HOW TO ADDRESS CLIMATE CHANGE WITH EFFECTIVE GIVING

PREPARED FOR THE RAY AND TYE NOORDA FOUNDATION

Harvard University Effective Altruism Student Group
Philanthropy Advisory Fellowship

June 2017

Contents

Executive Summary

Climate change is linked to multiple facets of modern economies and global institutional structures. Choices between mitigation of greenhouse gas emissions and climate adaptation reflect the joint challenge of averting severe climate change and preparing for its effects. The first section of the report examines potential interventions subject to a set of criteria, including potential impact, data quality and tractability. The most effective interventions are highlighted. The second section draws on the material of the preceding section to provide more detailed recommendations on specific interventions and organizations.

Section I - Background and Context

Direct emissions reductions are broken down into energy, land use and transport.

- **Energy:** The greatest opportunities for additional impact are local, through community, policy and advocacy work, rather than direct implementation of specific technologies. Promising strategies include the development and demonstration of innovative ownership and financing mechanisms, and building of connections between local and state government, non-profit groups and grassroots advocacy to curtail the lifespan of existing fossil fuel infrastructure and deter further investment.
- **Land use:** The primary challenge is economic. While afforestation has significant carbon mitigation potential, underdeveloped carbon markets limit its cost-effectiveness, due to the opportunity cost of forestry over other, more lucrative uses. Soil carbon capture technology has potential, but remains some distance from commercialization. Funding is best directed towards alleviating financial barriers, and supporting carbon pricing mechanisms that reduce opportunity costs to landowners.
- **Transport:** Low-carbon transport still requires technological advances, but relies most heavily on infrastructure and planning. The magnitude of investment in the sector is such that philanthropy is unlikely to have significant impact. Behavioral change programs for individual users present the most cost-effective direct interventions. The most effective policy interventions are those with multiplicative impact, shifting investment away from fossil fuel infrastructure, towards sustainable mobility systems.

Adaptation needs are difficult to assess, and subject to ongoing change based on actual and predicted climate impacts. Additional research is needed to understand available options and quantify direct and indirect benefits. Funding for adaptation planning, development of best practices, education, coordination and capacity building, or development of financial instruments may be particularly valuable at the subnational level.

Research and development activity is considered in three domains: mitigation, geoengineering, and policymaking. Programs include basic scientific research and the development of discoveries into technologies, business models and policies. Innovation-focused grants may have the most impact in areas where the Ray and Tye Noorda Foundation has sufficient leverage, such as funding early-stage clean-energy startups that align with its social and environmental goals.

Advocacy, litigation and governance are linked together to understand the elements and tactics that support effective advocacy campaigns. Particular attention is paid to the partisan divide in the U.S., litigation, governance gaps in subnational climate policy, and effective targets by industry, scope, and location. Accounting for the inevitable uncertainties and risks, advocacy work appears highly cost-effective when carried out optimally. Effective advocacy campaigns exhibit common characteristics and sequences of action. The most successful campaigns overall typically involve multiple organizations leveraging their respective expertise as needed. The clearest example of an effective target is fossil-fueled energy infrastructure, not least because the acute or chronic damage it can cause locally is a powerful leverage point for change.

Coordination and capacity building at the subnational and non-state levels are increasingly important components of global efforts to reduce greenhouse gas emissions. Over the years, coordinated pressure and commitment from non-state actors has become an integral part of the international negotiation process. While there is significant activity in this arena, there is a demonstrated need for umbrella organizations capable of boosting capacity, and improving the effectiveness, of subnational networks and actors. Areas currently lacking support include state legislatures, rural communities, and small municipal jurisdictions. Any strategy to address these gaps must also look for opportunities for cross-cutting regional cooperation across sectors and jurisdictions.

Climate finance may involve direct provision of financing; deployment of financial instruments; and stimulating financial flows. There are three ways of doing this: diverting public-private funds into mitigation/adaptation investment; aggregating philanthropic funds to facilitate larger projects than would otherwise be possible; and addressing investment gaps that capital markets cannot fill. All climate finance is not created equal—directly funding mitigation efforts may in general be far less catalytic (therefore less effective in the long term) than investing in the reduction of market barriers or mobilizing other private or public funding sources. Program-related investments are one such instrument, offering concessional terms and/or below-market returns to achieve specific program objectives. They are designed to be reinvested over time to achieve multiplicative impact, and can, if done effectively, spur additional investment from private capital. Regulatory barriers aside, while mission investments can be risky, they are key to bridging existing financing gaps for key technologies, and mitigation or adaptation programs.

Section II - Recommendations

Three recommendations for promising interventions are put forward:

- **Working with local partners to advocate against coal power in China, India and Southeast Asia.** Several organizations are working together in the region to advocate for environmental protections with climate co-benefits. Notable among these is 350.org East Asia and its partner organizations, many of which work at the local level to build and train grassroots networks to pressure local and national governments to curtail existing and planned coal power. Similarly effective organizations are Green Camel Bell (China), Piglas Pilipinas (Philippines) and Change (Vietnam). Large nonprofits like 350.org receive the most attention, leaving other effective but smaller groups underfunded. 350 works to alleviate this problem by extending financial support to smaller partner organizations. We recommend working closely with 350.org's partners or others similarly effective in the region.
- **Capacity-building and coordination at state and local levels in the U.S.** This strategy, besides addressing a clear gap in subnational climate governance, can reap multiple benefits by directly reducing emissions, while also boosting the confidence, political will, technical capacity and ambition of national governments, having a potentially catalytic effect. Promising areas of focus include supporting umbrella or "backbone" organizations; bridging partisan divisions; supporting legal challenges; and working with funders' networks.
- **Contributing to one or more climate philanthropy bodies that strategically target climate finance interventions.** The most effective financing strategies address financing gaps or barriers with a view to facilitating market-driven long-term climate financing, rather than tackling emissions reductions directly or funding advocacy programs that rely on grants and donors in perpetuity. Deployment of innovative financial instruments that close financing gaps for risky projects, and funnel private investments into clean infrastructure, can drive further investment.

Introduction

Climate change is among the greatest challenges facing current and future generations. It is connected to, and stems from, many facets of the modern economy, including energy, transport and land use, as well as the complicated institutional structures of global politics. In addition, given the prospect that mitigation of greenhouse gas (GHG) emissions will not occur rapidly enough to avert some effects of climate change—which are already occurring—adaptation is increasingly becoming an important consideration.

The cross-cutting nature of the climate challenge also creates a wide set of opportunities for action: in various parts of the economy, using multiple technologies and through policy and advocacy at all levels of government. In this report, a systematic approach is applied in evaluating the effectiveness of philanthropic foundations in funding a range of potential interventions. With the Ray and Tye Noorda Foundation's (RTNF) priorities in mind, we identify interventions spanning six categories:

- Direct Emissions Reductions;
- Adaptation;
- Research and Development;
- Advocacy, Litigation and Governance;
- Coordination and Capacity Building; and
- Financial Mechanisms and Program-related Investments.

Section 1 of the report assesses potential interventions within these categories using a predefined set of criteria, including:

- *Impact:* the neglectedness and potential effects of an intervention, including its current level of funding, its benefits as compared to its costs, and its potential for replicability and scalability across multiple geographies;
- *Data Quality:* the availability and quality of data related to an intervention, as well as the feasibility and sophistication of methodologies to quantify benefits and costs; and
- *Tractability:* the political, social, financial, and other factors that may either facilitate or inhibit effective philanthropic giving in the intervention area.

In this process, interventions with comparatively low impact, poor data quality, and/or lack of tractability are eliminated. Section 2 draws on this research to propose a set of recommended interventions, and suggest a number of organizations as potential candidates for giving. Section 3 concludes the report, and Section 4 (Annex) includes a framework that can be used to conduct detailed due-diligence on the candidate organizations and others in the future, as well as a recommended reading list and list of interviewees.

1. Background and Context

In this section, interventions across six categories are considered:

- Direct Emissions Reductions;
- Adaptation;
- Research and Development;
- Advocacy, Litigation and Governance;
- Coordination and Capacity Building; and
- Financial Mechanisms and Program-related Investments.

Direct Emissions Reductions. In this category, interventions are broken down into three sectors: energy, land use and transport. The interventions we assess are primarily focused on emissions mitigation, though some may also exhibit adaptation co-benefits.

Adaptation. This category assesses the viability of funding interventions in climate adaptation, including their potential to build the foundation for coordinated adaptation and mitigation actions.

Research and Development. This category considers research and development activities that target mitigation, geoengineering, and policymaking.

Advocacy, Litigation and Governance. This category considers the elements that contribute to effective advocacy campaigns, how to bridge the partisan political divide in the United States, the potential for litigation as an intervention area, and effective targets by industry, scope, and location.

Coordination and Capacity Building. This category considers the potential for establishing further linkages at the subnational and non-state levels, including umbrella organizations, state legislatures, rural communities and small municipal jurisdictions.

Financial Mechanisms and Mission Investments. This category presents an overview of climate finance, how philanthropies fit in this space, and the potential opportunity of mission investments.

1.1 DIRECT EMISSIONS REDUCTIONS: INTERVENTIONS BY SECTOR

This section addresses strategies to reduce emissions directly by funding specific projects and commercialized technologies. A range of possible interventions in the energy, transport and land use sectors are examined, while their expected cost-effectiveness, accounting for co-benefits where appropriate, is assessed.[1]

Energy

There is a wide array of potential climate change interventions in the energy sector. These are grouped into four categories: increasing end-use energy efficiency; deploying renewable energy technologies; transforming the electricity grid; and modifying or creating policy. The level of current funding varies substantially by intervention and the need for additional funding depends on a range of geographic, political and technological factors.

U.S. electric utilities spent approximately $3.9 billion (bn)[2] on residential and commercial **end-use energy efficiency programs** in 2014.[3] Nearly 30 states have energy efficiency resource standards mandating that utilities achieve energy savings targets through energy efficiency interventions (the Midwest and South are most neglected).[4] According to one estimate, the median cost of these programs from 2009-2013 was approximately $380/ton of carbon emissions abated.[5] A co-benefit of increased energy efficiency is reduced energy bills for customers, though there may be costs involved in making lighting, appliance and other end-use changes.[6] Overall, given existing funding commitments and the relatively high emissions abatement cost, this is not a priority intervention.

Deployment of renewable energy technologies is being pursued through multiple methods and at multiple scales. Many U.S. states have Renewable Portfolio Standards (RPS) that mandate a certain percentage of electricity generation from renewable sources by a target date.[7] Between 2010-2012, RPS abatement costs for a selection of U.S. states were estimated at $11-$270/ton.[8] Studies vary widely in the outcomes and co-benefits considered—including emissions, economic development, and price reductions—with benefits ranging anywhere from about $11-$275/ton.[9]

Renewables deployment is also being pursued locally through installation of rooftop solar photovoltaic systems by individual homeowners, with costs of $2.70-$3.30/watt of installed capacity.[10] Due chiefly to economies of scale, "commercial" systems—which fall between residential and utility-scale systems—cost $2.20-$2.30/watt of installed capacity.[11] Associated abatement costs vary depending on the features of particular systems, including siting, lifespan, and the systems they displace. Abatement costs for utility-scale systems, which are generally the most efficient, range from tens of dollars up to $200/ton or more.[12]

Another local approach is community solar systems. These systems— generally larger than residential rooftop systems—are owned by, provide power to, and/or provide financial benefits to multiple community members.[13] Like residential rooftop solar systems, these arrangements may provide cost savings to those involved. Depending on how such systems are installed (and by whom), co-benefits can include access to renewable energy, local economic development, and workforce training, though quantifying these benefits is difficult.

As in the case of energy efficiency, the current level of funding for renewables deployment, and the relatively high abatement costs, make this intervention a low priority. The exception is the development of novel financing and ownership structures (such as community solar) which can potentially be replicated in many geographies, including those lacking electricity infrastructure.

Electricity grids, like all infrastructure, are aging and require ongoing maintenance. Intermittent renewables, distributed generation, energy storage, and demand-response technologies require grids that differ in significant ways from the centralized systems of the past century. Utilities are spending billions of dollars per year on capital investments.[14] Although modernizing the electricity grid is critical for a clean energy system, the magnitude of action required, and the cost, places it outside RTNF's scope.

Policy mechanisms relevant to the energy sector include power plant regulation at the federal, state and multi-state levels. No comprehensive Federal GHG emissions program has yet been implemented, but there has been a substantial amount of research and lobbying in this area. In February 2016, the U.S. Supreme Court stayed implementation of the Obama Administration's Clean Power Plan, which sought to reduce carbon dioxide (CO_2) emissions from U.S. power plants. Federal regulation of GHG emissions is unlikely to move forward under the current administration, but protecting existing regulations should be a priority.

Nine mid-Atlantic and Northeastern states are part of the Regional Greenhouse Gas Initiative (RGGI), a cap-and-trade program that aims to reduce CO_2 emissions from power generation.[15] California introduced an economy-wide cap-and-trade program in 2012.[16] The costs and benefits of such programs can be difficult to evaluate, given varying impacts on consumers, power producers, utilities and state economies. A C2ES study estimated that the net eco-

nomic benefits of RGGI's second compliance period (2012-2014) are $1.34bn in present value terms. However, this masks the fact that power plant owners are expected to lose approximately $5 million (m) in revenue (in present value terms) due to RGGI-driven energy efficiency.[17]

Other policies seek to facilitate or incentivize changes in the energy sector. These include tax incentives for renewables deployment, net metering rules for distributed generation, and securities rules for investment in local projects. The greatest opportunities for impact in the energy sector are at the local level, through community, policy, and advocacy work rather than through direct implementation of energy efficiency, renewables deployment, or grid modernization. As with community solar, developing and demonstrating ownership and financing mechanisms replicable in multiple areas is a key opportunity, as is building connections between various local and state governments and nonprofit organizations, as well as grassroots movements, to limit the lifespan of existing coal plants, and to deter the construction of new plants.

