PUMA

PHILIPS

kpn

Sprint

THOUGHT LEADERSHIP

Trucost works with thought leaders to deliver world-class insight into the business implications of natural resource dependency across regions, sectors and investment portfolios.

• Trucost assessed the environmental damage costs of the world's largest 3,000 companies on behalf of the United Nations Environment Programme Finance Initiative (UNEP FI) and the United Nations Principles for Responsible Investment (UN PRI).

• Trucost is a member of the World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD)technical working group for the advancement of the Greenhouse Gas Protocol accounting rules.

• Trucost was commissioned by the UK Government to write its Environmental Reporting Guidelines for Business: Key Performance Indicators.

FINANCIAL SECTOR EXPERTISE

• Trucost has analysed the economic consequences of environmental dependencies associated with $2.7 trillion investment funds.

• Trucost data drives $582mn AUM in a range of environmentally optimised investment products for leading fund managers including Bank of America Merrill Lynch, Rabobank, Robeco, ASN Bank, PGGM, Legal and General Investment Management, NYSE Euronext, Standard and Poor's, UBS, Virgin Money.

•Trucost has been researching, standardising and validating the world's most comprehensive environmental impact data for over 10 years, including carbon emissions, water usage, waste disposal, pollutants and natural resource dependency.

CORPORATE SECTOR LEADERSHIP

• Trucost delivered the world's first public Environmental Profit and Loss Account for PUMA and has worked with other global corporate sustainability leaders including Philips, KPN, Sprint, Marks and Spencer

• Trucost has been researching, standardising and validating the world's most comprehensive environmental impact data for over 10 years, including carbon emissions, water usage, waste disposal, pollutants and natural resource dependency.

• Trucost is Newsweek's environmental expert partner for the annual Newsweek Green Rankings of the largest 1000 companies globally.

Our clients

TRUCOST

PHILIPS
SAMSUNG
Virgin
General Mills
FOTA
Sprint
L'ORÉAL
PUMA
JKX Oil & Gas plc
Hasbro
Legal & General
UBS
INDITEX
SSE Shanghai Stock Exchange
ARUP
McGraw Hill
University of Cambridge
Taylor Wimpey
MONSANTO
BNP PARIBAS
NIRAS
biogen idec
WWF
STANDARD & POOR'S
DELL
natura bem estar bem
KERING
LVMH Moët Hennessy . Louis Vuitton
SGX Singapore Exchange
Cradle to Cradle Products Innovation Institute
RED ELÉCTRICA DE ESPAÑA
ASN BANK
Bank of America Merrill Lynch
kpn
FTSE The Index Company
GOODYEAR
BlackBerry
AXA Investment Managers redefining / investment solutions
Conservation International
Yarra Valley Water
nab
CalSTRS
Utilyx
MAERSK
Atlas Copco
NBIM Norges Bank
VEOLIA WATER
VicSuper
KAIST
Credit Suisse
Friends of the Earth
COMGEST
Bloomsbury
Schroders
MASCO
Interface
Agilent Technologies
Sands Las Vegas Sands Corp.
StanleyBlack&Decker
AustralianSuper
Stanford University
Environment Agency
JSR
IFU Investment Fund for Developing Countries

Advisory panel

TRUCOST

Dr Robert Costanza Advisory Panel Coordinator	Professor of Ecological Economics and Director of the Gund Institute of Ecological Economics at the University of Vermont and co-founder of the International Society for Ecological Economics.
Dr Robert Ayres	Emeritus Professor, Environmental Resource Management, INSEAD, France.
Dr Kerry Turner CBE	Director of CSERGE and Professor in the School of Environmental Sciences at the University of East Anglia.
Dr Robert Goodland	Environmental Commissioner, for the EIR, a World Mining Commission, for the UN World Summit on Sustainable Development 2002. Previously Environmental Advisor to the World Bank for 25 years.
Dr Peter Victor	Professor of Environmental Studies at York University, Toronto. Previously the Assistant Deputy Minister of the Environmental Sciences and Standards Division with the Ontario Ministry of Environment and Energy.
Dr Glenn-Marie Lange	Team leader, Policy and Economics. Environment Department, The World BankDr. Leads the Wealth Accounting and Valuation of Ecosystem Services (WAVES), a World Bank-led global partnership to promote sustainable development worldwide through the implementation of comprehensive wealth accounting that focuses on the value of natural capital and integration of 'green accounting' in more conventional development planning analysis
Dr Stephen Farber	Professor in the Graduate School of Public and Urban Affairs & International Development and Director of Environmental Policy Studies at the University of Pittsburgh
Dr Robert Repetto	Senior Fellow at the United Nations Foundation. Previously, Professor in Economics of Sustainable Development, Yale School of Forestry and Environmental Studies.
Dr Tim Jackson	Professor of Sustainable Development at the University of Surrey and Director of the Research group on Lifestyles, Values and Environment (RESOLVE).

