

The Laudato si' Challenge

On Care For Our Common Home



Together, let us inspire creativity worldwide to improve the lives of **one billion** of the most vulnerable people and the vitality of our most **vulnerable ecosystems**

Every dimension of the climate challenge is an opportunity to
act for the care of our common home.



I. Introduction



In 2015, Pope Francis issued an encyclical letter calling for a dialogue among all people about our common home: Earth. The earth—the source of all life—is both our inheritance and our legacy.

We humans possess the God-given gifts of foresight and creativity that are necessary not only to anticipate but to bend the arc of history—for our planet and for ourselves. The opportunity to exercise those gifts lies at the heart of this Challenge.

Seventy years ago, a wondrous event occurred: human beings were able to view the earth from space for the first time. In the decades since, we have become accustomed to seeing our common home in its true form—as a singular sphere of life in a vast cosmos. However, only recently have we become aware of having crossed another threshold of comparable significance: in our lifetimes, the very weather that brings the rain and wind—forces believed by ancient peoples to represent divinity itself—has become subject to human decision-making.

We have learned that choices made daily by literally every person who shares our common home affect the climate changes we are experiencing today and the planet we are passing on to our children. We have come to call this phenomenon climate change, but it is in fact a change in the human condition, one that is mediated through our immediate biological and physical environment. This includes, but is in no way limited to, changes in the chemical composition of the atmosphere that extends miles above the earth.

Throughout human history, sudden advances in technology and associated changes in economic fundamentals have always affected the biophysical environment that sustains us. At each of these turning points, humankind awoke to previously unimaginable possibilities and equally unimagined challenges. We are now at one of those pivotal moments—one that is, for the first time, truly planetary in scope.

Climate change has a profound impact on the planet and on our species, but it also provides tremendous opportunity. As Pope Francis has said, “Love does require a creative, concrete, and ingenious attitude. Good intentions and conventional formulas, so often used to appease our conscience, are not enough.”

Understanding the human dimension of climate change enables us to appreciate that the challenge of a changing climate presents us all with a singular invitation to serve one another as we show our respect for God’s gifts. Therefore, the essence of The Laudato si’ Challenge is a call to humans to respond to the opportunity created by climate change. It is an opportunity to care. It is an opportunity to contribute. And it is an opportunity to create. Opportunities abound when we extend our imagination and turn our will toward taking action along these three dimensions.

II. The Context

The historical forces of industrialization that have caused this dramatic shift in the human condition over the past two hundred years have been central to a wave of progress that has extended the human lifespan and measurably improved the wellbeing of people nearly everywhere.



The urgent challenge to protect our common home includes a concern to bring the whole human family together to seek a sustainable and integral development, for we know that things can change. We require a new and universal solidarity. [Everyone can contribute to] the care of creation, each according to his or her own culture, experience, involvements, and talents.

- Laudato si'



However, some human-driven historical forces—notably the burning of fossil fuels, in combination with other practices such as large-scale animal husbandry and forest clearing—have demonstrably and unquestionably caused the earth's surface temperature to rise and the weather to become more volatile.

Atmospheric concentrations of carbon dioxide, the primary determinant of global climate change, have increased by more than 40 percent since pre-industrial times, from approximately 280 parts per million by volume (ppmv) in the 18th century to more than 400 ppmv in 2015. The resultant changes in the earth's climate have already begun to have a broad impact on natural systems and are producing major changes that affect human lives. Some examples:

- Melting glaciers in the Himalayas and Andes have begun to threaten the water supply of one-sixth of the world's population that depends on the glaciers for drinking water, hydropower, and irrigation.
- Crop yields have begun to decline in vulnerable places, leaving hundreds of millions of people facing possible future reductions in their local food supply.
- Coastal flooding resulting from rising sea levels, coupled with increased variability in the frequency and intensity of storms, could eventually affect the half of the planet's population that lives next to the ocean. There will be a disproportionate impact for Southeast and South Asia, small islands, and large coastal cities such as Tokyo, New York, Cairo, and London.¹
- Ocean acidification resulting from rising carbon dioxide levels has intensified, affecting the vitality of the oceans—and thus of all of us globally who rely on the oceans for either our sustenance, our livelihoods, or both.

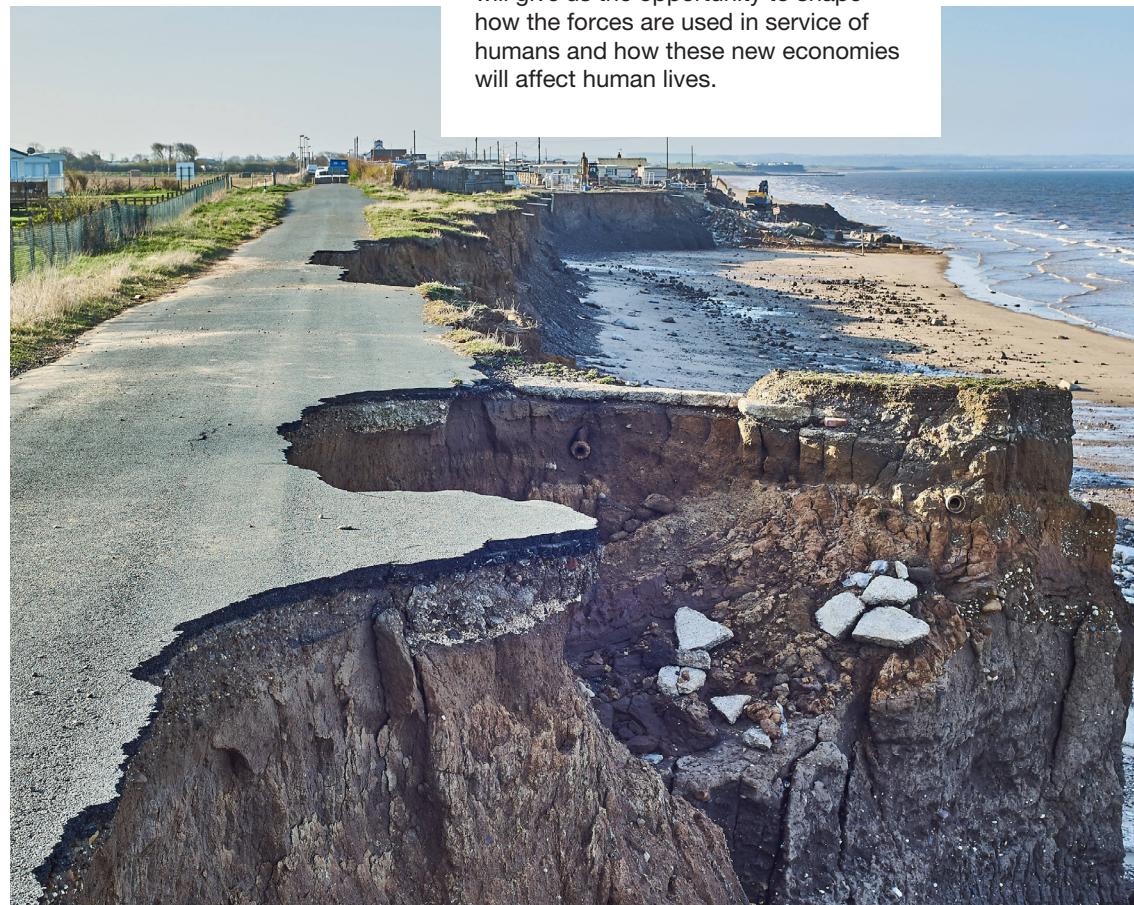
In this, as in other human-caused calamities, the poor of the planet are the most vulnerable.

What is more, while there are obvious limits to our ability to understand the functioning of the climate beyond the human experience, the best science suggests that abrupt and large-scale changes will become increasingly likely as planetary warming increases. These include sudden shifts in rainfall and other climate patterns; adverse impacts on food security; damage to major rainforest ecosystems; and the melting or collapse of ice sheets, resulting in a rapid rise in sea level.²

However, the most important fact regarding the impact the human species is having on our common home has nothing to do with the atmospheric chemistry and everything to do with sea-level economics. In this, as in other human-caused calamities, the poor of the planet are the most vulnerable. In a world in which the safety and security of many humans' homes will be more and more at risk, we must consider how to meet the challenge most effectively.

Knowledge dissemination and communications technology are some of the newest tools to revolutionize the ways we connect with one another and interact with our world. Some of these powerful forces will be the basis for new economies, which will give us the opportunity to shape how the forces are used in service of humans and how these new economies will affect human lives.

The Industrial Revolution was about finding ever more powerful ways to increase the productive capacity of manufacturing, but it had little or no concern for our planet or for the deep divisions that progress would bring. The next revolution will be about replacing industry with integral ecology, which signifies the balance that must ultimately exist between caring for one another and caring for our common home.³



III. Call to Action

*Our intention in announcing *The Laudato si'* Challenge is to inspire action in caring for our common home. The Challenge is equally and integrally intended to inspire action in the service of our fellow brothers and sisters—particularly those poorest in material circumstances who are at risk of bearing the brunt of the climate changes we humans have wrought.*



As this document describes, the deficit we face is one of imagination, not solutions. Indeed, important aspects of the climate opportunity can be addressed using existing technologies—and done so profitably.⁴ In fact, addressing climate change can unleash wealth and prosperity for businesses, investors, entrepreneurs, and workers around the world. But profits are not the only kind of opportunities to be unlocked. Remaking society to address climate change can mean finding ways to live more fulfilling and engaged lives, to build more beautiful and resilient communities, to be more secure and better nourished.

Technological approaches to climate change are critical, of course, but technological innovation is not the only kind of innovation required to realize the full potential of the climate opportunity. Innovation in the generation and dissemination of knowledge, in behavioral change, in policies, in organizational forms, in business models, and in finance are just a few of the additional areas where innovation is necessary.

The complexity of the climate and its interaction with the world's natural, economic, and social systems demands the engagement, creativity, and coordination of all of humanity. It also demands a certain kind of matchmaking; the people who best

understand the problems must connect with the people who best understand possible solutions. Teams formed to address these challenges must show a level of creativity that extends to their own composition by bringing together people with complementary skills to develop a common vision for achievable change.

Every past failure is an invitation to take immediate action, and each provides the opportunity to create sustainable climate solutions that rely on win-win outcomes—an approach that draws strength from its confidence in the limitless creativity of human beings. We are living at a time when real heroism, creativity, and connection with other people are possible and will enable us to take on the immense challenge of climate change in new ways. Every dimension of the climate challenge is an opportunity to act for the care of our common home.⁵

The *Laudato si'* Challenge describes eight such opportunities:

- The Energy Opportunity
- The Food Opportunity
- The Water Opportunity
- The Urban Opportunity
- The Human Potential Opportunity
- The Conservation Opportunity
- The Industry and Finance Opportunity

“

A more creative and better directed [path of productive development] offers the fullest possibilities to human ingenuity to create and innovate, while at the same time protecting the environment and creating more sources of employment. Such creativity would be a worthy expression of our most noble human qualities, for we would be striving intelligently, boldly and responsibly to promote sustainable and equitable development within the broader concept of quality of life.