Land Use

Deforestation has slowed markedly in the last 20 years, with an estimated $1bn in annual funding since 2006, but a net loss of forest cover is still seen annually. This will be difficult to reverse, particularly as demand for food and minerals rises, temperatures rise and pressures increase on forested areas.[18] The estimated global CO_2 emissions reduction potential from global forestry policy is 77 gigatons (GT) by 2100, corresponding to an avoided cost of $1.4 trillion (tn) in damages.[19] The primary areas of interest are rainforests in the tropics and (Southeast Asia and Amazonia), though temperate zones in the U.S., Russia and Eastern Europe are significant in aggregate.[20]

The last few decades have also seen a dramatic rise in the number of animals being farmed for human consumption and the clearing of large areas of land for industrial production and grazing. Animal farming alone produces 14.5% of total GHG emissions—more than transport.[21] Nevertheless, crop cultivation and grazing are still broadly outside the climate conversation, with most activity focused on water usage and reducing industrial fertilizer use. Organizations like the Urban Sustainability Directors Network, discussed in Sections 1.5 and 2.2, are actively seeking to raise the profile of agriculture as a mitigation opportunity.

The major cost associated with forestry as a mitigation tool is not land conservation itself, but the opportunity cost to the landowner vis-a-vis other potential uses. The high opportunity costs involved raise the probability of farmers (particularly smallholders) reverting to more profitable uses when under financial pressure. In most cases, crop growth or animal grazing is substantially more lucrative than forestry. Moreover, the co-benefits (biodiversity protection, reduced waste concentrations and less pesticide use) do not always accrue to the farmers, reducing their effectiveness in driving farmers' individual decision-making.

Data on land productivity and return on investment in agriculture and forestry are generally of high quality and resolution. Avoided carbon emissions of reforestation can be calculated on the basis of tree type and plantation density. The abatement cost of converting arable land to forests is estimated at $58-$132/ton depending on soil quality, food and timber prices, and scale.[22] Abatement in commercial/industrial-scale agriculture is more costly, estimated at $150/ton on average.[23]

In the absence of robust carbon pricing in the forestry sector, scalability and replicability of afforestation or abatement projects is extremely limited, owing to the lack of incentives for individual landowners. Differences in conversion costs and opportunity costs make setting the right carbon price difficult. While afforestation and agricultural emissions abatement provides significant co-benefits (improved soil quality, reduced toxin concentrations), opportunity costs remain a barrier that may get larger if food supplies become constrained over the coming decades. Importantly, CO_2 sequestered by one-off afforestation schemes is not permanently removed from the atmosphere unless the forest is continuously regenerated over time (naturally or artificially) to compensate for decomposing

matter re-releasing stored carbon. The short-term impact can be decisive, but afforestation requires long-term maintenance.

Forgone economic opportunities will continue to be a major obstacle, particularly in areas in which returns to large-scale agriculture are greatest. Substantial emissions abatement from efficiency gains are possible, but at high cost. Promotion of certification, carbon offset markets and fire control measures are key low-hanging fruit in global forestry policy.[24]. The primary areas of interest for RTNF, therefore, are mechanisms that reduce the opportunity cost of afforestation through certification or offset programs that increase the value of the timber produced; or mechanisms that incentivize the use of forested land to protect and enhance the productivity of nearby agricultural land.

A promising technological solution is **carbon storage in soils**, with potential for 1.5-1.6 GT sequestration annually by 2030 with a $20/ton carbon price, and 4.0-4.3 GT at $100/ton. Soil improvement does not suffer from "leakage" (relocation of emissions to less regulated jurisdictions) as long as soil improvements prove profitable to the farmer. Indeed, the global agriculture industry is already implementing soil carbon strategies in anticipation of regulation and demand for certification.[25] Investment in overcoming profitability barriers (training, credit markets, equipment), rather than in the intervention itself, will be useful in laying the groundwork for the technology to be successful, particularly in developing countries.[26]

While land use change through afforestation and soil carbon storage has significant greenhouse gas mitigation potential, the lack of credible carbon markets prevents most such policies from being economically cost-effective, particularly for smallholders with low, volatile incomes facing high opportunity costs. As long as soil carbon capture technology remains underdeveloped, funding in this field is best allocated towards addressing financial barriers, either through providing improved financing options for smallholders or institutionalizing carbon pricing.

Transport

The central components of transport decarbonization are electrification, hydrogen technology, and sustainable biofuels. Electrification presents an opportunity to greatly reduce individual sources of CO_2 and use renewable energy as fuel. Commercialization of electric vehicles may speed this transition, but effective planning and transport policy is likely to deliver the greatest benefits. Philanthropic funding in this arena is, therefore, best directed towards policy advocacy.

The minimum scale of funding required to effect change in the transport sector is beyond the philanthropic community. Momentum comes largely from public sector infrastructure investment or the private sector. Needs are largely policy-oriented (subsidies, taxes, regulations), technological, and infrastructural.[27] Electric vehicle development is well-funded, with major manufacturers, like Daimler, investing billions of dollars over the next 10 years.[28] Global transport infrastructure spending is $1tn-$2tn annually, suggesting that resources may be best spent diverting such investment into sustainability-enabling projects.[29]

The critical component for cost-benefit analyses is co-benefits to human health from reduced vehicle pollution (primarily from fine particulate matter and nitrogen oxides), particularly in urban centers. Estimates of health co-benefits suggest they are much larger than direct climate mitigation benefits.[30] Accounting for these can make low-carbon transport investment much more attractive, but ambitious projects are often curtailed by large upfront capital costs, particularly in smaller municipalities. The most cost-effective transport strategies address demand and retain co-benefits by reducing the need to travel, shifting users to low-carbon transport modes (public transport or low-carbon vehicles) and reducing congestion and systemic inefficiency.[31] Although data availability for carbon and pollutant emissions from transport, and the opportunity costs of congestion is generally excellent, the practice of integrating climate and pollutant damages into investment decisions is underdeveloped. At scale, additional co-benefits include reduced dependence on, and displacement of, fossil fuels.[32]

One promising non-policy intervention is supporting behavioral change projects, which can reduce emissions per mile by 15-20% through improved driving efficiency, traffic flow, and reduced congestion, and is particularly effective for freight/commercial traffic.[33] It compares favorably in cost-benefit terms with competing policies.[34]

The investments needed for the modernization of transport infrastructure are vast enough that a philanthropic foundation is unlikely to make a dent. Outside infrastructure policy and investment, behavioral change programs are the most cost-effective intervention. Within infrastructure policy, the most effective interventions are those with multiplicative impact; those that shift public and private investment away from fossil fuel infrastructure, and towards low-carbon technologies.

1.2 ADAPTATION

Climate adaptation refers to action designed to limit or protect from the impacts of climate change. Regardless of whether mitigation targets are met, most of the anticipated warming to 2100 will still materialize, underlining the need for adaptation funding.[35] Adaptation spending varies widely across cities and regions,[36] but overall, mitigation receives a significantly higher proportion of public funding commitments.[37] Poorer countries are most affected by this imbalance of funding, as they are often more exposed to climate change impacts, and less able to adapt due to infrastructural, financial and governance shortcomings.[38] This section first examines the deployment of adaptation interventions, then considers adaptation planning, coordination and financing.

Deployment of adaptation interventions

Potential adaptation interventions include planning (e.g. land use, transportation, infrastructure and managed retreat/relocation); physical infrastructure development and resilience-building (e.g. water, communications and energy); conservation and management of environmental systems; and preparation for impacts on human health and society.[39] Deployment of adaptation interventions—such as physical alterations to the built or natural environment—is assessed with two examples: riparian buffers and seawalls.

Riparian buffers are vegetated areas (often forested) that act as protective barriers between cleared land and adjacent streams and waterways. The cost of installing riparian buffers depends on the tree and shrub species used to construct the buffer (and other local factors) and range from a few hundred to several thousand dollars per acre.[40,41] Depending on land use changes, buffers may also yield net GHG reductions, though such benefits vary widely depending on tree species. A study in Iowa found carbon sequestration rates of 1.2-4.4 tons/acre-year for switchgrass and poplar buffers, respectively.[42] Associated abatement costs range from tens to hundreds of dollars/ton, depending on species planted and lifespan of the buffer.

Seawalls are considerably more expensive, easily costing multiple billions of dollars, depending on the locality. A $1.2bn seawall was completed in New Orleans in 2014;[43] estimates for a New York City seawall are about $10bn-$20bn.[44] Given that seawalls provide insurance against (highly uncertain) future sea level rise and extreme weather events, it can be difficult to quantify their potential benefits. Although both of these interventions represent neglected areas for many coastal cities and waterways, the costs place direct action outside the scope of our recommendations.

Adaptation Planning, Coordination and Financing

Direct deployment of adaptation interventions may be too costly for philanthropy to make a significant impact. An alternative route is the promotion of effective adaptation methods and pre-deployment preparation. This may take the form of adaptation planning, coordination and capacity building, or development of financial instruments. The latter two are discussed in our recommendations, while adaptation planning is discussed here.

A report from *The Bridgespan Group* notes that "given the local nature of climate adaptation, there is a strong role for local and regional funders."[45] Local funders are well-positioned to understand adaptation challenges of particular localities. The report suggests funders should recruit scientists and engineers to adapt scientific knowledge to local circumstances.[46] Funders should "invest in neutral conveners" to coordinate stakeholders across sectors and jurisdictions.[47] Funders should also ensure that experiences with adaptation are used to build and share a knowledge base of best practices.[47] The following case study provides an example of using these strategies to improve climate change resilience.

Case Study: Cynthia and George Mitchell Foundation

Texas is experiencing significant water supply shortages, primarily due to sourcing and management systems being insufficiently robust to drought.[48] Shortages are likely to become more severe in future, due to "population growth, climate change, and aging water infrastructure."[49] One known solution is integrated water management (IWM), wherein water efficiency and conservation are improved by better coordination of the relevant parties. These improvements also have the co-benefit of reducing the carbon footprint of water.[50]

To accelerate IWM implementation in Texas, the Cynthia and George Mitchell Foundation (CGMF, based in Austin), commissioned several projects to determine how Texan cities could transition to IWM most effectively. Boston University's Institute for Sustainable Energy (ISE) is running one such project, focusing on the financial and economic aspects of IWM. As part of the project, the ISE will work with local stakeholders to identify and address the challenges specific to Texas, publish the findings to help build a local knowledge base on effective adaptation planning, and conduct an intensive outreach program upon the conclusion of their research to ensure the IWM model is effectively implemented.

The ISE project is a good example of adaptation planning to address water supply challenges. The amount of funding required for this project was within RTNF's range, suggesting such programs are a realistic option. In addition to CGMF, which typically focuses on water, other major foundations with leading adaptation programs include the Kresge, Rockefeller, MacArthur, Gordon and Betty Moore, and San Diego Foundations.[51,52]

The most effective philanthropically-funded adaptation projects focus on adaptation planning; coordination and capacity building; and finance. CGMF, and the San Diego, Kresge and Rockefeller Foundations, may be best-placed to serve as models and provide advice on current opportunities. If RTNF pursues this path, one approach could be to focus on adaptation needs in Utah or Intermountain West in consultation with other adaptation funders, and to seek out relevant collaborators in planning the project and conducting research.

1.3 RESEARCH AND DEVELOPMENT

The preceding sections discussed the effectiveness of programs aiming to reduce emissions or contribute to adaptation. This section discusses research and development (R&D) programs. These programs include basic scientific research and the development of any discoveries into commercial technologies, business models and policies that can be used for climate change mitigation (adaptation is addressed above). Three areas are considered here: R&D for mitigation, geoengineering and research to inform policymaking. Geoengineering is a subset of mitigation, but since, unlike other mitigation strategies, it involves "large-scale intervention in the Earth's natural systems," it is discussed separately.[53]

Mitigation

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) found that the CO_2 equivalent (CO_2e) stabilization required to prevent global warming beyond 2°C can be achieved by deploying existing technologies, or those soon to be commercialized.[54] The Fifth Assessment Report found that limiting warming to below 2°C is unlikely if additional mitigation is significantly delayed.[55] This suggests existing technologies should be deployed as fast as possible. However, there are several reasons why investment in R&D is still relevant. First, new technologies can further reduce mitigation costs.[56] Second, new technologies may make lower CO_2e stabilization levels achievable, reducing potential climate damages and associated adaptation costs.[57] Third, zero-carbon technologies will be necessary for sustainable development into the future.[58] Therefore, funding for both research and deployment is needed.

R&D involves multiple stages: discoveries are made in basic research, prototypes are developed, and fully functioning products are demonstrated, before a technology is commercialized.[59] Discoveries fail to translate into commercialized products for multiple reasons, including scientific or engineering challenges that cannot be overcome, or a lack of funding for the idea or product to progress to the next stage of development. Funding deficits are common when developing prototype products, since the risks to private investors are high.[60] This funding gap is commonly known as the *Innovation (or Technological) Valley of Death*.

