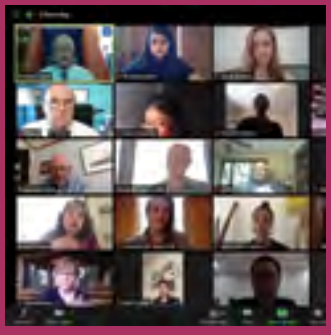
DESIGNS
FOR A WORLD THAT WORKS
FOR ALL

Solutions & Strategies for Meeting the World's Needs

Volume III




by Medard Gabel and

The Global Solutions Lab

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Volume III

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The Global Solutions Lab

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INTRODUCTION

Global Solutions Lab*

What you are about to read is the product of many young people from around the world.

This book represents the work of hundreds of young people from five continents and 40 countries. They came together each summer and worked extraordinarily hard on understanding what the most pressing problems facing their world are, and even harder at designing solutions and strategies for eliminating these problems.

This book was developed over a period of 16 years (2005–2020). It would not exist if not for some extraordinary people at the United Nations who provided their input, guidance and feedback along the way. These people took time out of their busy schedules and provided not only the guidance but also the inspiration that was needed to complete our tasks. They are listed above in the Acknowledgements.

Design science **is the organized use of imagination and science to develop innovative and viable solutions to critical real-world problems.**

The youth who participated in the programs that produced this book were part of the *Global Solutions Lab.* These Labs are ongoing and take place each June. Other *Global Solutions Labs* take place during the school year. The *Global Solutions Lab* is a workshop where the tools of design science are used by groups to collaboratively develop creative solutions to global and local problems, and strategies for the implementation of those solutions.

These particular Labs are focused on developing solutions and strategies for reaching the UN's Sustainable Development Goals[1] and were held each summer between 2005 and 2020. Each year's Lab focuses on a specific topic, such as poverty, food, energy, health care, education, climate change or environmental sustainability.

These *Global Solutions Labs* have taken place in New York at the UN and the UN International School, in Philadelphia at Chestnut Hill College and at the University of North Carolina in Asheville. They are put on by three organizations—BigPictureSmallWorld, Global Education Motivators, and EarthGame.[2]

The goals of the Lab included:

- Develop strategies for meeting the basic human needs of everyone in the world
- Learning about the Sustainable Development Goals, their usefulness to the world, and how we can use them to make the world a better place
- Developing viable strategies for achieving one or more Sustainable Development Goals
- Develop strategies for meeting the basic human needs of everyone in the world
- Learning design science and how to apply it to global and local problems
- Increasing our understanding of global dynamics, world resources, human trends and needs, and options for humanity's success
- Increasing the public's understanding of these issues through disseminating the strategies as widely as possible
- Serving as an incubator and growing force for developing and disseminating design science techniques for complex problem solving and development of viable solutions to the worlds problems
- Learning a methodology for changing the world.

Attending the Labs are groups of college and high school students and professionals ranging in age from 16 to 55 with the average age of 22. Labs run for one to two very intense weeks, where participants learn and apply the concepts and tools of design science as they develop their strategies to achieve the Sustainable Development Goals (SDGs). The participants are briefed by UN staff from the UNEP, UNDP, UNICEF, WHO and others on the SDGs, their context, history, measurement, the progress made so far, and strategies in use for reaching them. An

The work of the Global Solutions Labs are focused on demonstrating how, using present day technology, known resources, and limited financial wherewithal global and local problems can be solved in sustainable and affordable ways. The overall strategies developed by the participants of the Lab, as will be seen in this book, are more than the sum of their parts. Together, they describe a world where the basic human needs of all of humanity are met, the Earth's environmental life support systems are allowed to regenerate, and the world is safe and secure from war and crime.

introduction to design science, *Design Science Primer,* is then provided. Lab participants typically work ten to twelve hours a day on developing their solutions. On the last day of the Lab, participants go to the UN where they conclude the Lab with a presentation of their work to, and feedback from, UN staff, as well as corporate and foundation executives. An overview of this work is what is presented in this book.

The ideas and words describing the strategies are those of the Lab's participants. I (Medard Gabel) edited for consistency and filled in a few spots here and there where appropriate. Each chapter is different and reflects the team or individual that developed it, as well as the nature of the problem or issue being addressed.

Designs for changing the world—Design Science

Design Science is a methodology for changing the world. It involves the application of the principles and latest findings of science to the creative design and implementation of solutions to the probølems of society. It is a way of recognizing, defining, and solving complex problems that is based on innovation and thrives on transparency. It takes a whole systems, global, anticipatory and regenerative approach that fosters creative collaboration and synergy in the development of comprehensive solutions to both global and local problems.

Unlike many planning and political processes that compartmentalize issues and seek to develop solutions in a vacuum, Design Science stresses comprehensive thinking based on a clear understanding of the state of the world, available resources, appropriate technology, culture, environmental constraints, and the interconnections between world problems and opportunities. The Design Science planning process provides a framework for devising solutions to current problems as well as anticipating future needs.

Design Science is also different from other problem solving and planning methodologies in its comprehensive, anticipatory, inclusive, and transparent approaches to the development of solutions. It takes a "whole to particular" approach that is both global in perspective and in its examination of options. It seeks to build capacity rather than merely solve problems, and to develop solutions that are transformative rather than merely the reforming of already inadequate systems. It is informed by a moral vision that places a priority on designing ways of meeting

unmet basic human needs in ways that are environmentally sustainable and socially just.

The core of this approach to problem solving and planning is both a concern with whole systems—the whole Earth, the entire history of the planet, the global economy, all of technology, and all of humanity, both those living now and those yet to be born—as well as a recognition that everything is implemented locally, and that the "whole" is merely the context for the local. Design science has both a global perspective and a local focus. It recognizes that it is the local upon which the success or failure of a particular design solution will thrive or die.

If a problem can't be solved as it is, enlarge it.

—Dwight Eisenhower

Design Science is *comprehensive*, in that it starts from the whole system and works back to the special case. It deals with all facets of a problem including the larger system of which the problem is a part; in this sense, design science seeks to build capacity, not just solve problems. It is *anticipatory*, in that it seeks to recognize the threats coming down the pike before they arrive full blown on an unsuspecting or ill-prepared society; and it deals with the way things are going to be when the solution is going to be implemented, not just the way things are in the present. It is a *design* strategy, in contradistinction to a political or 'let's pass-a-law-and-change-human-behavior' approach; it seeks to change the larger system of which the specific problem is a part through the introduction of innovative artifacts or policies.

This "comprehensive anticipatory design science" is at least as much a perspective on the problems of the world as it is a methodology for tackling those problems. When applied to contemporary problems, it can lead to strikingly fresh insights and solutions.

Design science is a tool that is based on a global perspective and a systems approach to the problems of the world. It assumes that globalization has made the world an ever more interconnected whole, and any successful problem solving of society's systemic ills needs to be an approach that is global, comprehensive, visionary, and based on science, not politics, ideology, or wishful thinking. The entire world is now the relevant unit of analysis, not the city, state, or nation. We are onboard, as Buckminster Fuller pointed out, "Spaceship Earth," and the illogic of 200+ nation state admirals all trying to steer the spaceship in different directions is made clear through this metaphor—as well in

Fuller's more caustic assessment of nation states tending to act as "blood clots" in the world's global metabolism.

The design science process is augmented by vast quantities of statistical information about the state of the world, its resources, human trends, needs, and technology. With the advent of personal computers and the Internet this information became almost universally available—and with it, design science found its perfect complement. Coupled with the tools of the information age, design science gains the power to reach its potential. The Internet has not leveled the global playing field so much as expanded it, and the good-ol'-boy-status-quo-maintaining political process can now be subverted by a process that brings Thomas Jefferson into the twenty-first century.

We need to focus on creating wealth, not just reducing poverty. Development, not growth is our goal; we need to transform society, not just enlarge it.

In Fuller's words, design science is a process where individuals or teams of people can "make the world work, for 100% of humanity, in the shortest possible time, through spontaneous cooperation, without ecological offense or the disadvantage of anyone."

Making the world work for 100% of humanity reflects Fuller's global perspective as well as his values. We are not here just to make ourselves rich, famous, or top consumer of the day or decade, or here just for the 5% living in our part of the world; we are here for all humanity. The "spontaneous cooperation" is instructive in light of the previous discussion. The phrase does not read, "make the world work for 100% of humanity through a central government, or through enforced coercion by a strong military" but through cooperation that arises from a fundamental transparency of society and its needs. If everyone knows what the situation is, has a clear vision of what should be and what needs to be done, we cooperate to get it done—as we do as a society in times of emergency.

Fuller said:

> I am enthusiastic over humanity's extraordinary and sometimes very timely ingenuities. If you are in a shipwreck and all the boats are gone, a piano top buoyant enough to keep you afloat that comes along makes a fortuitous life preserver.

> But this is not to say that the best way to design a life preserver is in the form of a piano top. I think that we are clinging to a great many piano tops in accepting yesterday's fortuitous contrivings as constituting the only means for solving a given problem.

Design science is a method for developing the life preserving and enhancing solutions to society's problems.

The *Global Solutions Lab* uses the principles and methodology of design science and applies them to developing comprehensive strategies for the solution of global problems, primarily under the aegis of the United Nation's Sustainable Development Goals. The Design Science/ Local Solutions Lab takes an identical approach but the focus is on solutions that are to be locally implemented.

In summary, design science is a problem solving and strategic design and planning process based on the following "big picture" assumptions and design protocols:[3]

A map of the world which doesn't include Utopia isn't even worth glancing at.

—Oscar Wilde

- *Whole world*—The whole world is now the relevant unit of problem solving; problems need to be seen from a global perspective.
- *Long-term*—The long term is the framework in which we must operate; given this perspective, prevention, rather than treatment or cure, is the logical and most economical option.
- *Think Comprehensively*—Framing problems in their widest possible context helps see upstream interconnections and causative factors that can impact downstream problems and options.
- *Everybody wins*—Solutions with winners and losers are not sustainable.
- *Transparency* is key; solutions that don't make their assumptions and true costs and impacts visible to everyone are not sustainable.

You can no longer save your family, tribe or nation. You can only save the whole world.

—Margaret Mead

- *Capacity, not problems*, is the focus; we need to see "problems" not as something that needs to be "solved," but as a symptom of something larger—the need to enlarge the capacity of a system; we need to focus on creating wealth, not just reducing poverty.
- *Needs as markets*—the world's needs are real or potential markets; problems are unmet needs that can often be met through creative products matched to the real needs of real people; poverty is a mandate for design and entrepreneurial innovation and creativity, not just government intervention and paternalistic imposition of top down "solutions."
- *Design replaces politics*; design sees what is needed, not what is just expedient or politically easy, and figures out how to make it happen; design starts with a vision of what is needed, not what is popular; it seeks to find or design an artifact that solves a problem or builds the capacity of a system in such a way that the source of the problem is eliminated.
- *More with less* is the design ethic; getting ever-higher performance out of every gram of material and erg of energy invested in every function performed by our human-made life-support is critical to making the world's limited resources meet the needs of our growing population and to reducing our impact on our environment.
- *Biology replaces mechanics*; viewing the world as a living system fosters a respect for a problem's complexity, an awareness of the context or environment in which it is embedded, and the possible solutions that can result in strengthening the health of the system and the elimination of the problem.
- *Development, not growth* is our goal; we need to transform society, not just enlarge it.
- *Respect Gestation Rates*—everything has its own gestation rate, and working with these is essential, whether it is the growth and development of a technological option or societal change.
- *Scalability* is essential; if a solution to a problem, or a product or service for a market cannot be scaled up from the prototype stage to wide spread adoption and use, it is still born.
- *Look for the trim-tab*—Small and strategically placed interventions can cause large-scale and profound change; find the design leverage points where a small amount of change can bring about large impacts.

- *Preferred state planning*—what we want and where we want to be in ten years is more important than what the problem is right now; the vision of the ideal is more important and powerful than reacting to what is thought possible given current limitations; perspective adds opportunity, vision drives action; resources follow vision. The design science process begins with a vision statement of where we *want* the world to be. This vision of the preferred future is based on and informed by an ethical view of what should be, and then transformed through comprehensive design into an economically compelling solution.

The fundamental difference between creating and problem solving is simple. In problem solving we seek to make something we do not like go away. In creating, we seek to make what we truly care about exist.

—Peter Senge

Global Preferred State

Strategies for achieving the Sustainable Development Goals and Preferred State

As listed in the above assumptions and protocols, the Design Science problem solving process begins with a vision of how the world should be. This vision is usually specific to the general issue or problem being addressed, such as poverty, food and hunger, energy supply, education and the like. It is often helpful though to begin the design process with a broader preferred state for the whole world that encompasses the well being of all the world's life support systems. The following is such a global preferred state:

All of humanity—every child, woman, and man in every country in the world—has, on a sustainable basis,

- Abundant supplies of nutritious and culturally appropriate food.
- Adequate housing complete with sanitation facilities and clean running water.
- Abundant supplies of energy that are clean, safe, and affordable.
- Access to local comprehensive health care and the latest advances of medical science.
- Access to education, so that literacy is universal, as are opportunities for advanced (college level) education; access to the Internet is universal.
- Access to communication and transportation facilities that are readily available and affordable, so that anyone can communicate with anyone else on Earth who wants to be communicated with, and people can travel anywhere they want to go.
- Access to employment opportunities and fulfilling work—including vocational alternatives, re-training, and on-the-job-training—are available to all.
- Access to open borders, free of trade and emigration restrictions, subsidies, and other barriers to market-driven economies.
- Access to information so that all public negotiations (for example, labor contracts, legislation, and government contracts), accounting practices, and elections are transparent and open to inspection by anyone at anytime.
- Access to decision making, so that all citizens have a significant role in decision-making processes that affect their lives, and each

lives in a peaceful, democratic, secure and safe world that is free from crime, terror, and nuclear, chemical, and biological weapons.
- Access to a clean, healthy environment that is free of toxic wastes, pollution of all kinds, soil erosion, and damaging industrial and agricultural practices.
- The biosphere and its resources are self-regenerating, with humans cooperating to ensure this.
- Biodiversity is increasing throughout the world.
- Around the globe, strong social incentives foster democracy personal initiative, trust, cooperation, respect, and love—and discourage all forms of torture, degrading treatment, and punishment.
- Access to an independent and impartial tribunal to which each person is entitled, on an equal basis; each person has the right to nationality and to perform public service in one's own country.
- Access to rest and leisure.
- Access to special protection, care, and assistance for mothers and children.
- Freedoms of speech, of the press, and of religion are the rule everywhere.
- All forms of prejudice—against another's ethnicity, race, religion, origins, gender, age, sexual preference, or income level—are gone.
- Every culture and nation respects and celebrates the unique value of all others, and provides strong social supports for individuals, families, and communities.
- The arts in all forms are widely appreciated and cultivated.
- Spiritual growth and fulfillment is the norm for all humans.[4]

OVERVIEW AND PROBLEM STATE

Context/World Systems

In a very real sense the state of the world today is the preceding Preferred State with a negative qualifier attached. That is, all of humanity does *not* have "abundant supplies of nutritious and culturally appropriate food and clean water"; they do not "live in more than adequate housing complete with sanitation facilities and clean running water," etc.

In addition, and more specifically, the world today is characterized by[5]:

- 1 billion people are not adequately nourished or face the specter of hunger
- 884 million do not have access to clean water
- 1.6 billion people are without access to adequate sanitation
- 2 billion people are inadequately housed; 600 million live in urban slums
- 100 million people are homeless
- 800 million to 2.5 billion people have no access to essential health services
- 10 million children under 5 die from easily preventable causes each year
- 42 million people who die from curable infectious and parasitic diseases each year
- 40 million people are infected with the AIDS virus
- 300 million people seek treatment for malaria each year
- 2 billion people are infected with tuberculosis
- 900 million adults are illiterate
- 100 million children are not in primary school
- 1 billion people are without access to electricity
- 3 billion people are without access to adequate supplies of energy
- 1.2 billion people live on $1.00 per day or less
- 2.8 billion people live on less than $2.00 per day
- 40 million children are laborers
- 50 million people are refugees or displaced
- 7 million tons of carbon are added to atmosphere each year
- 2.5 billion tons of topsoil are eroded from world croplands per year

- 6 million acres of desert land are formed annually by mismanagement
- 15 million acres of forest are destroyed each year

Endnotes

1 For more information on the Sustainable Development Goals, see https://www.un.org/sustainabledevelopment/sustainable-development-goals/
2 The 2005–2007 Labs were also put on in cooperation with the Buckminster Fuller Institute. For more information on these organizations, see: http://www.bigpicturesmallworld.com; http://www.gem-ngo.org/ and http://www.bfi.org
3 *Regenerative Development* http://www.designsciencelab.com/resources
4 The description of the future was synthesized over a twenty-year period from over one thousand groups of anywhere from 30 to 250 people each in size. Each group answered the question: *What do you want the world to look like in twenty-years?* Adding the members of all the groups together resulted in over 200,000 people combining their collective expertise to answering that question.
5 For footnotes on each of the numbers, see: http://www.bigpicturesmallworld.com/war-peace/context_chap1.shtml

PART I

CLIMATE FOR ALL FOR LIFE

CLIMATE FOR ALL FOR LIFE

Introduction

The climate change work of the Global Solutions Lab is focused on demonstrating how, using present day technology, known resources, and limited financial wherewithal, the worst impacts of climate change can be avoided between now and 2040, *and* positive changes in employment, health, environmental and economic stability and opportunities are enhanced.

The overall strategy developed by the climate change teams in the Lab consisted of an interrelated multiple-part plan that, when aggressively implemented, would have a profound impact on the world. The results would include millions of new jobs, increased biodiversity and forest cover, reduction and removal of fossil fuel combustion, improved health and longevity—and a world that is safer, more secure, stable, and immeasurably richer as our life-support systems are regenerated.

The parts of this strategic plan include:

- **Climate Change:** ***Turbines, Filters, Trees, and Incentives***
- **ClimActs:** ***Creating a Climate of Change for Climate Change***
- **Climate Change and Regeneration**
- **The ReGeneration Corps:** ***Connecting Conservation, COVID-19, and Climate Change***
- **Changing the Climate of Business**

Climate Overview

Climate change is measurable changes in weather patterns over the span of many years. Current changes to Earth's climate are primarily caused by the addition of excessive amounts of greenhouse gases into the atmosphere. These gases are mainly caused by the use of carbon-intensive, inefficient, wasteful and long-term expensive production of energy, food, industrial processes, transportation, combustion of fuels, improper waste management and other factors. The impacts of climate change are global and severe. Human health is compromised, food production undermined and the global economy damaged to the tune of over $2 trillion per year. Impacts are most severe in the poorer regions

of the world and upon people who have had little to nothing to do with changing the climate. Climate change is a threat to life as we know it, and a threat-multiplier in that it impacts and makes worse many other problems facing humanity. It has the potential to push millions, perhaps billions, into poverty in the coming decades.

> "Climate Change is the defining issue of our time and we are at a defining moment. From shifting weather patterns that threaten food production, to rising sea levels that increase the risk of catastrophic flooding, the impacts of climate change are global in scope and unprecedented in scale. Without drastic action today, adapting to these impacts in the future will be more difficult and costly."

The threat and impacts of climate change are critical for countries. It is forcing people to evacuate homes, grapple with food insecurity or the impacts of deforestation and biodiversity loss – even as they also deal with the health and economic impacts of COVID-19. It affects the social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter.

State of the World Climate

- **Greenhouse gas**: Concentrations of the major greenhouse gases, CO2, CH4, and N2O, continue to increase in 2019 and 2020. See chart below.
- **Temperature**: Global mean temperature for 2020 was 1.2 ± 0.1 °C above the 1850–1900 baseline. See chart below.
- **Sea level**: Sea level continues to increase, with recent sea level rising at a higher rate due to increased melting of ice sheets in Greenland and Antarctica. See Chart below.
- **Ocean heat and acidification**: 2019 (latest available data) had the highest ocean heat content on record. The rate of warming over past decade was higher than long-term average, indicating continued uptake of heat from the radiative imbalance caused by greenhouse gases. In addition to being warmer, the oceans are more acidic. Over the last decade, the oceans absorbed 25% of human-generated carbon dioxide emissions, which has resulted in the oceans becoming more acidic.
- **Sea Ice**: In the Arctic, the annual minimum sea-ice extent was

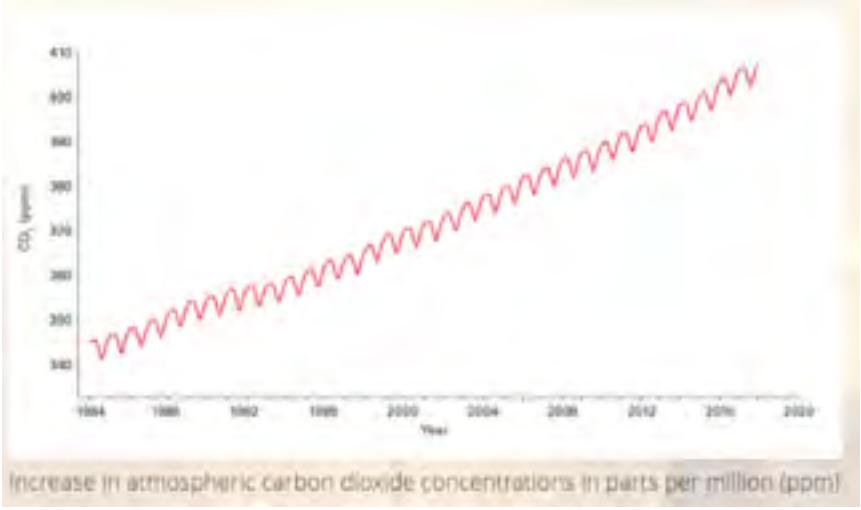
the second lowest on record and record low sea-ice extents were observed in the months of July and October. In Greenland, the ice sheet continues to lose mass—152 Giga-tons of ice were lost from the ice sheet in 2019.

- **Glacier melt**: Glaciers around the world continue to melt at unsustainable rates.
- **Rainfall**: Heavy rain and extensive flooding occurred over large parts of the world.
- **Hurricanes**: The north Atlantic hurricane season had its largest number of named storms on record with a record number making landfall in the United States of America.
- **Drought**: Severe drought affected many parts of the world.
- **Population**: Climate and weather events have triggered significant population movements and have severely affected vulnerable people on the move,

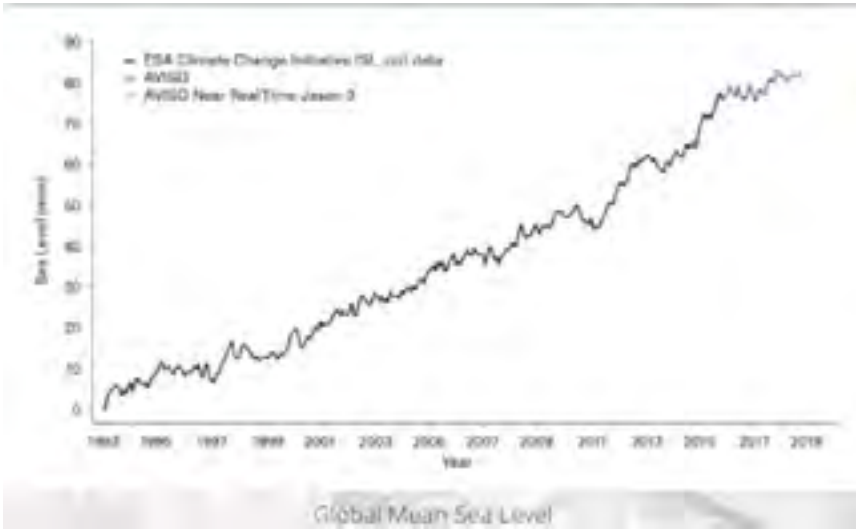
World Climate System Preferred State

"Preferred states" are important components of strategic plans. They help focus the design process on building and increasing capacity, rather than "problem solving." They move the focus from symptoms of problems to whole system health and well-being. The below is a preferred state developed at the Global Solutions Lab for the climate change situation confronting the world.