- **Laudato si'**

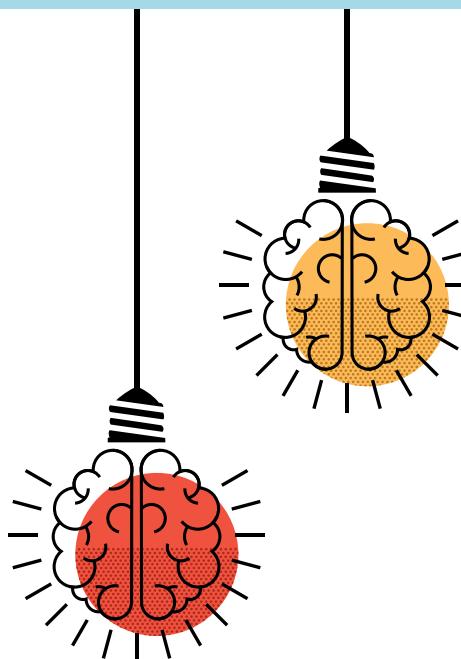
”

IV. How to Respond to The Laudato si' Challenge



This Challenge is intended to inspire action in the care of our common home along three vital dimensions:

- 1/ **Innovation:** Transformative businesses
- 2/ **Inspiration:** Collaborations and partnerships
- 3/ **Imagination:** A global movement



By harnessing the creative potential of humanity for transformative change, these three elements provide three crucial pathways to address climate change successfully. Business has an inherent ability to mobilize resources and people, find practical solutions to problems, and create pathways for distribution, and it has the capacity to scale to global levels. At the same time, resetting the foundations of our global systems requires creative partnerships, knowledge generation, and organizing from the local to the global level. And, finally, these solutions must be energized by a broadly and commonly held sense of passion, purpose, and imagination in caring for our common home.

1. Innovation: Building transformative, scalable businesses that respond profitably to the opportunities created by climate change.

- To enter a proposed business in the Challenge, candidate companies will submit information about their intended market, business model, team, learning to date, and pathway to scale.
- Using a three-tiered finance model, 50 selected innovations will go through three stages of growth: proof of concept, testing and positioning for scale, and transitioning proven solutions to scale.

2. Inspiration: Initiating collaborations and partnerships that have the potential to reset the foundations of the institutions and economic systems.

- Submissions in this category will consist of an inspired idea for a collaboration or partnership. They will include a clearly conceived plan to launch and scale the initiative; objectives and quantifiable goals; and, ideally, initial evidence of success.
- Selected submissions in this category will receive support in the form of access to networks and potential partners, and opportunities to showcase their actions and results.

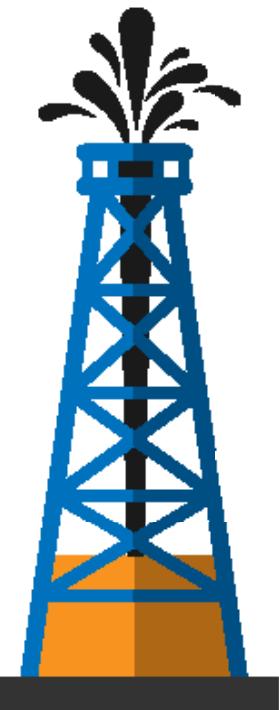
3. Imagination: Fostering a global movement of individuals, communities, and networks that are sharing ideas and engaging creatively in response to climate change.

- Sometimes solutions come from those closest to the problem, and not from a laboratory or library. Innovative and important ideas can come from anywhere. These entrants will share an approach to climate change that affects a local community, a region, or the world. Their ideas will be submitted via text message, email, Twitter, a video message or image, or even a handwritten note delivered to a local parish priest. The most inspiring ideas will be shared widely and recognized for their contribution to addressing the global problem of climate change.

The following categories encapsulate areas of ecological concern addressed by the Challenge. Each pathway describes opportunities to have a transformational impact, and offers guiding information and case studies. Solutions along these three dimensions sourced by the Challenge will contribute substantively to realizing the vision for integral development expressed in Laudato si'.

We know that technology based on the use of highly polluting fossil fuels...needs to be progressively replaced without delay. Taking advantage of abundant solar energy will require the establishment of mechanisms and subsidies which allow developing countries access...The costs of this would be low, compared to the risks of climate change.

- Laudato si'



1. The Energy Opportunity

Transform our energy systems to mitigate the most severe consequences of climate change.

Energy systems are major drivers of climate change worldwide: they are responsible for approximately two-thirds of all human-caused greenhouse gas emissions.⁶ Carbon dioxide (CO₂), the greenhouse gas largely responsible for modern-day climate change, is primarily emitted by burning fossil fuels (coal, oil, natural gas) for energy production.⁷

Methane (CH₄) makes up a much smaller percentage of the greenhouse gases in the atmosphere. However, its potency is four times higher than that of carbon dioxide, which makes it a significant factor. The warming effect of methane is four times that of carbon dioxide, and it lingers in the atmosphere with slowly diminishing potency; after 100 years it is still 28 times more potent than carbon dioxide. Methane is a byproduct of the production of natural gas, a key energy source.⁸ It is also a result of livestock production and the thawing permafrost.

More Energy, in Better Ways

The availability of energy directly correlates to quality of life. With 1.2 billion people lacking adequate access to reliable energy, we must find ways to increase that access, but without accelerating climate change.⁹ In general we do not want less energy use, as more energy can improve public health and quality of life, increase food security, and affect a wide range of human development issues. But we must generate and consume that



increased energy in a radically different way that doesn't have the drawback of producing carbon emissions and contributing to climate change.¹⁰

This is in fact already a global trend. In 2014, for the first time in 40 years, the global economy grew while energy-related CO₂ emissions stayed flat.¹¹ Decoupling emissions from economic growth shows that this is possible, which many countries have begun to demonstrate at the national level, but these trends still need to be accelerated globally.¹²

Creating Carbon-Neutral Energy Systems

There are many ways to attain carbon neutrality in our energy systems. The energy mix of the future is currently unknown, and achieving it will require



innovation in technology, business, and infrastructure management.

The current breakdown in greenhouse gas emissions by sector is as follows:

- Electricity generation and heat: 25 percent
- Industry/Manufacturing: 21 percent
- Transportation: 14 percent
- Buildings: 6 percent
- Other energy: 10 percent
- The remaining 24 percent comes from agriculture and land use.¹³

To mitigate the most severe consequences of climate change, we must transform our energy system across these four sectors: electricity, manufacturing, transportation, and buildings. We also must find ways to capture and store the carbon we have already emitted.

Technologies that are needed to make the transition to carbon-neutral energy systems already exist.

Opportunities for Innovation

Technological challenges remain, but major changes to our global energy system could be made now. Given the costs of delaying action on climate change, action taken now to deploy existing technologies would significantly decelerate climate change.

Opportunities for innovation to meet the world's growing energy needs are abundant—many are also profitable—from the large-scale deployment of decentralized renewable energy systems, to the education and certification of contractors to lead renewable energy projects, to fundamentally reimagining our sense of ownership.¹⁴

The innovation possible by fundamentally reimagining energy also provides the opportunity to do so in ways that create livelihoods and jobs, and enrich cultural practices.

PATHWAYS

- 1) Transition to **carbon-neutral** electricity generation in developed countries.
- 2) Develop **alternative industrial infrastructures** for emerging countries.
- 3) Fundamentally **reimagine and “decarbonize”** transportation, aviation, and shipping. Radically improve building and industrial energy efficiency.
- 4) Develop and implement **carbon-capture and carbon-negative systems** (such as bioenergy carbon capture and storage) to remove residual carbon from the atmosphere.





CASE STUDY

No Money Down Solar

Upscaling Distributed Renewable Energy Systems
in the U.S. and India

Sunlight is free, the ultimate source of life on our planet. Sunlight is the energy source that starts the food chain on which all life depends. Harnessing this abundant and free source of energy makes perfect sense, financially and environmentally. People have been working for decades to figure out how to do that, and solar panels are the result.

The latest generation of solar panels produces plenty of electricity, and they have quickly become cheaper than the prohibitively expensive early models. Solar panels now cost 85 percent less than they did just a decade ago, which means they can now pay for themselves in energy savings in a relatively short time.¹⁵ However, the initial cost of installation still remains too high for most individuals, families, and small businesses, and turning to solar is often a difficult investment decision, even for larger businesses with competing priorities.

That's where a new generation of businesses comes in. With such great savings in energy costs to be had, innovators saw an opportunity to start businesses that could make money while increasing the distribution of clean energy.

In 2003, SunEdison pioneered the model of "Solar as a Service" in the United States, which changed the

paradigm for solar energy companies. SunEdison bought, installed, and maintained solar panels for their clients, who benefited from the reduced cost of electricity. Clients pay for the service, which is still cheaper than their usual energy bill, thereby saving money and reducing carbon emissions at the same time.

In India in 1995, engineer Harish Hande and solar energy advocate Neville Williams started SELCO India. A social business, SELCO is committed to increasing energy access in India, where millions still lack access to basic electricity in their homes. SELCO partnered with banks and microfinance institutions to help poor rural households purchase solar panels, which the company installs and maintains. SELCO India has provided more than two million solar systems to their customers in India.

What these companies have in common is:

- Basing their fundamental value proposition on a customer need—affordable energy;
- Overcoming customer barriers to adopting solar panels—the relatively high up-front cost—and maintaining them by offering the specialized services needed with an innovative finance- and service-based business model;
- Blending financing and service models adapted to their customers' needs, using available technologies to create tailored solutions for different markets; and
- Tying their profitability to both social and environmental benefits, so the more money they make, the greater impact their services have.

Billions of dollars remain to be made in deploying solar and other energy renewables in this type of "distributed" system, both to people who have no access to electricity and to families and businesses that could benefit from having access to more affordable energy.



**CASE STUDY:**

Bullitt Center

The Greenest Commercial Building
in the World



In 2010, the buildings sector directly contributed more than 6 percent of global greenhouse gas emissions, and it was indirectly responsible for 12 percent of emissions due to its electricity use and the way it managed heating and cooling (IPCC, 2014).

To reduce its emissions and join the effort to pursue a low-carbon economy, the buildings sector will need to adopt such strategies as fuel-switching and large-scale energy efficiency improvements (White House, 2016). In order to help avert the worst effects of climate change, all new building stock should strive to achieve very low or zero-energy status, while older stock should plan to undergo large-scale upgrades using multiple technologies (IEA, 2013). To successfully decarbonize the buildings sector, this transition will require innovations in areas such as design and systems engineering.