This gap is particularly significant in the clean energy sector, since clean energy projects typically require significant capital resources and take a long time to reach commercialization.[61] Additionally, innovations in this sector have limited intellectual property rights protections, and new companies compete against established giants who underinvest in R&D relative to other sectors.[62] Energy policy uncertainty also makes it difficult to predict take-up incentives/subsidies for a product. Venture capital (VC) funds, who typically fund early-stage ventures, have shied away from clean energy, after showing some initial interest. A study documenting VC funding over time found that while investment in clean energy rose from $1bn-$5bn from 2004 to 2008, by 2014, funding had dropped to $2bn with the majority being invested in later-stage companies[63]. Though this was due at least in part to the onset of global recession,[63] a superficial analysis suggests VC investment in clean energy has continued to decrease.[64]

Closing the Clean Energy Funding Gap

The U.S. government has made efforts to plug the funding gap. The Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) has been awarding grants since 2009. Their mission is to advance "high-potential, high-impact energy technologies that are too early for private-sector investment."[65] ARPA-E is likely underfunded, however. From 2011-2015 they received $180m-$280m annually. The American Energy Innovation Council, a group of corporate leaders, recommends $1bn of annual funding.[66] Moreover, ARPA-E may yet face funding cuts under the current administration.[67]

At the COP21 negotiations in Paris, the U.S., along with 21 other countries and the European Union established Mission Innovation, which commits participants "to double their governments' clean energy R&D investments over five years, while encouraging greater levels of private sector investment."[68] The U.S. is already behind target, and Mission Innovation may not be a priority for the current administration.[69] Overall, there is still a significant funding gap for clean energy R&D in the U.S.

Philanthropy is well placed to address this funding gap, since the amounts being spent in early-stage innovation are small. By accounting for social and environmental, as well as financial returns, philanthropy can fund projects that VCs find too risky. Furthermore, for philanthropy, failure to commercialize a technology is not necessarily an outright failure. If due to scientific or engineering challenges, failure enables future R&D efforts to be focussed on strategies that will not face the same technical challenges.

Which technologies should be funded?

Multiple mitigation technologies are needed in all sectors, particularly agriculture, transport, electricity, buildings, and manufacturing. The Breakthrough Energy Coalition[70] has compiled a list of these technologies. Given the range of technologies required, and the expertise necessary for assessing their viability, it is best not to focus on funding one particular technology. Spreading funding across multiple technologies, with advice from scientific experts on particular technologies, is more likely to be successful. Funding should not be spread so thinly that projects fail due to a lack of funding; this can be avoided by collaborating with other funders.

Where and how should these technologies be funded?

Given that ideas can spread easily across the globe, where R&D is done does not necessarily determine where new technologies are deployed. R&D in developing countries may enjoy greater co-benefits, through job creation and development opportunities. Conversely, developed countries are generally better able to conduct R&D efficiently and effectively. It is not obvious whether R&D should be done in one place or another.

Philanthropic funding for early-stage cleantech is most cost-effective when combined with program-related investments (PRIs). The PRIME coalition, examined in Section 2.3, facilitates risk-efficient philanthropic investments in early-stage cleantech companies, using industrial and scientific expertise, alongside a range of other criteria, to select projects to fund.

Geoengineering

Geoengineering broadly encompasses two climate change mitigation techniques: Solar Radiation Management (SRM) and Carbon Dioxide Removal (CDR). SRM techniques reflect solar energy back into space to dampen global warming. Examples include having reflectors in space and spraying reflective aerosols in the upper atmosphere.[71] CDR techniques constitute "intentional efforts to remove CO_2 from the atmosphere."[72] One example is ocean fertilization: nutrients are added to the ocean to promote phytoplankton growth, which ultimately reduces atmospheric CO_2.[73] A related technique to CDR, is carbon capture and storage (CCS), which focuses on "reducing CO_2 emissions from point sources such as fossil fuel power plants" by capturing emissions and storing them securely.[72] CCS is not typically considered geoengineering but it does have some of the same risks and so it is discussed here.

Risks and Potential

SRM and CDR are highly risky, and their impact uncertain. Their deployment could dramatically alter the earth's climate and ecosystems in unpredictable ways.[74] Unilateral deployment by one nation could adversely impact others, making geoengineering politically risky.[75] These problems could be addressed with robust governance systems and further research on the climate system, but problems remain. SRM, for instance, does not alter oceanic CO_2 levels, so cannot solve ocean acidification.[76] Focusing on geoengineering may also divert funding from low-carbon technologies. Similarly, CCS techniques that store carbon underground could induce seismic activity, while any leaks would pose a public health risk.[77] Despite the risks, geoengineering technologies may still need to be deployed if mitigation and adaptation efforts prove insufficient for addressing dangerous climate change. The IPCC's scenarios with high-emissions that "are likely to maintain warming at below 2°C...are characterized by a greater reliance on CDR technologies beyond mid-century."[78]

Funding Geoengineering R&D

Given the risks of CDR and SRM deployment, near-term funding should focus on non-CCS R&D, identified by GiveWell as a relatively underfunded area.[79] Federal funding for geoengineering research (excluding CCS) was $101m

in fiscal year 2009-2010.[80] In contrast, CCS is well-funded: the Obama administration committed $190m to retrofit CCS at a single coal power plant.[81] The U.S. Congress is actively working on removing barriers to CCS deployment; "President Trump could make CCS a priority of international climate talks, as some of his fossil-fuel allies are urging."[82] Philanthropic funding, therefore, should focus on more neglected methods, and not CCS. This research may be very cost-effective: Giving What We Can highlights a study that estimates the cost-benefit ratio of SRM research to be almost certainly higher than one (given $750m/year in funding),[83] even accounting for significant uncertainty.[84] Further research is required for both technological innovation and governance. Indeed, most organizations do not advocate deployment of geoengineering without further scientific and governance research. Notably, there are organizations and projects that focus on governance, for example: The *Solar Radiation Management and Governance Initiative*.[85] GiveWell[86] and The *Fund for Innovative Climate and Energy Research*[87] have lists of projects, on innovation and governance, that could be potential grant recipients

Funding for geoengineering R&D may be necessary to prevent warming above 2°C, and it is also relatively neglected. However, aggregate U.S. Federal spending on geoengineering is vastly larger than RTNF's proposed grant size. Innovation-focused grants, therefore, are likely better deployed in areas other than geoengineering where RTNF's grants can have more leverage (such as funding early stage clean-tech startups).

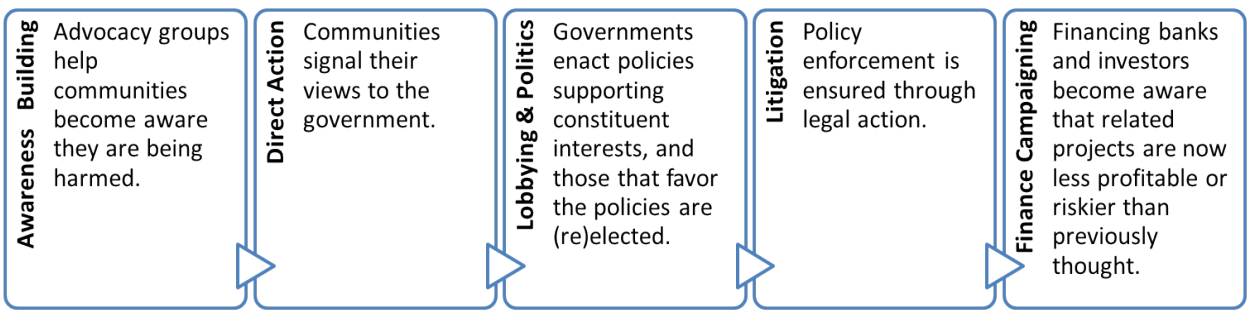
Research to Inform Policymaking

There are many areas of research that can inform climate change policymaking. Prominent research areas include environmental economics, climate modelling and policy research among others. This research can be conducted by universities, governments, NGOs or think tanks. We have not looked into this area in depth, but several of our interviewees suggested that in general terms, research to inform policymaking was likely already adequately funded. One area that may be neglected is basic scientific research. For example, the *Science Philanthropy Alliance* recommends funding research that aims to better understand the carbon cycle.[88]

1.4 ADVOCACY, LITIGATION AND GOVERNANCE

Overall, advocacy work appears to be a cost-effective method of reducing GHG emissions. When is successful, the results can have a lasting, multiplicative impact. Advocacy organizations and strategies are difficult to compare quantitatively in terms of real impact achieved. Successful organizations employ a range of strategies, and their success is typically difficult to quantify until large-scale results have been achieved after years of effort. Meanwhile, smaller and newer organizations may learn from past successes and failures. While individual organizations may work on some or all aspects of advocacy campaigns, often multiple organizations work together, coordinating their capabilities to maximize impact.[89] With some variation contingent on political circumstances, effective advocacy campaigns typically utilize a combination of the following tactics and strategies.[90,91]

- **Awareness Building**—Educating the public about the importance of an issue;
- **Direct Action**—Strikes, demonstrations, and other public forms of protest;
- **Lobbying and Political Advocacy**—Persuading politicians or public officials;
- **Litigation**—Taking legal action;
- **Finance Campaigning**—Influencing banks and other financial institutions' decision-making.



Awareness building is crucial for raising consciousness about how climate impacts and related problems, such as toxic emissions from fossil fuel combustion, are directly harming communities.[92] Once communities are aware they are being harmed, it becomes easier to galvanize their support.

Direct action by grassroots advocacy groups can create political pressure once community support has been built around an issue. Direct action signals a community's stance to policymakers and other stakeholders in decision-making positions. It is useful for signaling broad-based support for issues among constituents, particularly among politically disenfranchised groups.[93] Evidence suggests direct action is most effective in countries that are neither fully democratic nor highly authoritarian, since any politically disenfranchised groups who are not able engage with direct channels of democratic participation, are nonetheless able to engage in peaceful protest.[94] The emerging environmental justice movement in the U.S., recently enjoying significant media attention and broad-based support for campaigns such as the Standing Rock anti-pipeline protest, is a prominent example, as is the growing voice of frontline communities within grassroots climate advocacy groups. Grassroots policy advocacy is most likely to be most successful in nations with relatively functional democratic institutions, however.[95]

Lobbying can be pursued separately, from or in tandem with, direct action. At the grassroots level, lobbying is most helpful when conducted around a specific public policy known to have broad public support.[96] As an advocacy strategy, lobbying is less successful for controversial issues, and issues facing substantial corporate opposition. Lobbying tends to be an underused strategy by grassroots organizations unable to navigate the political system effectively.[97] When carried out effectively, with the support of influential networks and alignment of incentives, lobbying can produce high payoffs: U.S. corporations can see returns on investment of between 100-1,000 times the money spent, depending on the industry.[98,99] Within the U.S., the amount of money companies spend on lobbying is among the most accurate predictors of its success.[100] Substantial advocacy resources are being spent to influence Federal decision makers. Environmental interest groups ranked seventh in political giving among all industries in the 2014 election cycle, and as much as $25.4m/year has been spent on environmental lobbying in Washington.[101] While advocacy spending has little hope of matching corporate spending, there is certainly scope for tactical and strategic improvement in effective deployment of lobbying funds.

Strategies that simply aim to match the lobbying power of industry may not be wise. A more effective approach would explicitly target the current partisan deadlock on climate policy by broadening the range of voices and solutions across the political spectrum - a critical and potentially transformative investment. Indeed, most climate change advocacy funding currently goes to national, left-leaning organizations, while right-leaning organizations and think tanks are often prevented from engaging substantively on the issue, due in part to reliance on funders linked to the fossil-fuel industry, notably the Koch Brothers. This leaves a major gap in conservative thought leadership on addressing climate risk.[102] Opportunities to close this gap should be seen as more cost-effective than the status quo. Organizations on the frontier of bipartisan climate advocacy include the Citizens Climate Lobby[103], a volunteer network working to advance climate policy. Notable successes include the creation of the House of Representatives' Republican Climate Resolution and the first bipartisan Climate Solutions Caucus.[104] Another, RepublicEN, is an organization building conservative grassroots support for addressing climate change through a free enterprise model.[105]

Litigation is often employed to ensuring effective policies are properly enforced once they are in place around an issue, such as emissions controls or waste disposal from fossil fuel extraction. Litigation around existing regulations (such as the Clean Air Act, which reduces GHG emissions indirectly by placing limits on activities around fossil fuel burning and extraction[106]) is particularly helpful for groups directly harmed by climate impacts, or by related problems such as deforestation or water pollution, but who are sufficiently marginalized such that their concerns do not receive widespread political support.[107] Litigation strategies are also helpful for advocacy groups unable to compete for lobbying space with larger, more entrenched interests. Recently, litigation tied to the Standing Rock protests, and other climate justice movements across the U.S. and Canada, has forced significant delays, and

higher costs, for energy and extraction projects. In the context of fossil fuel infrastructure, litigation can introduce uncertainty into corporate decision-making before a ruling is made, demonstrate to project funders that existing regulations will be implemented after a decision is made, which increases fossil-fuel project costs and the financial risks associated with accidents.

Legal strategies in the U.S. have traditionally focused on regulatory policy, with financial support from national environmental organizations. Given the deregulatory agenda of the current Administration, the climate litigation field is likely to be dynamic on various fronts in months and years to come. Nevertheless, national groups that work aggressively at the federal level typically have far less capacity and infrastructure at the state level. Suits brought in state courts fighting fossil fuel extraction and infrastructure, for example, have the potential to push the boundaries of existing legislation and set Federal precedents. Finally, litigation efforts focusing on damages related to climate impacts and GHG emissions is an emerging area that warrants closer attention and support going forward. Given its potential to establish new legal precedent with sweeping long term results, litigation can be highly effective, but requires long-term dedication of resources and is subject to significant uncertainty.