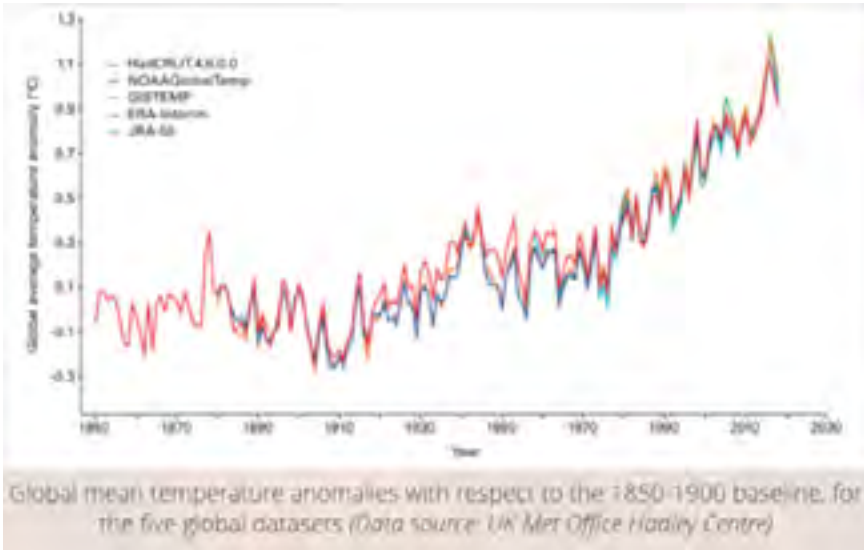
All charts below from: https://gcos.wmo.int/en/global-climate-indicators



Increase in atmospheric carbon dioxide concentrations in parts per million (ppm)



Global Mean Sea Level



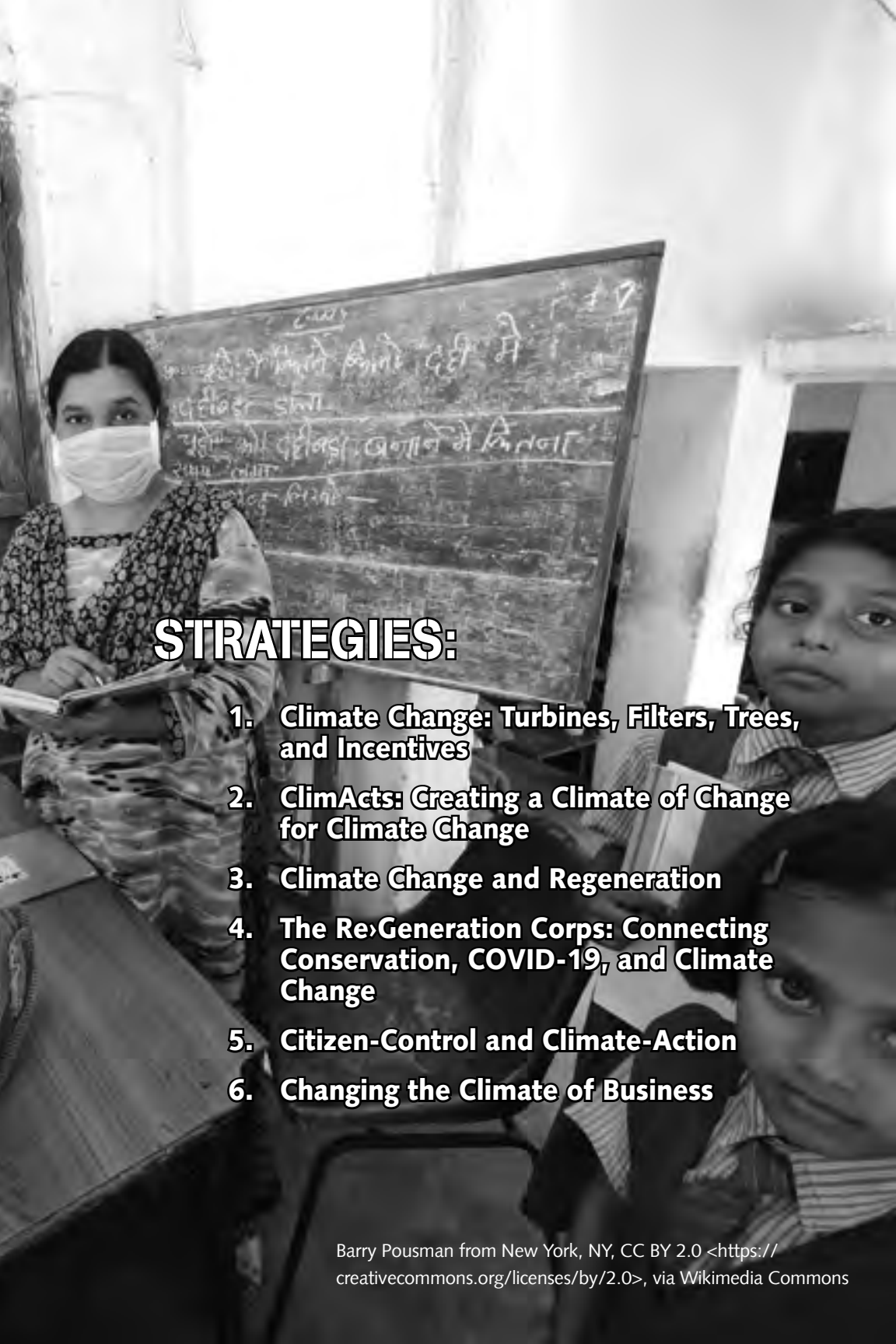
Global mean temperature anomalies with respect to the 1850-1900 baseline, for the five global datasets *(Data source: UK Met Office Hadley Centre)*

By 2030:

- 100% of humanity will live in a region and world free from life-threatening impacts caused by a changing climate.
- 100% of humanity will not have their health negatively impacted by climate change.

- Greenhouse gas emissions will be at net-zero. Meaning, the amount of gasses released will be absorbed by natural or human-made assortation processes.
- The average global temperature will be stable.
- Sea levels will no longer be rising; glacier and sheet ice shelfs in Greenland and Antarctica will no longer be decreasing in size.
- Weather patterns and weather-caused natural disaster events will return to pre-climate change levels.
- Dealing with the impacts and threats of climate change will be an engine of economic development, resulting in millions of new jobs and economic strength

The following pages present a series of strategies, developed by participants of the Global Solutions Lab, that seek to accomplish the above.



STRATEGIES:

1. **Climate Change: Turbines, Filters, Trees, and Incentives**
2. **ClimActs: Creating a Climate of Change for Climate Change**
3. **Climate Change and Regeneration**
4. **The Re›Generation Corps: Connecting Conservation, COVID-19, and Climate Change**
5. **Citizen-Control and Climate-Action**
6. **Changing the Climate of Business**

1. CLIMATE CHANGE: TURBINES, FILTERS, TREES, AND INCENTIVES

By An Nguyen (Vietnam), Fawwaz Ali Khan (Pakistan), Gurinder Singh (India)

Strategic Summary: *Climate change is measurable changes in weather patterns over the years. Current changes to Earth's climate are primarily caused by the addition of excessive amounts of greenhouse gases into the atmosphere. These gases are mainly caused by the use of carbon-intensive, inefficient, wasteful and long-term expensive production of energy, food, industrial processes, transportation, combustion of fuels, improper waste management and other factors. The impacts of climate change are global and severe. Human health is compromised, food production undermined and the global economy damaged to the tune of over $2 trillion per year. Impacts are most severe in the poorer regions of the world and upon people who have had little to nothing to do with changing the climate.*

The processes of climate change can be slowed and even reversed if environmental health and sustainability are prioritized, and industrial, energy, and materials use practices are changed.

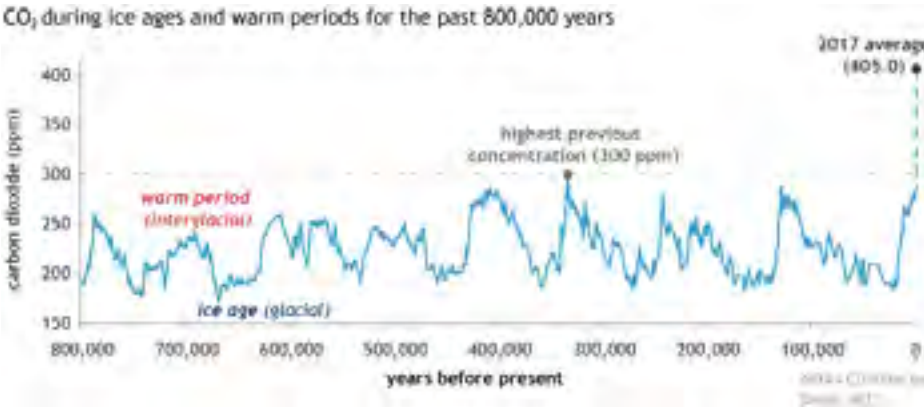
The following strategy deals with the causes of climate change and is divided into two phases. Phase One focuses on cleaner energy production using underwater turbines and the use of new filter membranes on smoke outlets in industries that reduce climate change chemicals released into the atmosphere. Phase Two focuses on a) improving existing conditions of the environment by installing giant air purifiers and filters in heavily polluted areas of urban environments throughout the world; b) global school and curriculum based tree-planting programs that involve the students of the world; and c), serious penalties for climate change pollution and significant tax-break incentives for industries working in the field of green energy production.

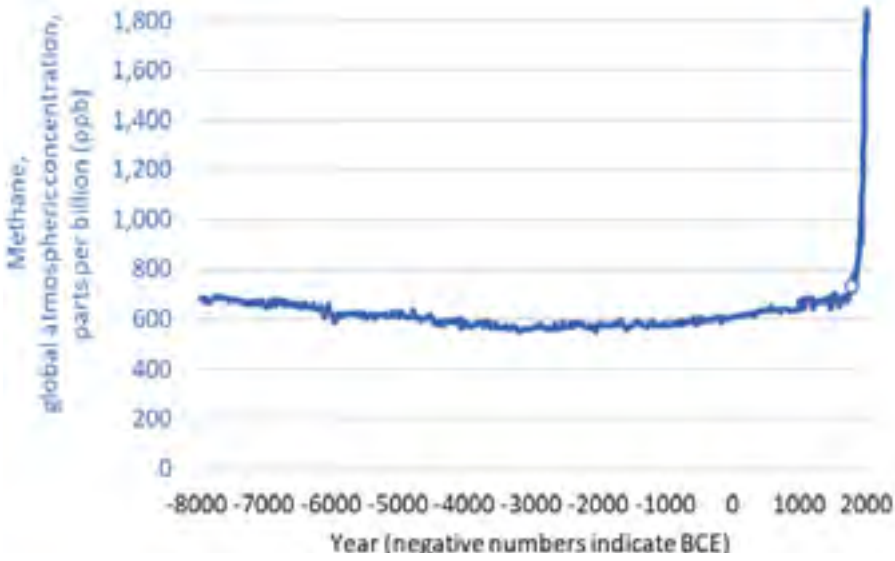
Problem State

The severity of climate change and its impacts can be measured by:

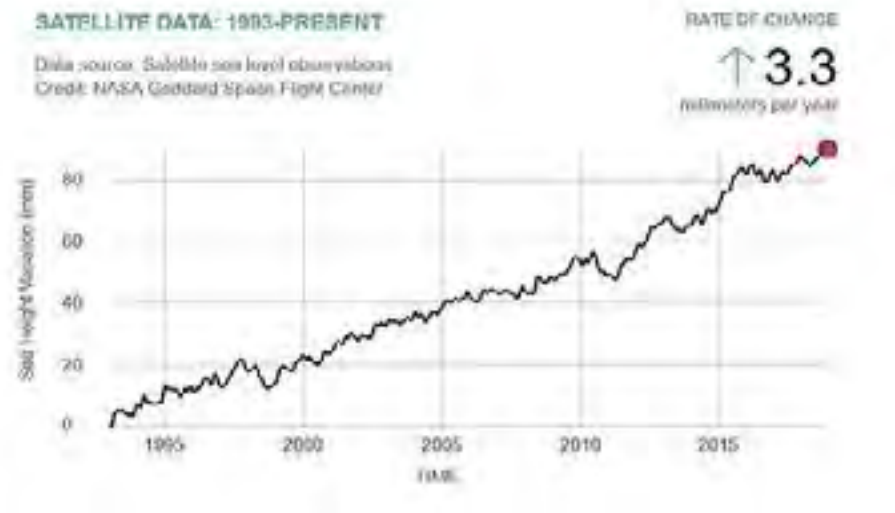
- The *temperature* of the Earth and how it has changed over the years. The Earth naturally goes through cycles of warming and cooling but the difference has never been so large this quick.
- *Melting of glaciers* and ice sheets causing a *rise in global sea levels* which impacts hundreds of millions of people living near the sea shores.
- *Seasonal and severe weather disruptions* around the world. Irregular monsoons, increased size and wind speeds of hurricanes, droughts and floods are some of the impacts of global rising temperatures.
- *Rising levels of air pollutants* and smog that it is affecting the health of millions of people around the world.
- *Deforestation* is causing the loss of wildlife and also increases the carbon content in the atmosphere.

One measure of the cause of climate change is the amount of CO2 and methane in the atmosphere. The following charts makes clear the historical severity of where our world is and is heading:

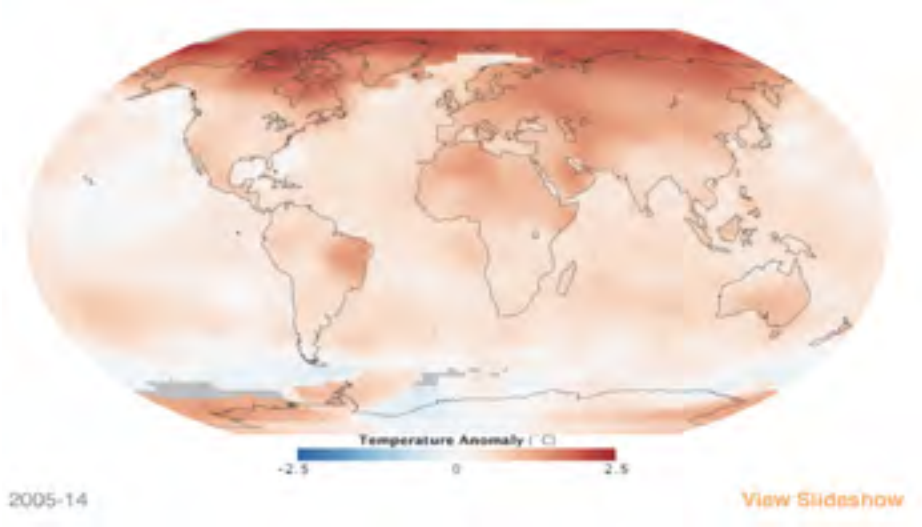




Global atmospheric concentration (ppb) over the years



Variation in sea levels

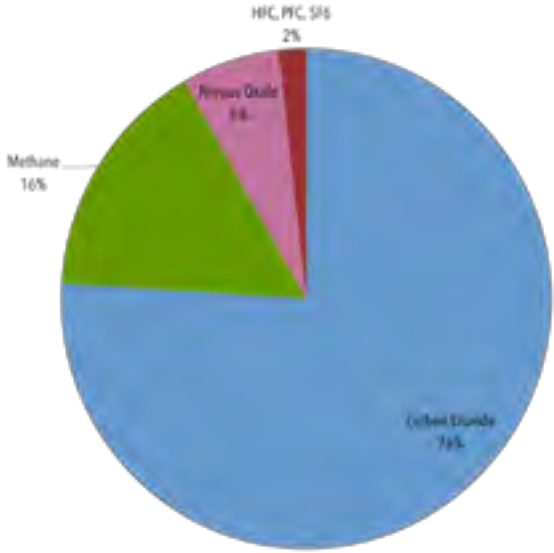


The above graphic shows the annual increase of temperature around the globe in 9 years (2005-2014). It can be seen that the change is maximum near the north pole and areas that surround it. Some parts of Asia, Africa and North America are seen to be the most affected due to high population and increasing demands.

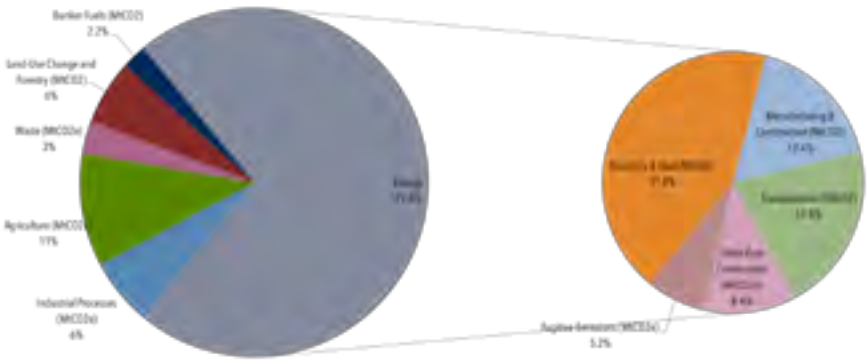
Present State

The increasing amount of greenhouse gases present in the atmosphere is the main source of change in climate. These greenhouse gases include carbon dioxide, methane, nitrous oxide and others. CO2 accounts for about 76 percent of total greenhouse gas emissions. Methane, primarily from agriculture, contributes 16 percent of greenhouse gas emissions, and nitrous oxide, mostly from industry and agriculture, contributes 6 percent to global emissions. All figures here are expressed in CO2-equivalents.

Globally, the primary sources of greenhouse gas emissions are the production of electricity and heat (31%), agriculture (11%), transportation (15%), forestry (6%) and manufacturing (12%). Energy production and consumption of all types accounts for 72% of all emissions.



Inventory of U.S. Greenhouse Gas Emissions 1990-2015 (EPA, 2017)



Climate Analysis Indicators Tool (World Resources Institute, 2017)

Preferred State

A Preferred State for environmental and climate health and sustainability in the world is where there is a:

- Reduction to naturally sustainable levels of human-generated atmospheric emissions from combustion of energy, agriculture, industries and other sources.
- Stabilization of global temperature below the level that increases global warming.
- Switch to greener methods of energy production such as solar, wind, geothermal, tidal and others.
- 90% reduction of all carbon-intensive fuels.
- Restoration of forests to pre-industrial levels.
- Increase in youth and general public knowledge of, prioritization of, and involvement with the state of the world's climate and the factors that impact it.

Strategic Plan for Reducing the Impact of Climate Change and Achieving the Preferred State

Our strategy aims to first prevent further disruption of the existing global atmospheric environment by switching to greener methods of energy production as this sector comprises of 31% of total greenhouse gas emissions into the atmosphere.

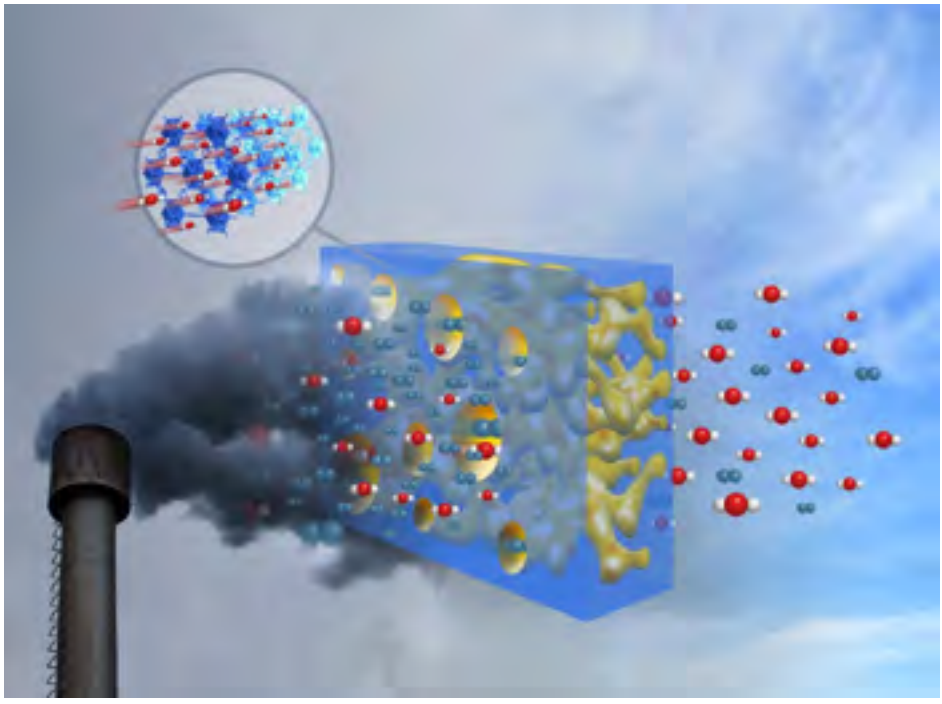
Phase One: Use of Underwater Turbines

Underwater (and tidal) turbines are a proven technology. Technological feasibility and proof of concept has occurred, in some cases, decades ago. They are essentially windmills installed onto an ocean floor or river bed. Underwater currents produced by tides (or rivers or ocean currents) spin blades arranged like an airplane propeller. These turbines are attached to a gear box, which is connected to an electrical generator. This produces electricity that is carried by cable to shore where it is plugged into an electrical grid and distributed. Turbines in water are more efficient than those in air as wind-flow is not be as strong and uniform. In addition, water is about 800 times denser than air, therefore, water flow can produce more energy compared to a same sized turbine blade in air.

Use of Carbon Capture Membranes

An emerging, and successfully tested at industrial scale, technology that has great potential in combating climate change are carbon capture filters. These are an atmospheric filtration system that utilizes a semi-permeable membrane that allows beneficial atmospheric gasses to pass through while trapping carbon and other pollutants. These can be used to great affect for atmospheric purification purposes as well as eliminating pollutants released from factory emissions. The Bill and Melinda Gates Foundation has partially funded a plant of such filters with fans to circulate air through them and extract carbon and other pollutants that can then be harvested and disposed of or reused.

The carbon capture membranes provide a few advantages in their way of removing carbon. The cost is lower due to the use of a membrane on a semi-permeable substrate instead of a solvent or a sorbent to help catch carbon molecules. They are more efficient than other methods, being able to remove Hg vapor and H2S in addition to standard carbon. Such technology can also be deployed easily into remote areas, such as the Gates Foundation-funded plant demonstrated. Multiple membranes can be included into a single module or unit which allows easier transportation and installation.