The Bullitt Center in Seattle, Washington, provides a fascinating example of the transformative possibilities in the buildings sector. The Bullitt Center drew from a wide array of ready-made innovations around the world and incorporated them under one roof. The building design was influenced by the concept of biomimicry, a method of replicating natural processes to help create sustainable solutions for the built environment. Several notable features of the building are a large solar photovoltaic array, waterless composting toilets, a rainwater catchment system, constructed

wetlands for greywater filtration, geothermal heat pumps, and automated external window blinds. These features are some of the reasons why the Bullitt Center is regarded as one of the greenest commercial buildings in the world (Bullitt Center, 2017).

In order to help avert the worst effects of climate change, all new building stock should strive to achieve very low or zero-energy status.

However, such large-scale design innovation can come at a cost, especially when certain technologies have not yet gained widespread market penetration. Estimates suggest that the Bullitt Center cost roughly 23 percent more than a typical office building in the Seattle area. However, much of that added cost was attributed to the novel design methodologies used in its construction, and it can be reduced through economies of scale. Despite some initial financing and regulatory challenges, the Bullitt Center is now a cash-flow-positive building and provides an example of how to challenge the status quo in the buildings sector to help drive transformative change in the marketplace (Bullitt Center, 2017).



CASE STUDY

The Case of Tesla

Breaking Down Market Barriers

Disruptive technologies can play a key role in advancing clean energy solutions, but they can also face challenges with market entry and penetration (Stringham et al., 2015; Vaishnav, 2008).

In the United States, the electric vehicle market has had to contend with an incumbent automotive industry defined by the internal combustion engine and powerful companies such as Ford, Chrysler, and General Motors (Klepper, 2001). Numerous attempts to break down electric vehicle market barriers have been met with challenges such as high cost, low range per charge, lack of charging infrastructure, unattractive model options, and concerns over lifetime performance (MIT, 2008; PWC, 2016; Ungar et al., 2010; Winton, 2014). Thus, the electric vehicle industry faces the critical question of how to blend automotive performance optimally with high environmental standards, without sacrificing product quality.



Enter Tesla Inc. A relatively young company founded in 2003 (Tesla, 2017), Tesla has seemingly defied logic by becoming the most valuable U.S. automaker as of April 2017 (Welch, 2017). In pursuit of a mission to “accelerate the world’s transition to sustainable energy” (Tesla, 2017), Tesla has quickly become a harbinger of technological and marketing innovation that has brought disruptive change to clean-energy markets. Despite its other product offerings, such as solar panels and energy storage, one of Tesla’s biggest success stories may be the rollout of electric vehicles.

Part of the Tesla strategy has been to take the time necessary to get the



technology and design considerations right, regardless of the number of iterations needed (Stringham et al., 2015; Tesla, 2017). The company started small, with an expensive, low-volume approach to production (Stringham et al., 2015), and had subsequent plans to make each new vehicle increasingly affordable (Tesla, 2017). Its first electric vehicle was the Roadster, which launched in 2008. The Tesla Roadster had a range per charge



of 245 miles, and the ability to do 0 to 60 mph in less than four seconds. Since it began production of the Roadster, Tesla has unveiled three newer models, Model S, Model X, and Model 3. These three models have demonstrated continuous improvement in Tesla’s offerings. The Model S, for example, can go 265 miles per charge, and it won Motor Trend’s 2013 Car of the Year award. It also received a five-star safety rating from the U.S. National Highway

Tesla has quickly become a harbinger of technological and marketing innovation that has brought disruptive change to clean energy markets.

Traffic Safety Administration, which demonstrates the company’s ability to provide a high-quality product that blends automotive and environmental performance.

Beyond continuous improvement and innovation, a major portion of Tesla’s success has been in forming successful partnerships and cross-pollinating ideas (Stringham et al., 2015). By establishing partnerships with companies such as Lotus, Daimler, Panasonic, and Toyota, Tesla was able to leverage existing technology, manufacturing infrastructure, and expertise to help navigate market entry barriers and get its first vehicle to market (Stringham et al., 2015). In 2014, Tesla also decided to release all of its patents to the public, in part to encourage other entrants into the electric vehicle space (Stringham et al., 2015). By adopting a business strategy that valued both competition and collaboration, Tesla has achieved some notable early success in moving the transportation sector toward sustainable energy.

2. The Food Opportunity

Remake our food systems to minimize their contribution to greenhouse gas emissions, make them resilient within a changing climate, and guarantee food security for all.

Reimagining the future of food is a core challenge of climate change. Our food systems currently contribute 24 percent of global greenhouse gas emissions, a percentage likely to increase significantly if current trends continue. A rising population in the next century will increase global demand for food, perhaps by as much as 70 percent by 2050, making agricultural productivity and climate-resilient food systems increasingly critical.¹⁶

Food-System Drivers of Climate Change

As people attain a higher standard of living, they tend to eat more meat. Raising livestock to supply this increase contributes to greenhouse gas emissions in two important ways. First, the digestive process of livestock, especially cattle, produces methane gas, which, as stated, is four times more potent than carbon dioxide. Methane production from livestock currently represents 45 percent of the greenhouse gas emissions from agriculture and land use.

Second, producing feed for the livestock contributes directly and indirectly to greenhouse gas emissions; it makes up 39 percent of the total gases generated by agriculture and land use.

The ways we use land for food and feed production contribute to climate change. For example, when forests are cleared for agriculture, they no longer provide the important service

of absorbing carbon dioxide from the atmosphere and storing (sequestering) the carbon.

Finally, the production and use of fertilizers and growing feed for animals involve industrial and chemical processes and transportation, which produce greenhouse gases.

Impact of Climate Change on Food Systems and Food Security

Decreasing food security for many people is a likely impact of climate change. Drought, increased flooding, and more frequent and intense storms across large regions of the world will increase risk of crop failures and lower overall productivity.

Food prices—already likely to rise with the increasing population, higher



demand for meat, and decreased yields because of climate change—will become increasingly unstable, driving prices up further as the market responds to price shocks. Furthermore, livelihoods dependent on agriculture will be threatened: 50 percent of employment worldwide is in the agriculture sector.

Fisheries—a major source of protein for more than 3.1 billion people—are also threatened because of the current environmental degradation and overfishing. As a consequence of climate change, the global distribution of catch potential will shift, and the loss of biodiversity will make the ecosystems that sustain fisheries unstable.¹⁷

PATHWAYS

- 1) Reimagine our **livestock production** and consumption systems so they can be carbon neutral or carbon negative.
- 2) Replace the current dominant food-system drivers of **deforestation and land degradation**.
- 3) **Protect marine and freshwater fisheries** from collapse due to the disruption of these ecosystems.
- 4) Increase our **agricultural systems' productivity and resilience** to environmental change by harnessing emerging scientific, technological, and financial innovations.
- 5) Introduce **new technologies** and mechanisms to restore **20 percent of the earth's land** that has been degraded.
- 6) **Improve opportunities** for smallholder farmers.



CASE STUDY

Climate-Smart Agriculture

and Indigenous Knowledge in a Changing World

Scientists are currently working with farmers to revive the more traditional farming approach of treating land, crops, and species as one holistic system.

In the face of a changing climate, it will be important for societies to develop climate-smart agricultural strategies that protect against climate risks and reduce greenhouse gas emissions stemming from agricultural activities. Climate change poses a number of direct and indirect risks to global agricultural systems, and it is expected to have a net negative impact on both crop and livestock production in most regions.

Direct risks include higher average global temperatures and the increasing frequency and intensity of extreme weather events, while indirect risks include concerns over water security and soil health. The agricultural sector is also a large contributor of greenhouse gas emissions and is responsible for 24 percent to 31 percent of direct and indirect global emissions (from land use changes, including deforestation; OECD, 2015). Therefore, adaptation and mitigation in the agricultural sector should be a high priority.

Agricultural systems stand to benefit from a blend of scientific and indigenous knowledge related to climate-smart agriculture (FAO, 2013), which can drive innovation and reduce climate risk. In the coastal Indian state of Kerala, farmers are facing climate-related threats that include rising temperatures and sea levels (Jena, 2017). Although the Green Revolution in



India led to large increases in crop yields through the use of chemical fertilizers and pesticides, as well as improved varieties of wheat and other food plants, some farmers in Kerala are reverting back to 150-year-old farming methods to hedge against the risks of future climate change.

Scientists are currently working with farmers to revive the more traditional farming approach of treating land, crops, and species as one holistic system that can decrease the need for chemical fertilizers and reduce risks caused by climate and weather extremes. For example, cow dung is used to make fertilizer, fish and rice are organically coproduced, and vegetable crops are planted in low-lying areas next to coconut trees, which helps fortify embankments against flooding. The anticipated benefits for farmers include greater self-sufficiency from lower dependency on fertilizer and greater income security from raising crops and fish simultaneously (Jena, 2017).





CASE STUDY

Protein Substitution

The Aspire Food Group and Lab-Grown Meat



Crickets may not seem key to fighting climate change, but the Aspire Food Group may prove otherwise.

With palm-weevil operations in Ghana and a 13,000-square-foot cricket warehouse in Texas, this social venture is part of a growing movement to bring inexpensive proteins to the general public with little environmental impact.

Raising livestock—a major and growing source of protein—produces methane, the greenhouse gas four times as potent as carbon dioxide. Furthermore, producing the feeds livestock are given is energy intensive, and the land cleared for cattle to graze on often contributes to deforestation. Having fewer trees means less carbon is absorbed from the atmosphere, and it also threatens biodiversity. Substituting alternative protein sources could help shift our food systems toward carbon neutrality. In Ghana, Aspire's food source is already popular. The model aims to raise incomes and protein intake while reducing food insecurity.

Lab-grown meat might be healthier than traditional meat.

A high-protein, insect-based “power flour” the company produces could play a key role in disaster relief. Most recently, Aketta—its roasted cricket product line—is introducing American palates to the idea of eating insects.

Other approaches to changing our food systems include creating replacement products for meat, dairy, and seafood. One example is the lab-grown meat being developed by Memphis Meats, an American company. Biologically the same as meat from animals, it could alter the way we produce meat without requiring drastic dietary changes.

All new technologies come with tradeoffs, but early studies show that, because hormones are not used and it is produced in a sterile environment, lab-grown meat might be healthier than traditional meat. Evidence suggests that growing meat in labs would cut down on the amount of land required to produce meat products by 99 percent, reduce the need for water by 90 percent, and reduce greenhouse gas emissions by around 90 percent over conventional meat production.¹⁸

3. The Water Opportunity



Water is critical to ecosystems, to the global food supply, to economic development, to public health, to women's rights—to human survival. The risks to the planet's freshwater systems caused by climate change increase significantly with higher concentrations of greenhouse gases. The impact is felt in the rising percentage of the world population that is enduring water scarcity and is affected by flooding.