Finance campaigning dovetails closely with policy establishment and enforcement, aiming to achieve real impact by influencing major project funders such as banks, investment firms, and institutional endowment funds. Finance campaigning is particularly effective when combined with policies that already penalize emissions-intensive project, causing them to incur both additional financial costs and pose risks to investors.[108] The most effective campaigns often involve effective dialogue with decision-makers within investing institutions, on the basis of analysis demonstrating that particular projects or industries are higher risk or offer lower returns than available alternatives.[109]

Effective Targets by Industry, Scope, and Location

Targeting **industries** that produce visible, localized negative health impacts is most able to generate strong public support.[110] While communities are starting to recognize the risks of living near oil pipelines and refineries and fracking sites, in empirical terms, coal fired power plants are the most damaging. Coal combustion, in addition to being the most carbon-intensive form of widespread power production, has the strongest verifiable links to poor air quality, and persistent public health problems, primarily premature death from cancer and respiratory illnesses.[111] Tar sands production may have similar public health, environmental, and emissions impacts to coal, but more research is needed to determine whether this is the case.[112] Given the combination of high CO_2 emissions intensity and severe localized health impacts, coal is a clear target in terms of both mitigation and co-benefits.

When targeting particular industries, it is helpful to consider the **scope** at which advocacy is most likely to be effective. Within the U.S., local level advocacy can lend legitimacy to advocacy activities and increase the chances of successful policy creation, since local governments tend to be more accountable to their constituents and face less pressure from powerful lobbying groups (though the opposite may be true at the state level, at which a far higher level of organized support may be needed to spur policy creation).[113] In building national movements, advocacy campaigns have focused on achieving wins in cities and locales where their movements have tractability, demonstrating that change is possible, and building coalitions at the national level. While many key policies, laws and statutes can only be altered nationally, successful efforts within one state or locality can be replicated elsewhere if the networks required to do so are well-developed and capable of sharing information and resources effectively. This decentralized strategy has allowed local interests, when provided with sufficient support, to win out against moneyed interests both within the U.S. and internationally.[114]

Maximizing the impact of grants requires targeting **locations** where funds are likely to go the farthest. Countries with weak environmental protections present opportunities for the greatest gains, although poor governance structures and limited democratic freedoms may mitigate against this. In such countries, fossil fuel industries are associated with high levels of pollution, often concentrated in industrial areas with high population densities and

supporting critical ecosystems.[115] Advocacy in these areas is likely to enjoy strong local support, while maximizing public health and environmental benefits and protecting vulnerable communities. This is particularly true of rapidly industrializing countries that are also large CO_2 emitters. Grants are also likely to be more cost-effective in areas with relatively little advocacy funding, and those in which it is inexpensive to operate.

A number of countries meet these suggested criteria. China is the world's largest consumer of coal, with sufficient influence that world coal consumption depends to a significant extent on Chinese policy.[116] China also has weak environmental protections, and its coal-fired power plants are largely located in major population centers, contributing to growing air pollution and public health concerns, as well as public support for government action.[117] India has the world's second-largest, and fastest-growing, coal consumption rate.[118] Like China, India has weak environmental protections. Its democratic institutions and less centralized governance structures mean advocacy efforts are more likely to meet with success.[119] Indeed, grassroots organizations in India have already achieved some significant victories.[120] Much of Southeast Asia shares India's pattern of growth: steadily increasing coal usage in the presence of nominally democratic institutions but weak environmental protections.[121,122]

While China's emissions now exceed those of the U.S., developed countries in the Organization for Economic Cooperation and Development (OECD) as a whole are still responsible for the majority of cumulative emissions since the industrial revolution.[123] A recurring theme of climate negotiations is the demand that industrialized nations bear the greatest costs in reducing emissions and take the most immediate action. Global trade flows in goods produced from pollution-intensive processes reinforce this claim: developing countries with burgeoning manufacturing economies are burning increasing amounts of CO_2 to produce goods for export to developed nations, with significant unaccounted-for costs to the health of local populations. Consumption in Western Europe and the U.S., for example, is linked to more than 108,600 premature deaths in China annually.[124] Developing nations are caught between constructing new fossil-fueled infrastructure to meet foreign and domestic demand, and addressing the concerns of (generally low-income, marginalized) communities that suffer the consequences. The potential of advocacy in these areas, while largely latent, is significant and will require sustained, strategic support to develop.

1.5 COORDINATION AND CAPACITY BUILDING

In recent years, the critical role of subnational and non-state actors in supporting global mitigation efforts has assumed increasing prominence in the context of international climate negotiations. Some studies indicate that commitments made by subnational governments and private companies could, if delivered, "avoid as much carbon pollution as all the pledges nation states made in the lead up to the Paris Agreement," helping close "as much as two thirds of the remaining 'emissions gap' we face to get the world onto a trajectory to limit global warming to two degrees or lower this century."[125]

Efforts to track individual and joint initiatives among subnational and non-state actors have emerged including the UNFCCC's NAZCA platform[126] and UNEP's Climate Initiative Platform.[127] Maximizing opportunities to reduce emissions through this diverse array of potential actors requires strong network coordination, communication, and mobilization of resources and effective action. This is needed across the business community, advocacy and climate movement organizations, and subnational governments, though some networks have existing infrastructure that is more robust than others. Networks of major cities (e.g. C40, Global Covenant of Mayors) have emerged with the ambition and resources to mobilize and showcase urban leaders taking climate action. Conversely, city councils and state legislatures, though critical to advancing subnational U.S. climate policy, have relatively little support through available networks to build capacity, share best practices and mobilize resources. The importance of building such support is even more important in the wake of the Trump Administration's decision to withdraw from the Paris Agreement on climate change.

Another gap area is coordination across sectors and jurisdictions at the regional level. The Southeast Florida Cli-

mate Compact offers an example of regional self-governance designed to engage public and private partners across county lines to advance climate mitigation and adaptation while providing an efficient means for state and federal agencies to engage with technical assistance and support.[128] Similar efforts are needed across the country to ensure that jurisdictional lines and governance structures do not inhibit effective climate action.

Finally, while there are a growing number of initiatives offering subnational support on climate action, many focus heavily on locales at the forefront of climate ambition, leaving a gap in support for smaller, rural, and under-resourced locales struggling to navigate the array of resources available.[129] Umbrella networks can play a critical role in providing additional support to small and mid-sized cities that lack technical expertise and capacity to navigate the growing supply of resources and opportunities to engage.

1.6 FINANCIAL MECHANISMS AND PROGRAM-RELATED INVESTMENTS

Climate Finance

"Climate finance" refers to funds channeled specifically into climate change mitigation and adaptation programs. It takes three main forms: direct provision of finance; deployment of financial instruments; and encouraging financial flows. From 2012-14, global climate finance flows amounted to approximately $350bn annually, 70% of which was spent on deploying renewable energy.[130] Developing countries are progressively assuming a larger role, receiving 11% more investment than OECD countries in 2014, mostly from domestic sources (though still less on a per capita basis). Globally, domestic investment represented 74% of climate finance in 2013-14, of which 75% came from private sources. 90% of private climate finance is invested domestically. In terms of destination, 30% goes to East Asia and the Pacific, and 25% to Western Europe. Only 4% goes to South Asia and 2.5% to Sub-Saharan Africa, despite their respective vulnerabilities, burgeoning populations and risk of entrenching further fossil-fueled growth. NGOs and foundations received under 1% of all climate finance in 2014—less than $3bn.[131]

Meanwhile, the global infrastructure and efficiency investment needed to comply with countries' pledges to the Paris Agreement is estimated at $13.5tn by 2030,[132] of which $3.5tn is for the developing world, and $1tn for transportation and building investment in China alone.[133] The UNEP Adaptation Gap report documents a significant lag between the projected costs of climate change and investment. Current annual adaptation needs are in the order of $280bn-$500bn, while investment in 2015 was a mere $25bn, 11-20 times below what is required to compensate for climate damages.[134]

The link between climate finance deployment and emissions reductions is clear, but measuring impact is complex. While tracking disbursement of funds is generally straightforward, data on how they are deployed is scarce, particularly in developing countries suffering from poor governance and corruption.

Philanthropy and climate finance

Given the vast scale of financial need, and the limited resources available to the philanthropic community, a multiplicative effect is essential to have any impact. The combined assets of the 100 largest U.S. foundations is $300bn—nowhere near big enough to confront the challenges. Foundation funding cannot compete with either private or public climate financing. Currently, less than 2% of philanthropic dollars are spent on climate change.[135] Even if this increased to 50%, it would still be a very small proportion of the total need. Philanthropy provides under 0.1% of total climate finance, while the total climate-related assets of the largest pooled fund, the ClimateWorks Foundation, are a mere $300m.[136] Ultimately, the relative effectiveness of investing in any of the specific initiatives, programs or technologies described above is moot unless they catalyze further action. The Rockefeller Foundation's climate program, for instance, focuses specifically on incentivizing private capital flows towards sustainable infrastructure projects.[137]

With such a significant mismatch between supply and demand of philanthropic funding, philanthropy will have little aggregate impact by funding and sustaining mitigation or adaptation projects directly. Rather, foundations should shape and prove financial innovations that are later scaled by public or private actors with sufficient capital resources.[138] There are three main tactics available to foundations for exercising financial leverage.

First, diverting public-private funds into climate investment (hence away from emissions-intensive investment). In one prominent such case, philanthropically-funded research by Carbon Tracker first linked the concept of a "carbon budget" to capital markets, helping diffuse carbon pricing in the private sector, and galvanizing the fossil fuel divestment movement. Philanthropic support was crucial: 25% of divestment pledges were from foundations. Strong ripple effects were observed in the UK, where the Ashden and Mark Leonard trust successfully persuaded 30 foundations worth $8bn to divest their holdings.[139]

Second, pooling funds to facilitate projects that would otherwise be underfunded; and addressing investment gaps that capital markets cannot fill. Several organizations active in the climate arena pool funds as a means of financing larger projects. Prominent examples include The Funders Network for Smart Growth and Livable Communities, and Environmental Grantmakers Association. The most influential is the ClimateWorks Foundation, with $300m in climate-dedicated funding from major donors including the Oak, Hewlett, Packard and MacArthur Foundations. While ClimateWorks supports organizations and projects across a wide range of areas including some of those we recommend, the aggregate effectiveness of its current grant portfolio is unclear, owing to a lack of data on how its funding is deployed. Its largest grants are typically allocated to energy projects, climate advocacy groups and land use projects. Project funding is allocated by consensus within the Funders' Circle, access to which is restricted to those pledging $10m or more. RTNF may well decide that ClimateWorks' project portfolio is suitable for funding, but should be aware that influence over the grantmaking process is limited for smaller donors.[140]

Third, addressing investment gaps that capital markets cannot fill. In a combination of all three tactics, the Hewlett, MacArthur, Grantham and Packard Foundations jointly provided $30m in government-matched funding to India. The project's aims are twofold; (a) make solar projects finance-ready by reducing red tape and increasing availability of small-scale financing; and (b) provide concessional seed financing for solar projects, taking on risks that would otherwise deter private investment.[141] The purpose is not to invest directly in emissions reductions, but to reduce financial barriers and deploy investment vehicles that can generate momentum, mobilizing larger pools of capital. This plays to foundations' comparative advantages: they can take risks that traditional investors cannot, and adapt quickly to change, relatively unconstrained by political or bureaucratic processes.[142] Multilateral development banks and other institutional investors cannot take on early-stage development risks.[143] Philanthropy is needed to plug this gap by supporting investment vehicles that integrate climate costs and benefits into investment and planning in the public and private sectors.[144]

Understanding the effectiveness of climate finance as a mitigation or adaptation tool is not a theoretical issue, but an empirical one. Philanthropic funding of climate finance initiatives is a relatively recent development. This means that justifying the choice to invest relies heavily on data from non-philanthropic sources, and on a robust theory of change, rather than a track record. The fundamental logic is sound, however: directly funding mitigation efforts may in general be far less catalytic than investing in the reduction of market barriers or mobilizing other private or public funding sources.

Program-related Investments

Program-related investments (PRIs) are one of two possible types of "mission investments."[145] Only, PRIs count towards a foundation's 5% payout to maintain tax-exempt status and so they are the only type of mission investment discussed here.[146] PRIs are made by foundations in furtherance of their philanthropic goals, and may additionally be expected to generate below-market financial returns.[145] They are designed to achieve the objectives of a specific

program, trading-off financial return for a potentially greater social or environmental impact. While RTNF was not planning to make PRIs to further their environmental program, they deserve to be highlighted, as making PRIs can be more impactful than grantmaking. Leading organizations in the field include charities that work with foundations to remove regulatory barriers, allowing foundations to support early-stage cleantech companies (see PRIME Coalition case study, Section 2.3).