Graphical representation of carbon capture membrane that depicts how only the clean particles are released into the air whereas all the carbon and other harmful chemicals are captured within the membranes.

Phase Two: Large-Scale Air Filtering Towers and Machines

The second part of the strategy focuses on cutting existing atmospheric pollutants. This can be accomplished through the installation of giant air filtering machines and purifiers on a city-wide scale, such as the example installation below.

Air Purifying towers are designed to consume minimum energy while maximizing output. The towers have greenhouse chambers at their base that absorb the sun's heat to increase the temperature of air captured inside. The hot and less dense air starts to rise up and is forced through different layers of membranes that help to purify it.

Use of large and small scale air filters can purify the air around us. These absorb dust, smoke and particulate matter from the air and give out fresh air. Large scale air filters have been installed in a few cities of

The above image shows an air purifying tower installed in a city of China. This purifying tower has the capacity to clean the air up to 10kms of radius around it.

China to tackle the problem of rising smog. These city scale air filters are high towers—up to 100 meters tall that have the capacity to purify the quality of air over an area of 10 square kilometers in the city. Since installation, each tower has produced about 10 million cubic meters of purified air per day. Records show that the average reduction in PM 2.5 (small pollution particles which penetrate deep into the respiratory system and cause the most damage to the body), fell 15 per cent.

In Delhi, India, a small scale air purifying tower (40 feet tall) was installed with a capacity of cleaning air within 3km of radius around it. A single tower of s this scale costs about $10,000.

Similar to this, there are cities like Rotterdam, which have come up with city-scale air purifiers that absorb pollutants and smog from the air and convert it to jewelry.

This technology can be further developed and used in other cities and urban areas where the quality of air is needs improvement.

Another part of Phase Two of our strategic plan focuses on replenishing environmental systems to pre-industrial levels. This is achieved by the creation of tree plantations at a scale that has a global impact. Trees are natural purifiers of air that can absorb about 48 pounds of carbon dioxide per year and can sequester a ton of carbon dioxide by the time it becomes 50 years old.

An example of a large scale air purifying plant installed at the terrace level in the industry. It absorbs carbon from the gas produced after combustion. The captured carbon is collected and is reused to make inks and paints.

Tree Plantations

Our strategy calls for harnessing the interests, energy and enthusiasm of youth in schools and colleges to promote the plantation of trees. Every student will plant one tree, once a year as a part of their curriculum. The cost for one tree is as low as 10 cents. This and other associated costs of this program will be provided by the school's community.

The number of students in the world is about 1.29 billion for schools only. Given this number, and the planting of just one tree each year by every student, it is possible to replenish the greenery in the environment over the course of a few years. Recently, Ethiopia set the world record for planting 350 million trees in 12 hours. The country has a goal to regain the lost forest area from their land which dropped from 30% to 4%.

Funding for mass-tree planting can be promoted at city, state and country levels in different parts of the world. Tree planting competitions between schools, cities, states and countries can bolster the awareness, interest and fun of this initiative.

Implementation

Scale

The strategic initiatives presented above will be able to be scaled up differently in different countries according to the current situation that they are in. All of the solutions will be implemented on a global scale to make a real difference in the amount of carbon produced and removed from the atmosphere.

Costs

Giant Air Purifying Towers for large cities. The current models in use in China cost $2 million per plant.

Given their impact, it is estimated we will need 1,000 (at a cost of $2 million) each year for 10 years to make the kind of impact our Preferred State calls for. This is a small fraction of the damage the current air pollution causes to human health, economic productivity, and environmental sustainability. *Total cost per year: $2 billion; total cost over 10 years: $20 billion. Total area cleaned: 100,000 sq. kms. of the highest human population densities and highest human harm from air pollution in world (cities).*

Small Scale Air Purifiers for public squares and small areas. Each of these air purifiers costs $10,000. It is estimated we will need 10,000 or these (at a cost of $100 million) each year for ten years. *Total cost per year: $100 million; total cost over 10 years: $1 billion.*

Trees for Mass Plantings and reforestations of areas near schools and cities. At $0.10 per tree and 1.29 billion students in the world, it will cost $129 million for one tree per student per year to remove over 28 million tons of carbon per year. After five years, this will be approximately 140 million tons per year.

Carbon Capture Membranes for industrial exhaust into the atmosphere. The current costs of these membranes is between $20 to $60 per ton of carbon removed. To remove 10 million tons of air polluting carbon from industrial processes will cost approximately $200 to $600 million. Amortized over ten years this will be $20 to $60 million per year.

Carbon Capture Plant: $100 per ton of carbon for use in cities to reduce heavy polluted areas. With a price on carbon of $100 or more per ton, these plants are a bargain.

First Steps/Next Year

New regulations and incentives are needed to boost this strategy into high gear. A global carbon tax of $100 per ton will curtail fossil fuel use and spur investments to make much of the above a reality. Penalties, and their aggressive enforcement, for atmospheric pollution will be another big help. Tax incentives for investment into green energy and increased funding for school based tree-plantings will get that initiative moving quickly.

Removing all subsidies to fossil fuels will have an enormous impact on moving society away from carbon-intensive fuels.

Providing large-scale funding for green energy research to universities and tax incentives to companies for development of green energy technology will be a huge accelerant.

Endnotes

1 The average surface temperature on Earth rose 0.95 degrees celsius between 1880 and 2016. U.S. National Ocean and Atmospheric Administration
2 The average surface temperature on Earth rose 0.95 degrees celsius between 1880 and 2016. U.S. National Ocean and Atmospheric Administration
3 In 2014, global sea level was 2.6 inches above the 1993 average—the highest annual average in the satellite record (1993-present). U.S. National Ocean Service.
4 Air pollution contributes to 9% of deaths globally – this varies from 2% to 15% by country. University of Oxford.
5 Conventional methods of energy production involve burning of fossil fuels such as coal which releases harmful gases like carbon monoxide into the air.
6 Density of water is higher than that of air. Compaction of particles in a liquid is tighter than the compaction of particles in a gas.
7 Carbon Capture Filters are put at the smoke outlets in industries and factories. Any kind of smoke produced from the industry has to pass through these membranes which do not allow harmful gases to pass through them.
8 Bill Gates is banking on a new technology that could reduce atmospheric CO2 levels on an industrial scale. This technology enables scientists to suck CO2 out of the air by separating it from other molecules and converting it to solid matter. Carbon Engineering, one of a handful of companies leading the development of these technologies, and a recipient of Gates Foundation funding, claims their current prototype technology can remove 1 million tons of pure CO2 from the air each year.
9 The nation's average PM2.5 readings came in at 61 micrograms per cubic meter for January and February 2019, according to a Ministry of Ecology and Environment survey of 337 cities, with only 83 reaching the national standard of 35 micrograms.
10 The average value of PM2.5 in air is 72 μg / m3, which is the 2.06 times the annual average second level standard (35 μg / m3) by the environment air quality standards in China which fell down to 61.2 μg / m3 after installation.
11 The smog particles filtered by the tower are compressed for 30 minutes and turned into dark, boxy gems. The "diamonds" are then used for rings and cufflinks, each representing 1,000 cubic meters of pollution. 12 48 Pounds of carbon cleaned by a tree in a year; 2400 pounds of air cleaned in 50 years. (Approximately 1000 Kgs or 1Ton)
13 In the year 2014, the estimate for all enrolled students in primary and secondary schools in the world was 1,287,078,204 (1.29 billion). Primary: 719,059,053. Secondary: 568,019,151. That's about 17% of the world population. UIS Data from UNESCO 14 The initiative was part of a wider tree planting policy launched by Ethiopian Prime Minister Abiy Ahmed, whose administration aims to tackle deforestation and climate change by planting 4.7 billion trees by October this year.
15 According to the UN, forest coverage in Ethiopia has declined drastically since the start of the century, reaching a low of just 4% in the early 2000s, as opposed to 35% 100 years ago. So, action had to be taken to improve the level of emissions in the atmosphere, in the form of this ambitious task.

16 A single 200 feet long air purifying tower (world's largest) costs $2 million for its installation. It works on solar energy and hence the price is limited just to its execution.
17 A single small scale air purifier that is 40 feet tall costs $10,000 for its installation. Production of these towers on a large scale may allow in reduction of the overall cost.
18 1.29 billion x $.10 = $129 million; 1.29 billion trees per year each removing 48 pounds /year = 61.92 billion pounds/yr divided by 2200 = 28 million tons/yr x 5 years' worth of trees = 140 million tons/yr carbon extracted from global atmosphere after five years.)

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2. CLIMACTS: CREATING A CLIMATE OF CHANGE FOR CLIMATE CHANGE

By Anita Shervington (UK), Davina George (Saint Lucia), Jawaria Ali (Pakistan), Sarah Allaben (USA)

Strategic Summary: Youth and climate change education are critical if the world is to avoid the worst of a changing climate. A person's level of education about climate change makes a critical difference in the understanding and active engagement in mitigating the impacts of climate change. We, however, need to look beyond what we think of as education in terms of school and formal institutions of learning. This strategy presents one such approach that harnesses the creativity, enthusiasm and power of youth to deal with climate change. It presents a youth powered, technology-aided strategy to catalyse public education, behavioural change, and political action needed to address the problem of climate change. Given the ubiquity of smartphones and their use by youth around the world, an app that deals in a creative and empowering manner with climate change by letting its users connect with each other, reliable climate change information and actions, and which also enables climate change actions to be organized and publicized, is needed. This strategy presents such a tool.

Preferred State By2030

- All young people around the world understand climate change is a critical issue, and actively participate in implementing solutions that can mitigate it both locally and globally
- Youth feel empowered and equipped to lead in this effort.
- Youth are globally connected and educated about climate change and actions they can take to make a difference
- Youth are enabled to take actions that they see will help avert climate disaster and reach a climate-safe world
- Youth will have easy access to technology and social media to exchange information, ideas and to form collaborative teams to build local, nation and international movements to combat climate change
- Youth will have access to climate change content that is accurate, culturally appropriate and socially responsive, and which takes into account youth differences of language, culture, religion
- Youth engaged in climate change education and action will have

public support for their initiatives

Introduction/Problem State

The global temperature rise, extreme weather events, rising sea levels, and other intensifying impacts of anthropogenic climate change will require a network of widespread, creative solutions. Generating and supporting these solutions, however, requires that citizens across the world have a strong foundation of climate knowledge and experience with cross-cultural collaboration. Education and centralized climate resources are essential to bring about awareness and action among young people (ages ~15–25), a demographic that not only will bear the brunt of climate change impacts, but also will serve as the leaders and innovators of the future.

The current worldwide education system does not adequately prepare young people for these roles. In much of the developing world, greater than 50% of the population has never heard of climate change. School curricula often fail to address climate change; in the United States, only 42% of teachers incorporate it in their lesson plans, and many of those teachers do not clearly convey the human-caused nature of the crisis. The 2015 UN General Secretary's Envoy on Youth found that, while 89% of surveyed young people believe that youth can make a difference in preventing climate change, 83% of respondents felt that they needed more information to do so. Whi5le the climate movement continues to grow among young people, there is still an urgent need to bring knowledge and networking tools to *all* youth, empowering action

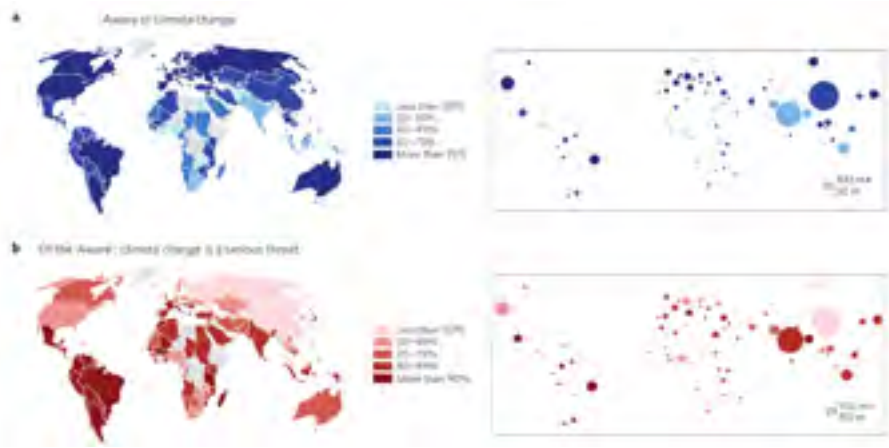

Figure 1 from Lee et al. (2015)

Figure 2. from Global Digital Overview 2020

and leadership in communities across the globe.

Paralleling this educational need is the dramatic rise of social media platforms worldwide, especially among young people. Over 50% of the world population currently uses social media, demonstrating a 10.5% increase in users in just the past year. Individuals between the ages of 18 and 34 make up the greatest percentage of users on most sites, including Instagram, Facebook, and Twitter. With the ever-expanding influence of the Internet and social networks, we believe that the most effective way to spread accurate information, garner support for pre-existing climate action groups, and ignite new movements is to reach young people through a social platform dedicated to climate change action.

Strategy

In order to bring about the desired positive changes needed to mitigate climate change, our strategy involves designing, launching and establishing an application called *ClimActs*. This app is designed to increase and sustain climate change awareness and action. It will propagate accurate, reliable and up to-date information regarding climate change. The app is also aimed to encourage people, especially youth to actively participate in the implementation of solutions that can

mitigate climate change both locally and globally, and make youth feel and be empowered, connected, and equipped to lead the world in this effort. ClimActs will provide a platform to do this.

ClimActs

The app will be structured around providing a smart phone platform for climate change centric activity and awareness. It will do so by presenting new initiatives, solutions and data, as well as the opportunity to participate in existing and new initiatives, causes, and solutions. All this will be available on a single platform.

The app will be free and have the feature to login and create an account to access some features such as for attending an event or seminar. The app can be accessed without signing in as well. It will be available both on GooglePlay and the Apple app store.

The primary components of ClimActs app are:

- **Events & Seminars:** this tab of the app will be responsible for hosting events for people in their local communities that youth would like, that are curated or specific to what works in that setting. For example, events and awareness seminars on coral reef conservation in the Caribbean or forestation strategies for a local community. The app will also have the option for individuals in an area to propose a climate change event or request for a seminar or workshop of their choice. The app will help in locating relevant specialists, representatives or team to help carry out that event.
- **Connecting, Interacting, Building Community:** This tab of the app will be responsible for having various existing social media applications linked to ClimActs, such as Instagram, Facebook and Twitter, where users can upload photos and updates of themselves participating in climate change mitigation or climate change events, and communicate with one another and connect. Since this app is focused on youth, users can tap into having their content result in viral trends and contribute to 'trend culture' where media posted on the app and other socials picks up enough momentum to become widespread and encourage other users to also join the cause, for example, via fun internet challenges.

- **Create & Start Initiatives:** This tab of the app will help users connect and be engaged by other means such as providing a platform to organize protests, letter-writing campaigns, petitions, polls, climate change actions other forms of activism for climate change, both locally and globally.
- **Resources & Information Database:** This tab of the app will be a hub of vetted, accurate digital climate change information that is trusted, up-to-date and curated to provide the global picture as well as hone in on local climate change issues around the world. The app will partner with organizations such as the Sustainable Development Solutions Network (SDSN), the UN Earth Dashboard and the UN statistics website for their Sustainable Development Goals (SDG) indicators. It will incorporate this data or websites and resources and make it more widely available to all through ClimActs. This section of the app will also have various other vetted sources and media information such as climate change education resources available for students. All of this will be free of cost.
- **Specialists & Experts:** This tab will have detailed lists and short bios of specialists and experts regarding climate change that users can connect with in real time Lists will include environmentalists, scientists, engineers, biologists and other accomplished climate changes experts. The lists of experts will also be culture and area specific. Users can work with sociologists and other to help to determine the specific barriers to climate change education in communities in their area, nationally or worldwide.
- **Partnered Projects & Organizations**: This tab will provide information and the opportunity for users to take on or participate in existing climate change initiatives or projects. It will also provide the opportunity to work with established and successful climate change organizations. The app will support and bring attention to existing climate-related initiatives, events, organizations, and programs and help users connect with them. Programs and organizations that ClimActs will partner with include (but are not limited to) the United Nations Framework Convention on Climate Change (UNFCCC) programs, UN Youth Climate Summit and the UN Climate Change Learning Partnership. Other organizations are listed here. The app also aims to partner with universities and educational institutions. Users can also “like” and “follow” existing opportunities on the

application and post job opportunities related to climate change for other users to see. As this app is centered on youth, ClimActs also hopes to collaborate and partner with social media influencers, celebrities and influential people to spread awareness and help with engagement related to climate change.

- **Competitions and Games:** This tab of the app will be host to an incentive "point" system in which points are awarded when users donate either their time or money to climate causes by participating in climate change activities, online climate change games and competitions on the app. The collected points will accrue real-world money which will be donated to climate change organizations or directly contribute to climate change causes such as planted trees, etc.
- **Donate:** This tab for individuals, organizations, businesses or classes to donate money to an existing or to a new climate change cause or organization.

Timeline

The projected time for our strategy to be in full effect is three to five years, with tangible results and impacts within 6 months.

BY 6 MONTHS

1) Research and Development

Prior to the app design and development, information will be gathered on different components. These components include:

- *Sustainable Development Goals and other United Nation Resources:* Our targeted goal is #13- Climate Action. Here, actions are made to improve education and awareness while pushing to mitigate current climate change. This research will be part of the foundations of the development of the ClimActs app.
- *Climate Change Regulation by Region:* Information here allows us to understand the current climate conditions in different regions while also noting possible mitigating actions. Gathering regional information will also help the ClimActs to further learning and cross-fertilization between regions.
- *Reaching out to NGOs, Corporations, and Groups with Similar Ideas:* There could be other groups or projects similar in intent or function to ClimActs that could possibly further the development of ClimActs. If such a groups is found, ClimActs will seek to partner or collaborate with them.
- *Regional Rollouts:* There will be challenges to rolling out the app to ClimActs targeted user group in different countries, for example, technological or cultural barriers or costs.
- *Education:* Current climate change educational resources will be examined for accuracy, relevance and reliability for students and youth.

2) Pitch to Investors

- *Local Focus Groups:* Creating focus groups to pitch ideas allows us to understand the public's reaction to the creation of such a platform for climate change. We can hear and understand their attitudes and opinions regarding the app, while also taking in pointers to make them more user- friendly.
- *Investors, sponsors, donors or partners*: Ideas will then be brought to different investors with the plan of building a partnership to fund the app project.

3) Work with Developers

After research and groundwork is established, work will begin with developers and application designers. Several prototypes will be pilot tested and released in different demographics. Feedback and results will be utilized as the base for the final app. Continuous

surveys, researches and polls will be conducted to get an idea of what it is that ClimActs users would benefit from most.

4) Implement Test Runs

- *Local*: Initial focus groups would initiate test runs on the prototype/ final app for 1-2 months. Individual critiques will help update the app framework, content and ease of use.
- *International:*
    i. 2-3 countries will be selected to run the ClimAct prototype.
    ii. Participants will be acquired through focus groups, volunteers, and/ or public events

5) Profile Creation Available

Within the 6 months stage the app will be developed enough to support user profiles, a sign-up option for individuals and organizations, and for registering for events and seminars. The objective is to ensure the users' attention is grabbed from the first interaction of the app and to work on marketing, development issues, bugs, and updates to content.

The app will be available in English and the six official languages of the UN.

BY 2 YEARS

1) Go public and influential

By the two-year mark ClimActs will have gained enough momentum to have caught the attention and interest of influencers, youth leaders, and public figures to spread the

importance and usefulness of the app. The app will also be promoted through public events, social media, and ads on video platforms**,** such as YouTube.

2) Updates and Development

Continue updating user, security, and information areas of app for each region the app is based in by working with regional scholars and activists to provide accurate and reliable information with each update.

3) Trends

By this stage ClimActs will have a trend, or hashtag, to be used for the ClimActs brand, platform, and user base that will allow it to be tagged or referred to whenever a user achieves their set goal or activity. Sharing the set hashtag allows for the app to be seen and gain more audiences.

4) Sponsors

At this stage of the ClimAct strategy it will have reached out to potential sponsors and investors/sponsors and established numerous partnerships and connections. These may include (but are not limited to):

- UNFCCC
- UNESCO
- SDSN
- Climate Reality Project
- Partners with similar motifs or ideas
- [NOTE: See footnote #9 for list of additional partners]

BY 5 YEARS

1) **Global**
   By 5 years, ClimActs app be available in all countries around the world, in most languages, accessible to most of the world's population available on all smartphone platforms and operating systems.

2) **Influential Partnerships**
   The ClimActs development strategy calls for celebrities, politicians, influential leaders, organizations and influential figures such as religious, NGO and UN Agency heads to partner with ClimActs and promote climate change awareness, education and mitigation and reversal to their respective audiences.

3) **Latest Updates**
   ClimActs will constantly update, revise and revamp its technological platforms to current standards, fix bugs, as well as regularly rolling out new updates that take into account feedback and user suggestions via constant polls and satisfaction surveys.

4) **User Monetization**
   By the time ClimActs is fully established as a popular and influential platform, users will be able to monetize their content on the app, just like existing platforms such as YouTube or Instagram provide.

Costs / Where Do the Resources Comes From?

Smartphone app development experts estimate the cost of the ClimActs to be:

According to Cleveroad.com

- Estimated average software development rates per hour by region (USD)
- US & Canada: $30–$300
- Latin America: $30–$50
- UK: $50–$170
- Western Europe: $35–$170
- Eastern Europe: $20–$150
- India: $18–$80

- Australia: $50–$150
- Time Based on Complexity
- 700–1200 hours (medium to very complex)
- Costs of Basic Features**:** $27,000
- Total Cost of Employees (Hourly) by Region (USD):
- US: $1,252
- Latin America: $465
- Eastern Europe: $415
- Asia: $287
- Maintenance
- Ranging from 15%–20% of development costs
- Work Breakdown Starting in Total (USD)
- Medium Complexity: $120,000
- Complex: $200,000

Cost Summary/Strategy Budget

- **$200,000** initial app development
- **$200,000** for research (social impact communication, behavioral economics)
- **$300,000** for 3–4 communication and branding specialists (PR)
- **$30,000** for app maintenance/updates
- **$100,000** for public events, seminars, drives
- **$50,000** for influencer/ambassador partnerships
- **$10,000** for youth internships

Total: $890,000 USD

Possible Funding Sources

- Sponsors
- Partner companies/organizations
- Seed funding
- Philanthropists
- Grants
- Investors
- Crowdfunding
- Media Impact Funders

Public Events

ClimActs will participate in trade shows and seminars to increase awareness in the ClimActs product, but to also educate people about climate change.

1) Trade Show

- Budget for trade space averages around $21 USD per square foot.
- The budget is also broken down into venue services, promotions, constructions, and shipping.
    iii. Minimum booth size: 20 x 20
    iv. Total: $8,400 USD
    v. Additional service, labor and expenses
        a. Total: $27,000 USD

2) Seminars

- Budget for seminars tend to depend on the:
    ii. Location
    iii. Food and drink
    iv. Hand-outs
    v. Services
    vi. Equipment

3) Marketing

- Budget is for promoting and broadcasting the effectiveness of ClimActs for the purpose of acquiring a larger audience.