In much of the world where surface and groundwater resources are reduced, which includes much of the Global South, there is a significant risk of increased competition between countries and sectors for water resources. By contrast, climate change in a significant portion of the Global North will lead to greater water resources. Climate change is widely expected to reduce water quality because of higher temperatures, increased sediment and pollutants from rainfall and flooding, a concentration of pollutants during drought, and disruption of treatment facilities during flooding.¹⁹

PATHWAYS²⁰

- 1) Increase the efficiency of water usage in agriculture through improved techniques, such as micro-irrigation and water recycling.
- 2) Increase water availability through radically improved desalination or mesh filtration.
- 3) Create climate-resilient freshwater management systems:
 - Scenario planning and learning-based approaches
 - Participative planning at multiple scales
 - Improved knowledge-sharing and data collection
 - Strengthened international research
 - Cost-effective and adaptive water management
 - Technology transfer adaptation and capacity (business innovation)
 - Ecosystem-based freshwater management
- 4) Leverage financing for water-management adaptation and risk-management:
 - Conduct systematic assessments of climate change resilience of all utilities for the use of risk management financing
 - Develop investment vehicles for infrastructure and demand management adaptation (finance innovation)

“

Access to safe drinking water is a basic and universal human right, since it is essential to human survival and, as such, is a condition for the exercise of other human rights. Our world has a grave social debt towards the poor who lack access to drinking water, because they are denied the right to a life consistent with their inalienable dignity.

- Laudato si'

”



CASE STUDY

Look to the Desert

for Water Innovation

Amid current and future concerns over freshwater availability, the water sector will need to unearth truly innovative strategies to help preserve the quantity and quality of global freshwater resources.

In the dry desert of Nevada in the United States, the city of Las Vegas is serving as a fountain of innovation for water-resource management. In addition to more traditional management methods, such as municipal fines and incentive programs, the city has partnered with an incubator called WaterStart to test some new techniques to conserve water resources (Daigneau, 2016).

One technique is to use hydrophones, which are underwater sensors that can be used for the early detection of pipeline leaks and ultimately help prevent a large rupture. Hydrophones use auditory detection, which can be an efficient and complementary technique for water management (Khulief, 2012). Las Vegas is now home to the first public utility in the United States to pilot this technology (Goldman, 2016). Another technique uses a device called the PipeMinder, which can capture high-resolution data on water pipeline infrastructure to help detect leaks (Daigneau, 2016).

At the water-systems macro level, Las Vegas has an ongoing water recycling program that funnels water used indoors back into Lake Mead, which is an important source of the city water supply. The recycling program has helped Las Vegas decrease its water use by one-third, even while the city has seen a surge in population growth (Goldman, 2016). Through these methods and other innovative techniques, Las Vegas is poised to become a water-project incubator that can help other communities under increasing strain and uncertainty from climate change to adapt their water-resource management systems.

The city of Las Vegas is serving as a fountain of innovation for water-resource management.





CASE STUDY

Safeguarding Water Resources

in an Uncertain Climate



India is likely to experience a range of negative impacts on its agricultural systems in the future due to climate change, including greater seasonal variations in temperature and longer heat waves.

One major consequence of these projected changes is the alteration of summer monsoon precipitation (Kumar & Gautam, 2014), which could have a widespread impact on crop production. Sugarcane is a major crop in India, which is one of the largest sugarcane producers in the world (Solomon, 2016), and it is a major tool in rural and economic development (Gold Standard, 2017). It is estimated that the production of sugarcane supports more than 35 million Indian farmers. Sugarcane is a water-intensive crop (Kumar & Gautam, 2014), so it is critical that Indian farmers adopt innovative strategies that help them cope with an uncertain water supply.

It is estimated that the production of sugarcane supports more than 35 million Indian farmers.

The Sustainable Sugarcane Initiative (SSI) is currently working with smallholder farmers to help them meet the future demand for sugarcane in a sustainable manner. In terms of water consumption, the SSI is using a variety of techniques to assist farmers with smart strategies for water conservation.

One technique involves raising seedlings in a nursery for up to one month before planting them in the field, which can reduce the amount of water needed up to 90 percent. A second technique involves using ample spacing between plants to help accommodate drip irrigation, which also can save a large amount of water. The SSI will recycle some of the revenues back into the project in order to increase the number of farmers who are able to participate in the program (Gold Standard, 2017).

Some benefits of the SSI include greater crop yields, fewer chemicals, rural job creation, higher incomes, water conservation, and greater agricultural productivity. The SSI is also capable of being scaled; the goal is to increase from approximately 1,500 farmers currently using the techniques to more than 20,000 within five years (Gold Standard, 2017). Projects like the SSI can provide numerous benefits to society and can be replicated in other communities to improve water use and protect against the adverse impact of climate change.

4. The Urban Opportunity

Build and reinvent our urban communities with an eye on carbon neutrality and resilience in the face of climate change in ways that are inclusive, value local knowledge and culture, and provide opportunity for all to flourish, regardless of income or identity.



Humankind is becoming more urban every day. More than half of the world population lives in cities, and that figure is growing by 200,000 a day. By 2050, six billion people—70 percent of humankind—will live in cities, and nearly all of humanity will live less than a day's travel from a midsized city.

Cities are the engines of prosperity: they define the global economy, create prosperity, and generate waste. The way cities are structured and governed determines and will determine much about the lifestyles that will have a real impact on climate change. Those factors also determine whether citizens are able to prosper and thrive within a climate-change scenario.

On a per-capita basis, cities have considerably smaller environmental footprints than rural or even peri-urban environments. Cities are large enough to make a difference on climate change while also being small enough to escape the political divisiveness

that frequently impedes action at the national or even the provincial level. New cities emerging in the Global South offer an opportunity to reinvent the city altogether, whereas cities in the Global North can become more competitive, innovative, resilient, and healthier by redesigning urban structures to be more sustainable and livable.²¹

Many cities have not used land sustainably or offered their residents healthy and enjoyable lifestyles. People often are trapped in their cars during long commutes, and in some cities, basic services are unavailable to those who live in cramped slums. Smog blankets some cities, which causes respiratory problems and shortens lives. Despite these problems, cities continue to attract masses of people, as the concentration of industry offers opportunities to earn a livelihood that are impossible to find in rural areas and smaller communities. Cities are likely to be the future home of many people now living in rural and suburban communities that are facing the effects

of climate change.

Cities are likely to be the future home of many people now living in rural and suburban communities that are facing the effects of climate change.

PATHWAYS

- 1) Structure emerging cities to meet the housing, food, and transportation needs of their populations in carbon-neutral ways.
- 2) Change urban transport systems to make them carbon neutral.
- 3) Share sustainable urban innovation on a global scale.
- 4) Structure cities to be resilient to locally relevant climate impacts.



CASE STUDY Sustainable Development Goals



More than half of the world's current population lives in urban areas, and that number is projected to swell.

Estimates are that urban areas will absorb another 2.5 billion people by 2050 and harbor 66 percent of the global population, while rural areas will see a contraction in population by mid-century. In 2014 there were 28 known mega-cities—those with ten million or more residents—a number that is also expected to increase (United Nations, 2014). This pressure on urban populations will bring numerous challenges, but it also can provide opportunities to address them through innovative public policies.

Sustainable development will be a crucial aim for urban areas if they are to ensure that they can meet population growth with economic opportunity, social inclusion, and environmental protection. The United Nations Sustainable Development Goals (SDGs; United Nations, 2017) lay

out an ambitious agenda to help meet the goals of sustainable development, and they provide an important planning tool for urban areas. The Sustainable Development Solutions Network (UNSDSN, 2016) recently undertook an innovative effort to localize the SDGs to cities and human settlements that can serve as a guide for SDG implementation and help meet the challenges of sustainable development in urban areas. The SDG Cities Guide can be an important tool to engage urban planners, residents, policy-makers, business and civil society, and other key stakeholders in a holistic effort to address urban challenges and craft solutions that will help urban areas thrive into the future.

The SDG localization effort is already under way in some areas, with active initiatives in Brazil, Colombia, and the United States. Among other goals, these initiatives seek to implement a process of SDG monitoring, achieve specific local objectives, and integrate the SDG framework within existing plans and policies. In Colombia, the government has already created a special commission to roll out its SDG agenda in a manner that will promote collaboration between existing agencies, such as foreign affairs, finance, environment, social prosperity, statistics, and national planning (UNSDSN, 2016). Thus, SDG localization plans can be used as convening tools that cut across different agencies and economic sectors to promote inclusivity and represent the needs of diverse stakeholders.

The SDG Cities Guide can be an important tool to engage key stakeholders in a holistic effort to address urban challenges.

5. The Human Potential Opportunity

Minimize the human suffering that occurs when climate change forces the most vulnerable among us to leave their homes or makes our communities more susceptible to the outbreak of disease or warfare.

Migration

There is an integral link between “home” and “migration.” Voluntary migration is hope: to seek a home. Forced migration is despair: to lose a home. Just as we show compassion in caring for our common home, we also must show compassion in caring for those who have lost their personal homes.

In this way, caring for our common home also demands that we care for people when their homes become so unsafe that they are compelled to leave them.

Climate change has the potential to cause the most serious humanitarian disasters in human history. Droughts, floods, rising seas, and worsening storms seriously threaten people living on the margins of society. Smallholder subsistence farmers can be disastrously affected by even a small shift in rainfall. Rising sea levels will make some coastal areas uninhabitable and completely inundate several small island nations. Furthermore, an increase in violent conflicts has been directly tied to environmental conditions that are characteristic of what occurs under climate change. Under these circumstances, people fleeing conflict may be forced to become refugees.



It is possible that more than 200 million people will become climate migrants by the end of the 21st century.²² People forced to flee from their homes face incredible hardship and uncertainty. The majority migrate to cities or other rural communities within their own countries in a process known as internal displacement. They also—although much less frequently—seek safe refuge beyond national borders. Migration can be an important strategy for adapting to and surviving crisis, but it may be out of reach for many poor people who become further impoverished by climate change.²³ In the face of deteriorating conditions, people should have an equal right to stay where they are or to move to an area where they can live a sustainable existence.

Traditional approaches to aiding migrants and refugees have not been adequate. The increase and changes in the patterns of people moving provide an opportunity to rethink how we respond. Opportunities to respond to climate migration include supporting policies that allow people to increase their ability to survive through migration, and ensuring that people displaced internally and across borders due to slow- and sudden-onset disasters

“

We need to strengthen the conviction that we are one single human family. There are no frontiers or barriers, political or social, behind which we can hide, still less is there room for the globalization of indifference.