Benefits of PRIs:

- **Scalability:** By supporting companies with a marketable product, PRIs can achieve scale through markets.[149]
- **Returns on investment:** PRIs can have multiplicative impact, as foundations can reinvest the returns they obtain from successful investments.
- **Catalytic investments:** If a foundation's investment decisions are made by expert committee, it can spur other parties, particularly VCs, into investing in the same program. Foundations can also catalyze investments by meeting matching requirements in industries where investment funding is scarce.[147]
- **Other benefits:** Redstone Strategy Group has surveyed mission investments at the Packard Foundation, highlighting their key benefits.[148]

Drawbacks of PRIs:

- **Regulatory barriers:** To make a PRI, a foundation must prove that the PRI is a below-market rate investment in programs that support the foundation's mission. This creates a regulatory barrier which normally only large foundations, with significant resources, can overcome. As PRIs become more popular, however, more third-party organizations are working to address these barriers.
- **Requires field-building:** In select cases, PRIs could solve problem, but there is a lack of organizations able to receive and deploy investment (e.g. deforestation in Indonesia; see below).
- **Risk:** As the Redstone report notes, mission investments can be more risky than typical grants, as they are often made in "new markets" (e.g. carbon markets), using untested business models (e.g. biofuel certification), and/or featuring early stage organizations (e.g. nonprofits branching out into revenue-generating activities).[148]

Current Funding Opportunities

Redstone has also conducted an analysis of mission investment opportunities within climate change mitigation.[149] Their criteria are similar to those used in this report: abatement potential; scalability; additionality; and viability. They recommended focusing on preventing deforestation and peat loss in Indonesia; supporting distributed solar generation in India; developing business models that promote energy efficiency; and funding early-stage cleantech companies.

For each of these except the last, at least some field-building is required. For preventing deforestation, Redstone suggests the need for "a fund [that] could offer concessionary loans to farmers so they can improve productivity while meeting deforestation targets. In turn, yield improvements and price premiums for sustainability-certified palm oil can repay the loans."[150] Although such field-building is beyond RTNF's remit, it is worthwhile being aware of mission investment opportunities that arise as field-building is completed by others. For funding early-stage cleantech companies, the PRIME coalition has already completed field-building; RTNF should consider making PRIs through PRIME.

An interesting example of using mission investments within climate change adaptation are the mission investments made by the Kresge, Gordon and Betty Moore and Packard Foundations into The Freshwater Trust.[151] These mission investments allowed the trust to set up a water quality trading scheme.

2. Recommendations

In this section, we present three primary recommendations of promising intervention areas:

- Working with local partners to advocate against coal power in China, India and Southeast Asia;
- Building capacity for and networks across local and state governments and nonprofit organizations in the U.S.; and
- Contributing to one or more climate philanthropy bodies that strategically target climate finance interventions.

2.1 COAL-FIRED POWER PLANTS

A number of organizations are working together to advocate against existing and planned coal power, and for related climate-benefiting environmental protections in China, India, and Southeast Asia. Notable among these is 350.org East Asia and its partner organizations.[152] As a larger organization, 350.org has pursued a strategy of working closely with smaller local organizations, building resilient grassroots networks with multiple community-led groups, and providing critical training and support to local organizations in need.[153] Other, larger organizations that have achieved success blocking expansion of coal infrastructure in South and East Asia include Greenpeace India[154] and other country hubs, and Pacific Environment (operating in the Pacific Rim).[155] Successful local organizations and campaigns include Green Camel Bell (Gansu, China);[156] Change (Vietnam);[157] and 'Piglas Batangas Piglas Pilipinas' (Philippines).[158] Many other local organizations are active but keep a lower media profile; some have limited publicity resources, while others do so to avoid political risks. Consequently, large nonprofits like 350.org often receive the lion's share of philanthropic support, leaving other effective but smaller groups underfunded.[159] 350.org is working to alleviate this problem by extending financial support to smaller partner organizations.[160] The greatest impact may be had in working closely with organizations with strong local partnership bases that are able to clearly identify organizations in need of funding on an ongoing basis.

Case Study: The Sierra Club's Beyond Coal Campaign

The Sierra Club's U.S.-focused Beyond Coal campaign is a notable example of successful advocacy work. The campaign employs various strategies, emphasizing grassroots engagement, policy advocacy, and litigation, in curtailing existing coal power generation and preventing new builds. From 2010-2015, 238 of the 523 U.S. coal plants operational in 2010 were phased out.[161,162]

Modelling the health impacts of reducing coal emissions suggests one premature death is averted for every 5,000 tons of emissions abated[163]. If Beyond Coal were responsible for all of the resulting decline in coal production, the cost/ton of carbon emissions averted is $0.04.[164] Bloomberg Philanthropies suggests that Beyond Coal's efforts were pivotal for approximately 40% of the decline, corresponding to plants that were still fully operational but intentionally phased ahead of projected retirement.[165] In reality, the campaign was probably less effective than this, as economic factors (including the shale gas revolution) were behind at least some of the decisions to close existing plants. However, even if Beyond Coal was responsible for only 6% of the decline, and even no other deaths are attributed to coal production (mining hazards, water pollution, contaminant-related cancers), Beyond Coal would still have achieved an effectiveness of $3,333/life saved, competitive with work by the Against Malaria Foundation, a GiveWell-recommended organization recognized for its cost-effectiveness in achieving human impact.[166]

2.2 CAPACITY-BUILDING AND COORDINATION AT STATE AND LOCAL LEVELS

Building capacity for (and networks across) local and state governments and non-government organizations in the U.S. can reap multiple benefits by directly reducing emissions, while also boosting the confidence and political will and ambition of national governments, having a potentially catalytic effect. Below are several specific opportunities we recommend supporting or exploring:

- **Umbrella or "backbone" organizations** to improve coordination and effectiveness among subnational actors. Across mitigation and adaptation strategies, and within entities focused on advocacy and litigation as well as governance, there is a substantial volume of activities and resources in the ecosystem of efforts to address climate change. Key to maximizing their potential are strong institutions and organizations dedicated to coordinating various collaborators in the ecosystem. Without infrastructure to facilitate coordination, the field can become a crowd of disparate voices competing for funding. Backbone organizations that can fill multiple roles including coordination, network building, measuring progress, and capacity building, are critical to success, and are often weak or missing at the state and local levels in the U.S. The Climate Justice Alliance is a collaborative of over 35 community-based organizations that bring together frontline communities to transition toward local, living economies.[167] Other critical gap areas include state legislatures, rural communities, small jurisdictions, and regional cooperation across sectors and jurisdictions.
- **Broadening the range of voices** at the forefront of climate action. Supporting groups working to elevate underrepresented voices in the climate dialogue in the U.S., including those focused on mobilizing across the partisan divide (e.g. RepublicEN, Citizens Climate Lobby, described above).
- **Legal strategies:** organizations that provide research and legal expertise to bring state-based legal claims that may be considered novel or boundary-testing, and are closely linked with advocacy and organizing campaigns. Successful international examples include Earth Rights International and ClientEarth, but state-level legal support in the U.S. is a clear gap and legal thinking in the area is still evolving.[168] The NAACP, an established organization representing marginalized communities, has launched a climate justice program. Its strong existing networks, experience and expertise could make it a more effective legal platform than less established counterparts.[169]
- **Funders networks:** In order to ensure the best alignment with existing efforts, we also suggest exploring participation in existing funders networks, subject to various qualifications (see Section 1.6).

Case Study: Urban Sustainability Directors Network (USDN)

USDN is a member-driven association cities, counties and local governments working collaboratively to build capacity, promote peer-to-peer information exchange, mobilize members to pursue collaborative projects and promote innovation to address urgent climate and sustainability related challenges. Founded in 2009 by a handful of urban sustainability practitioners, the network has grown to include over 165 cities and counties across U.S. and Canada, representing 80 million people. As a regranting entity, USDN has provided over $6.6m in high-leverage small grants, and provides a platform for information exchange, professional development, collaboration, and resources for members and partner networks addressing a range of sustainability efforts, including climate mitigation and adaptation.[170]

Additional resources would allow USDN to entrench its platform at a regional level, to grow deeper roots and offer more tailored support to localities based on their particular risk profiles, resources, and political environments. Support from RTNF-sized foundations based within specific regions to establish regional hubs could, in the medium-term, prove transformative for regional climate readiness in the U.S. while embedding climate change consciousness in localities that would otherwise remain unengaged.

2.3 STRATEGIC FINANCING

Philanthropic foundations have the potential to be most effective when strategically funding programs that mobilize additional funds.[171] Foundations active in the field typically address financing gaps or barriers with a view to facilitating market-driven long-term climate financing, rather than tackling emissions reductions directly or funding advocacy programs that rely on continuous support from grants and donors. The Rockefeller Foundation has developed a series of "innovative finance" programs designed to fill the financing gap for risky projects, and funnel private investment into clean energy infrastructure.[172] The "Zero Gap" finance initiative specifically targets initiatives using "immediately actionable" financial instruments that can drive further investment—a venture-philanthropy hybrid.[173] Past and present projects in the Zero Gap portfolio include:[174]

- **Forest Resilience Impact Bonds:** raising capital from private investors to fund forest restoration and water availability in California aimed at fire prevention. Investors receive returns paid for through U.S. Fire Service cost savings from reductions in number and severity of fires, and water utility revenues.[175]
- **African Risk Capacity:** a mechanism for issuing "catastrophe bonds" to fund insurance against extreme weather events, thereby unlocking climate adaptation financing.[176]
- **Global Infrastructure Basel**: using research to demonstrate the financial and social returns to building sustainable, resilient infrastructure, thus de-risking sustainable infrastructure investment and mainstreaming resilience and sustainability criteria into infrastructure projects.[177]

The Global Innovation Lab for Climate Finance[178] is another major collaboration designed to identify, develop and launch financial instruments that are able to unlock scalable climate finance and address existing investment barriers. The project is a joint initiative of the Rockefeller Foundation and the Climate Policy Initiative.[179] In 2015, it raised $500m in funding for pilot instruments in three major areas:

- **Access to transparent analytics** for pricing climate risk into investments, reducing uncertainty, therefore reducing cost of financing.
- **Closing the financing gap** for smallholder farmers, catalyzing sustainable intensification of agriculture and preventing deforestation
- **Mobilizing domestic resources** for low-carbon water stress relief projects
- The Call to Action on Climate Finance[180] pursues similar objectives, using a three-point framework to divert long-term investment into green projects.

Case Study: PRIME Coalition

PRIME is a 501(c)(3) public charity whose mission is to "[empower] philanthropists to place charitable capital into market-based solutions to climate change."[181] Specifically, PRIME helps foundations make grants to, or investments in, U.S.-based early-stage cleantech startups, using a three-pronged strategy.

- **Removing regulatory barriers** to mission investments. Foundations can choose from three types of investment, summarized in the table below. These investment options allow foundations to choose the combination of regulatory barriers and expected financial return that suits them best. More information is available in the PRIME docket accompanying this report (also available by direct request).[182]
- **Collaborating with experts** to pick promising companies**.** PRIME has a registry of over 1600 companies. A team of scientists and engineers determines a proposed technology's potential GHG emissions reduction potential. Then, an experienced committee of clean-tech venture capitalists (including ARPA-E's cofounder), determines whether the startup meets specific criteria, such as exit potential and having an experienced team. They also ensure that any investments are "additional"; i.e. they target companies that would otherwise be unable to attract commercial capital.

- **Establishing pipeline partners** to guide companies they work with from research to commercialization. PRIME has over 75 pipeline partners.These include startup accelerators and incubators, such as Cyclotron Road, that help to develop companies that may then receive PRIME funding. PRIME also partners with investors like the Breakthrough Energy Coalition, who are able to provide the next stage of funding, or to match PRIME's funding.

Significantly, the Redstone report on mission investments also identifies the latter two steps as necessary for successfully commercializing advances in cleantech.[183] As shown above, clean-tech innovation is under-funded at every stage, especially for early-stage companies occupying the "Innovation Valley of Death".

Investment Option	Regulatory Barrier	Financial Return
Overarching grant to PRIME	Simple grant documentation	No financial return
Recoverable grant to PRIME	No risk of violating charitability rules (sheltered by PRIME)	Maximum return is the negotiated interest rate
PRI directly to company	Exposed to regulatory risk of PRIs	Foundation receives maximum possible financial return

Foundations typically make $100,000 to $200,000 investments through PRIME. Coinvestors make up the rest of the amount a company receives (typically $1.5m-$2m). Catalyzing other, larger, investments is key to the overall effectiveness of such investments. Risk-taking is an inherent part of PRIME's work. For every two breakout successes, PRIME predicts 3-5 modest successes, and 3-5 failures. Although it is worth noting again that failures due to technical challenges may still expand scientific knowledge. Either way, to mitigate this risk, PRIME is currently preparing to offer investors the possibility of investing in a charitable fund with diversified investments in a range of PRIME's docket companies. Investments in the charitable fund will still be able to made using any of PRIME's three investment options.

Beyond the benefits of PRIs mentioned above, there are other co-benefits of PRIME's work. A major co-benefit is the option of reinvesting returns from successful investments. Secondary co-benefits include human health promotion and adaptation readiness. For example, Anfiro, a company supported by PRIME in 2016, develops energy-efficient desalination membranes. These reduce GHG emissions from the desalination process, while also reducing the cost of desalination, which is critical for areas likely to face water shortages in the coming decades.

Whether PRIME's portfolio of companies will reach commercialization, achieve GHG reduction targets, and provide returns on investment is not yet clear. To date, however, some investments have spurred others' interest, enabling companies to meet funding matching requirements. PRIME was the lead investor in the first seed round for Quidnet, which enabled a year-long pilot project, the success of which attracted investment from the Clean Energy Venture Group for the second round. The Utah-based Sorenson Impact Foundation[184] was one of the foundations that funded Quidnet through a direct PRI to Quidnet. PRIME also invested $0.75m in RedWave, enabling them to meet matching requirements of other investors, and unlock an additional $5.25m. Another measure of PRIME's success is the field-building they have achieved in developing new ways of funding cleantech startups; a metric PRIME uses to measure its own success is the number of foundations making grants through PRIME that have not previously given to clean-energy R&D.