Impacts

1) Educational resources taken into communities without strong education systems.

a. Taking the ClimActs app into less-formal education available communities allows ClimActs to inform community members about the seriousness, challenges and opportunities of climate change. ClimActs will provide up-to-date information regarding climate change actions in your community, region, and globally.

2) Young people are involved in climate initiatives in a fun, user-friendly format.

a. By using the ClimActs app, kids, teens, and young adults will be able to take part in different challenges and activities to increase their climate change awareness. They

will be able to participate in tasks as a single member or against friends for competitions

3) **Information spread to older generations (including parents and teachers).**
   a. Young people are the voices of tomorrow. Using information acquired from ClimActs will help decrease the gap between climate change opinions among adults.

4) **Social media and trending culture (e.g. banning plastic straws to save the turtles picked up on social media and had huge success mainly due to social media's coverage on it) used to our advantage, will provide momentum to climate change cause.**
   a. Broadcasting, or advertising our app allows us to make our cause known. It can be utilized across all media platforms. Users are able to see in real time efforts being done and shared by others to make an impact.
   b. Branching off onto media platforms allows ClimActs to reach more individuals in each country by providing reliable information and knowledge on the importance of climate change.
   c. Social media and trends will allow collaborations with different influencers who can promote climate change.

5) **Accurate and vetted climate information is accessible with the touch of a button.**
   a. ClimActs will work with researchers to provide reliable and validated information within our brand. Providing validated information decreases the chances of false climate change claims and studies. With accurate information, the public would be more accurately informed about different climate change circumstances, procedures and actions that need to be taken.

6) **Climate nonprofits/programs are united and organized within a single platform.**
   a. ClimActs understands there are numerous non-profits, companies and projects with the mission of fighting climate change. ClimActs aims to collaborate with as many organizations as possible to combine resources and

methods. ClimActs would also provide users and audience with information of these organizations through our app and during our events.

b. ClimActs will provide a simple way for organizations to solicit donations of time (volunteering) and money within each region. Members would be altered of community engagement activities done by ClimActs and others though the ClimActs platform.

7) Creates international community, prompting awareness and support for climate actions in different regions.

a. ClimActs, aims to grow climate change awareness throughout each community. Creating the app and increasing awareness is a small step in the mission towards fighting climate change. Informing users of actions and providing tools will help increase positive climate-impacting habits while decreasing negative actions. By having local and global community engagements, ClimActs hope to have an immediate and long-term impact that would continue to influence future generations.

Conclusion

Climate change solutions—renewable energy innovations, regenerative farming, forestations, protection of natural areas, and so on--are rendered fruitless without the strong leadership and support required to put them in action at scale. We believe that the education and connection of younger generations is essential in providing such leadership and support, now and for years to come. The ClimActs app, is a means of featuring existing and new climate change mitigation efforts in one place, providing vetted educational resources, and allowing young people to communicate and collaborate cross-culturally that can serve as a relatively low-cost and accessible way to empower young people to ignite change across the globe.

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3. CLIMATE CHANGE AND REGENERATION

By Mohanad Aljarboua, Gurinder Singh

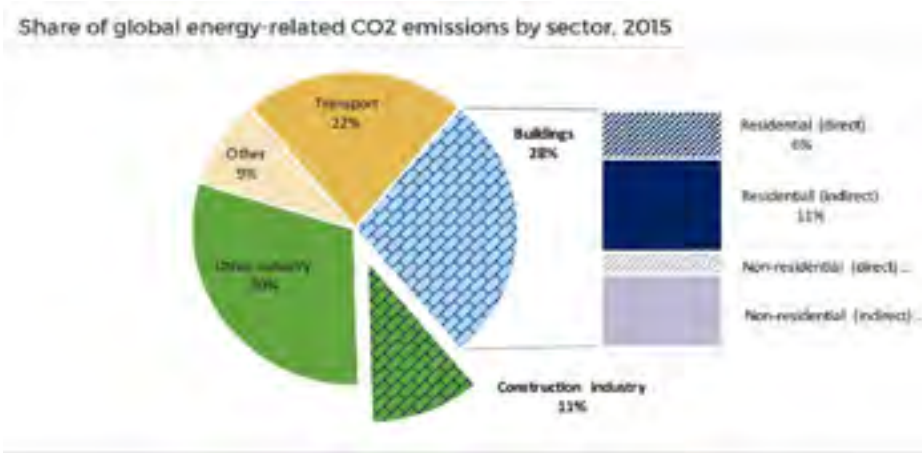
Strategic Summary: *Climate Change is the slowest form of a pandemic that has been lingering on the head of humanity. It doesn't matter whether we observe the changes due to climate change locally because at a larger scale it has been causing glaciers to melt which is related to sea levels and the global temperatures rising- ultimately, sooner or later, we all will see the impacts of this change affecting our lives. Amongst all the sectors that contribute to climate change, the buildings and construction sector play a huge part. Not only does this sector contribute to carbon sequestering but also acts as a major source of global energy consumption. Despite available technology, regulatory standards, green building materials, and sufficient awareness of climate change, it is not a common practice to construct every new building as a certified regenerative green building. Strategies and actions that help bridge the gap to a greener future in building construction and development is presented here.*

Introduction/ Problem State/Present State

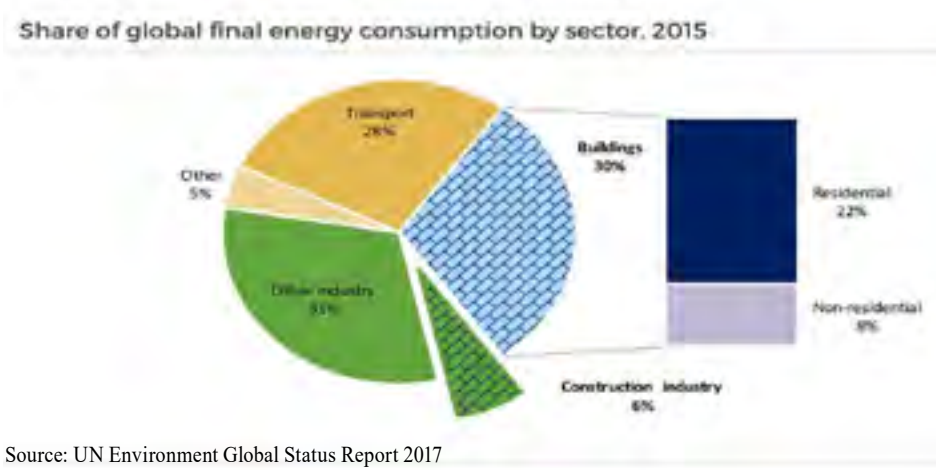
The building construction sector of the economy is energy intensive. From the start of a project to a building's lifespan, buildings consume a lot of energy to meet the needs of its users. About 40 percent of the world's total energy is consumed by buildings and about one-third of total carbon emissions are caused by the buildings. These alarming numbers illustrate the impact of today's building industry. One way to help fix this situation is to make the buildings and structures spread around the world produce their own energy, and use renewable resources in the construction

Despite the advances in technology and services, the world still experiences uneven distribution and accessibility to energy. 13 percent of the world does not have access to electricity, and the poorest 40% of the world's population uses only 10 percent of the world's energy supply. The lack of access to affordable and reliable supplies of energy is caused by various factors but it is not inevitable. Careful investment

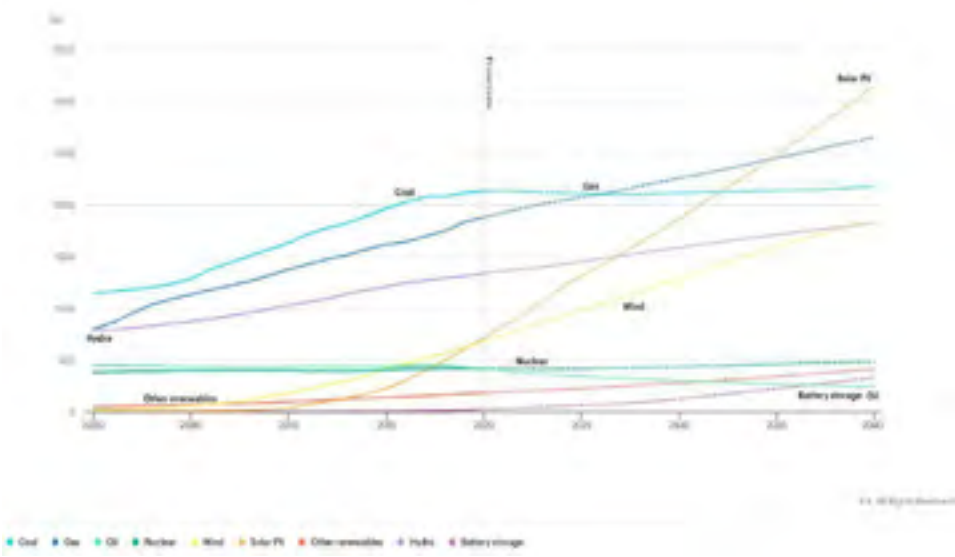
in the right technology will increase supply and the use of renewable energy-producing resources—and reduce dependency on non-renewable energy production.



Source: Un Environment Global Status Report 2017
Buildings + Construction industry = 39% emissions



Source: UN Environment Global Status Report 2017
Buildings + Construction industry = 36% consumption



IEA, Installed power generation capacity by source in the Stated Policies Scenario, 2000-2040, IEA, Paris

Preferred State By 2035,

- All buildings will create 100% of the energy they use as a means of mitigating the effects of climate change and reducing the costs of running the building.
- Buildings as **micro energy suppliers** is the standard
- All buildings provide low cost energy for the use of the building
- All buildings incorporate regenerative design
- 75 percent of carbon emission are reduced from new and retrofitted buildings

Challenges to Overcome:

1. Improvements in global energy efficiency have slowed down. Rate of yearly improvement peaked in 2015 at 3 percent. In 2018, the rate dropped to 1.2 percent.
2. Investments in energy efficiency in buildings remain relatively small: Energy efficiency spending made up $139 billion or 3 percent of total global spending on buildings in 2018.
3. Energy-related CO2 emissions from buildings have risen and may continue to rise if energy efficiency is not addressed: By 2060, buildings sector floor area will double

4. Rapid change is needed to meet the UN's Sustainable Development Goals. To reach the SDG 7.3 target we need to double the global rate of improvement in energy efficiency by at least 3 percent every year until 2030.

Strategy #1

There is a critical need to make improvements in global energy efficiency. One way to do this is to produce enough energy in every building so that the building is either a net energy "exporter" to the local energy grid, or at least self-sufficient in its own energy consumption. To meet our goals, the strategy calls for this to happen by 2030. By 2035, the majority of the larger buildings in the world will be energy sources, not sinks. The energy sources will be renewables.

A core feature of this strategy is to scale-up production of renewable energy harnessing technology and making these technologies available to a wider range of consumers—from skyscrapers to factories and large box stores to apartment complexes and even single-family dwellings. This will lead to less dependency on fossil fuels, increased employment in the renewable energy and energy efficiency sectors of the economy, and a greener future.

Scaling up such a large-scale initiative of energy-efficient solutions needs to be done in different stages to ensure its workability. These stages include prototype testing, expansion to a district scale up to city, state, country, and to the world scale. A good example of a community that made this strategy practical is The Sierra Crest development in Fontana, California. At this site there are twenty residential buildings that are integrated and make use of solar-powered energy generation. The project demonstrated that on site energy production is the one of the most impactful and cost-effective ways to bring about zero net energy use in buildings. If this approach were carried out at a country scale the results would have a large impact of energy use efficiency. If the strategy were implemented globally, 70% global CO2 being dumped into the atmosphere by the buildings could be reduced by 2050 and be completely omitted by 2060.

Due to lack of free spaces in urban landscapes for large scale solar farms, wind farms, etc. it becomes a potential solution to utilise the facades and roofs of existing structures for installation of renewable energy technologies. Technologies such as roof and window solar photovoltaic panels, solar blinds, micro wind turbines, cogeneration

units, etc. can be installed at households to produce energy to meet needs. When installed in a local region at scale, the technology can produce enough energy to supply some back to the utility grid. This kind of system offers consumers the option of being a producer in the energy system by providing a site suitable for the installation of such technologies. To accelerate this transition, the community of suppliers could get subsidies in their energy bills to help them make the investments need to bring about the strategy

Additionally, it is important to note that solar energy generation from *SolarGaps* can produce 35 kWh energy per day (12,775 kWh/year). The annual energy consumption rate by a regular-user household is 3,500 kWh. Though the initial costs for the installation of these technologies are higher than monthly bills for energy, over the long-term they are by far less expensive. The surplus energy generated by the solar power energy generation technology—and the income from selling this surplus on the electric grid would off-set the initial start-up costs relatively quickly. The entire project will incorporate the help of diverse groups, including investors, organizations, and the project beneficiaries, which in this case are the families within a particular locality.

Strategy #2

The second strategy is focussed on making every new structure a regeneratively designed building. The 'regenerative design' approach is a step further than a 'sustainable design' approach. Instead of having a net-zero impact on the environment, the regenerative approach mandates that a structure is an energy producer and a carbon sequestering structure, hence has a negative carbon footprint. It accomplishes this through methods such as-on site energy production, waste management systems, stormwater harvesting systems, green facades, green roofs, thereby making a net positive impact on the environment.

A key part of getting this strategy implemented is a government policy that provides a subsidy in the form of tax breaks on every new site for construction of structures that adhere to the principles of regenerative design. Where feasible, National Architecture Councils of every country will help regulate this strategy.

Architects and designers under every country's council are expected to follow certain design principles and guidelines for new constructions. The 21st-century guidelines will be modified in ways that incorporate

regenerative design techniques. Such an approach will hasten the transformation of the built environment.

Conclusion

There are many viable solutions to the problems of climate change—but because of the exorbitant subsidies given to fossil fuels and other environment-destroying practices they are deemed unaffordable or "impractical". Retrofitting existing structures and building new ones that incorporate the latest technology for making our buildings regenerative will help the world avoid the worst impacts of a changing climate and to achieve a sustainable environment by the year 2030.

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4. THE RE›GENERATION CORPS
CONNECTING CONSERVATION, COVID-19, AND CLIMATE CHANGE

By Ravi Cullop (USA), Cynthia Muaka (Democratic Republic of Congo), Duong Nguyen (Vietnam), Nafisa Nujhat (Bangladesh), Aza O'Leary (Canada), Ellen Wilson (USA)

Strategic Summary: Climate change is an existential threat to humanity. Jobs that pay a living wage are needed to pull the economy out of the pandemic-caused economic collapse. Planting and protecting trees and ecosystems help mitigate climate change and create jobs-- potentially millions of jobs. Planting one-trillion trees will have a profound impact on climate change through carbon sequestration and on employment through a global Conservation Corps type organization. This report presents a compelling case for the development of such an effort through a global Re-Generation Corps.

Introduction/Problem State

What Needs to Be Fixed:

- The world has lost about half of its stock of trees. We have gone from 6 trillion trees to about 3 trillion—and continue to lose 15 billion trees each year. Given that trees extract vast quantities of carbon from the atmosphere and thereby play a critical role in mitigating climate change, this loss is critical to the well-being of humanity.
- Each tree is a valuable resource—15 billion are almost priceless. A continuing loss of this magnitude causes direct harm to local and the global economy.
- Ecosystem degradation affects the well-being of 3.2 billion people and costs the world about 10% of its annual gross product, according to the United Nations.
- About half of land-based greenhouse gas emissions (5–10 Gigatons of CO2e annually), come from deforestation and forest degradation.

Simultaneous converging crises of deforestation, the COVID-19

pandemic, economic collapse, job loss and unemployment, climate change impacts such as increased severity of droughts, hurricanes, coastal flooding, ocean acidification, species extinction, and rising sea levels, all contribute to the current problems of the world.

The following charts help illustrate the growing complexity of the problem:

Sourzce: https://www.stockholmresilience.org/research/research-news/2015-01-15-new-

planetary-dashboard-shows- increasing-human-impact.html

Preferred State

By 2030, one trillion new trees have been conserved, restored or planted globally and the people who do this work are paid a living wage. The rate of deforestation has been cut in half, the climate has been stabilized, unemployment reduced, and full sustainable economic recovery is well underway. The risk of future pandemics has been reduced due to the existence of fewer zoonotic diseases. The impacts of climate change are beginning to be reversed, human health and longevity are on the rise as a result of cleaner air, and there are enhanced international alliances,

trade and cooperation around climate change. The number of climate refugees has dropped sharply and continues to fall, as does conflict between countries for reasons tied to climate change. Global poverty and inequality of wealth are reduced. The one trillion new trees capture two-thirds of the man-made carbon emissions.

Strategy for Reaching the Preferred State

1) Establish a Re-Generation Corps

A modern-day Civilian Conservation Corps, the Re-Generation Corps project will have as its primary objective the mitigation of climate change. Research shows one of the most effective ways to do this is to protect standing forests and to reforest the planet.

In addition, forests can be central to a green recovery from the COVID-19 pandemic. One component of such a recovery is the role forests can play in lowering the risk of future pandemics, since loss of habitat is concomitant with zoonotic diseases. Eighty percent of the biodiversity on land is found in the forests so another positive outcome of protecting forests is preventing, or at least slowing down, the extinction of some species of flora and fauna.

Besides zoonosis emergence, deforestation not only takes away the potential of trees to absorb carbon in the future, but much of the carbon that had been sequestered and stored by the trees previously is released back into the environment when they are burned.

There are other benefits, as the following chart illustrates.

Source: https://www.crowtherlab.com/

Forests are a stabilizing force for the climate. They regulate ecosystems, protect biodiversity, play an integral part in the carbon cycle, support livelihoods, and supply goods and services that can drive sustainable growth.

Planting a significant number of trees so that their combined CO2 absorbing capabilities will have a significant impact on climate change dynamics will also employ many people. Our strategy calls for the planting and maintaining of one trillion trees and the forests of which they are a part—and with the people doing the planting and maintaining being paid a *living wage*—which is not to be confused with "minimum wage" or the bare minimum needed for survival. It is rather, the amount needed for a modest middle-class lifestyle, capable of supporting a single person or small family.

It would begin as a pilot program in the United States and then quickly expand around the world. Teenagers to the elderly and people from all demographic backgrounds would participate. Eventually additional wings of the program would be set up to accommodate special groups that would work together—such as religious groups, incarcerated people, corporations, etc.

The Re-Generation Corps (RGC) would start off by offering a free program at schools in the communities where RGC projects will happen. The program would combine a science and environmental curriculum that educates children about climate change and make it relevant to their lives by explaining what the Corps will be doing, why it is needed, and how it will benefit their community.

The RGC builds on the legacy of the Civilian Conservation Corps but in a modern context. It would be funded through a redirection and reallocation of Defense Department resources.

Part of the start-up of a regional or local Re-Generation Corps initiative is to determine the best areas to focus on. While growing individual trees is not difficult, large scale reforestation necessitates a solid understanding of the complexities involved that will determine the success of the project. This includes extensive knowledge regarding the many factors unique to each project site that must be considered that will, in addition to gaining the desired forest cover, maximize benefits to the communities, people, animals, and the environment.

Indigenous stewardship has been shown to be successful at conserving forests and protecting biodiversity. The Re-Generation Corps will seek to partner, wherever possible, with local communities

Photo credit https://www.cifor.org/

with traditional knowledge of the land and its resources. Giving local communities an understanding of benefits and real ownership of the process and outcomes will help ensure the success of the program.

The cost of each project will vary greatly depending on the region. Some of the key factors include the species of trees chosen for the plantings, the living wage paid to those who plant and/or care for the

*inspired by TerraMatch/WRI model https://www.terramatch.org/

trees, the current state of the land on which the trees will be planted and the remedial work, if any, that is needed to prepare the land for tree plantings. Another important consideration that will affect the cost of the project is the extent of care required to nurture the saplings until they are able to survive independently, such as the need for irrigation and availability of water, and the tree survival rate.

Cocoons

One part of the Re-Generation Corps strategy is the use of "Cocoons" in the planting of trees**.** The Cocoon concept was developed by the Land Life Company. It increases seedlings' survival rate by providing everything it needs during the most fragile period in its life. Cocoons are biodegradable tree incubators that hold 25 liters of water. The protective shield keeps the water from evaporating, protects seedlings from harsh heat and dry winds, and prevents animals and birds from eating them. Within 6 to 12 months, when the water has run out, the trees' roots have grown deeper into the soil where they can reach the moisture they need to continue to thrive. The cocoons provide everything the seedlings need as they are becoming established, including mycorrhizal fungi, which increase the surface area of the tree's roots between 100 to 1,000 times, increasing the tree's capacity to absorb nutrients. The fungi give the trees another boost by releasing enzymes into the soil that dissolve hard-to-capture nutrients, making them easier to absorb. The lack of maintenance is responsible for a big jump in seedling survival rates to 80-95 percent."

Cocoons could be key to successfully growing forests in arid regions as they enable trees to grow in these dry climates with little to no irrigation required. In the first year alone, the trees require five times less water compared with irrigation.

Coastal and Marine Ecosystems

There are two billion hectares of land on which plants and trees can grow in the world, but have been seriously degraded. Half of these are wetlands.

"Blue carbon" refers to the carbon stored in coastal and marine ecosystems. Examples of blue carbon ecosystems are mangrove forests, seagrasses, salt marshes, and peatlands. They are among the most carbon-rich of all ecosystems on Earth, and they are also among the most threatened.

https://materialdistrict.com/article/cocoon-sustainable-planter-gives-life-to-arid-land/

Although mangroves make up only 0.6% of global tropical forests, their deforestation is responsible for as much as 12% of greenhouse gas emissions. One of the great benefits of mangrove forests is that while terrestrial trees hold most of their carbon stores above ground, mangroves and other blue carbon ecosystems store most in the

Credit: Nicholas Institute For Environmental Policy Solutions, Duke University

soil, resulting in less carbon dioxide being released back into the environment. If not damaged or destroyed, these "carbon sinks" can keep the carbon locked in the soil for thousands of years.