- **Laudato si'**

”

receive adequate assistance and protection.²⁴ Further opportunities are presented by the political challenges associated with migration. Communications on climate change and migration can be restructured to tell the stories of people affected more effectively.²⁵

There are tremendous opportunities to build businesses and social enterprises that respond to the needs of climate migrants and refugees. Migrants and refugees experience a clear, three-phase journey, and there are opportunities in each phase to provide them with services and to help them maintain and restore their rights and dignity.

PATHWAYS

- 1) Predict and plan more fully for climate migration.
- 2) Improve the conditions in people's homes to reduce the need to migrate.²⁷
- 3) Ease the burdens of climate migrants' transit and temporary resettlement.
- 4) Integrate climate migrants into cities and other communities.
- 5) Document and manage the flow of climate migrants within and beyond borders.
- 6) Respond with leadership to the political challenges of migration and refugees.

The Migration Cycle

1. PREMIGRATION

In crisis settings, people balance the desire to maintain their lives and their bonds with family and community with the need for basic services, and for food and water. Many people remain trapped without the resources to migrate or to live safely at home, but choosing to leave makes them vulnerable to scam artists and smugglers.

2. IN MOTION

Threatened individuals and families begin their arduous journey toward a better life. Carrying just a few belongings, they must leave behind most of the wealth and assets they have acquired over a lifetime of work. Their journey often involves sleeping outside and having no access to toilets, food, electricity, or clean water.

3. IN TRANSITION

Many find temporary accommodation in a camp, border-crossing area, or other transitional facility. As many as 10 million people are currently stuck in these no-man's lands, waiting to resume their lives.²⁶



Health and Climate Change

CONFLICT, MIGRATION, AND HEALTH

Multiple complex, coincident, and interacting environmental changes will alter habitability and drive population displacement. These changes are likely to be accompanied by the additional burdens of disease and disability, as displacement is associated with sharp increases in infectious disease outbreaks, malnutrition, and physical and mental trauma.

INFECTIOUS DISEASE

Infectious diseases like malaria, schistosomiasis, dengue fever, and zika are a large burden globally. Moreover, they are highly sensitive to changes in environmental conditions, including temperature, soil moisture and precipitation patterns, deforestation, dams and irrigation projects. Animal disease is an important subtheme of climate change, as zoonotic diseases are also likely to increase. Changes in the animal population can have a deleterious effect on biodiversity, food security, and livelihoods.

NUTRITION

Much of the global burden of disease is related to an inadequate intake of calories, micronutrients, and important

The warmer temperatures associated with climate change increase the formation of tropospheric ozone, a main constituent of smog and a contributor to cardiorespiratory disease.

foods such as fruits, vegetables, meats, nuts, and seeds. The burden of disease is also associated with an excessive intake of the wrong foods. As the global food demand increases at an unprecedented pace, the biophysical conditions that underpin our global food production system have also been changing rapidly. These changes in access to nutrition make humanity enormously vulnerable to the impact environmental change.

MENTAL HEALTH

There is a growing body of research on the mental health dimensions of global environmental change. Gaining a better understanding of these issues is needed to inform resource-management decisions and urban design in order to mitigate the impact environmental change has on mental health.

NON-COMMUNICABLE DISEASE

The warmer temperatures associated with climate change increase the formation of tropospheric ozone, a main constituent of smog and a contributor to cardiorespiratory disease. A warming climate is also associated with a longer pollen season and increased pollen production, which can intensify respiratory diseases such as asthma. Particulate air pollution is driving an increase in cardiovascular diseases and associated mortality. Also of concern is the global epidemic of over-nutrition, characterized by the excessive intake of the wrong foods. This trend is largely driven by inadequate access to fruits, vegetables, fish, and nuts and seeds, and is resulting in unprecedented rates of obesity, diabetes, and heart disease.²⁸



PATHWAYS

- 1) Anticipate, plan for, and prevent increased disease vector ranges.
- 2) Integrate locally relevant public health responses to the impact of climate change into public health and governance structures.
- 3) Empower public health and health-care workers to use their expertise to support decision-making about climate action.
- 4) Provide health expertise on climate risk and cost-benefit analysis.
- 5) Integrate climate change mitigation broadly into public health strategies.

Employment and Human Creativity

Reducing poverty and creating the opportunity for all people to flourish is a global challenge shared by all.

Climate change is threatening these goals. Most poor countries have a hot climate and face high rainfall variability even without climate change; further warming will exacerbate these factors. Poor countries are greatly dependent on agriculture, the most climate-sensitive economic sector. Their low incomes, inadequate health care, and low-quality public services and infrastructure make them particularly vulnerable to climate changes and make adaptation more difficult.



For individuals and families in poor countries, climate change will likely reduce income, increase illness and death, and reduce their ability to save money for future investment. Climate-induced challenges will force increased spending at the national level while also reducing revenues, further impairing poor nations' ability to invest in infrastructure.²⁹

Action on climate change therefore must address the poverty dimension of climate change. The human potential in poor countries is tremendous, especially as their populations are relatively youthful. Creative ways of generating income and activating this potential are an important factor in approaches to climate change.

For individuals and families in poor countries, climate change will likely reduce income, increase illness and death, and reduce their ability to save money for future investment.

POTENTIAL AMONG THE GLOBAL MAJORITY OF PEOPLE

The global informal economy, which consists largely of poor and vulnerable populations, is an important economic force that generates up to 50 percent of non-agricultural GDP.³⁰ Estimates are that from 20 percent to 70 percent of people around the globe work in the informal economy.

The current global median age is 28; 1.2 billion people are between the ages of 15 and 24. As many as half of all young people in the global labor force may lack adequate work. Youth unemployment leads to their having lower earnings throughout life and a greater likelihood they will turn to organized crime and violence, and it especially limits the life choices for young women.³¹

PATHWAYS

- 1) Mobilize the creativity and potential of the informal workforce to address and adapt to climate change, meanwhile providing humane wages and living conditions.
- 2) Mitigate and adapt to climate change in ways that provide jobs and other opportunities for the world's most vulnerable youth
- 3) Maximize the opportunities for unemployed or underemployed people throughout the world to take part in economic activities that address or adapt to climate change.
- 4) Engage young people and marginalized communities in the use of accessible technology, citizen science, and entrepreneurship to respond to one of the climate opportunities identified in this Challenge document.



CASE STUDY

Informal Sector Engagement

(WIEGO/Environmental Agents)



The informal economy broadly includes jobs, workers, and economic activities that are not afforded protection or regulated by the state (WIEGO, About the Informal Economy, 2017).

The informal economy has been expanding since it was first recognized in the 1970s, and today it represents 50 percent to 75 percent of non-agricultural labor in most developing nations (WIEGO, About the Informal Economy, 2017). Along with making a large contribution to the global economy, the informal sector can help reduce poverty and inequality if it is recognized and supported in public-policy decisions (WIEGO, 2017).

Waste pickers are one of many groups in the labor force of the informal economy (WIEGO, Waste Pickers and the Law, 2017). These workers perform a variety of waste management services that drive sustainability and improve urban health and sanitation (WIEGO, Waste Pickers and the Law, 2017). Despite their economic, social, and environmental contributions, waste pickers face a range of challenges to their rights due to legal and regulatory barriers, including discrimination, economic insecurity, and threats to personal health and safety (WIEGO, Waste Pickers and the Law, 2017).

In Pune, India, waste pickers decided to organize in an effort to improve working conditions and seek more formal recognition in the local economy. After citing the many benefits their work provides to society and the local community, a worker-owned cooperative was established that consisted of waste pickers and other informal sector workers involved in municipal solid waste management. The cooperative also partnered with the local Pune Municipal Corporation; it now provides recognized waste management services for the city, and waste pickers and buyers now represent more than three-fourths of the workers in Pune's local recycling market.

Research suggests that, in 2006, the informal economy in Pune recovered 118,000 tons of material and prevented approximately 22 percent of recyclables from going into landfills, which resulted in substantial municipal cost savings (Chikarmane, 2012).

As waste pickers continue their fight for recognition, technology may be able to play a useful role in such issues as compensation for services provided. For example, a project in Brazil sought to help increase waste pickers' earnings by leveraging the use of a mobile application along with direct community engagement to better understand their various roles and needs. The project found that using a mobile application can provide an array of useful services to waste picker communities, including easier access to market value information, quantification of materials collected, and greater access to buyers and waste-collection facilities (Fox, 2017). Having this type of enhanced information-sharing network through technology applications could help alleviate some of the challenges currently faced by waste pickers and other communities around the world.

In Pune, India, waste pickers decided to organize in an effort to improve working conditions and seek more formal recognition in the local economy.

6. The Conservation Opportunity

Protect the world's most fragile ecosystems, preserve global biodiversity, and maintain healthy and thriving ecosystems worldwide. Maximize the breadth of ecosystems that sequester carbon and protect human society from the effects of climate change.

To grasp our own true nature is to understand that humans are not aliens on this earth; we are part of nature. Every day we fill our lungs with air, we drink water, we eat plants and animals, which in turn are sustained by the air, water, sunlight, and minerals.

The complex relationships between organisms and their environments support life—including our own—in countless ways. Plants produce oxygen, which we breathe. They filter water and form the base of countless food chains. Bacteria that live inside our own bodies are essential in enabling us to use the nutrients from foods. Fungi break down the organic waste that would otherwise drown our world.

These organisms and the complex relationships between them and their environments form ecosystems; there are countless ecosystems in the world, from the tiny to the planetary. Ecosystems have real economic value:

they provide irreplaceable services worth \$33 trillion.³² More importantly, the plants, animals, fungi, and microorganisms we share our home with—and the ecosystems they form—have intrinsic beauty and value.

CLIMATE CHANGE AND ECOSYSTEMS: THE SIXTH GREAT EXTINCTION

Climate change threatens the natural systems that support all life, including human life. Species are adapted to live within certain temperature ranges and environmental conditions. When these are exceeded or disrupted and a species cannot adapt, or the other species it depends on to live cannot adapt, its survival is threatened.