No other organizations fulfil the same function as PRIME. The CREO Syndicate[185] and Climate Solutions Collaborative,[186] use education and collaboration to help foundations make investments addressing climate change, but do not use PRIs, nor do they focus solely on funding early-stage cleantech companies.

3. Conclusion

This report has provided a detailed overview of the many options available to funders looking to address climate change. Rigorous assessment of cost-effectiveness, and comparison across different strategies, is not always possible, or even desirable. As such, the findings and recommendations of this report are absolute, not relative, and subject to the results of studies and the evolution of modelling and materialization of climate impacts. Foundations' unique capacity to take financial risks that other actors cannot, and their ability to adapt to change much more rapidly than their counterparts in the private and public sectors, is central to the recommendations made here. Funding emissions reductions or adaptation measures directly is unlikely to constitute a wise use of philanthropic funds, given the scale of need and the lack of leverage.

This report considers those interventions most likely to spur further activity to be the most cost-effective means of pursuing climate goals, given the constraints within which RTNF operates. Anti-coal advocacy in South and Southeast Asia is critical not only in terms of mitigation, but in placing pressure on political and financial actors to incorporate climate damages and risks into investment decisions. State-level network-building in the U.S. is similarly critical to maintaining U.S. leadership on climate change and building an ecosystem of actors able to share information and best practices, develop local capacity, and act accordingly, across partisan lines. Finally, use of financial leverage, whether in making PRIs or funding financial innovation in areas suffering from financial and administrative barriers, is essential if the relatively small pool of philanthropic funding for climate change is to make any difference to the state of the world that future generations will inherit.

4. Annex

4.1 SUGGESTED GRANTMAKING CRITERIA

Analyzing the cost-effectiveness of different initiatives, policies and programs in mitigating or adapting to climate change is very different from taking decisions on which specific organizations to support. The below are a suggested list of grantmaking criteria specific to climate change. They take into account the particular nature of emissions reductions as a global public good, and the importance of scalability and leveraging of market-based tools to catalyze further action. The criteria used by the Rockefeller Foundation, PRIME Coalition and Redstone Strategy Group were used as a basis for assessment.

Initial Screening

- Proposals should be screened on the basis of the following:
- A clearly defined, measurable goal
- High ambition (in the context of what is achievable in the given area)
- Feasibility
- An evidence-based roadmap for reaching the goal
- Clear plan for long-term viability

Assessment Criteria

- Impact (in terms of both expected emissions reductions *and* any associated co-benefits, which can often be larger than climate benefits themselves)
- Scale (for climate finance investments, Rockefeller use a minimum market potential of $1bn)
- Catalytic potential for larger investments
- Replicability across issue areas, cultural and institutional boundaries, and geographies
- Complexity of the challenge being addressed
- Risk profile
- Innovation: a clear comparative advantage versus similar initiatives

Organizational

- Need for funding
- Scope for interactive partnership with grantee in directing project
- Quality of project team
- Availability of required resources for reaching goal

This list is not exhaustive, but at a minimum identifies the issues that should be considered when funding climate-related projects.

4.2 RECOMMENDED READING

Buchner, B. (2016) “Philanthropy’s Role in Financing a Climate-Resilient World”. Climate Policy Initiative. Available at: <https://climatepolicyinitiative.org/2016/06/16/philanthropys-role-financing-climate-resilient-world/>

Galvanizing the Groundswell of Climate Actions (2017). “Memorandum: How can Funders Accelerate Global Climate Action to 2018 and 2020?” Available at: <http://www.climategroundswell.org/blog-test/2017/3/7/memorandum-how-can-funders-accelerate-global-climate-action-to-2018-and-2020>

Karnofsky, H. (2013) “Passive vs. rational vs. quantified”. *The GiveWell Blog.* Available at: <http://blog.givewell.org/2013/08/08/passive-vs-rational-vs-quantified/>

Kramer, L. and Larson, C. (2015) “Foundations Must Move Fast to Fight Climate Change”. *The Chronicle of Philanthropy*. Available at: <https://www.philanthropy.com/article/Foundations-Must-Move-Fast-to/229509 >

Mazza, F., Falzon, J. and Buchner, B. (2016) *Global Climate Finance: An Updated View on 2013 & 2014 Flows*. Climate Policy Initiative. Available at: <https://climatepolicyinitiative.org/wp-content/uploads/2016/10/Global-Climate-Finance-An-Updated-View-on-2013-and-2014-Flows.pdf>

Morena, E. (2016) *The Price of Climate Action: Philanthropic Foundations in the International Climate Debate*. Cham: Springer International Publishing.

Redstone Strategy Group (2016) *Philanthropy’s Full Force: Mission Investments to Catalyze Climate Solutions*. Available at: https://www.packard.org/insights/resource/mission-investments-to-catalyze-climate-solutions/

4.3 INTERVIEWEES

Jason Anderson, ClimateWorks Foundation

Jennifer Alley, ClimateWorks Foundation

Jacqueline Ashmore, Boston University Institute for Sustainable Development

Megan Bailey, Harvard Kennedy School

Prof. William C. Clark, Harvard University

Todd Edwards, Mission 2020

John Farrell, Institute for Local Self-Reliance

Katherine Gajewski, City Scale

Graham Gottlieb, Former White House Staff

Brendan Guy, Natural Resources Defense Council

Thomas Hale, Oxford University / Galvanizing the Groundswell of Climate Actions

Adam Hasz, SustainUS

Marc Kastner, Science Philanthropy Alliance

Sarah Kearney, PRIME coalition

Josué Lopez, Massachusetts Institute of Technology

Lissa Lynch, Natural Resources Defense Council

Nils Moe, Urban Sustainability Directors Network

Prof. William Moomaw, Tufts University

Jake Segal, Social Finance

Prof. Robert N. Stavins, Harvard University

Jean Su, Center for Biological Diversity

Laura Tomasko, Former White House Staff

Rachel Wasser, PRIME coalition

ENDNOTES

1. Co-benefits represent the non-climate benefits associated with a particular intervention. They can be a complicating factor in assessing overall cost-effectiveness. Many interventions, for example, directly reduce carbon emissions, but also reduce emissions of other substances or cause reductions in energy demand, both of which can impact local human health outcomes. For example, see: Harlan, S.L. and Ruddell, D.M. (2011). "Climate change and health in cities: impacts of heat and air pollution and potential co-benefits from mitigation and adaptation". *Current Opinion in Environmental Sustainability* 3: 126-134.
2. Please note that all dollar amounts in this report are in 2017$.
3. U.S. Energy Information Administration (2015). *Analysis of Energy Efficiency Program Impacts Based on Program Spending*. Available at: <https://www.eia.gov/analysis/studies/buildings/efficiencyimpacts/pdf/programspending.pdf>.
4. American Council for an Energy-Efficient Economy (2016) "Energy Efficiency Resource Standard (EERS)". Available at: <http://aceee.org/topics/energy-efficiency-resource-standard-eers>.
5. Hoffman, I.M. et al (2015) "The Total Cost of Saving Electricity through Utility Customer-Funded Energy Efficiency Programs: Estimates at the National, State, Sector and Program Level." Electricity Markets & Policy Group Brief, Lawrence Berkeley National Laboratory. Available at: <https://emp.lbl.gov/sites/all/files/total-cost-of-saved-energy.pdf>. Costs were converted from kWh using an average 2009-2013 U.S. emissions rate of 56.52 kg CO2 per million Btu (see U.S. Energy Information Administration at: https://www.eia.gov/environment/emissions/state/analysis/pdf/table7.pdf).
6. For an example of broad considerations of consumer welfare in the energy efficiency context, see: Allcott, H. and Kessler, J.B. (2015). "The Welfare Effects of Nudges: A Case Study of Energy Use Social Comparisons". NBER Working Paper 21671.
7. Note that Idaho, Wyoming, Nebraska, West Virginia, Kentucky, Tennessee, and a number of southern states do not currently have RPS programs. See: Database of State Incentives for Renewables and Efficiency. Available at: <http://programs.dsireusa.org/system/program/maps>.
8. Heeter, J. et al (2014) *A Survey of State-Level Cost and Benefit Estimates of Renewable Portfolio Standards*. National Renewable Energy Laboratory Technical Report. Available at: <http://www.nrel.gov/docs/fy14osti/61042.pdf> p.v. Costs were converted from MWh using an average 2010-2012 U.S. emissions rate of 56.47 kg CO_2 per million Btu (see U.S. Energy Information Administration at: https://www.eia.gov/environment/emissions/state/analysis/pdf/table7.pdf).
9. Ibid, p.vii. Costs were converted from MWh using an average 2010-2012 U.S. emissions rate of 56.47 kg CO_2 per million Btu (see U.S. Energy Information Administration at: https://www.eia.gov/environment/emissions/state/analysis/pdf/table7.pdf).
10. These numbers are for a 5-kW system and exclude profit. See Chung, D., Davidson, C. Fu, R. Ardani, K. and Margolis, R. (2015). *U.S. Photovoltaic Prices and Cost Breakdowns: Q1 2015 Benchmarks for Residential, Commercial, and Utility-Scale Systems*. National Renewable Energy Laboratory. Available at: <http://www.nrel.gov/docs/fy15osti/64746.pdf>, p.10.
11. Ibid, p.23. These estimates are for a 200-kW system and do not include net profit.
12. Clean Air Task Force (n.d.). "Comparison of CO_2 Abatement Costs in the United States for Various Low and No Carbon Resources". Available at: <http://www.catf.us/resources/factsheets/files/CO2_Abatement_cost_comparison.pdf>.
13. For more information, see: Coughlin, J. et al (2010). *A Guide to Community Solar: Utility, Private, and Non-profit Project Development*. National Renewable Energy Laboratory. Available at: <http://www.nrel.gov/docs/fy11osti/49930.pdf>.
14. For more information, see U.S. Department of Energy (2017) *Quadrennial Energy Review:* Transforming *the Nation's Electricity System: The Second Installment of the QER*. Available at: <https://www.energy.gov/epsa/downloads/quadrennial-energy-review-second-installment>, p.1-22 to 1-24.
15. Regional Greenhouse Gas Initiative. Available at: <https://www.rggi.org/>.
16. California Air Resources Board (2017). "Cap-and-Trade Program". Available at: <https://www.arb.ca.gov/cc/capandtrade/capandtrade.htm>.
17. Hibbard, P.J., Okie, A.M., Tierney, S.F. and Darling, P.G. (2015) *The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeast and Mid-Atlantic States*. Center for Climate and Energy Solutions. Available at: <https://www.c2es.org/docUploads/rggi-mou.pdf>.
18. Norman, M. and Nakhooda, S. (2015). *The State of REDD+ Finance*. Center for Global Development Working Paper 378. Available at: <https://www.cgdev.org/sites/default/files/CGD-Norman-Nakhooda-Climate-Forests-5-REDD-Finance.pdf>
19. Popp, A. et al (2014) "Land-use protection for climate change mitigation". Nature Climate Change 4: 1095-1098.
20. Sheeran, K.A. (2005) ""Forest conservation in the Philippines - a cost-effective approach to mitigating climate change?" Ecological Economics 58: 338–349.
21. Scheer, S.J. and Sthapit, S. (2009) Mitigating Climate Change through Food and Land Use. Worldwatch Report 179. Washington, D.C.: Worldwatch Institute.
22. Ibid.
23. Vermont, B. and De Cara, S. (2010) ""How costly is mitigation of non-CO_2 greenhouse gas emissions from agriculture? A meta-analysis"". Ecological Economics 69: 1373–1386
24. Scheer, S.J. and Sthapit, S. (2009) Mitigating Climate Change through Food and Land Use. Worldwatch Report 179. Washington, D.C.: Worldwatch Institute.
25. Ibid.
26. Duguma, L.A., Minang, P.A. and van Noordwijk, M. (2014) ""Climate Change Mitigation and Adaptation in the Land Use Sector: From Complementarity to Synergy". Environmental Management (2014) 54: 420-432.
27. American Public Transport Association (2008) The Benefits of Public Transportation: Public Transport Reduces GHG and Conserves Energy. Washington, D.C.: American Public Transport Association.
28. Economist (2017, 18 Feb) "Volts wagons: Electric cars are set to arrive far more speedily than anticipated". The Economist. Available at: <http://www.economist.com/news/business/21717070-carmakers-face-short-term-pain-and- long-term-gain-electric-cars-are-set-arrive-far-more>
29. Ebinger, J.O., Vandycke, N. and Rogers, J.A. (2015) ""More Climate Finance for Sustainable Transport". Connections. World Bank Group Transport & Information and Communication Technology Global Practice.
30. Coady, D. et al (2015) *How Large are Global energy Subsidies?* IMF Working Paper WP/15/105. Available at: <https://www.imf.org/external/pubs/ft/survey/so/2015/NEW070215A.htm>
31. Asian Development Bank (2010) Evaluation Study: Reducing Carbon Emissions from Transport Projects. Evaluation Knowledge