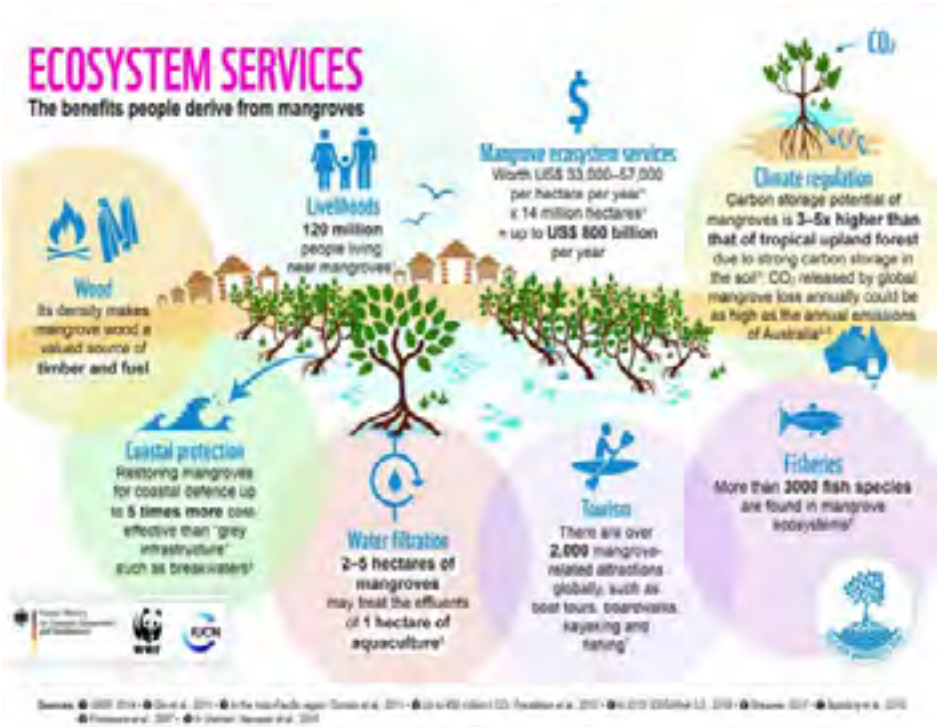
Current studies point out that mangroves and coastal wetlands annually sequester carbon at a rate ten times greater than mature tropical forests. They are also more efficient than their tropical counterparts, storing three to five times more carbon below ground.

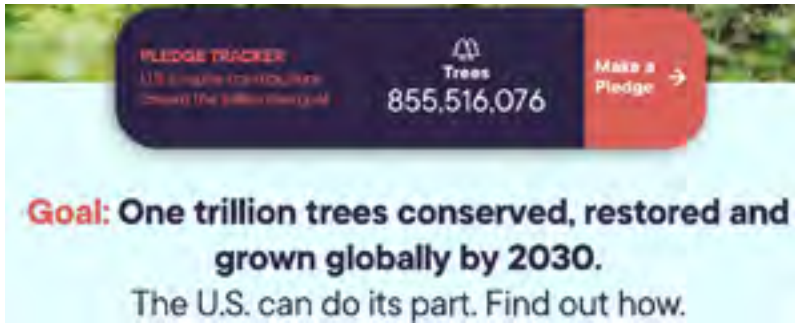
Besides the loss of a source of immense carbon capture and sequestration, the destruction of mangrove forests costs the environment in other ways. When a mangrove forest is lost, so is its capacity to filter water, slow erosion, provide some protection for communities against inundation from storms and flooding, and provide a habitat for fish and other species that support the livelihood of nearby communities.

2) Begin with Pilot Country

The United States has 20 million acres of public land. The planting of six billion trees on these lands would employ hundreds of thousands of people. Removing "the cap on the U.S. Forest Service Reforestation Trust Fund would free up an additional $90 million annually from funds that

Infographic Credit: IUCN https://www.iucn.org/theme/marine-and-polar/our-work/climate-change-and-ocean/mangroves-and-coastal-ecosystems



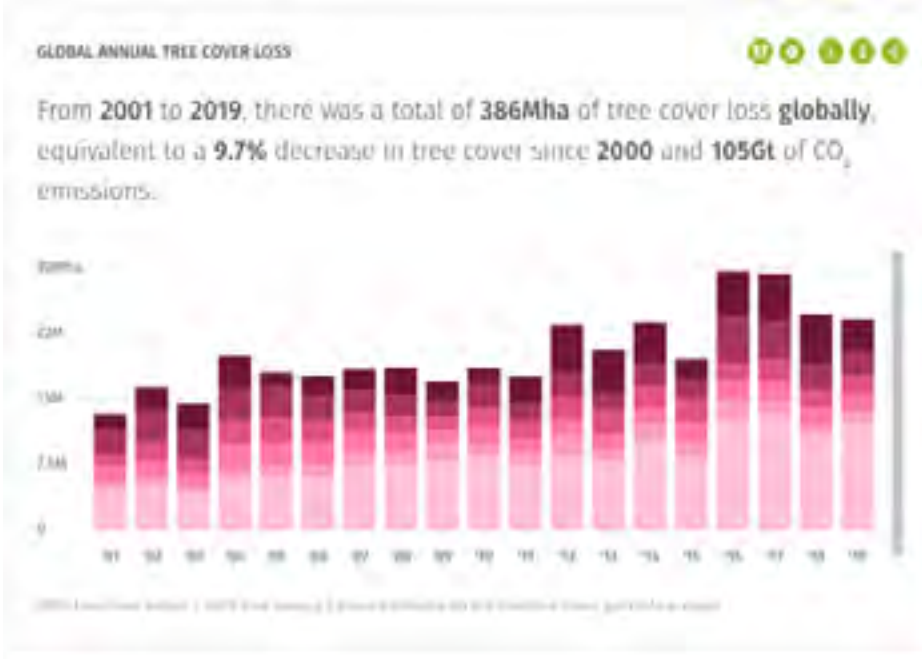


were originally set aside for reforestation." This amount would employ almost 4,000 people in rural communities and keep our national forests covered in trees.

Related to this is an initiative already under way—the "US. 1t" effort:

Almost one-billion trees have been pledged to be planted by the "US.1t" network so far.

The US.1t.org chapter has formed a "U.S. Stakeholder Council". The Stakeholder Council is made up of senior-level representatives from U.S.-based governments, corporations and nonprofit organizations. They guide the strategic direction of the chapter and ensure that its operations and technical services equitably meet the needs of all stakeholders.



While planting new trees is crucial, the importance of conserving existing forests can't be understated. Eleven percent of the world's greenhouse gas emissions caused by humans is the result of deforestation.

Between 2001 to 2019, 386 mega hectares (1,490,543 square miles) of tree cover were lost worldwide— a 9.7 percent loss in tree cover since the year 2000. Deforestation and wildfires are on the rise. A regeneration and restoration revolution is needed to stem the impacts of these climate changing problems.

In the U.S. alone, forests currently capture 15% of the nation's carbon dioxide emissions from fossil fuels. There is an opportunity to double this. In addition, there are two other positive impacts: (1) trees absorb air pollutants, which helps prevent up to 670,000 cases of asthma and other acute respiratory symptoms annually in the U.S.; (2) for every million dollars invested in forest restoration in the U.S., 40 new jobs are created. Globally, the sustainable management of forests could create $230 billion in business opportunities and 16 million jobs worldwide by 2030.

In summary, the short-term strategies of the Re-Generation Corps is to get the 20 million acres of national forests reforested, plus engage in the planting of 6 billion trees in the U.S. as the start of its North America initiatives.

3) Expand Globally

The Re-Generation Corps will expand over time and geography. The overall aim is to conserve and expand the Earth's forests and blue carbon ecosystems, increase global awareness of why this is so crucial, and create meaningful and well-paying employment opportunities. Along with increasing society's appreciation of nature, the RGC will strengthen community relationships and can, where appropriate, serve as a learning center on a diverse range of subjects, such as business, climate change, wellness, lifestyle, soil science, regenerative agriculture, youth education and how these areas overlap and intersect.

It is also a project that can be safely participated in under pandemic social distancing guidelines.

This was proven in British Columbia, Canada when 300 million trees were planted during the 2020 pandemic with zero cases of COVID-19.

Impact Summary: *The Re-Generation Corps will help:*

- Preserve biodiversity and maintain ecosystem services.

- Reduce the spreading of zoonotic diseases into human populations.
- Restore the Earth's carbon reservoir and moderate net change in global temperatures.
- Slow down erosion and generate a richer soil quality
- Preserve intact and healthy mangroves.
- In the development of new medicines and cures for diseases as a result of protecting the rainforests where many plants that hold these potential cures can be found.

Strategy: Needed Resources

The Re-Generation Corps project will need staff, access to funds, lands in need of reforestation, sufficient water supplies, accurate, reliable and timely information, appropriate plant care tools, travel and transport vehicles, safety gear, communication and outreach platforms, surveillance, monitoring, and data collecting tools (drones + satellite data), affiliation with academic and industry experts, and local guides and translators.

Strategy: Next Steps (First 6 Months)

The first six months of the Re-Generation Corps strategy is focused on working with experts for mapping the first wave of U.S. forests and coastal and marine ecosystems, so as to make sound decisions about first project sites. These decisions will be based on where they are most likely to be successful and will have the most impact in sequestering carbon.

Initial hires will be core staff—an executive director, director of funding/development, HR director, IT director, academic and industry experts—one in forestry and one with specialized knowledge about mangrove trees and coastal ecosystems. Additional hires will be made as Re-Generation Corps projects begin and as additional funding becomes available.

Launching an initiative like the Re-Generation Corps requires creativity in all aspects of the initiative, including fundraising. For the social media campaigns, we will develop a system that allows a donor to name the tree(s) that will be planted with their donation. One of the goals of the RGC is to have a tree 'named' for all the children of the world and eventually all of humanity. Over time, there would be more named trees than living people in the world as people die and their tree continues to live.

The Re-Generation Corps would GeoTag named trees so they could

be located using an app. One of the goals would be to start with the oldest and biggest trees on Earth. We would work with Eco-Teka to make this happen to tag the trees. This would enable people to one day visit and connect with 'their' tree.

"What about naming trees? ...if we have a tree in our name, we want that tree to live."

—Jane Goodall

To inspire people who are influenced by celebrities to donate, we will solicit the support of celebrities who are already involved in the global warming cause and post their picture and endorsement with our hashtag and share them automatically with other social media users, inviting them to contribute.

Strategy: Next 3–5 Years

Our strategy for the next 3–5 years involves setting up operations in additional countries, hiring more staff, monitoring progress, analyzing data collected from ongoing projects, assessing the survival rate of new plantings, and evaluating and addressing any challenges and underlying issues or impacts.

The strategy calls for expanding the capacity and role of the pilot project in the USA, including working in conjunction with educational institutions, rehabilitation centers, and prison reform initiatives. The Re-Generation Corps will partner with educational institutions by offering paid internship opportunities for students. We will start a prison reform initiative that supports reintegrating non-violent formerly incarcerated individuals into the Corps.

During this three to five-year post-launch period, the RGC will expand overseas. We will collaborate with institutions such as World Wildlife Fund (WWF) and International Union for Conservation of Nature (IUCN) to gather data on forests and landscapes throughout the world where actions are most needed. WWF analysis shows that the destruction of tropical forests increased by 150% in March, 2020 as COVID-19 spread around the world. Satellite data from 18 countries that showed 645,000 hectares of tropical forests were destroyed in March, or 40 times the area of Brussels. The forests of Indonesia paid the heaviest price with a loss of 130,000 hectares, followed by the

forests of the Democratic Republic of Congo (100,000 hectares) and those of Brazil (95,000 hectares). These three countries would be the focus of our first expansion outside the USA as they offer among the greatest opportunities to make an impact.

One of the Re-Generation Corps' goals is to help plant 6 billion trees by 2030 in the USA and another 4 billion worldwide, for a total of 10 billion or 1% of the 1t.org goal. This will require meticulous and serious work in keeping track of the planted trees around the world. To do this, RGC would utilize tools such as Eco-teka, which enables computerized asset management using:

- A mobile application that allows you to enter information in the field, list the health status, take photos, and update the tree file
- A web-based management application which enables access to data collected in the field, entry of information (such as pruning instructions and in-depth health monitoring) and analysis of data collected (various statistics on the tree heritage, etc.)

This tool offers a digital identification system for each tree. Every tree is followed by its "computer identity card" gathering all the information concerning its date of planting, successive watering, pruning, state of health (physiological state, wounds, fungi, shocks) to facilitate the diagnosis of dangerous trees and is the subject of regular monitoring, which makes monitoring and evaluation of planted trees easier and more comprehensive.

Strategy Costs for Pilot Country: USA

Depending on the terrain, reforestation and afforestation efforts can cost between $100 to $450 per acre, with an average of 500 trees planted per acre. An additional $2-$4 is needed for ongoing maintenance. With an average investment of $275 per acre, it would cost $5.5 billion to establish and run the ReGeneration Corps project in the United States. This would include costs of site preparation, reforestation, and silvicultural practices and cover 20 million acres of land. It would add approximately 10 billion trees to U.S. lands. Once the project has been established, maintenance costs incurred would be about $4 per acre, which translates to $80 million per year to manage approximately10 billion trees over 20 million acres of land.

The average American works about 1,770 hours per year

(according to 2019 data). Employing 500,000 Americans and paying them a livable wage would cost about $13.3 billion per year. (500,000 Employees x 1770 hours/person x $15.00/hour = $13,275,000,000 USD)

Factoring in other expenses, launching the pilot project would cost about $18.8 billion ($13.3 billion + $5.5 billion = $18.8 billion USD), with an annual cost of $13.38 billion (thirteen billion three hundred eighty million) USD, which includes forestry maintenance costs, as well as employee salaries.

This calculation only accounts for the USA pilot project. Pay scales would be lower in many, perhaps most, parts of the world, depending on living costs of the different countries. An estimated global cost for the Re-Generation Corps is $30 billion per year.

Paying for the Re-Generation Corps

Just the annual carbon extraction function of ten-billion additional U.S. trees—as well as the one-trillion global tress doing the same—would be enough to cover the costs of the entire Re-Generation Corps project—*if* the services of the carbon extraction was a part of our economic accounting system.

This currently not being the case, here are some additional ways the

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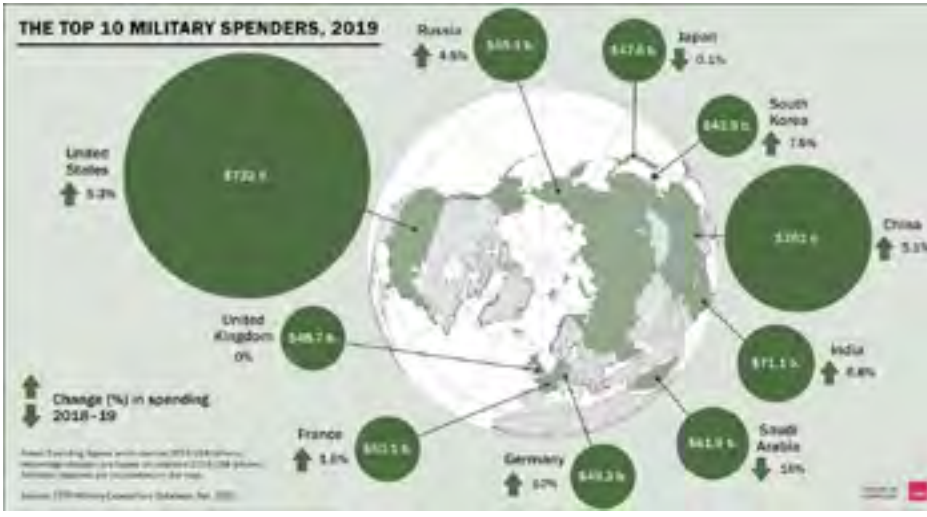
Global military spending surpassed $1.9 trillion in 2019, but nearly 75% of this total can be traced to just 10 countries. https://www.sipri.org/



ReGeneration Corps can be funded:

1. The global military budget currently is at $1.91 trillion. A small portion (1.5%) can be invested in making with world safe from climate change.

   The purpose of the military is to protect a country and its citizens from harm and threats of harm. Climate change is an existential threat to every country and every person on the planet. Unemployment is a threat to the well-being and safety of the unemployed and the rest of society. Redirecting a small portion (1.5%) of the global military's budget to protecting the world from the greatest challenge and threat to global safety and security is well within the military's mandate to protect and serve.

   One percent of the world's annual military budget of $1.92 trillion is more than what is needed for the entire U.S.-based program. One and a half percent of the world's annual military budget would get the Re-Generation Corps started around the world and well on the way to planting one trillion trees throughout the world.

2. The military can play another role in making the Re-Generation Corps a success, in addition to providing a small portion of their budget. If the RGC got a good portion of the soldiers of the world involved with the Re-Generation Corps it would go a long ways towards meeting its goals—as well as providing the military with a valuable, life-supporting role in the world.

   In terms of human resources, the military is known for its versatile, well trained and disciplined personnel who receive widespread support from people. These advantages, if lent to the operation of the RGC, will help the Corps achieve its ambitious regeneration goals.

   There are at least two ways in which such help is possible. One is by the integration of regenerative goals into military training and job scope. Forestry experts can participate in delivering lessons and administering training for soldiers. Military job scope can be enlarged to include reforestation training and providing help to communities dealing with the consequences of deforestation. *Several countries have already been doing this. Some examples:*

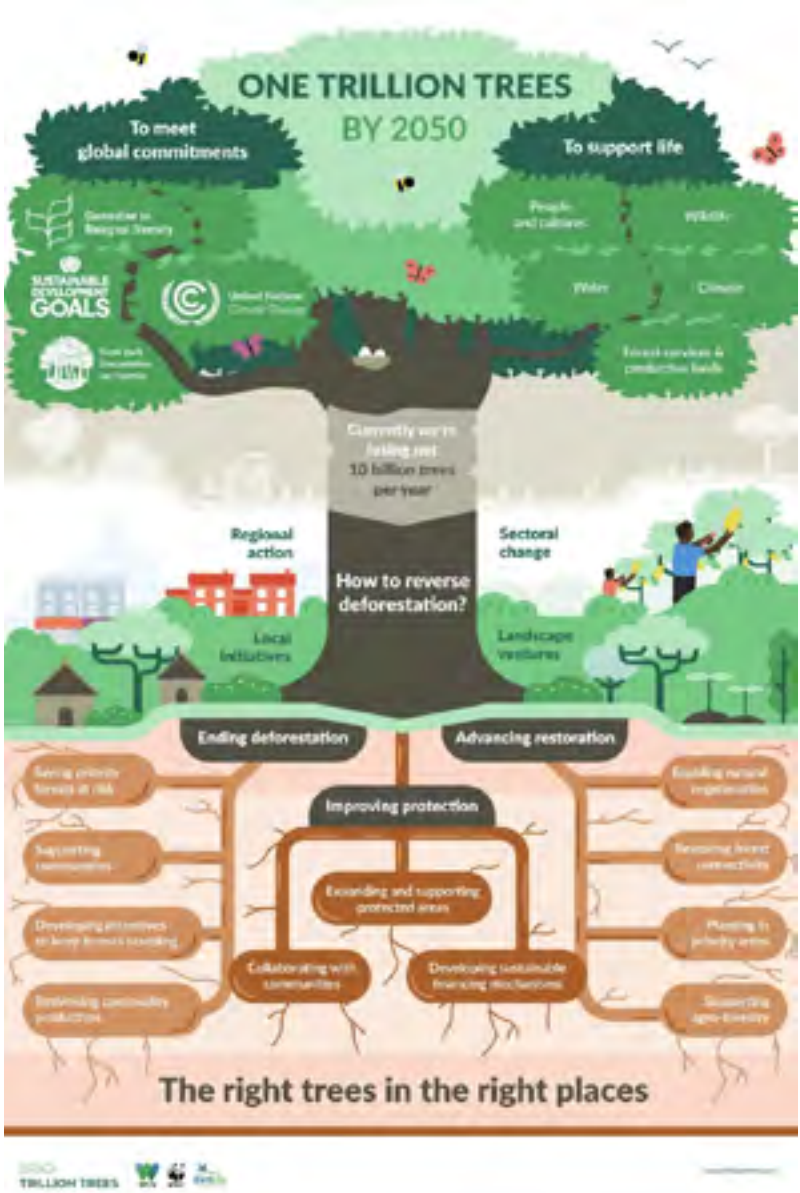
- Vietnam assigns soldiers the duty of reforestation
- China has deployed 60,000 soldiers to plant a forest area the size of Ireland
- and the Jordanian army has planted more than 2.5 million trees in military camps.

Additionally, there are NGOs such as Peacetrees Vietnam, that dislodge bombs and plant trees where bombs used to be. Operations such as these, in war-torn areas, would benefit from a helping hand from military's mine and munitions experts—as well as its soldiers for tree plantings.

3. Another funding source for the Re-Generation Corps project is an annual .05% tax on the global fossil fuel industry. This would contribute to rectifying the enormous climate change damage done by that industry over the last century. Ideally, such a tax would be in place until all the carbon put into the atmosphere by the fossil fuel industry was removed.

Conclusion/Summary

The Re-Generation Corps purpose is to plant 10 billion trees in the United States and work with a global movement to plant one trillion trees around the world. One percent of the global military expenditures would be enough to make this possible.



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Endnotes

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5. CITIZEN-CONTROL AND CLIMATE-ACTION

By Scott DeJong (Canada), Engels Diaz (Honduras), Huong Hoang (Vietnam), Hamza Kiyani (USA), Sophia Lee (USA), Rebecca Muller (USA), Aurora Wiley (USA)

Strategic summary: Global warming and climate disruption is an existential threat to human well-being. The actions needed to avert disaster are not happening because government grid-lock, weaponized misinformation generated by those threatened by needed change, and ignorance. The world needs a decision-making process that leads to effective action, not further talk, enforcement of agreed upon accords and targets, not arbitrary compliance, and mass-citizen involvement rather than top-down dictation. The Citizen-Control and Climate-Action strategy uses Citizen Assemblies and other innovative citizen-led tools for facilitating the rapid transformations needed by global society to avert global warming catastrophe.

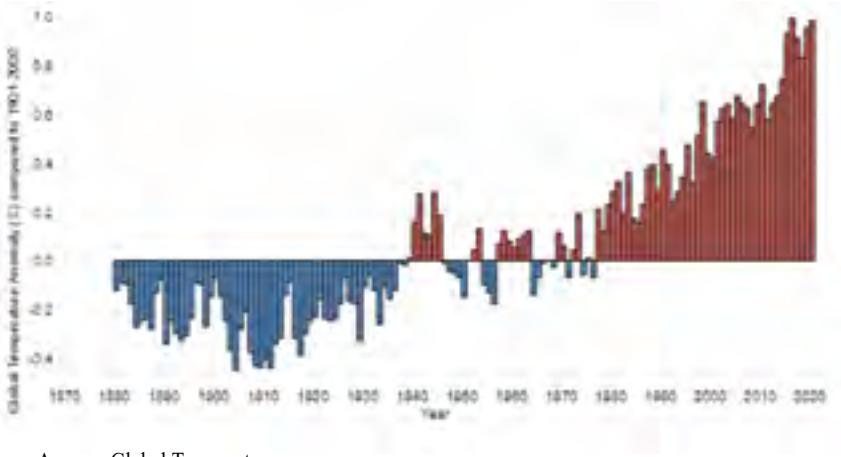
"The Earth is in a death spiral. It will take radical action to save us."

—George Monibot

Overview/Summary

The planet's climate situation is well documented and increasingly comprehensive. Nearly every week new studies are released that detail facets of the increasingly dire situation we are in due to global warming. (See pages 2 to 6 of this document.)

The impacts on our environment, including the decrease in biodiversity and destruction of habitats, and on humans, including out health and longevity, and the injustice and society-destroying impacts of that inequality on those impacted by climate change vs. those causing it is not just alarming, it is leading us to catastrophe.