High rates of extinction—the permanent loss of species from the earth—result in a less diverse and less healthy global ecosystem. Although there is a normal “background” rate of extinction,

PATHWAYS

- 1) Improve baseline knowledge and monitoring of all fragile ecosystems threatened by climate change at a granular level.³⁶
- 2) Integrate scientific methods, technology, and local and indigenous knowledge.
- 3) Conserve and restore ecosystems that capture and store carbon.
- 4) Link ecosystem conservation and restoration to sustainable livelihoods, cost savings, profitable businesses, and scalable financial models.³⁷
- 5) Halt the loss of biodiversity due to climate change.
- 6) Protect the most fragile ecosystems from the impact of climate change.
- 7) Identify new technologies and solutions to mitigate the effects of ocean acidification and warming.
- 8) Deploy protective ecosystems to help mitigate the damage to coastlines, water resources, and flooding caused by climate change.



scientists estimate that, due to human activity, the current rate is 100 to 1,000 times faster than the normal background rate.³³

Climate change is already causing major disruption in the earth’s ecosystems, as seen in the bleaching and death of coral reefs, and in the major shift in the range and biological cycles of organisms. And these have occurred with an average warming of the earth’s surface of less than 1 degree Celsius. The extinction rate is as much as 1,000 times that of background or normal extinction due to climate changes, and one-quarter of all land species will be threatened with extinction by 2050. Marine ecosystems are also at great risk, due to higher water temperatures and the acidification of the oceans as they absorb carbon dioxide from the atmosphere.³⁴ If the predicted six degrees of warming by the end of the century occurs, the results to ecosystems could be catastrophic.

ECOSYSTEMS SUPPORTING CLIMATE HEALTH

Ecosystems also help stabilize the climate. Plants naturally absorb carbon dioxide from the air during photosynthesis. This process, called carbon sequestration, removes a significant amount of greenhouse gas from the atmosphere. Deforestation reduces that natural service, thus exacerbating climate change. Protecting our remaining forests and replacing those already destroyed is one important way to counter the climate change threat. Restoring ecosystems to something closer to their original state and functions would have many benefits, and could mitigate the effects of a warming climate.³⁵



CASE STUDY

The Death of Bees

and Our Threatened Food Systems



All around the world, bees are dying. Since the early 2000s, beekeepers have been reporting a rapid decline in their honeybee colonies.

This is sometimes associated with a mysterious phenomenon called Colony Collapse Disorder. Death rates among commercial bee colonies have been between 20 percent and 60 percent since 2000, which compares with 5

To meet their nutritional needs throughout the season, bees need a variety of flowers that bloom at different times. The decrease in wild spaces and increased use of land for agriculture—where generally only one or two crops cover vast expanses—are two factors.

percent to 10 percent in the 1980s. If this trend continues, commercial honeybees are unlikely to survive. Wild bees are also disappearing; 30 percent of American wild bumblebee species are threatened with extinction.

This is bad news, because our food systems depend heavily on pollination by bees. The United Nations Food and Agriculture Organization estimates that

71 of the top 100 staple food crops rely on bee pollination. In the United States alone, that represents \$15 billion worth of crops. Wild bees offer a sort of insurance policy for farmers, and they also seem to improve crops, in many cases doing a better job of pollination. Bees are important for natural ecosystems as well. The 25,000 bee species around the world are the most important pollinators for both farmed and wild plant species. With plants at the base of most food chains, this could spell a major disruption of ecosystems worldwide.

Climate change is one of several explanations for the death of the bees. To meet their nutritional needs throughout the season, bees need a variety of flowers that bloom at different times. The decrease in wild spaces and increased use of land for agriculture—where generally only one or two crops cover vast expanses—are two factors. Another is the increased use of pesticides that harm bees, especially a class called neonicotinoids. Attacks from Varroa mites are a third factor. Climate change adds to these pressures in at least two significant ways. First, because of changes in weather patterns, flowers are blooming at different times in the season. Bees may not always be able to adapt if their life cycles do not match up with the flowering times of their food sources. Second, increased CO₂ levels in the atmosphere are changing the composition of plant pollen, making it less protein-rich and therefore nutritionally inadequate for bees.

We need to find ways to save our honeybees, and we need to increase the diversity of wild bees that are able to pollinate. Addressing climate change directly is one important step; another is to think holistically and creatively about how to manage the ecosystems in which bees live, and to invest directly in bee biodiversity.



CASE STUDY

Valuation of Ecosystem Services

Through the Natural Capital Project

The team was able to pinpoint several areas of high ecological importance that could be targeted for conservation investment decisions



Ecosystems provide a multitude of benefits to society, including medicines, the purification of drinking water, and opportunities for recreation (National Wildlife Federation, 2017).

These benefits, known as ecosystem services, are inherently valuable to society and to the global economy. Consequently, it is important to quantify ecosystem services to aid in various areas of decision-making, such as resource management.

The Natural Capital Project does just that. It develops tools and accounting approaches for ecosystem services to help guide decision-makers in planning a more sustainable future. The group has undertaken projects at the international level with stakeholders from multiple sectors to help develop nature-based solutions to a diverse set of problems. These projects include climate resilience and coastal hazard planning, risk management in corporate supply chains, and developing targeted investments for forest restoration. The group maintains

a set of free, open-source software tools to support these projects in an effort to integrate scientific information into decision-making (Natural Capital Project, 2017).

One such project involved ecosystem planning in China to help inform rezoning investment decisions for restoration and conservation sites (Natural Capital Project, 2017). Using their software that rates land areas' ability to sustain human life, the team was able to pinpoint several areas of high ecological importance that could be targeted for conservation investment decisions (Stanford, 2017). Natural Capital Project's software is now being used in more than 80 countries, and the hope is that other countries and subnational actors will follow suit and begin to apply ecologically informed methodologies in their decision-making processes.





CASE STUDY

Global Growth of Citizen Science

Recent research suggests that ecological and environmental citizen science projects have been on a steady rise since the 1940s.

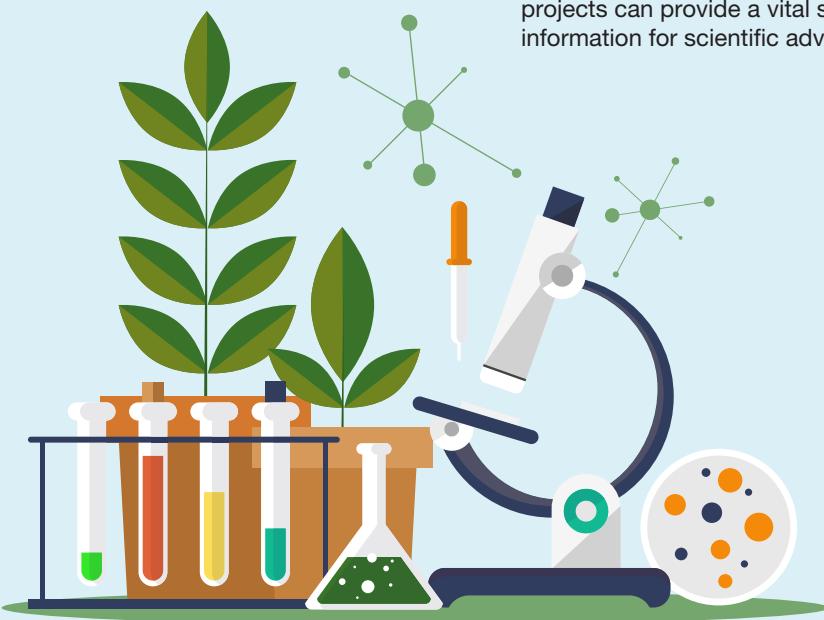
You don't need to be an astronaut to get involved with science. Citizen science, which is driven by members of the general public who volunteer to perform various aspects of the scientific process, has been on the rise across the globe.

Recent research suggests that ecological and environmental citizen science projects have been on a steady rise since the 1940s, and they have increased by 10 percent per year over the last couple of decades. The study also indicates that the diversity of ongoing projects available to the public has increased over time (Pocock, 2017), which suggests that there is ample opportunity for the public to pursue a variety of interests.

Climate change is an area that would likely benefit from citizen science endeavors, given its scope and complexities. The Citizen Science Association and Citizen Science Alliance are two groups that provide opportunities for the general public to engage with citizen science. One example is a project that has volunteers help comb through museum collections to determine the original range of species in the U.S. Midwest. That information is used to develop baseline maps that can help determine shifts in species' ranges due to climate change (Zooniverse, 2017). Such citizen-driven projects can provide a vital source of information for scientific advancement,

and can also help connect the general public with issues that matter to them.

There are opportunities for business innovation in citizen science as well. Using communications technology and data-collection tools to facilitate the aggregation and sharing of information gathered by citizen scientists could provide an important service that governments, management organizations, and academic institutions would be willing to pay for.³⁸



**CASE STUDY**

A Last Opportunity to Save a Natural Gift

Biodiversity Loss and Fragile Ecosystems

Coral reefs are small but mighty. Although they cover less than 0.1 percent of the earth, they are home to 25 percent of marine life.

Their value in ecosystem services is tremendous: coral reefs are estimated to provide at least \$1 trillion in food, jobs, tourism, medicine, and coastal protection. They are also one of the world's natural wonders—essentially magnificent underwater cities built by tiny animals that provide a home for some of the world's most beautiful and intriguing creatures.

But “were” might be a better word than “are,” as 50 percent of the world’s corals have been lost in the last 30 years. It is estimated that fewer than 10 percent of the world’s reefs will survive until 2050. Some regions, like the Caribbean, have already lost over 80 percent of their corals. This year, the Great Barrier Reef—the world’s largest living system, which stretches 8,000 kilometers along the coast of Australia and is the most extensive reef system in the world—suffered from a second “bleaching” or mass death event in two years. Scientists say it has reached the “terminal stage” and is unlikely to recover.

Climate change is undoubtedly the most significant factor in the death of the coral reefs. Most of the excess heat in the atmosphere has been absorbed by the oceans. The resulting higher water temperatures, which are greatest near the surface of the ocean where corals live, threaten these systems. Another factor is the acidification of the oceans. This is caused by the absorption of large amounts of carbon dioxide from the atmosphere, which forms carbonic acid. About 40 percent of global emissions have been absorbed by the oceans, which has increased acid concentration and made calcification impossible for the tiny polyps whose hard skeletons form the structure of the reefs. Warming temperatures and decreased calcification directly kill the corals, which makes them more susceptible to predators and storm damage.



Coral reefs are not only beautiful; they provide home to a great range of marine life and form the basis of many food chains humans depend on for their protein source, their livelihoods, and their businesses. Approximately 90 percent of the planet’s remaining coral reefs will die in the next 30 years due to climate change. This loss will impact more than 500 million people around the world who rely on coral reefs for food and income.

Acting now—and only now—can prevent some of the world’s reefs from vanishing. The most critical action is to

cut down on the emission of carbon dioxide. However, because residual carbon dioxide will remain in the atmosphere, large-scale innovation to reverse ocean acidification may be needed; this can be accomplished through geoengineering. Protecting reefs from other pressures at the local level, like pollution, can help make them more resilient. Finally, careful study of changes in coral reefs and other ecosystems will help us understand how they are affected by climate change and where intervention may help to save some species.