Brief REG 2010-16.
32. Sims, R. et al (2014) "Transport" in Edenhofer, O. et al (eds.) Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change . Cambridge: Cambridge University Press.
33. Committee on Climate Change (2014) ""Road transport"". Available at: <https://www.theccc.org.uk/charts-data/ukemissions-by-sector/transport/>
34. Howey, D., North, R. and Martinez-Botas, R. (2010) Road transport technology and climate change mitigation. Imperial College London, Grantham Institute for Climate Change Briefing Paper No.2.
35. Van Renssen, S. (2011) "The Case for Adaptation Funding". *Nature Climate Change* 1: 19-20. <http://www.nature.com/nclimate/journal/v1/n1/full/nclimate1051.html>
36. Carbon Brief (2015), "Global Climate Change Adaptation Spending". Available at: <https://www.carbonbrief.org/huge-divide-in-spending-on-climate-change-adaptation-across-worlds-megaticities>.
37. Terpstra, P. (2013) "Is Adaptation Short-Changed? The Imbalance in Climate Finance Commitments". *World Resources Institute*. Available at: <http://www.wri.org/blog/2013/11/adaptation-short-changed-imbalance-climate-finance-commitments>
38. See, for example: Fankhauser, S. and McDermott, T.K.J. (2014). "Understanding the Adaptation Deficit: Why are poor countries more vulnerable to climate events than rich countries?" *Global Environmental Change* 27(1): 9-18.
39. See Center for Climate Strategies (2011) *Center for Climate Strategies Adaptation Guidebook*, Available at: <http://www.climatestrategies.us/library/library/download/908>, Appendix 3 for a catalog of potential actions.
40. U.S. Department of Agriculture (2005) *Economics and Survival of Hand- Planted Riparian Forest Buffers in West Central Maine*. Natural Resources Conservation Service. Available at: <https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcs143_009647&ext=pdf>.
41. Lynch, L. and Tjaden, R. (2000) *When a Landowner Adopts a Riparian Buffer - Benefits and Costs*. University of Maryland Cooperative Extension Fact Sheet 774. Available at: <https://extension.umd.edu/sites/extension.umd.edu/files/_docs/programs/riparianbuffers/FS774.pdf>.
42. Tufekcioglu, A., Raich, J.W., Isenhart, T.M. and Schultz, R.C. (2003). "Biomass, carbon and nitrogen dynamics of multi-species riparian buffers within an agricultural watershed in Iowa, USA". *Agroforestry Systems* 57:187-198.
43. Irfan, U. (2014) "New $1.1B sea wall protects New Orleans against major storms but may cultivate complacency". *ClimateWire*. Available at: <https://www.eenews.net/stories/1059999621>.
44. Navarro, M. (2012) "Weighing Sea Barriers as Protection for New York". *New York Times*. Available at: <http://www.nytimes.com/2012/11/08/nyregion/after-hurricane-sandy-debating-costly-sea-barriers-in-new-york-area.html>.
45. Searle, R and Al-Khafaji, K. (2013) *How Philanthropy Can Help Communities Advance Climate Change Adaptation*. The Bridgespan Group.
46. Ibid.
47. Ibid.
48. Ashmore, J. (2017, 24 May) Personal communication.
49. Fox-Penner, P. as cited in Boston University (2017) "Boston University and CGMF Collaborate on Innovative Long-term Texas Water Management Project". Available at: <https://www.bu.edu/news/2017/02/22/boston-university-and-cgmf-collaborate-on-innovative-long-term-texas-water-management-project/>.
50. Griffiths-Sattenspiel, B and Wilson, W. (2009) *The Carbon Footprint of Water*. River Network.
51. Williams, T. (2014) "Resilience is Hot Among Climate Funders. Here's Who Is Out Front Prepping for Doom" *Inside Philanthropy.* Available at: <https://www.insidephilanthropy.com/home/2014/5/5/resilience-is-hot-among-climate-funders-heres-who-is-out-fro.html>.
52. See, for example: The San Diego Foundation (2017) "Climate Resilience: Vulnerable Populations. Higher temperatures, health risks and new opportunities". Available at: <https://www.sdfoundation.org/wp-content/uploads/2017/05/economic-resilience-vulnerable-populations.pdf>.
53. Oxford Geoengineering Programme (2017). Available at <http://www.geoengineering.ox.ac.uk/>.
54. IPCC (2007) "Summary for Policymakers". In Metz, B. et al (eds.) *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.
55. IPCC (2014) *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Geneva: IPCC.
56. Ibid.
57. Ibid.
58. Roberts, D. (2013). "Ending the stupid technology innovation vs. deployment fight once and for all." *Grist.* Availble at: <http://grist.org/climate-energy/ending-the-stupid-technology-innovation-vs-deployment-fight-once-and-for-all/>.
59. Jenkins, J., and Mansur, S. (2011). *Bridging the Clean Energy Valleys of Death: Helping American Entrepreneurs Meet the Nation's Energy Innovation Imperative*. Breakthrough Institute.
60. Ibid.
61. Ibid.
62. Ibid.
63. Gaddy, B.E., Sivaram, V., Jones, T.B. and Wayman, L. (2017). "Venture Capital and Cleantech: The wrong model for energy innovation". *Energy Policy* 102: 385-395.
64. See, for example, data on renewables and energy efficiency in the PwC MoneyTree Report. Available at: <https://www.pwc.com/us/en/technology/moneytree/explorer.html#/type=history&category=&currentQ=Q1%202017&qRangeStart=Q1%202002&qRangeEnd=Q1%202017&chartType=bar&mfsec=Energy%20and%20Utilities>.
65. Advanced Research Projects Agency-Energy (2017). Available at: <https://arpa-e.energy.gov/?q=arpa-e-site-page/about>.
66. American Energy Innovation Council. (2015) "Restoring American Energy Innovation Leadership: Report Card, Challenges, and Opportunities". Bipartisan Policy Center.
67. Greentech Media Editors (2017). "EPA and ARPA-E Funding Survive Congressional Budget Cuts—For Now". *Greentech Media.*

Available at: <https://www.greentechmedia.com/articles/read/EPA-and-ARPA-E-Funding-Survive-Congressional-Budget-Cuts-For-Now>
68. Mission Innovation (2017). Available at <http://mission-innovation.net/about/>.
69. Ifran, U. (2017) "A grim prognosis for Mission Innovation under Trump". *E&E News* Available at: <https://www.eenews.net/climatewire/2017/01/09/stories/1060048035>.
70. Breakthrough Energy Coalition (2016) "The Landscape of Innovation". Available at: <http://www.b-t.energy/wp-content/uploads/2016/10/BreakthroughEnergyCoalition_Landscape.pdf>
71. Oxford Geoengineering Programme (2017). Available at <http://www.geoengineering.ox.ac.uk/>.
72. National Research Council (2015) "Climate Intervention: Carbon Dioxide Removal and Reliable Sequestration." Washington, DC: The National Academies Press.
73. Weier, J. (2001) "John Martin (1935-1993): The Iron Hypothesis". *NASA Earth Observatory*. Available at: <https://earthobservatory.nasa.gov/Features/Martin/martin_4.php>
74. IPCC (2014) *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Geneva: IPCC.
75. Hanafi, A. (2014) "Geoengineering the climate may be possible, but who decides?" Environmental Defense Fund. Available at: <https://www.edf.org/blog/2014/03/25/geoengineering-climate-may-be-possible-who-decides>.
76. Black, R. (2012) "Geoengineering: Risks and benefits". *BBC News*. Available at: <http://www.bbc.com/news/science-environment-19371833>.
77. IPCC (2014) *Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change.* Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
78. IPCC (2014) *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Geneva: IPCC.
79. GiveWell (2014). "Geoengineering Research". Available at: <http://www.openphilanthropy.org/research/cause-reports/geoengineering>.
80. U.S. Government Accountability Office (2010). "Climate Change: A Coordinated Strategy Could Focus Federal Geoengineering Research and Inform Governance Efforts".
81. Plumber, B. (2017) "How carbon capture could become a rare bright spot on climate policy in the Trump era". *Vox*. Available at: <https://www.vox.com/energy-and-environment/2017/4/12/15269628/carbon-capture-trump>.
82. Ibid.
83. Bickel, J.E. and Lane, L. (2009). "An analysis of climate engineering as a response to climate change." *Smart Climate Solutions* 40.
84. Wilkinson, H. (2016). "Climate Change (Part 2 of 2)." *Giving What We Can*. Available at: <https://www.givingwhatwecan.org/report/climate-change-2/#fn62>.
85. Solar Radiation Management Governance Initiative. Available at: <http://www.srmgi.org/>
86. GiveWell (2013). "Geoengineering research funding 10-9-13" Available at: <http://files.givewell.org/files/shallow/geoengineering/Geoengineering%20research%20funding%2010-9-13.xls>.
87. Fund for Innovative Climate and Energy Research. Available at: <https://keith.seas.harvard.edu/FICER>.
88. Rothman, D. H. et al. (2015) "Are We Headed for a Sixth Extinction?" *Science Philanthropy Alliance.* Available at: <http://www.sciencephilanthropyalliance.org/what-we-do/resources/extraordinary-opportunities/are-we-headed-for-a-sixth-extinction/>.
89. Hansen, S. (2012), "Cultivating the Grassroots: A Winning Approach for Environment and Climate Funders". *Philanthropy at Its Best*. National Committee for Responsive Philanthropy. Available at: <https://www.ncrp.org/wp-content/uploads/2016/11/Cultivating_the_grassroots_final_lowres.pd>
90. Collard et al. (2015), "Move Beyond Coal: The Global Movement in 2015". *The Sierra Club*. Available at: <https://content.sierraclub.org/creative-archive/sites/content.sierraclub.org.creative-archive/files/pdfs/1188-Beyond-Coal-Report-Web_04_low.pdf>
91. See Ethridge, M. and Handelman, H. (2014), *Politics in a Changing World*. Boston, MA: Wadsworth Publishing. Ch. 6 "Interest Groups".
92. Goodman, J. (2017), "Social Movement Participation and Climate Change". *Oxford Research Encyclopedia, Climate Science.* Available at <http://climatescience.oxfordre.com/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-340?rskey=jKFcCJ&result=71>
93. Ethridge, M. and Handelman, H. (2014), *Politics in a Changing World*. Boston, MA: Wadsworth Publishing. Ch. 6 "Interest Groups".
94. See Zuber, D. (2013), "How to Build a Grassroots Climate Change Movement in China". *Pacific Environment Blog: Updates from the Field.* Available at <https://pacificenvironment.org/how-to-build-a-grassroots-climate-change-movement-in-china/>
95. Ethridge, M. and Handelman, H. (2014), *Politics in a Changing World*. Boston, MA: Wadsworth Publishing. Ch. 6 "Interest Groups".
96. Ethridge, M. and Handelman, H. (2014), *Politics in a Changing World*. Boston, MA: Wadsworth Publishing. Ch. 6 "Interest Groups".
97. Move to Amend (2016), "Citizen's Lobbying Guide", *Take Action Toolkit.* Available at <https://movetoamend.org/toolkit/citizens-lobbying-guide>
98. Oil Change International. (2017), "Fossil Fuel Funding to Congress: Industry influence in the U.S." *The Price of Oil.* Available at <http://priceofoil.org/fossil-fuel-industry-influence-in-the-u-s/>
99. ValueWalk (2016), "The Best ROI Ever? $1,171 For Every $1 Of Lobbying." *ValueWalk.* Available at <http://www.valuewalk.com/2016/04/best-roi-ever-1171-every-1-lobbying/>
100. Warren, E. (2016), *This Fight is Our Fight: The Battle to Save America's Middle Class.* New York, NY: Metropolitan Books. p.171.
101. Open Secrets Center for Responsive Politics (2017) *Environment: Background*. Available at: <https://www.opensecrets.org/industries/background.php?cycle=2016&ind=Q11>
102. Gunther, M (2017) "Climate Converts: The Conservatives Who Are Switching Sides on Warming". Yale Environment 360. Available