Average Global Temperature

Preferred State—Where We Want and Need Our Climate to Be

The preferred state, in terms of global warming and its impacts on our environmental life-support systems and humanity, is one where:

- CO2 and other atmospheric emissions related to global warming are reversed
- Global warming is stopped
- Biodiversity is increased
- Clean, carbon-free and renewable energy resources are used in all new developments and retrofitted into existing systems

- Business practices are sustainable at worst, and regenerative as quickly as possible.
- Business, governments, organizations and individuals are held accountable for their negative impacts on biodiversity and human health.

Citizen-Control/Climate-Action Strategy

Part 1, *Action-Conferences*

Using the UN's climate conferences as a model, the *Citizen Control and Action for Climate Strategy* (CCACS) will hold an annual event that highlights actions for dealing with climate change and its impacts. This *action-conference* will not be a typical conference but rather explicitly function as a networking, communication/cooperation/collaboration and community- and alliance-building meeting for people actively engaged in dealing with global warming and its impacts. It will not feature talk, "pledges" and the like to do something, but will be about what people and organizations have done and are doing. One of the goals of this action-conference will be connecting knowledge with action, and activists with leverage and tools for change.

The action conference will put scholars, activists, NGOs, industry reps and citizen groups in a space where they can actively discuss, not just what they have done and its efficacy, but tangible next steps for industries, organizations, schools, governments, and citizen groups. The conference will also develop accords and targets that will be revisited every three years.

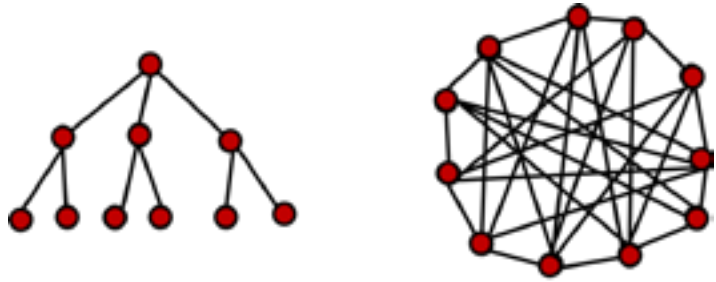
The action conference will highlight the latest data, present benchmarks for progress measurement and the latest findings of science, plus most importantly, the work, approaches, methodology, and findings of citizen activists and their actions.

Part 2, *Citizen Assemblies*

In order for the world to make the transformation from its current log-jammed political situation—where nothing is accomplished other than the posturing of politicians—the world needs to wrest control of the societal and climate change decision-making process away from do-nothing political "leaders". Society, and our environmental life-support systems that are being systematically damaged and in some cased, killed, need a process wherein the latest consensus scientific findings

about global warming and the actions that need to be taken to deal with it are implemented. This process needs to be immune to the large sums of money and the influence over the political process that fossil fuel companies and other entrenched power-brokers exert. Luckily, such a decision-making process exists and has been successfully used in numerous settings.[1]

This tool is called *Citizen Assemblies*. Rather than traditional top-down hierarchical decision-making processes, Citizen Assemblies are characterized by bottom up, networking decision-making.



Active Citizen Assemblies are groups of citizens, sometime selected randomly, like jury duty in the United States, who meet regularly to learn about critical, intransient problems facing society and come up with what needs to be done—free of political influence and coercion.

Global Warming Citizen Assemblies will be convened in every country around the world. Each assembly will have 100 people in it, chosen by lottery, and will reflect the demographics of their country in terms of gender, ethnic groups and income levels. They will begin by discussing and being briefed by vetted scholars and researcher on the global warming issue, its challenges and the potential solutions for climate change. Each Citizen Assembly will be regionally focused and globally informed.

After discerning a path forward and the actions needed for success in stopping, mitigating impacts, and alleviating already caused harm, the Assembly will present its action plans at local and international levels to the media, governments and business. Global actions will also be presented at the yearly Global Warming Action-Conference event mentioned above.

Part 3, *Citizen-Action Task-Force*

After local ideas for action from the worldwide Citizen Assemblies have been brought to the global stage of the annual Action-Conference and agreements for action agreed to, they need to be implemented. That is the primary role of the *Citizen-Action Task Force.*

The *Citizen-Action Task Force* will:

- Be made up of people from around the world—with nations providing members in the way they currently provide troops to UN international peacekeeping efforts;
- Manage agreed upon global standards for labor, business, investment, government, academic, and civil society practices, and
- Monitor and assess the environmental impact of global business, government, academic and civil society. They will do this via annual reports, and working with sustainability officers and existing NGO programs;
- Help implement the initiatives provided by citizen groups and manage the accords that are implemented;
- Partner with NGO's to make sure citizen-initiatives continue as citizen-led approaches and are not co-opted by governments or corporate entities;
- Help bring local initiatives to fruition
- Establish and maintain knowledge initiatives focused on sustainable business, government, academic, and non-profit organizational practices.

Strategy Summary

Yearly Climate Action-Conference—Brings citizens together to connect with multinational corporations/governments/NGOs/Activists to build coalitions, determine binding targets, actions for reaching targets, and monitoring results and progress.

Citizen Assembly—Local initiatives held around the world where ideas are produced in at-risk regions

Task Force—Making sure the accords are being followed and local initiatives are being implemented

Costs

The estimated costs for the three facets of the strategy is less than $250 million per year, once the project is at scale—which is less than half the cost that UN global peace keeping efforts spend each *month*.

At start-up the needed funds would be used for:

PROGRAM	Estimated Annual Cost
Yearly Action-Conference	$20 million
Citizen Assemblies	$50 million
Citizen-Action Task Force	$50 million
Management	$10 million
Auditing	$1 million
Support for regenerative product transition	$100 million
TOTAL	$231 million

Possible sources for needed resources to launch strategy: Governmental budgetary support

- Local NGO, corporate, academic and philanthropic sponsors/ partners
- Carbon tax
- Natural Capital use fee

Next 6 Months:

In the next six months the strategy calls for doing the following to reach the Preferred State:

- Begin organizing, constructing, and running a global event that focuses on sharing climate actions, knowledge and creating tangible accords and targets
- Identify initial regions and begin forming citizen assemblies

Next Steps 5–15 Years

- 5 years
  - Hold annual Action-Conferences
  - Build support for and implement the Citizen-Action Assemblies and Task Force

- Construct globally agreed upon climate performance accords and implementation time targets for business, governments, academia, and organizations with penalties for non-compliance.
- Organize and run the Action-Conferences around updates on the established actions and accords, plus run *Citizen Assemblies* and *Citizen-Action Task-Force*' every other year (replacing yearly event).

• 15 years
- Continue enforcing and following climate action accords;
- Maintain and adjust climate action accords if the benchmarks and goals are not being met or are super-ceded;
- Continually run and implement insights from citizen assembly workshops and bi-yearly events

Endnotes

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6. CHANGING THE CLIMATE OF BUSINESS

By Yueheng "Ansel" Yi (USA), Tran Anh Ngan (Vietnam), Kassidy Kryukov (USA)

Strategic Summary

Climate change surfaced as a 21st century issue that arose from excessive greenhouse gas (GHG) emissions from anthropogenic sources over the last 150 years. Solutions to climate problems are not being implemented by businesses at the scale necessary to have the kind of impact that will avert climate disaster. Businesses contribute to a large portion of GHG emissions through production of goods and services, energy use, and transportation. This report describes actions and services that businesses need to set up and use to minimize their impact on climate, and what government actions can be implemented to ensure businesses play an important role in reaching a future of zero GHG emissions.

Preferred State

A *Preferred State* provides a vision of the world in which we want to live, specific goals to aim for, and a standard by which to measure the success of strategies for reaching those goals. In our preferred state, businesses understand the significance of climate change, recognize the importance of adapting current practices to minimize impacts, and leads the implementation of climate-related actions by the business. In addition, each business demonstrates an interest in, prioritizes funding for, and implement strategies that reduce their, and others, negative environmental impacts. They manage and conserve their energy usage, reduce operational waste, drastically lower their contributions to climate change, and act as role models to other aspects of society in the fight against climate change. In this preferred state model, businesses are supported by government policy and society in implementing sustainable practices. One result of the preceding is that the marketplace becomes a powerful engine for fighting climate change.

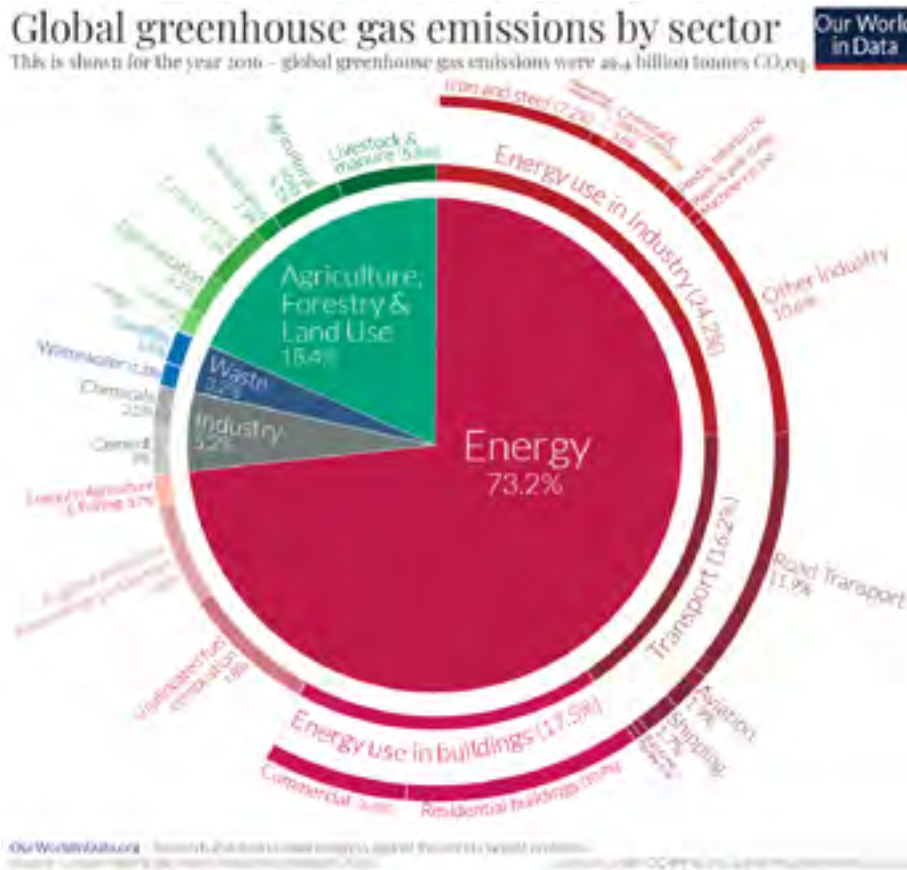
Progress towards the preferred state will be measured by greenhouse gas emissions of businesses, their energy consumption and

conservation, their waste production and recycling, and their support for massive, society-wide climate change action.

Problem State

Industry contributes a large part of global greenhouse emissions. The total energy use by business and industry is 32.5% of total emissions (see chart below). Manufacturing processes such as cement and chemical production contribute 5.2% of all GHG emissions. Oil and gas leaks ("fugitive emissions from energy production"), contribute 5.8% of emissions, and cause serious ecological damage.

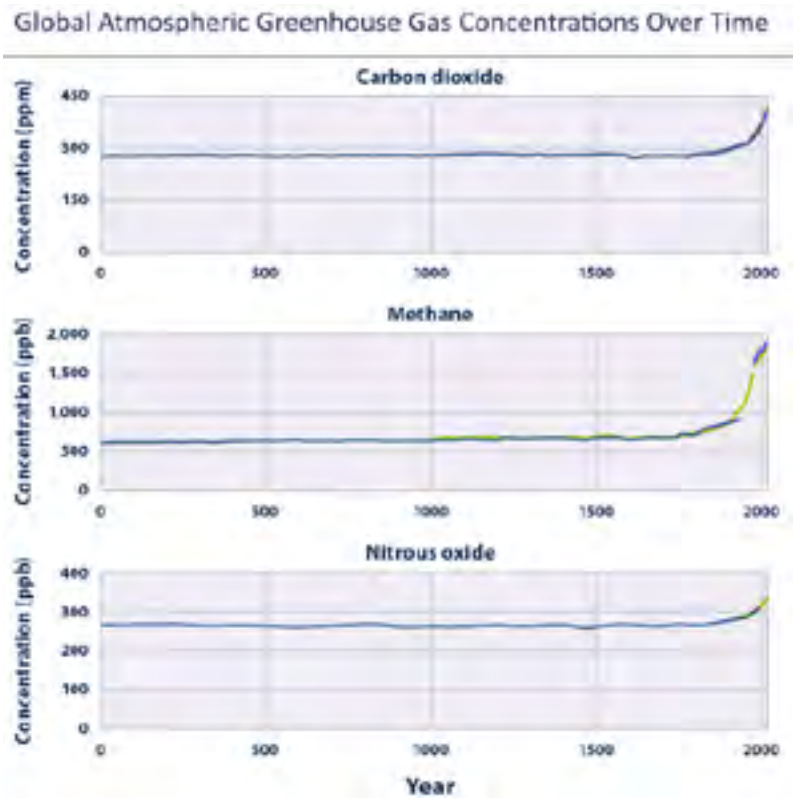
Restaurants are part of the problem. Their yearly contribution to food waste is worth USD $2.6 trillion. 34% of this waste is produced at the last stage of food preparation.



Present State

I. Negative Factors

Greenhouse gas emissions have significantly increased since pre-industrial times. CO_2 concentration in the atmosphere has increased by about 40%, methane concentrations have gone up around 250% (2.5 times), and nitrous oxide has risen approximately 20% since the start of the Industrial Revolution. These emissions have caused problems that impact everyone in the world. The global temperature increase of 1.1°C has contributed to rising sea levels and natural disasters. By all credible accounts, these conditions are getting worse, not better.



II. Examples of Positive Responses

Some corporations have started to take action to reduce their carbon footprint. Presented below are three examples of companies of different industries endeavoring to increase corporate sustainability in distinct ways.

Whether the below are "green-wash" campaigns by cynical corporations, or real commitments to dealing with climate change, time will tell.

1. Uber's Clean Air Plan and Uber Green - the use of cash incentives

In 2019, Uber started its Clean Air Plan with the ambition to create an entirely eco-friendly driving community by 2050. Part of this plan is the Uber Clean Air Fee. It charges customers an additional 15 pence per mile for each trip using the Uber app in London. This money is used to support drivers to buy and pay the expenses of an electric vehicle. So far, the project has acquired 135 million Euros, which has increased the number of trips driven by fully electric vehicles to 3.5 million in London.

In addition, the plan called for and implemented a new ride-hailing platform that uses entirely electric vehicles. Called Uber Green, it was introduced in 2019, and has been expanded to more cities in the world. Its goal is to support drivers switching to electric vehicles, and thereby reducing GKG emissions. Cities where Uber Green is available include San Francisco, Los Angeles, Washington DC, Miami, Houston, New York City, Chicago, Tuscan, and London.

2. Unilever Sustainable Living Plan - the use of policies

In 2010, the Unilever Sustainable Living Plan (USLP) was announced. It serves as the company's roadmap for long-term success by assisting in the expansion of its brands, cost savings, and innovation. USLP stands apart because it encompasses Unilever's full portfolio and market, as well as its socio-economic dimension, and works across the entire value chain, from raw material suppliers to consumers.

3. Hilton Hotel LightStay System - the use of measurement

Created in 2009 by Hilton, the LightStay system monitors the sustainable performance of each Hilton hotel. It calculates the hotel's energy consumption, develops goals based on the reported performance, and implements actions that reduce energy consumption and environmental impacts. It also focuses on the hotel operation process, including: water consumption, waste production, transportation, plastic waste, and overall carbon footprint. It also monitors the predicted amount of energy consumption, which enables hoteliers to prevent exceeding the accepted energy level.

These corporate efforts provide a foundation and inspiration for the strategy and its product presented below. It also serves as an indicator

of the possibility for climate change actions by corporations as it demonstrates the ongoing willingness and interest of businesses in reducing their impacts on climate change and their carbon footprint.

Barriers to change— government policy

A cynical view is that governments have a very short-range view— that they only see as far as the next election. The business view might be even shorter—next quarter's profit margin. Short-term time horizons result in longer-range climate change problems not being adequately or consistently addressed by governments and business. Climate change policies and actions receive little attention and funding compared to other, less important problems. There is a lack of effective legislation that encourages and enforces climate change actions regarding energy use, GHG emissions, carbon footprint, etc. Current legislation, when and where it does exist, is often by-passed through ineffective enforcement. In addition, there is a ripple effect that results when climate change is not placed as a priority in developed countries as the solutions developed by wealthier countries do not reach developing countries.

Strategy

Our strategy is to address business and government contributions and actions related to climate change on three different levels: local, professional, and governmental.

To reach the preferred state, the strategy will build three separate but related web-based tools and services:

1. *EarthDeal*: This site will research and publish policies and methods of operation for businesses that reduce carbon footprints. It will also do the same for needed incentives for the widespread adoption of these actions. It will draw on the increasing volume of already existing resources in these areas.
2. *EarthMeal:* This initiative will design and develop a service that supports sustainable businesses in one sector of the economy as an example of what is needed in other sectors.
3. *EarthLink:* This site will research and develop ways that businesses can collaborate with each other, and with local and national governments to implement sustainable business practices. It will have a "Linking Service" that links businesses with each other so that resource use can be reduced and to maximize learning from business to business.

I. EarthDeal: Policies and Methods for Reducing Business Carbon Footprints

There is a need to provide incentives for reducing corporate carbon footprints and ways to fund incentives that get it done. Government and corporate policies and actions for dealing with climate change impacts related to office space, energy use, waste disposal, etc. are needed. The use of solar energy needs to become ubiquitous. Every office needs to have solar panels on their building's roofs, south-facing sides, and parking lots that generate the power their business needs. An additional option includes green roofs to minimize the need for air conditioning and to lessen the urban heat island effect. Governments need to make sure there are compelling economic reasons for doing this, as the market has failed to do so.

Other investments need to be made— such as strategically placed windows that increase natural lighting and decrease electric lighting usage, and sourcing certified sustainable materials that are subsidized in such a way that that costs of sustainable products are less.

These changes need to be accompanied by employee and customer education so that a cultural change in business happens. The COVID-19 pandemic has allowed more people to work from home, which can cut CO_2 emissions at a given business location. Education and training about climate change, and why changes need to be and are being implemented will make these actions understandable to the general public and make people more receptive to climate action.

Government and business need to work together when the market fails to provide incentives for change. In this creative and collaborative manner, the emergency of climate change can be responded to with the required urgency.

II. EarthMeal

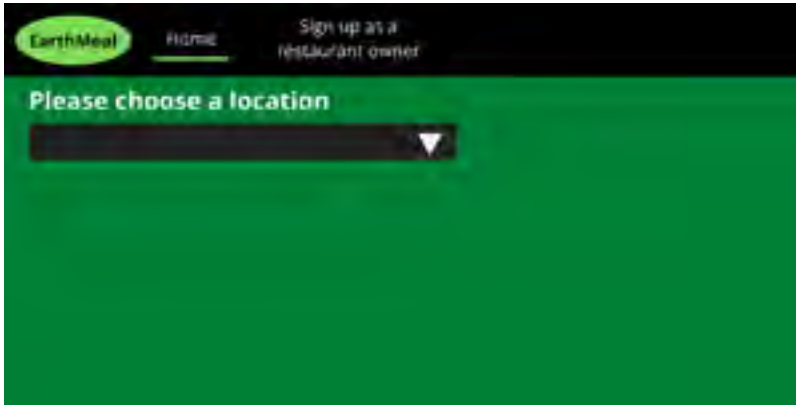
This product is a service that is empowered by a website called EarthMeal. The website serves as a platform for businesses, ranging from restaurants, convenience stores, and school cafeterias, to coffee shops and grocery stores. It purpose is to reduce food waste.

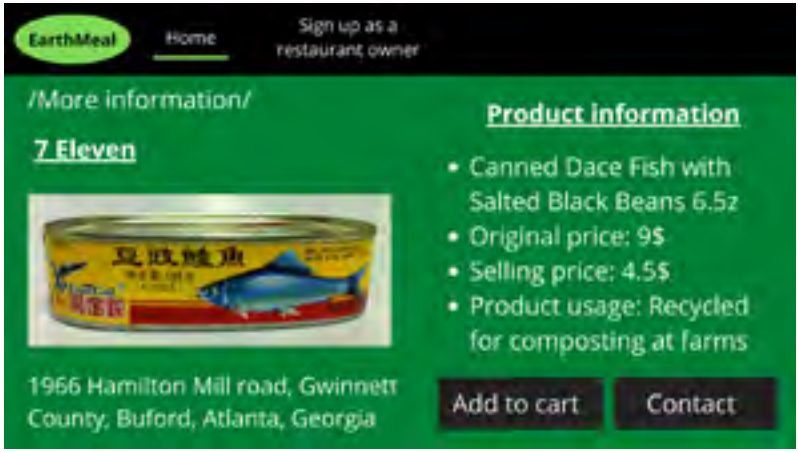
EarthMeal allows businesses to deal with the two types of food that are recyclable but usually wasted. Businesses with well-cooked food that can still be eaten or fruits that look less than perfect and cannot be sold will be connected to people in need, people who have pets, and food banks (organizations that distribute food to those in need).

Businesses with half-eaten food or food that has crossed the expiration date will be connected to local farmers and the growing number of compost businesses, who will use them for composting and other agricultural and gardening purposes.

Businesses will sell the edible, EarthMeal surplus food at much lower prices than the original, or provide it for free, if subsidized by foundations or the government. EarthMeal will educate its customers about these types of food options. Re-sellers will be required to sign a digital contract with EarthMeal that ensures the quality of the food is safe and edible. The website is similar to an eCommerce site where customers can "add items to cart" as well as communicate with the restaurant to discuss price and pick-up time, which allows transactions to be flexible.

The following is an EarthMeal website demo:





III. EarthLink: Linking Businesses, Organizations, and Government in Collaborations

The above example, the *EarthMeal* product, provides an example of the way businesses, organizations, and governments can collaboration for the common good. The core function of EarthLink is the following: *Governments, at local, state, national and international levels, need to facilitate and incentivize more and deeper collaborations with businesses that allow and encourage surplus and waste from one business to become the inputs into another business, or that meets a consumer need. The need to empower the circular economy*

One way of funding these collaborations is to reduce and phase out government subsidies for the fossil fuel industry, which are currently

at $649 billion/year. Reducing this vast amount to zero and investing these funds in making the transition to a net-zero society will help lessen the financial and other impacts of climate change. Another funding source is the enforcement of current regulations and fines for fossil fuel infractions (such as oil spills, pollution from the use of fossil fuels, etc.). This will also will help eliminate the false economic argument that fossil fuels are a low-cost option for a society in need of energy.

Scaling EarthMeal, Deal, and Link: Needed Resources

The *EarthMeal*, *Deal*, and *Link* websites will start small, local, and scale for there. For example, EarthMeal will start with one location, Atlanta, Georgia.

All three sites will need financial, technological, and human resources to build their web sites, research and populate each site with the needed information and links, and to coordinate (for example the EarthMeal site), with restaurants, food relief and distribution organizations— as well as to manage and duplicate the prototypes in other cities and scales of operation.