Coral reefs are among the most fragile and vulnerable ecosystems on the planet. On land, forest, tundra, and alpine ecosystems are also threatened by climate change. According to recent mapping of such changes, the Arctic tundra, parts of Europe, Canada’s boreal forest, tropical rainforests in South America, and eastern Australia are some regions in the world most ecologically sensitive to climate change. We must take action to understand and preserve these ecosystems from the threats of climate change. There are opportunities to do so creatively through large-scale geoengineering projects, by using data and communications systems, and by developing creative ways to organize communities and exercise leadership in protecting our common home.

Climate change is undoubtedly the most significant factor in the death of the coral reefs.

7. The Industry and Finance Opportunity

Reshape our industries, business models, and finances to mobilize \$10 trillion in investments by 2030 to create a carbon-neutral global economy. Create a new ecosystem of businesses that provide products and services to help individuals and communities adapt to climate change.

ACTIVATING ECONOMIC APPROACHES TO CLIMATE PROBLEMS

Business, industry, trade, and finance are all products of human talent and creativity. Business is also a powerful force in the world today. A challenge as large as climate change needs the power of business to mobilize people and resources quickly. The large-scale success of clean power, green buildings, and sustainably designed products requires businesses capable of delivering them.

Business is ultimately about serving human needs and providing livelihoods; we provide for our own needs by providing what others need. In this way, business is a reflection of the interdependence that characterizes our planet's natural systems. However, some of the ways our markets and corporate structures create systems pollute the planet, and create inequality and injustice.



UNLOCKING BUSINESS OPPORTUNITIES AND UNDERSTANDING CLIMATE RISKS

Business can be a powerful force for change. The flaws in the systems we have developed offer opportunities to create profitable new models of business that also create a better world. Business can benefit by employing the human potential offered by the world's growing population of young people. It can share ideas, open up innovation, and promote good governance. It also can address the causes and impact of climate change, and find where there is a demand for climate-responsive products and services. And it can do all this profitably.

Solving climate problems is not entirely about technology; it is also about developing business models. How a company makes a technology available to customers and how it structures the financial transaction can have an enormous impact on unleashing and scaling innovation.³⁹

Furthermore, responsible business leadership in the 21st century requires a clear understanding of the risks to business that are associated with climate change. Disruption of the supply chain and labor force, the effect on real assets, and the cost consequences of

“

We need to strengthen the conviction that we are one single human family. There are no frontiers or barriers, political or social, behind which we can hide, still less is there room for the globalization of indifference.

- Laudato si'

”



climate-responsive regulation are among the issues that responsible managers need to consider.⁴⁰ Many business leaders are now reporting on their carbon footprints, both internally and to investors. Many investors now consider efficiency and responsible use of energy to be proxies for efficient management of a company; opportunities for cost savings are often made very clear by the carbon-auditing process.⁴¹

MOBILIZING FINANCE

Finance has a special role to play in addressing climate change. Trillions of dollars in investments are necessary to combat this global crisis. A growing number of finance industry leaders have already begun to invest in financing the transition to a clean energy, climate change resilient world, but a wealth of opportunity remains untapped in this emerging sector. The rigorous finance industry can find and grow profitable and sustainable business approaches to climate change.

Finance also has an important role to play in monetizing the risk profiles associated directly with climate change, and with policies created to address it. Increased risks to natural and human systems are the fundamental problem posed by climate change. The insurance and reinsurance industries are already dealing with the effects of climate

change in their calculations, which will be an important part of managing these risks.

Opportunity for innovation exists in better informing asset owners of both the opportunities and the risks associated with climate change. Financial firms at the forefront of the industry now recognize that considering climate change and other environmental, social, and governance topics is a critical part of fiduciary duty.⁴²

According to research conducted by investment managers, long-term investment decision-making needs to incorporate climate risk to stay ahead of the “climatic risk curve” and preserve value in their portfolios. Investors also can position themselves to capitalize on investment opportunities related to mitigating and adapting to climate change. Technological advances, business model innovations, and policy evolution all provide opportunities for investors.⁴³

Pioneering work on creating conservation asset classes can be extended into the climate sector. Using metrics from the sustainable investing and impact investing fields and models from conservation finance, a range of financial products can be created that solve climate problems while making profits for investors.⁴⁴

THE TRUE COSTS OF CARBON

The current price of fossil fuels in the market does not reflect the true cost of the damage they do to the planet. This is so obvious that many companies are now planning for a global carbon price by implementing “shadow carbon pricing” and reinvesting that income into sustainability measures.⁴⁵ Innovations that solve the problem of implementing fair carbon pricing could potentially revolutionize the world economy. This would set off a global paradigm shift away from the economic calculations that keep the benefits of action on climate change in the too distant future to induce meaningful market change now.



PATHWAYS

- 1) Mobilize \$10 trillion to finance climate action:⁴⁶
 - Establish climate protection finance as an asset class⁴⁷
 - Create a suite of investment products that result in better management of the commons and protection for investors, while also earning a profit for investors⁴⁸
 - Align missions; values-driven institutional investors chart a course to align their organizations' values and investments⁴⁹
- 2) Implement carbon pricing that reflects the true cost of fossil fuel emissions.
- 3) Transition industrial and production processes and supply chains into

- closed-loop, zero-waste, and carbon-neutral systems:
- Shift from production-based to efficiency-based business models
 - Remake material inputs to form closed-loop, low-energy supply chains
 - Overcome premium price points for recycled supply, quality, and logistics
 - Create tax policies that incentivize recycling materials
 - Open education and certification channels for awareness and standardization
 - Increase access to capital for closed-loop supply chains
- Involve bottom-of-the-pyramid labor and creativity as much as possible in closed-loop supply chains
 - 4) Link profit and climate action.
 - Develop innovative business models that solve energy-generation problems⁵⁰
 - Develop demand for high-quality services that people gravitate to
 - 5) Mainstream climate change issues in business and finance education:
 - Enable MBA/finance students and financial management professionals to evaluate the environmental and social impact of their decisions⁵¹



CASE STUDY

Regional Leadership in Carbon Pricing

Carbon pricing schemes can be an important tool to reduce greenhouse gas emissions and account for the social cost of carbon.

Numerous national and subnational actors have already established carbon-pricing policies amid growing belief that a more widespread price on carbon may be likely (Carbon Pricing Pathways, 2015; Carbon Pricing Watch, 2016; CDP, 2016). The experiences of state and non-state actors that already have such policies in place can serve as a catalyst and blueprint for future carbon-pricing decisions. Those without such policies will have a prime opportunity to demonstrate leadership on the issue and to craft innovative ways to reduce emissions while pursuing other economic, social, and environmental objectives.

Many state actors currently have or are considering carbon-pricing schemes. Some of the earliest examples of carbon-pricing schemes are a carbon tax in Finland and Poland that took effect in 1990. As of early 2017, it is estimated that more than 20 percent of global greenhouse gas emissions could be covered by existing carbon taxes and emissions-trading initiatives (Carbon Pricing Watch, 2016). At the subnational level, many companies have begun

to introduce internal carbon prices to manage carbon risk and contribute to global greenhouse gas mitigation efforts. CDP has reported that, in an effort to prepare for conducting future business in a low-carbon global economy, more than 1,200 companies have disclosed information (or plan to) about internal carbon-pricing activities (CDP, 2016; Carbon Pricing Pathways, 2015).

It is estimated that more than 20 percent of global greenhouse gas emissions could be covered by existing carbon taxes and emissions-trading initiatives.

The introduction of carbon-pricing schemes can also spur interregional cooperation and foster new partnerships. For example, the California cap-and-trade program is working with several provinces in Canada through the Western Climate Initiative to develop cost-effective strategies to reduce emissions (California Environmental Protection Agency, Air Resources Board, 2017). These actions exemplify some of the global efforts currently under way to reduce greenhouse gas emissions, mitigate climate risks, and advance the pursuit of a low-carbon future.



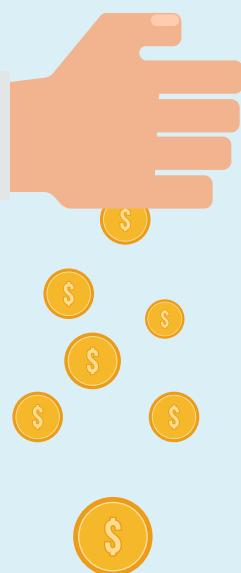


CASE STUDY

BlackRock

How a Global Investment Giant Makes the Business Case for Pro-Climate Investing

Inconsistent carbon pricing across markets makes it more difficult for investors and businesses to plan for change and actually threatens the financial position of many companies.



No one could call BlackRock a marginal financial services firm. The U.S. global investing giant manages \$5.1 trillion for its investors, making it the largest such firm in the world.

BlackRock is putting pressure on other companies to disclose their carbon footprints, on governments to set consistent prices for carbon, and on investors to plan for the risks associated with climate change and to maximize their returns by investing in climate-smart businesses.

The risks and opportunities climate change brings to investors cut across four channels, as BlackRock argued in its 2016 report: the physical impact of climate change, technological shifts that undermine existing business models, regulatory shifts, and social changes that reflect growing awareness of climate change. These factors play out over the short, medium, and long terms, and thus affect all types of investors.

Inconsistent carbon pricing across markets makes it more difficult for investors and businesses to plan for change and actually threatens the financial position of many companies. This is why BlackRock and others believe that governments should step in. BlackRock is not alone in its concern over carbon pricing; according to the *Financial Times*, “130 investors with more than \$13 trillion in assets under management,” including Sweden’s national pension funds, Amundi, BNP Paribas Investment Partners, and HSBC Global Asset Management, called on the G20 to “provide stable, reliable and economically meaningful carbon pricing that helps redirect investment.”

BlackRock, like other pioneering investment firms, goes further. In its 2016 report, the company made the case that profitable investment and climate progress are compatible: “Climate-aware investing is possible without compromising on traditional goals of maximizing investment returns, we conclude,” it says. “All asset owners can—and should—take advantage of a growing array of climate-related

investment tools and strategies to manage risk, to seek excess returns or improve their market exposure.”

BlackRock also points the way to potential leadership from investors, who can also make returns on their investments that perform as well as or better than traditional investments: “Is the aim to protect against climate change’s impact on the portfolio? Or is the objective to invest in companies poised to benefit from the transition to a lower-carbon economy and/or have a positive impact? Some investors try to avoid return-adverse outcomes while adding potential return boosters. Others want to shape outcomes.”