at: <http://e360.yale.edu/features/climate-converts-the-conservatives-who-are-switching-sides-on-climate-change>
103. See https://citizensclimatelobby.org/.
104. Bornstein, D. (2017) "Cracking Washington's Gridlock to Save the Planet". New York Time. Available at: <https://www.nytimes.com/2017/05/19/opinion/cracking-washingtons-gridlock-to-save-the-planet.htm
105. See http://www.republicen.org/.
106. Meador, R. (2015), "A look at the spectacular success of the Beyond Coal campaign". *MinnPost.* Available at: <https://www.minnpost.com/earth-journal/2015/06/look-spectacular-success-beyond-coal-campaign>
107. Ethridge, M. and Handelman, H. (2014), *Politics in a Changing World*. Boston, MA: Wadsworth Publishing. Ch. 6 "Interest Groups".
108. Meador, R. (2015), "A look at the spectacular success of the Beyond Coal campaign". *MinnPost.* Available at: <https://www.minnpost.com/earth-journal/2015/06/look-spectacular-success-beyond-coal-campaign>
109. Carrington, D. (2015), "Guardian Media Group to divest its £800m fund from fossil fuels". *The Guardian.* Available at: <https://www.theguardian.com/environment/2015/apr/01/guardian-media-group-to-divest-its-800m-fund-from-fossil-fuels>
110. Jordan, R. (2017), "Stanford expert suggests focusing on shared values rather than climate change". *Stanford News.* Available at: <http://news.stanford.edu/2017/04/04/stanford-expert-lets-talk-jobs-not-climate-change/>
111. Cunningham, N. (2014), "Coal: The World's Deadliest Source Of Energy". *OilPrice.com.* Available at: <http://oilprice.com/Energy/Coal/Coal-The-Worlds-Deadliest-Source-Of-Energy.html>
112. Tenenbaum, D. (2009), "Oil Sands Development: A Health Risk Worth Taking?". *Environmental* Health *Perspectives*. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2679626/>
113. Weissmann, S. (2015). "All Politics is Local: Grassroots Advocacy". National Active and Retired Federal Employees Association. [PowerPoint Slides]. Available at: <https://www.narfe.org/pdf/legconf15_All%20Politics%20is%20Local%20Grassroots%20Advocacy.pdf>
114. Collard et al. (2015), "Move Beyond Coal: The Global Movement in 2015". The Sierra Club. Available at: <https://content.sierraclub.org/creative-archive/sites/content.sierraclub.org.creative-archive/files/pdfs/1188-Beyond-Coal-Report-Web_04_low.pdf>
115. Kahn, J. and Yardley, J. (2007). "As China Roars, Pollution Reaches Deadly Extremes". *The New York Times.* Available at: <http://www.nytimes.com/2007/08/26/world/asia/26china.html>
116. Bauerova, L. (2016). "Global Coal Use to Stall as India Props Up Growth, IEA Says". *Bloomberg Markets*. Available at: <https://www.bloomberg.com/news/articles/2016-12-12/global-coal-demand-to-stall-as-india-props-up-growth-iea-says>
117. Kahn, J. and Yardley, J. (2007). "As China Roars, Pollution Reaches Deadly Extremes". The New York Times. Available at: <http://www.nytimes.com/2007/08/26/world/asia/26china.html>
118. PTI (2016). "India's coal demand to see biggest growth globally: IEA" The New Indian Express. Available at: <http://www.newindianexpress.com/business/2016/dec/12/indias-coal-demand-to-see-biggest-growth-globally-iea-1548302.html>
119. Venkatesu, E. (2016). *Democratic Decentralization in India: Experiences, Issues and Challenges.* Abingdon: Routledge.
120. Nace, T. (2011). "Down with coal! The grassroots anti-coal movement goes global". *Grist*. Available at: <http://grist.org/coal/2011-05-27-down-with-coal-the-grassroots-anti-coal-movement-goes-global/>
121. Cornot-Gandolphe, S. (2016). "Southeast Asia Coal Demand and Imports". *EIA Conference* [PowerPoint Slides]. Available at: <https://www.eia.gov/conference/2016/pdf/presentations/gandolphe.pdf>
122. Tan, A. (2004). "Environmental Laws and Institutions in Southeast Asia: A Review of Recent Developments". *Singapore Yearbook of International Law.* Available at: <http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan026596.pdf>
123. Kahn, J. and Yardley, J. (2007). "As China Roars, Pollution Reaches Deadly Extremes". The New York Times. Available at: <http://www.nytimes.com/2007/08/26/world/asia/26china.html>
124. Zhang, Q. et al (2017) "Transboundary health impacts of transported global air pollution and international trade". *Nature* 543: 705-709.
125. Hale, T. (2016) "After Trump, the Groundswell of Global Climate Action is ever more central to the climate regime". *Oxford University Blavatnik School of Government*. Available at: <https://blogs.bsg.ox.ac.uk/2016/11/22/after-trump-the-groundswell-of-global-climate-action-is-ever-more-central-to-the-climate-regime/>
126. See: http://climateaction.unfccc.int/.
127. See: http://climateinitiativesplatform.org.
128. See: http://www.southeastfloridaclimatecompact.org/.
129. For a robust list and analysis of key actors, networks, and initiatives, see Galvanizing the Groundswell of Climate Actions (2017) "Building a Catalytic Ecosystem for Subnational and Nonstate Actors". Available at: <http://www.climategroundswell.org/blogtest/2017/3/7/memorandum-how-can-funders-accelerate-global-climate-action-to-2018-and-2020>
130. Mazza, F., Falzon, J. and Buchner, B. (2016) *Global Climate Finance: An* Updated *View on 2013 & 2014 Flows*. Climate Policy Initiative.
131. Ibid.
132. Ibid.
133. Williams, T. (2016) "Can Philanthropy Spur the Massive Climate Finance the Developing World Needs?" Inside Philanthropy. Available at: <https://www.insidephilanthropy.com/home/2016/6/10/can-philanthropy-spur-the-massive-climate-finance-the-develo.html>
134. Buchner, B. (2016) "Philanthropy's Role in Financing a Climate-Resilient World". Climate Policy Initiative. Available at: <https://climatepolicyinitiative.org/2016/06/16/philanthropys-role-financing-climate-resilient-world/>
135. Kramer, L. and Larson, C. (2015), "Foundations Must Move Fast to Fight Climate Change". The Chronicle of Philanthropy. Available at: <https://www.philanthropy.com/article/Foundations-Must-Move-Fast-to/229509>
136. Morena, E. (2016) The Price of Climate Action: Philanthropic Foundations in the International Climate Debate. Cham: Springer International Publishing.
137. Lazarova, I. (2016) "Inside the Rockefeller Foundation's climate finance strategy". GreenBiz. Available at: <https://www.greenbiz.com/article/inside-rockefeller-foundations-climate-finance-strategy>
138. Reich, R. (2013) "What Are Foundations For?" *Boston Review.* Available at: <http://bostonreview.net/forum/foundations-philanthropy-democracy>
139. Campanale, M. and Daramus, I. (2016) "Philanthropy's role in mobilizing green finance". Alliance Magazine. Available at: <http://

www.alliancemagazine.org/feature/philanthropys-role-in-mobilizing-green-finance/>
140. ClimateWorks Foundation (2017) "Grants Database: Current Grants." Available at: <http://www.climateworks.org/portfolios/grants-database/>
141. Williams, T. (2016) "Can Philanthropy Spur the Massive Climate Finance the Developing World Needs?" Inside Philanthropy. Available at: <https://www.insidephilanthropy.com/home/2016/6/10/can-philanthropy-spur-the-massive-climate-finance-the-develo.html>
142. Morena, E. (2016) The Price of Climate Action: Philanthropic Foundations in the International Climate Debate. Cham: Springer International Publishing.
143. Lazarova, I. (2016) "Inside the Rockefeller Foundation's climate finance strategy". GreenBiz. Available at: <https://www.greenbiz.com/article/inside-rockefeller-foundations-climate-finance-strategy>
144. Buchner, B. (2016) "Philanthropy's Role in Financing a Climate-Resilient World". Climate Policy Initiative. Available at: <https://climatepolicyinitiative.org/2016/06/16/philanthropys-role-financing-climate-resilient-world/>
145. Mission Investors Exchange (n.d.). "About Mission Investing". Available at: <https://www.missioninvestors.org/node/7>.
146. Ibid. The other type of mission investment is a market-rate investment (MRI), also known as a mission-related investment. MRIs generate market-rate financial returns while also achieving a social or environmental impact in line with the foundation's mission. They are investments of a foundation's endowment that do not count towards its 5% payout. Therefore, they are not discussed here.
147. Systrom, N., Kearney, S. and Murrary, F. (2017) "Foundations: exploring the emerging practice of philanthropic investing to support innovation in science and engineering". MIT innovation initiative.
148. Redstone Strategy Group (2015) "Mission Investments at the Packard Foundation". Available at <https://www.packard.org/what-were-learning/resource/mission-investments-at-the-packard-foundation/>
149. Redstone Strategy Group (2016) "Philanthropy's Full Force: Mission investments to catalyze climate solutions". Availabe at: <https://www.packard.org/what-were-learning/resource/mission-investments-to-catalyze-climate-solutions/>
150. Ibid.
151. Ibid.
152. 350.org. (2016). "Campaign Update: East Asia". Available at: <https://350.org/campaign-update-east-asia/>
153. Smith, H. (2014). "How 350.org went from "strange kid" to head of the green class". *Grist*. Available at: <http://grist.org/climate-energy/how-350-org-went-from-strange-kid-to-head-of-the-green-class/>
154. Vaidyanathan, G. (2015). "In India, climate change takes a back seat to coal-powered development". *Climatewire*. Environment and Energy Publishing. Available at: <https://www.eenews.net/special_reports/greater_expectations/stories/1060026415>
155. Pacific Environment. (2017). "Building Citizen Power to Keep Coal in the Ground". Available at: <https://pacificenvironment.org/what-we-do/the-climate-challenge/coal/>
156. Morris, R. (2012). "Cleaning up China's dirtiest region". *Deutsche Welle*. Available at: <http://www.dw.com/en/cleaning-up-chinas-dirtiest-region/a-16287019>
157. Change (2017). "Discussion on Impacts of coal thermal power on marine environment and people's lives: Case study of Hon Cau marine protected area". Available at: <http://www.changevn.org/?p=2992>
158. Greenpeace Philippines. (2016). "Piglas Pilipinas: 10,000 march against coal plants in Batangas, nationwide". Press Release. Available at: <http://www.greenpeace.org/seasia/ph/press/releases/Piglas-Pilipinas-10000-march-against-coal-plants-in-Batangas-nationwide/>
159. Hansen, S. (2012), "Cultivating the Grassroots: A Winning Approach for Environment and Climate Funders". *Philanthropy at Its Best*. National Committee for Responsive Philanthropy. Available at: <https://www.ncrp.org/wp-content/uploads/2016/11/Cultivating_the_grassroots_final_lowres.pd>
160. Klein, N. "This Changes Everything: Capitalism vs. the Climate with Naomi Klein". The Canada Program, Weatherhead Center for International Affairs. 19 April 2017. First Parish in Cambridge, Cambridge, MA. Lecture.
161. Nilles, B. (2016), "Beyond Coal, Beyond the United States". *Bloomberg Philanthropies Blog*. Available at: <https://www.bloomberg.org/blog/beyond-coal-beyond-united-states/>
162. Hitt, M. (2017). "Sierra Club's Beyond Coal Campaign Crosses 100,000 MW Milestone for America's Clean Energy Transition". *The Huffington Post*. Available at: <http://www.huffingtonpost.com/mary-anne-hitt/sierra-clubs-beyond-coal_b_9842428.html>
163. This calculation and its inputs are available in our Supplementary Report. Note that the damage caused by coal combustion varies widely depending on the ash content of the coal itself, how it is mined, and the proximity of power plants to population centers.
164. Grace, K. (2013). "Less Burn for Your Buck: Part II". Giving What We Can. Available at: <https://www.givingwhatwecan.org/post/2013/11/less-burn-for-your-buck-part-ii/>
165. Grunwald, M. (2015). "Inside the war on coal". *Politico*. Available at: <http://www.politico.com/agenda/story/2015/05/inside-war-on-coal-000002>
166. Giving What We Can (n.d.). "Against Malaria Foundation". Center for Effective Altruism. Available at: <https://www.givingwhatwecan.org/charity/against-malaria-foundation/>
167. See Grassroots Global Justice Alliance: http://ggjalliance.org/ourpowercampaign.
168. Abate, R.S. (2016) "Climate Justice: Case Studies in Global and Regional Governance Challenges". Faculty Books and Book Contributions 24. Available at: < http://commons.law.famu.edu/faculty-books/24>
169. National Association for the Advancement of Coloured Peoples (2017) *Environmental & Climate Justice*. Available at: <http://www.naacp.org/issues/environmental-justice/>
170. See Urban Sustainability Directors Network: https://www.usdn.org.
171. Morena, E. (2016) The Price of Climate Action: Philanthropic Foundations in the International Climate Debate. Cham: Springer International Publishing.
172. Williams, T. (2016) "Can Philanthropy Spur the Massive Climate Finance the Developing World Needs?" Inside Philanthropy. Available at: <https://www.insidephilanthropy.com/home/2016/6/10/can-philanthropy-spur-the-massive-climate-finance-the-develo.html>
173. Buchner, B. (2016) "Philanthropy's Role in Financing a Climate-Resilient World". Climate Policy Initiative. Available at: <https://climatepolicyinitiative.org/2016/06/16/philanthropys-role-financing-climate-resilient-world/>
174. Lazarova, I. (2016) "Inside the Rockefeller Foundation's climate finance strategy". GreenBiz. Available at: <https://www.greenbiz.

com/article/inside-rockefeller-foundations-climate-finance-strategy>
175. See: https://www.rockefellerfoundation.org/blog/fighting-wildfire-with-finance/.
176. See: http://www.africanriskcapacity.org.
177. See http://www.gib-foundation.org/2017/04/resilience-dividend-yes-exists/. See also Cities Climate Finance: http://citiesclimate-finance.org.
178. See http://climatefinancelab.org
179. Buchner, B. (2016) "Philanthropy's Role in Financing a Climate-Resilient World". Climate Policy Initiative. Available at: <https://climatepolicyinitiative.org/2016/06/16/philanthropys-role-financing-climate-resilient-world/>.
180. See: http://ndci.global.
181. PRIME Coalition (2017). Available at: <http://primecoalition.org/>.
182. The attached files include information on PRIME's due-diligence on their 2017 docket companies and more information about their investment options.
183. Redstone Strategy Group (2016) "Philanthropy's Full Force: Mission investments to catalyze climate solutions". Availabe at: <https://www.packard.org/what-were-learning/resource/mission-investments-to-catalyze-climate-solutions/>.
184. Sorenson Impact Foundation: <http://sorensonimpactfoundation.org/>
185. Creo Syndicate: http://creosyndicate.org/about/
186. The Climate Solutions Collaborative: http://climatesolutionscollaborative.org/

PREPARED FOR
THE RAY AND TYE NOORDA FOUNDATION

Harvard University Effective Altruism Student Group
Philanthropy Advisory Fellowship

Authors:
Alexandra Batchelor
Shira Miller
Stuart Iler
Amber Houghstow
Alex Clark

Special thanks to:
Eric Gastfriend
Hayden Wilkinson

June 2017