Costs—

EarthMeal set-up

Food waste reduction product

1. Prototype websites cost breakdown:
   - **Set-up:** The initial, one-time, set-up cost for each of the three sites will be between $50,000 - $100,000 (with WordPress hosting, custom eCommerce designs, plugins and services)
   - **Maintenance** cost per year: $10,000 – $15,000
   - Marketing/**Advertisement** (using Google AdWords: $10,000 - $50,000/year)
   - **Staffing: Directors, Researchers, Sources and User Coordinators: $500,000/year**
   - Estimated Set-up costs: $100,000 for first site, $0 - $5000 for subsequent sites set-up as they will use the first site's app with local modifications
   - Estimated total yearly cost, with staffing: $100,000 to $200,000

Potential investors/funders for the EarthMeal product/service include:

a) Companies that own multiple restaurants: (such as Jollibee Foods Corporation, JAB Holding, Yum Brands, etc.)
b) Companies that own one restaurant
c) Governmental organizations that manage agriculture and food services
d) Individual investors
e) foundations.

2. Potential investors/funders in the EarthDeal product/service include:
    a. Local business associations
    b. Foundations
    c. Government
3. Potential investors/funders in the EarthLink product/service include:
    a. Local business associations
    b. Foundations
    c. Government

EarthDeal set-up

Policies and Methods of Operation for Reducing the Carbon Footprint of Business

Costs of changing business policies, methods of operation, and organizational partnerships could be facilitated by a re-allocation of one-percent of the subsidies given to the fossil fuel industry. This subsidy —$6.49 billion—would facilitate the changes needed in business operations to put them on an accelerated path towards net-zero emissions.

An additional approach to reduce the impact of fossil fuel use and to fund fundamental business change is to implement a carbon tax. The highest carbon tax in the world is in Sweden, at $137/ton. Our carbon tax would be higher— $200/ton— as this will reduce the USA's impact on GHG emissions, help fund the transition to net-zero, and acknowledge the historical impact that US emissions have had on causing climate change.

A carbon tax will provide incentives for large and small companies to reduce emissions because they will save money by doing so. In

our design, 50 percent of the money from a carbon tax will go to the victims of climate change 30 percent will support local businesses in making the net-zero transition, and 20 percent will support sustainable business in developing countries.

EarthLink set-up

Linking businesses resource wastes to resources needs of other business and other collaborations

Prototype EarthLink website cost breakdown:

- **Set-up:** The initial, one-time, set-up cost $50,000 - $100,000 (with WordPress hosting, custom eCommerce designs, plugins and services)
- **Maintenance** cost per year: $10,000 – $15,000
- Marketing/**Advertisement** (using Google AdWords: $10,000 - $50,000/year)
- **Staffing: Directors, Researchers, Sources and User Coordinators: $500,000/year**
- Estimated Set-up costs: $100,000 for first site, $0 - $5000 for subsequent sites set-up as they will use the first site's app with local modifications
- Estimated total yearly cost, with staffing: $100,000 to $200,000

Timeline

In six months, websites will be completed. New legislation will be drafted that will enhance the effectiveness of the services of all three websites and introduced to appropriate legislative bodies. In one year, the website's pilot program will be launched and feedback obtained for improvements and for scaling the products into other locations.

In a perfect, or even reasonable world, the drafted legislation would have concluded and been implemented after one to two years. Given the actual world we live in, with "captured" and grid-locked legislative bodies, each of the products will have a "Plan B" that will not rely on government legislation, but use market forces to reach its goals.

After five years, the websites will be well known throughout the country and have international locations. The carbon tax will have been implemented in the US as a whole and in the EU, Japan and China will follow with higher rates. It will make its way to be implemented into other countries.

Impacts

Impacts will be at multiple levels. Restaurants and other food related operations that use the EarthMeal website will increase the availability of food as well as allow food charities to decrease spending on food. The community would be better fed and healthier, and the amount of food waste will reduce significantly, which in turn, will contribute to the fight against climate change.

Office workers will see a boost in health and productivity due to green policies. More windows would increase natural sunlight and decrease eye strain. Green roofs and additional trees planted will make workers feel more productive and more creative. On-site energy production will increase exponentially thereby reducing the use of fossil fuels.

Most importantly, companies will become a driving force for sustainable development and investment. The world will see less climate-driven natural disasters and an increased quality of life.

Conclusion

Businesses, as a major and important part of global society, with vast human, technological, and financial resources— have been and continue to be a large contributor to climate change. Businesses need to play an equally important role in the fight against climate change and its impacts. They need to apply sustainable practices to all their operations.

To be the significant force for dealing with climate change that the world needs, business need to implement new operational methods and products: 1) They need to transform their operations from non-sustainable, non-circular economy modes of operation to sustainable circular economy methods *(EarthDeal*); 2) They need become a cooperative and collaborative force working together on meeting the challenges of climate change (*EarthLink*); and 3) they need to develop products and services that develop the circular economy— such as *EarthMeal*, a smart phone app and website that finds users and uses for food that would be wasted. Such new products and services are an example of a new business model that is collaborative, fits into a circular economy, and can inspire and be used as a model for other wasted resources in the local and global economy. Together, these three strategies can change the climate of business by promoting and strengthening sustainable business for a sustainable Earth.

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7. BIO-FARMING HUBS FOR FOOD SECURITY

By Baruch Bashan (U.S.A.), Precious Bamfo, (U.S.A.), Keisha Jackson, (U.S.A.,) Isaiah Laborde, (U.S.A.), Levy Nyirenda, (Zambia), Gurinder Singh, (India)

Strategic Summary

The world is confronted by the stark reality of close to 800 million people who are hungry and a food production system that is steadily destroying the capacity of the food system to produce the food needed to feed the world's growing population. BioFarming is a solution to both. BioFarming leads to better access, distribution, and quality of food, lessens food supply insecurity caused by fluctuating food production, plus it reduces negative environmental impacts and simultaneously increases the health of the most essential ingredient to food production— soil. The strategic plan/proof-of-concept targets local farmers in three African countries. The implementation of bio-farming increases food self-sufficiency by improving the quantity and quality of crops and the soils upon which they depend.[1]

The plan calls for surplus crops to be sold locally, thereby helping relieve food insecurity. With growing evidence of the success and profitability of farms that have transitioned to bio-farming, neighboring farms and countries will replicate the strategy.

Preferred State

The UN Sustainable Development Goal #2 calls the world to *"End hunger, achieve food security and improved nutrition and promote sustainable agriculture."*[2]

The Global Solutions Lab takes this bold goal a few steps further. It envisions a world where:

- There is zero hunger in the world. Food is abundant, affordable, culturally appealing, nutritious, and accessible for all.
- There is zero food waste.

- Meat and seafood are sustainably produced.
- Food production is done in a way that leads to soil regeneration and enrichment that:
    - leads to increased soil health, vitality,
    - water retention,
    - carbon storage
    - and food-producing capacity.
    - It also reduces costs,
    - CO2 emissions,
    - water pollution,
    - and expensive and damaging chemical use.
- Profitable employment opportunities in agriculture increase.
- Food production increases, costs decrease, and water usage is more efficient and lower.
- The above qualities permeate the entire global food system—from farmer to consumer, from local to global, from production to distribution to education, from financing to government policy.

To get to this Preferred State, we need to start from, and understand, where we are, the present and problem states, as well as the gap between the Preferred State and the present.

Problem State

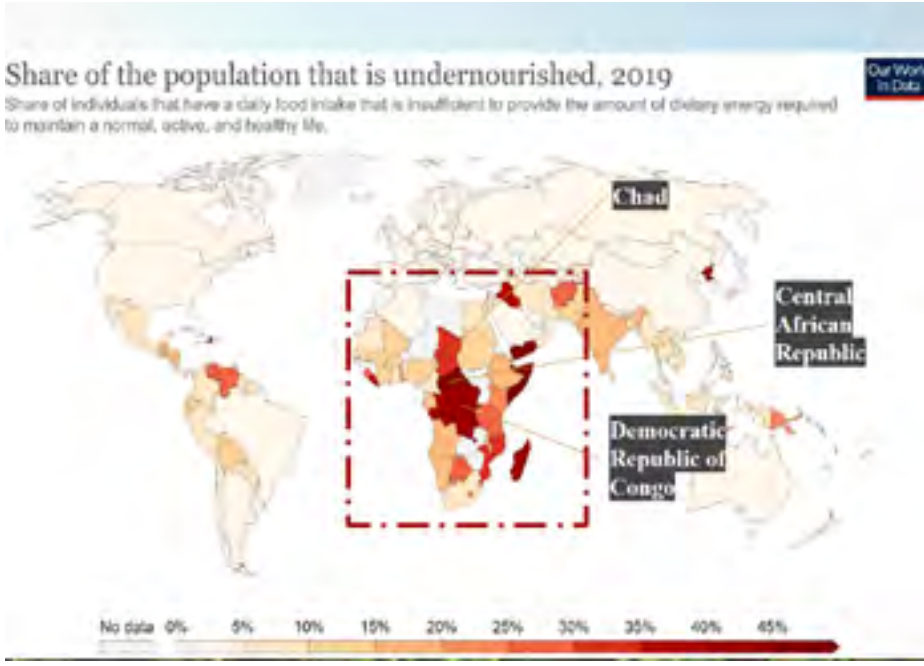
If we are to achieve the above global Preferred State, as well as the Sustainable Development Goal #2, the following is where we need to start.

Global Problem State

Our team identified the following as key indicators of the current state of the world regarding hunger:

- *Hunger: 345 million people face severe hunger.*[3] *800 million go to bed hungry. 3.1 billion cannot afford to eat a healthy diet.*
- *Soil:* The planet's living and priceless topsoils, vital for feeding the world, are rapidly being destroyed. Recent estimates point to 40-60 years of topsoil left.[4] Roughly 65% of Africa's farmland is unproductive, eroded or otherwise degraded.[5]
- *Waste*: Over 30% of food is wasted yearly.[6] 10% - 80% of crops in some parts of the world are lost post-harvest.[7]

- *Economic Impact*: $400 billion is lost annually due to degraded land and soil.[8]
- *Knowledge*: There is a lack of knowledge about farming in ways that are sustainable— which endangers present day and future generations.

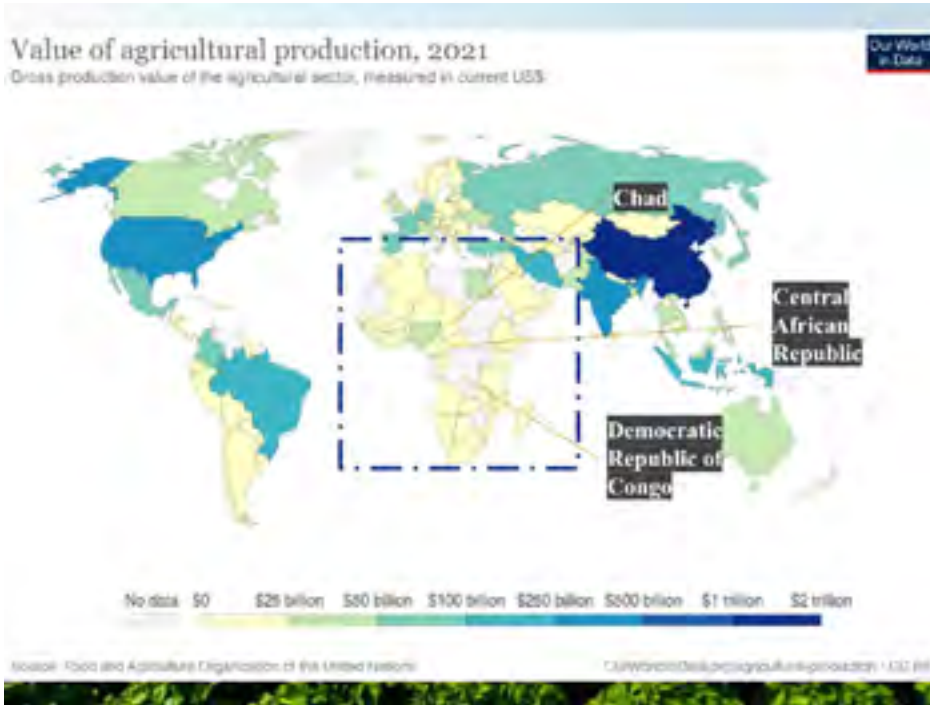


Reaching the Preferred State demands bold action at scale. The strategic design and plan presented here picks three countries in Africa that have some of the world's most serious food system problems as "proof-of-concept" test sites.

The above map shows the three targeted countries in our strategy (Chad Central African Republic, and Democratic Republic of Congo). All three have some of the largest shares of undernourished people in the world.

The below map shows that the three targeted countries are among the least successful in terms of the value of their agriculture production.

Problem State: Crops quantity and quality



Combined with the fact that these three countries have major problems with hunger and that a significant portion of their populations are involved with agriculture, this project targets these countries to implement the proof-of-concept/first round of the "Hub Farms Strategy" that demonstrates and teaches the practices of farming biologically.

BioFarming Project

The BioFarming Project begins by targeting the three countries identified above. The aims of the strategy include increasing food production in these food-short areas while rebuilding topsoil, decreasing climate change impacts, and increasing economic and community strength and health.

Impacts of Farming Biologically include:

1. Increased quantities and quality of crops.[9]

2. Improved soils, allowing farming in the same location over many years.
3. Decreased costs for the farmer and less water required to grow more crops.
4. Increased profitable opportunities.
5. Decrease in pollution from chemical runoff.
6. Decreased amounts of carbon dioxide in the atmosphere from conventional farming[10]. practices.
7. Decreased illnesses due to malnutrition because of improved nutritional quality of crops.[11]

Strategy

The Bio-Farming Hubs strategy addresses the issues of hunger, and the related damages and destruction of soils and communities, reliance on fossil fuels, and contributions to climate change by the food system. It does this through a series of actions, programs, and policies at three different levels: local community, national, and global. The strategy starts in Africa, in three countries: Chad, Central African Republic, and the Democratic Republic of Congo.

Overview: HUBS— Bio-Farming For Food Security Strategy

A key part of reaching the Preferred State is increasing the efficiency and production while decreasing the impact of the current agriculture system. To do this won't happen by government law, academic treatise, or wishing it so. Our strategy calls for a series of demonstration farms ("Hubs") that are located, to start, in worst-case areas where large segments of the population are going hungry or threatened by food shortages.

Each Hub will demonstrate a food production regime that is compellingly attractive to surrounding farms. The Hub will demonstrate techniques, technology, and practices that increase yields, save money, increase soil and farm productivity and long-term value—plus positively impact health, the economy, and climate change.

Once the results of the demo farm Hubs are visible, the Hub will hold workshops for "first adapters" from the surrounding farm communities and assist them in making successful transitions to more ecosystem friendly farming techniques. As these new farms demonstrate the economic viability and superiority of bio-farming techniques, other,

more conservative/hesitant-to-change farmers will switch.

To make the Hubs more attractive to local communities and farmers each Hub will demonstrate not just bio-farming techniques but also (where appropriate) solar powered irrigation and household lighting, refrigeration, and other advantages of a reliable electricity supply, producing food and energy through agrivoltics[12], on-farm and community-based food storage facilities that reduce waste, and other ecosystem compatible, health and wealth increasing innovations that the surrounding communities want.

Details: HUBS— Bio-Farming For Food Security Strategy

The approach for reaching a zero-hunger state in the world, plus positively impacting climate change drivers, the cost of food production, and health, begins as a large-scale demonstration and proof-of-concept in the three hunger-afflicted countries in Africa listed above. Setting up a Hub in each country will follow these procedures:

1. **Partner(s):**
    a. Establish local partnership with existing NGO and/or local government.
    b. Locate and establish partnerships with 1-2 farmers in the targeted region(s) and communities who conduct trial food producing techniques that compare growing using the farmer's conventional methods with bio-farming techniques.
2. **Results/Education**
    a. Education via workshops, farm tours, posters, etc. after results of trials are in. Hub staff and local farmers will go over results with the local farming community and sign up the farmers who are interested in making the leap to bio-farming.
3. **Hub Farms Stage 2**
    a. Existing and new Bio-Farms act as "Hub Bio-Farms" providing demonstrations, training, consulting services—as well as bio-farming "ingredients" such as compost for neighboring farms.

Needed Technology

In addition to existing technology used by most farms in the three regions in the African countries where the first stages of the Bio-Farming

strategy is implemented, there will be a need for tools for making compost and compost extracts, such as wire cages, pallets, tarps. These will be provided to the first-adapter farms for free as a way of assisting them in their transition and for rewarding them for their risk.

Each Bio-Hub will have a trained staff person who will use a microscope to determine the health and needed soil treatments to maximize the health of the soil and the productivity of the farm in as quick a way as possible.

Needed Resources: Human and Material

1. Staffing:
    a. Bio-Farm Hub Project will need a core staff of one to two people to do the following:
        i. Starting in one of the three identified countries: Locate, meet with, and successfully initiate a joint planning process that leads to an in-country demo site(s) with at least one in-country partner NGOs and government agency(s) with whom the Bio-Farm Hub Project can work.
        ii. Obtain additional ongoing support and funding for the program to expand to two additional countries for the completion of the proof-of-concept phase of the Bio-Farm Hub project.
    b. Each Bio-Farming Hub will need one to two staff persons to initiate and maintain the in-country program.
        i. Responsibilities include recruiting one to two local farmers to be Bio-Hub farmers, training them in bio-farming techniques, making sure they have the tools and materials needed for the transition to bio-farming, holding educational programs and tours for other farmers interested in the program, and monitoring progress and results.
        ii. In addition, the Bio-Farm Hub staff prepares outreach materials, including flyers, pamphlets, posters, websites, and smart-phone apps that pertain to bio-farming in the local language.
        iii. Bio-Farm staff will be trained in soil analysis so that they can more accurately monitor microbes, soil nutrients and health to assist in the transition to bio-farming.

Bio-Farm Project— Going to Scale

Proof of concept— what is needed to justify scaling up:

Solid, reproducible evidence of easy-to-implement and cost-effective techniques that increase yields and the well-being of the farmer and their family. Improvements to harvest yields, crop health, costs of farming, soil biome composition, soil compaction, and other variables are needed to set in motion the groundswell of change to more and more bio-farms.

Scaling— Next Steps:

Once the above has been accomplished, the results are widely published via social media, conferences, scientific journals, etc. and communicated to the public, farmers, government agencies, NGOs, and funding sources.

Next steps include the adoption of the food production methods of the bio-hub program by additional countries throughout the world. This is accelerated by a Bio-Farming NGO that trains farmers, NGO staff and government agency staff in bio-farming.

Costs

Start-up costs for the Bio-Farming Hub Project, including U.S. staff, in-country staff, materials, travel, and farmer subsidies needed to attain profitable sustainability will be approximately $250,000. Yearly costs, assuming growth of the program from one country to three, will be $300,000 to $350,000 in the first three years.

Funding

Start-up costs for the Bio-Farming Hub Project will be sought from wealthy country foundations, development aid agencies, national governments where the project will work, and partner NGOs. With documented evidence of the economic superiority of the bio-farming program proposals will be made to governments illustrating the cost/benefits of the bio-farming program to current government funded programs.

Next Steps

The first things that need to be done is to locate NGOs that have a similar mission to the Bio-Farming Hub Project and/or its core bio-intensive approach to food production.

These organizations will be contacted, sent a proposal of what the Bio-Farming Hub Project is and wants to do, and partnerships of one form or another will be explored and formalized with receptive organizations.

Appropriate people, organizations, government agencies, communities, and individuals need to be contacted in one or more of the countries in which the Bio-Farming Hub Project intends to work. Partnership relationships need to be formed.

Working together, funding sources need to be contacted and funds secured for Stage One in-country implementation.

Working together, appropriate local communities and farmers will be identified and visited. Conventional and bio-farming methods compared, and interested farmers will commit to the bio-farming program. Partnerships will be secured and working with local farmer(s) and the local NGO, plans of action will be put in place and implemented over the coming growing seasons. A set of trials will be designed to compare the results of the farmer's usual approach to growing a crop with those of a plot grown using bio-farming techniques.

A qualified staff person, preferably from the region or country in which the bio-hub farm is located, will be hired when the first country is identified. This person will be well-trained in bio-farming, project management, outreach, their responsibilities, goals, and measures of success.

Next 2 to 4 Years

Over the course of the first three to four years of the project documented and published results from the in-country farms in terms of agricultural productivity, economic improvements, soil regeneration and other benefits will allow the Bio-Farming Hub Project to expand throughout Africa and globally.

Conclusion

The strategy presented here, *Bio-Farming Hubs For Food Security*, can make a significant difference in ending hunger, lessening agriculture's impact on climate change and the environment, while producing quality food at affordable prices—if done at scale. The strategic design and implementation plan show a path to scale that is based on best practices and which can succeed. It needs to be done as soon as possible to avert human and environmental disaster.