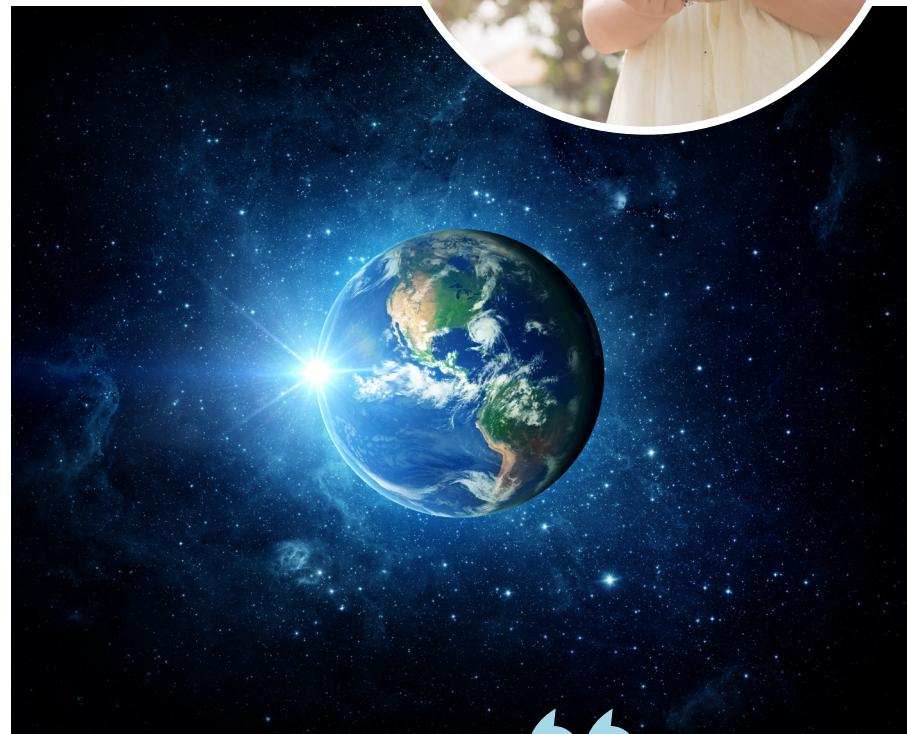
8. The Eighth Opportunity

The Laudato si' Challenge concludes with an Eighth Opportunity that ties together the previous seven. This is the opportunity to live, every day, in the spirit of Laudato si'

As we seek solutions for the climate crisis and new paradigms for the systems that comprise our environment, we must ask ourselves what purpose all these activities serve. The image of the beautiful blue earth floating in space reminds us that, although our world and our problems may seem huge and complex, we live on one small planet. What kind of world will we leave to those who inherit this planet from us?

The Laudato si' Challenge is about more than making changes to a series of connected systems. It is about recognizing ourselves in relationship to the interconnectivity of all that exists. It is about creative and passionate engagement with our world, with each other, and with past and future generations of people.

The challenge of climate change provides opportunities to invent new technologies, to create new business models, and to build new economic institutions in the manner we have



outlined in the previous pages. But above all it provides us with an opportunity to meditate deeply and continuously on every aspect of the physical, social, and spiritual worlds we are a part of.

Reflecting the universal imperative of accepting moral responsibility for our part in shaping the future of all life, the Eighth Opportunity calls on each of us to attend continually to the care of our common home.

- 1/ What is the purpose of our life on Earth?
- 2/ Why are we here?
- 3/ What is the goal of our work and all our efforts?
- 4/ What need does the earth have of us?



It is no longer enough, then, simply to state that we should be concerned for future generations. We need to see that what is at stake is our own dignity. Leaving an inhabitable planet to future generations is, first and foremost, up to us. The issue is one which dramatically affects us, for it has to do with the ultimate meaning of our earthly sojourn.

- Laudato si'



AUTHORS

AHMAD ASHKAR

Hult Prize Foundation

PHILIP AUERSWALD

Policy Design Lab

SHARON BENZONI

Policy Design Lab

ALEX DEHGAN

Conservation X Labs

ACKNOWLEDGEMENTS

We offer special thanks to Eric Harr for shepherding the creation of the Challenge document; to Darcie Newton for her effective coordination; to Dan Vermeer for his important role in advancing and deepening our research; to Tim Bushman for his diligent work as the team's research assistant; and to Dody Riggs for her able copy editing.

A heartfelt thanks to our dear friend, Paul van Engen, for convening the right people in the right place, Right Now! There would be no Laudato si' Challenge without your grace, your guidance and your fortitude.

We also would like to thank the following people for offering their time and insights to the process of drafting the Challenge document:

- **Rebecca Adamson**, *Founder, First Peoples Worldwide*
- **Bernard Amadei**, *Founder, Engineers Without Borders*
- **David Bollier**, *Co-founder, Commons Strategies Group*
- **Martha Chen**, *Founder, Women in Informal Employment Globalizing and Organizing (WIEGO)*
- **Geoffrey DaBelko**, *Director, Environmental Change and Security Group, Woodrow Wilson Center*
- **Harish Hande**, *Co-founder, SELCO-India*
- **Ron Gonen**, *Co-founder and CEO, Closed Loop Fund*
- **Ilana Kessler**, *General Partner, One Acre Fund*
- **Stephanie Kimball**, *Conservation International*
- **Eric King**, *Senior Scientist, Nike*
- **Cary Krosinsky**, *Executive Director, Network for Sustainable Financial Markets*
- **Suzanne Lee**, *Founder, Biofabricate*
- **Michael LeVine**, *Pacific Senior Counsel, Oceana*
- **Tom Lovejoy**, *Senior Fellow, United Nations Foundation*
- **Kathryn Matthews**, *Deputy Chief Scientist, Oceana*
- **Colin McCormick**, *Chief Technologist, Valence Strategic*
- **Caitlin Sparks**, *General Partner, Full Cycle Energy Fund*
- **Robert Stavins**, *Director, Harvard Environmental Economics Program*
- **John Tobin de la Puente**, *Cornell Institute for Public Affairs*
- **Dan Vermeer**, *Executive Director, Center for Energy, Development and the Global Environment, Duke Fuqua School of Business*
- **Paul Woods**, *Chief Technology Officer, Skytruth*

We also thank our partners who enabled the creation of the Laudato si' Challenge:

- **Ibrahim AlHusseini** (*Founding Partner*)
- **Chade-Meng Tan** (*Founding Partner*)
- **Thomas Ermacora** (*Founding Partner*)
- **Andrew Mangino** (*Founding Partner*)
- **Jeff Cherry** (*Founding Partner*)
- **Lola Grace** (*Founding Partner*)
- **Theresia Gouw** (*Investor*)
- **Renato Libric** (*Investor*)
- **Joe Ritchie** (*Investor*)
- **Stephen Forte** (*Accelerator Director*)

Finally, and above all, we express our deep gratitude to **His Holiness Pope Francis** for having inspired this Challenge via the encyclical letter Laudato si', and to **Cardinal Turkson**, whose commitment to a future guided by Laudato si' has illuminated our work.

Selected Sources and Reference Materials

1. At levels of warming of 3-4°C and above.
2. Stern Review: The Economics of Climate Change.
3. The previous two sentences attributable to Dan Vermeer.
4. Shah, J. Creating Climate Wealth. 2013.
5. Language in this sentence attributable to advisor Dan Vermeer.
6. OECD/IEA 2015: <https://www.iea.org/publications/freepublications/publication/WEO2015SpecialReportonEnergyandClimateChange.pdf>.
7. <https://www.epa.gov/climate-change-science/causes-climate-change>.
8. <https://www.edf.org/energy/methaneleakage>.
9. <http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/>.
10. Dan Vermeer, personal interview.
11. <https://www.iea.org/publications/freepublications/publication/WEO2015SpecialReportonEnergyandClimateChange.pdf>.
12. <http://www.wri.org/blog/2016/04/roads-decoupling-21-countries-are-reducing-carbon-emissions-while-growing-gdp>.
13. IPCC 2014 AR5 WGIII.
14. Shah, J. Creating Climate Wealth.
15. SunEdison.
16. Compared with 2005-07 levels; http://www.fao.org/fileadmin/templates/wsf/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf.
17. FAO, 2016.
18. <http://pubs.acs.org/doi/abs/10.1021/es200130u>.
19. IPCC AR5.
20. Adapted from http://www.unwater.org/downloads/analytical_brief_oct2013_web.pdf.
21. Adapted from Worldchanging. Steffen, A., ed. Abrams, New York, 2011.
22. IPCC AR5; Worldchanging.
23. <http://climatemigration.org.uk/climate-migration-trapped-populations/>.
24. <https://www.weadapt.org/organisation/uk-climate-change-and-migration-coalition>.
25. http://aloftatuvalu.tv/FR/12_liens/12_articles_rapports/UKCCMC_climat_migration.pdf.
26. Hult Prize Foundation, 2016.
27. Geoffrey DeKalb, personal interview.
28. <https://planetaryhealthalliance.org/research/>.
29. Stern Review: The Economics of Climate Change.
30. There are four features of the urban informal economy that make it particularly important for building economies that are greener and more inclusive. First, the informal economy is not only large, especially in terms of employment, it is growing. No serious attempt to transform the global economy, socially and environmentally, can ignore it. Second, relations between local authorities and the informal sector are usually strained and often dysfunctional. Improving these relations is critical if green economy agendas are to be pursued inclusively. Third, the informal economy displays enormous variation in environmental performance. While there is potential for engaging it constructively, that engagement must be discriminating. Fourth, the informal sector is not only critically important to many of the poorest households, it is highly gendered, with important implications for the pursuit of both social and environmental agendas (Brown & McGranahan, 2015).
31. Worldchanging.
32. Millennium Ecosystem Synthesis Report.
33. Center for Biological Diversity; http://www.biologicaldiversity.org/programs/biodiversity/elements_of_biodiversity/extinction_crisis/.
34. <http://www.chgeharvard.org/topic/climate-change-and-biodiversity-loss>.
35. Thomas Lovejoy, interview.
36. IPCC AR5; Kathryn Matthews, Oceana, personal interview.
37. Lovejoy, personal interview.
38. Mike Levine, Oceana, personal interview.
39. Dan Vermeer, personal interview.
40. Dan Vermeer, personal interview; Risks and Opportunities from the Changing Climate: Playbook for the Truly Long-Term Investor. Cambridge Associates. 2015.
41. Dan Vermeer, personal interview.
42. Krosinsky, C., and Purdom, S. Sustainable Investing: Revolutions in Theory and Practice. Routledge, London and New York. 2017.
43. Risks and Opportunities from the Changing Climate: Playbook for the Truly Long-Term Investor. Cambridge Associates. 2015.
44. Conservation Finance. CreditSuisse; Sustainable Investing: Revolutions in Theory and Practice. Krosinsky and Purdom, eds. Routledge. 2017.
45. Dan Vermeer, personal interview.
46. IAEA 2030 goal, quoted in Shah, J. Creating Climate Wealth.
47. Conservation Finance.
48. John Tobin de la Puente, personal interview.
49. John Tobin de la Puente, personal interview.
50. Creating Climate Wealth.
51. John Tobin de la Puente, Dan Vermeer, personal interviews.