Analysis of Fossil-Free Portfolios

MSCI Divestment Studies

In a 2013 paper produced by MSCI, the volatility of the fossil fuel industry is discussed. It states that, "the Energy Sector has consistently been among the most risky sectors in the global economy since 2005" (MSCI 2013, 7). Statistical data is furnished to demonstrate the risk in the Energy Sector, exemplifying its volatility, particularly during the 2008 financial crisis (MSCI 2013, 7). The report concludes that, "fossil fuel divestment has the potential to reduce overall portfolio risk because of Energy Sector volatility" (MSCI 2013, 8). In two time-series analyses, a divested portfolio showed "modest *outperformance*" as compared to a portfolio still fully invested in fossil fuel companies (MSCI 2013, 8). Modest underperformance from the divestment portfolio was however seen in a 10-year analysis, primarily resulting from high oil prices during the first years of the study (8). Nevertheless, this further shows how minimal risk to the endowment is likely to be and how divesting can actually improve portfolio security and return.

A follow-up paper in January 2014 from MSCI detailed further studies of divestment. MSCI compared three divestment options against its benchmark All Country World Index (ACWI). The study simulated the performance of each portfolio from January 1, 2007 to December 31, 2013 (MSCI 2014, 2). These models revealed that all three divestment strategies "performed roughly in line with the MSCI ACWI, with annualized returns ranging from 4.22% to 4.40%., compared to 4.30% for MSCI ACWI. Tracking error ranged from .47 to 1.23" (MSCI 2014, 2). The three divestment options were: (1) full divestment, (2) low carbon, which excludes the largest fossil fuel companies listed in the MSCI ACWI from the portfolio, and (3) carbon tilt, which does not exclude any companies but instead gives greater weight to companies with better performances on their carbon reduction strategies (MSCI 2014, 2).

The annualized return rates, including the MSCI ACWI portfolio as a control, were as follows:

Full divestment—4.40

Low carbon—4.43

Carbon tilt—4.22

MSCI ACWI—4.30

The return/risk rates were similarly comparable between divestment and inaction, with full divestment, low carbon, and the MSCI ACWI all yielding a return/risk rate of 0.23, while carbon tilt had one of 0.22 (MSCI 2014, 4). Finally, volatility was virtually even as well, both divestment and the low-carbon portfolio had volatility values of 19.08, carbon tilt: 19.00, and the MSCI ACWI: 18.95.

Advisor Partners Divestment Study

This study, entitled "Fossil Fuel Divestment: Risks and Opportunities," concludes that: "our investment analysis suggests that removing [fossil fuel] energy stocks from a well-diversified portfolio has little impact on investment risk; however, the evaluation of the impact on portfolio performance will depend on an investor's perspective" (Advisor Partners, 2). The study simulated the performance of a portfolio made up of the S&P 500 from the end of 1989 to the end of 2012 (5). It compared a hypothetical portfolio that had been fully divested of fossil fuel stocks, to one that had been partially divested, and one that had not been divested at all (3). Although increased oil prices lead the non-divested portfolio to outperform either divestment portfolio during those price increases, the report states that, “simulated performance of the full divestment portfolio was virtually indistinguishable from that of the S&P 500 index” (4).

Impax Report--Implications

This illustrates the inherent instability of continued fossil-fuel investments. As states begin to more aggressively transition from fossil fuels and employ more legal measures to do so, the value and viability of fossil fuel stocks will greatly diminish. Given the growing body of evidence that divestment does not pose a threat to University endowments and that more generally, “it is likely that many investors will face growing pressure from their beneficiaries to divest from oil, gas and coal companies for ethical and environmental reasons. As discussed above, investors may be overstating the risks involved in entirely screening out companies involved in oil, gas and coal extraction and production” (Impax, 8). By fully examining divestment, the University would most effectively confront this changing financial reality and best prepare the endowment for a prosperous future.