Endnotes

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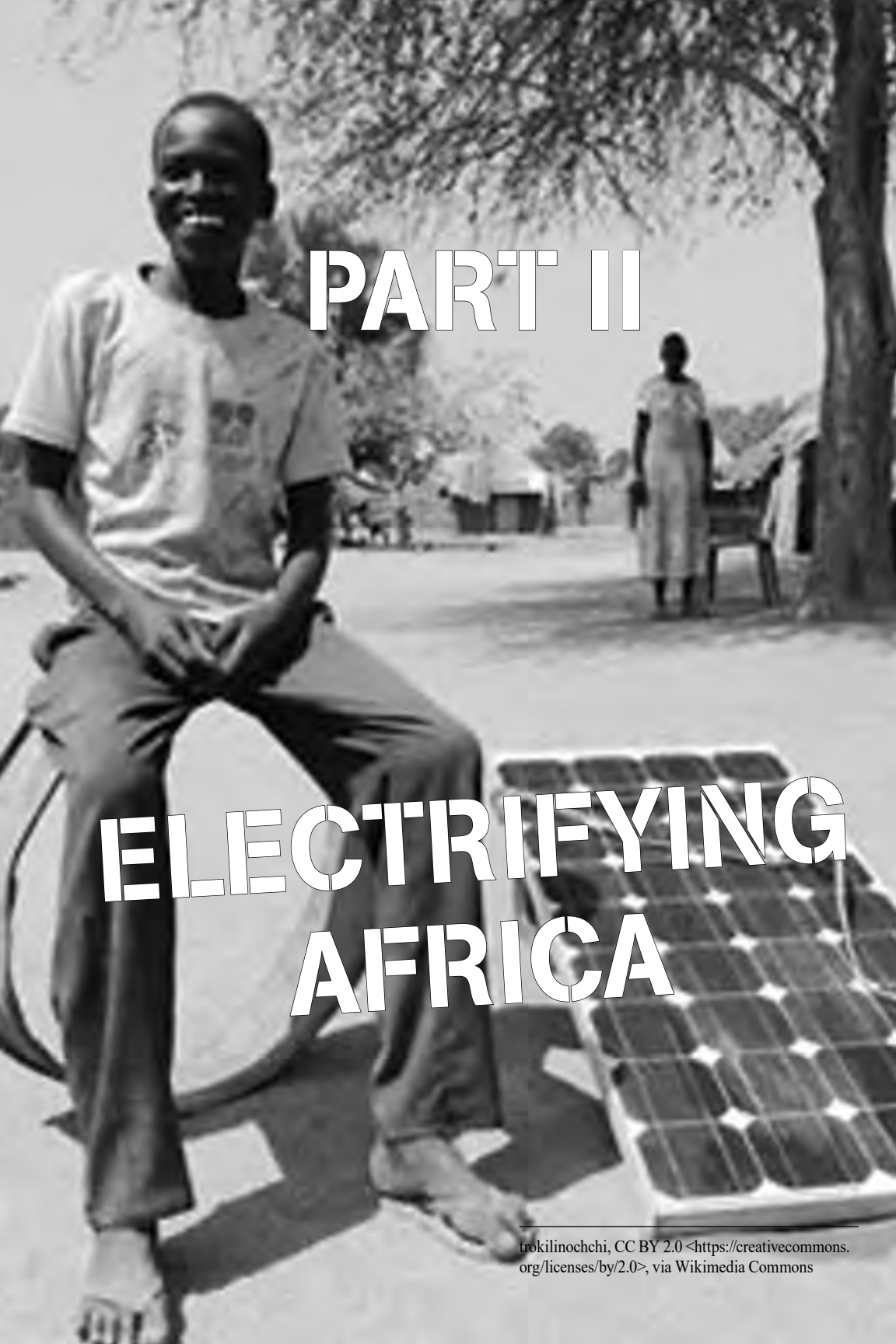
PART II

ELECTRIFYING AFRICA



ELECTRIFYING AFRICA
OVERVIEW, AND TECHNOLOGICAL OPTIONS FOR GETTING AFRICA THE ENERGY IT NEEDS

By Medard Gabel, Kanji Katayama
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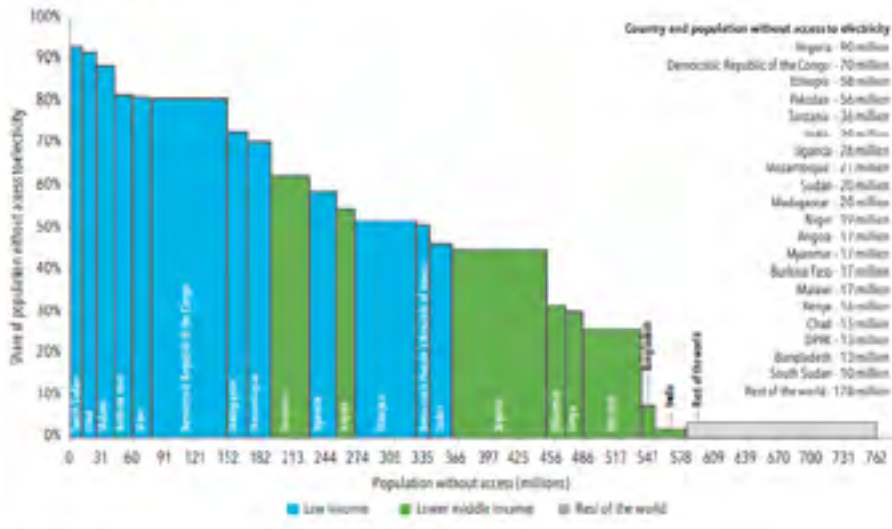
Introduction

Africa has 1.4 billion people, 560 million of which are under the age of 15. Average life expectancy, at 52 years, is 20 years below that of more economically developed parts of the world. Nearly 600 million are without access to electricity, and nearly all of the other 800 million do not have a sufficient, clean, reliable, or affordable supply of electricity needed to meet the needs of a 21st century participant in the global economy.

For Africa to eliminate the widespread, extreme poverty that impacts not just the people and economy of Africa, but that of the whole world, as well as become a prosperous, leading member of the global community, electricity needs to reach *everyone* in Africa—and it needs to be more than a "bare minimum" level. Electricity must be provided in a manner that goes beyond meeting basic human needs, and provide electricity levels comparable to those of the most developed countries. Electricity use needs to provide the basis for a prosperous, productive, modern and healthy economy and society, not just raise living standards of critically important, (and currently impoverished), segments of Africa to a bare-minimum or subsistence

FIGURE 1.37 • Share of population and total population without access to electricity, top 20 access-deficit countries, and rest of world, 2019



Source: World Bank 2021

level. It is also critical for the world and Africa that this level of energy use is not equivalent in quantity, but in functional quality. The goal is to increase life expectancy and prosperity, while lessening environmental impacts. In other words, Africa uses the latest, most efficient electricity generation and use technology in the world to accomplish these goals.

This need for electricity can be meet with current, least-cost, and comparatively low-environmental-impact technology. It can also be paid for using existing accessible funding sources. However, electricity needs will not be able to be met by continuing to utilize and implement past, outdated methods for supplying energy. Essentially, doing more of the same, even a lot more of the same, will not be enough— for meeting Africa's need for electricity or for making sure that energy is owned, managed, and benefits Africans.

A positive side of Africa's current energy system is that its lack of an extensive (and inefficient) 100+ year-old legacy energy system such as exists in most developed countries, makes it uniquely situated to go down a more efficient, equitable, and sustainable path.

Meeting Africa's needs for clean, safe, reliable, resilient, and affordable electricity—owed and managed by the people of Africa, demands a series of bold actions at unprecedented scale. More importantly, it demands a conceptual shift away from separate, national and incremental-improvement approaches that serve the status quo

while ignoring the needs of those living in poverty. This conceptual shift needs to be to a whole-systems, collaborative, and continent-spanning pan-African vision and approach that goes after the visionary aspirations of the African Union— to have a "prosperous Africa based on inclusive growth and sustainable development".

The following presents such a vision and some of the options for electrifying Africa, one that leads to a prosperous Africa that is *electrifying* in every sense of the word— as a location that has universal access to electricity *and* one that arouses a sense of great excitement, a place that is dynamic, creative, and leading the world in new directions. The following is not intended to be a blueprint or strategic plan, but rather to demonstrate that the resources and technology for meeting the electricity needs of Africa are abundant, affordable, and available right now.

Non-Bare-Minimum Goal

The goal of electrifying Africa is not the consumption of increased amounts of energy but what energy consumption should lead to— increased life expectancy, sustainable prosperity and a regenerating environment.

Per-capita energy consumption is a fair indicator of standard of living. Therefore, we decided to use a country with a high standard of living to establish a per-capita energy/electricity consumption benchmark. The per-capita energy goal we have chosen is that of Denmark which has a higher standard of living than the United States— as measured by life expectancy, health care, pollution, safety, cost of living, level of income equality, economic and political stability, quality of public education, climate and other factors. In addition, it is important to note, Denmark has a much lower per capita energy consumption while maintaining its high standard of living. It's energy consumption, which includes electricity, transportation, cooking, heating, etc. is 28,314 Kwh per person. The U.S. energy consumption, at 74,000 Kwh per person, is over 2.5 times higher. Per capita electricity consumption is 5,638 kWh and 11,757 kWh for Denmark and the United States, respectively.

The goal of electrifying Africa is not to supply this amount of energy to every person in Africa, but for everyone in Africa to enjoy the same level of health and prosperity as those living in Denmark. To meet this goal, using the most efficient, state-of-the-art and proven energy production, storage, transportation and use technology will necessitate suppling roughly 19.6 trillion kwh per year to the people of Africa.

The following outlines how this amount (~20 trillion kwh/year) can be produced and delivered by and to the people of Africa using renewable energy and present-day technology. It involves the use of the latest technology, coupled with government policy, programs, and actions, business development, traditional and innovative funding, plus local, regional, continental, and global actions.

Action Overview

To electrify Africa, to meet its needs for abundant supplies of electricity for all its people, the priorities for this need to be (a) the 600 million people without any electricity access, (b) supplying electricity to the health and educational sectors of the economy, and (c) transitioning away from the fossil fuels that currently supply 79% of the continent's electricity.

Such an approach, if it is to meet needs in a timely manner, necessitates a series of simultaneous actions on different geographical and political levels and scales: local, regional, national, and continental. Local, community-based, led and owned solar and wind *micro-grid installations* are the priority. These initiatives are linked to regional *Energy Hubs* that purchase and distribute locally produced surplus electricity and hydrogen. In addition, large-scale *Mega-Energy* projects such as off-shore and land-based wind and solar facilities in the 100-to-10,000-megawatt scale that are pan-African initiatives are critical to meeting all the electricity needs of a growing, sustainable African economy. In addition, solar cell and wind power manufacturing plants based in Africa, employing Africans, and majority-owned and managed by Africans is critical to the de-colonization process that is essential for an *electrifying* Africa to take its critical place in the global economy.

ELECTRIFYING AFRICA: WHAT'S NEEDED

1. Technology

Supplying electricity to all of Africa will involve a multi-faceted approach that uses many technologies for harnessing varieties of solar, wind, hydro and other renewable energy sources. These include:

- Large-scale, mega- and giga-watt solar installations, both on-land throughout Africa, at mine sites, and floating on lakes and canals, linked to areas in need through existing and new smart grids
- Small-scale, kilowatt range solar installations in rural and urban communities, plus at healthcare and educational facilities— linked via microgrids to other small installations and to EnergyHubs that buy and distribute surplus electricity
- Off-shore wind farms in the 100 megawatt to gigawatt size range
- On-land wind farms in the 100 megawatt to gigawatt size range
- Small-scale hydro
- Geothermal
- Hydrogen production facilities

Examples of the above:

SOLAR

There are numerous examples of solar installations in the world that can be duplicated and scaled to match the electricity needs of Africa. The following pictures are a few examples of large-scale solar parks around the world whose design and scale can be adapted for use in Africa.

Large-Scale On-Land Solar

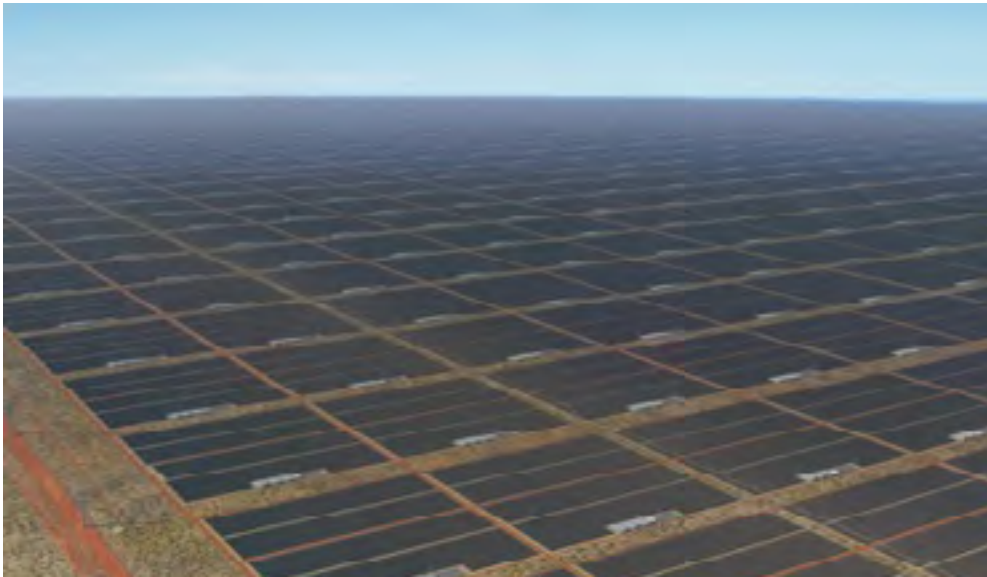
Solar Parks

The above picture shows one of the world's largest solar parks. Located in India, it has a 2.245-gigawatt (GW) capacity. Such an installation could produce between 5 billion kwh and 8.2 billion kwh per year.

In addition, the Indian state of Rajasthan is adding 1.8-gigawatts of solar capacity at two sites in Jaisalmer and Bikaner (a 1.0-GW park in Bikaner, an 800-megawatt solar park in Jaisalmer).

The above shows another solar park installation in India.

Australia



The above shows what will be the world's biggest solar and battery energy storage project. Located in Australia this project will generate 17-20 GW from its solar farm that is coupled with 36-42 GWh of battery energy storage. This solar facility will occupy 12,000 hectares. It will generate between 60 billion kwh and 73 billion kwh per year.

To produce all the electricity Africa needs to reach a high standard of living (20 trillion kwh/year)— and using the above as a template, it would take about 33,000 square kilometers (12,700 square miles)— about .001 % of Africa's land mass, an area slightly larger than Belgium.

The above shows a 1.2 GW renewable energy hub in Australia.

Africa Solar Parks

Huawei and Meinergy plan to build a 1GW/5000 kwh facility in Ghana that will be one of Africa's larger solar-plus-storage projects.

Large-Scale Floating Solar

In addition to land-based solar parks, Africa has many opportunities for water-based floating solar installations.

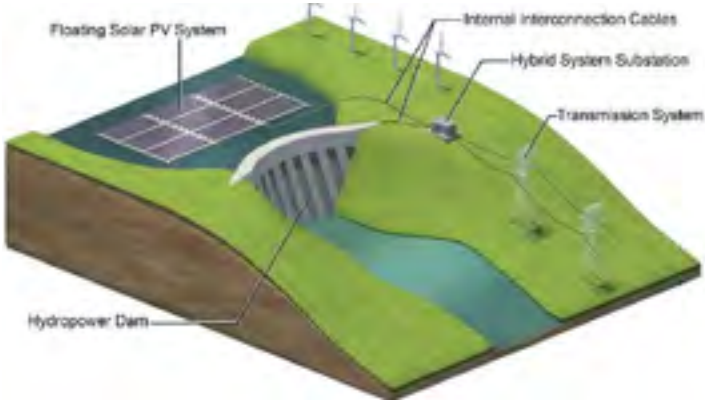
China

The above is a picture of new floating 320-megawatt solar system near Dezhou in China. In addition to electricity production floating facilities reduce evaporation, minimize algae blooms by shading the water, help produce a consistent supply of electricity during dry periods, and by staying cooler they run more efficiently.

Ivory Coast

The above shows a 20 MW floating solar array that will be built in the Ivory Coast by local utility Cote d'Ivoire Energies. The facility will be located on a water reservoir at the Kossou dam, in the center of Ivory Coast.

Hybrid Hydro/Floating Solar



Source: pv magazine

Potential in Africa

Combining floating solar array installations with Africa's large hydroelectric facilities is also a viable strategy. According to UN Food and Agriculture Organizations, there are 1,338 hydro dams in Africa. Each has a reservoir. The total reservoir surface area covered by the largest 146 hydropower reservoirs in Africa is 29,222 km2. Installing a 200-megawatt floating solar installation on just half of these reservoirs would generate between 85 and 106 billion kwh per year.

SMALL SCALE SOLAR/ COMMUNITY SOLAR

Solar mini-grid/community/household scale examples of electricity provision:

Solar Mini-Grids

Mini-grids are "isolated systems that may range in size from 1 or 2 kW up to 10 MW and provide power to local consumers through a local distribution network." Because they reach people not linked to traditional electric power grids—like the 600 million people in Africa without electricity access— mini-grids will play a critical role in achieving universal electricity access. The International Energy Agency (IEA), says that 40 percent of all installed capacity will need to come from mini-grids in order to achieve universal access to electricity by 2030.

According to the World Bank, there are 19,000 mini-grids connecting 47 million people in the world. The investment cost of these was $28 billion— less than $600 per person. Most of these are hydro and diesel systems. Solar mini-grids are expected to cost even less— $450 per person.

The following chart provides a summary of what is needed:

Source: The World Bank

Photovoltaics and solar-hybrid systems are seeing the greatest reduction in production costs. The World Bank states "Over the past decade…The costs of key mini grid components, such as solar panels, inverters, batteries, and smart meters, have decreased by 62–85 percent." Solar-hybrids have greater potential compared to other renewable sources such as wind and hydro, due to solar being a being widely available resource.

Third generation mini-grids are increasing in availability. Compared to first and second generation, third generation are more efficient and less costly. Most of the mini-grids being developed/planned for development are third generation solar-hybrid mini grids. "A typical third-generation mini grid consists of a solar-hybrid generation system that includes solar panels, batteries, charge controllers, inverters, and diesel/hydrogen backup generators. These mini-grids typically use smart, remotely controlled electricity meters that allow customers to prepay for their electricity in a pay-as-you-go (PAYG) model." In addition, maintenance required is relatively low with only 2 weeks of scheduled maintenance per year, equating to greater than 97% uptime. Therefore, performance is significantly better compared to previous generations of mini-grids as well as the most utilities across Sub-Saharan Africa. Electric cooking can also be supported by third-generation mini-grids, which is a cheaper, cleaner and safer alternative

to traditional cooking methods."

Using the above as a guide, to supply 600 million people with electricity over the next 10 years will cost $27 billion per year.

Using a recent report by The World Bank, a similar cost is arrived at– $26.4 million /year. According to The World Bank, "connecting half a billion people to mini grids by 2030 requires more than 210,000 mini-grids and almost $220 billion in investments."

These numbers point to 2,380 people getting their electricity per grid. Using this as a base for determining costs, we will need 252,000 grids to reach 600 million people. At $1.05 million per grid ($440/person), that's $264 billion or $26.4 billion/year.

Using costs from a recent Kenyan "pay-as-you-go" solar initiative, costs can be substantially lower. With this model, customers pay for the electricity they consume on a pay-as-you-go basis via their mobile phones. This model reduces costs to $40/per person, but has a steep price in that it is utility run and owned, and does not build community, or economic income for the community.

Other Community-Based Solar Facilities

Solar/Agriculture Combinations

Kenya

The above shows solar panels being used in agriculture to boost crops by 'harvesting the sun twice'. Successful trials found growing crops beneath panels – known as agrivoltaics – reduced water loss and resulted in larger plants.

Cooling/Cold-Storage

India

The above shows a multi-chamber, solar-powered cold storage facility that stores multiple perishable commodities in different temperature-controlled chambers under their respective ideal storage conditions.

WIND

To meet the energy needs of Africa more than large-scale solar parks and solar mini-grids will be needed. Wind, both on- and off-shore will play important roles.

Off Shore Wind Farms

Wind speeds are most often faster offshore than on land, which means more energy can be generated from a given wind installation

The above shows a proposed wind farm off the coast of South Africa.

On Shore Wind Farms

Kenya

The above shows the largest wind farm in Africa near Lake Turkana in northern Kenya. The 310-megawatt installation has 365 wind turbines. Using similar size turbines to meet the 20 trillion kwh needed to meet Africa's needs, would need around 9,800 such installations. Using the largest state-of-the-art turbines (GE's Haliade-X – 14 MW turbine) would need 570 such wind farms.

Hydrogen

Singapore sees hydrogen supplying up to half of its power needs by 2050. Why not Africa doing even better?

Other Renewable Energy Sources and Technology Applicable to Africa (not contained in this report)

- Micro-Hydro
- Geothermal
- Tidal
- Solar cell and wind turbine manufacturing facilities
- Energy Storage, including:
    - Batteries
    - Pumped storage
    - Compressed air
    - Molten metals

2. Funding

The money/resources to fund the *Electrifying Africa* project can come from numerous sources. These include:

- Current **subsidies to fossil fuels** in Africa are $84 billion per year. This is over three times the cost of the $27 billion needed to supply 600 million people with electricity from small-scale solar mini-grid installations over the next 10 years.
- Current global **investments in new energy systems** are $570 billion per year. These funds are projected to be spent on new oil and gas development and exploration every year to 2030. The "projected investments for new oil and gas could fully bridge the annual investment gap for wind and solar deployment required to meet the 1.5°C climate target" according to this new study.
- **Expand government expenditures** on clean energy development. Current tax rates in Africa are half of what they are in OECD countries (measured by tax-to-GDP ratios, Africa being at 16.6 and OECD countries at 33.8).
    - To start, increase taxes on current fossil fuel energy production and use all these funds for the transition to renewables for the 600 million people without any access to electricity.
    - Increase taxes on the wealthiest .01% of African citizens (140,000 people), who hold 42% of Africa's wealth, and dedicate these revenues to clean, affordable, reliable energy supply for everyone in Africa.
- **Implement new incentives for private sector energy investment**— on local/community levels, national, regional and all-Africa levels.
- **Obtain loans** to cover the costs of the transition to abundant renewable energy. Repay these loads from increased economic activity from a growing economy (brought about by the electrification of Africa).
- **Harness/leverage community wealth** through profit-sharing and pay-as-you-go arrangements
- **Export surplus energy**, after Africa's needs are met
- **Obtain reparations** for climate damage from wealthy countries to cover the costs of Electrifying Africa.

Conclusions— Bold, inclusive, long-range vision, brave, innovative decisions and solutions

The natural resources of solar, wind, hydro, geothermal, and the synergetic combinations of these are vast— well in excess of what is needed to supply all of Africa's energy needs. The technologies for harnessing these energy sources are proven, in use in other parts of the world, scalable, easily adapted to the needs and resources of Africa, and getting more efficient and less costly with each itineration. The materials, in addition to those that go into the energy-harnessing technology are available. The human resources, the intellectual capital, know-how, and guiding wisdom are present, as is the huge labor pool for construction, maintenance and expansion of the present and future energy systems of Africa. Funding is available and well in excess of what it needed for the transition to a renewable energy system, and a transformation to a society where every citizen of Africa has an abundant, reliable, and affordable supply of clean energy that meets all of the needs of all the people, the economy and future aspirations.

The need for a transformation of the status quo, from a force primarily concerned with keeping things the way they are, resistant to change, and under the control of the current power structure is needed, and necessary for Africa (and the world), to meet its basic needs and actively participate in making the world work for all.

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STRATEGIES:

1. Power Africa with Renewable Energy Sources
2. EM-Power Africa
3. Electrifying Africa: Solar Mini-Grid Are the Best Alternative Energy System for Africa

1. POWER AFRICA WITH RENEWABLE ENERGY SOURCES

By James Serwanga (Uganda), Deniz Wanyana (Uganda), Naswiiha Nambogga (Uganda), Betty Nakandi (Uganda), John Baptist Kasozi (Uganda), Olga Maria Ndibalekera (Uganda), Naira Najjuuko (Uganda)

> *"We have immense potential for renewable energy, and this abundance of wind and solar energy can power the development of Africa. Rather than trudging in the fossil fuel footsteps of those who went before, we can leapfrog this dirty energy and embrace the benefits of clean power. A transition to clean energy is a no-brainer. It will create jobs, protect local economies, and accelerate the sustainable industrialization of Africa."*
>
> —William Ruto, President of Kenya

Strategic Summary

Most electricity in Africa is produced by fossil fuel power plants plus hydro. These power plants and the electricity they produce and distribute are grossly inadequate as there are over 600 million people still without access to electricity in Africa. Africa can meet its needs for electricity entirely from renewable energy. This report, using Ethiopia as a case study, shows how this can be done.

Introduction/Overview

Energy is critical for socio-economic development and is a backbone of a modern economy. A quantitative relationship between energy use and economic growth has been well documented for countries in different phases of development. According to the World Bank, lack of electricity has caused a gap in basic services, with only 24% of primary schools and only 30% of health clinics able to access electricity. In addition, there is low production of needed goods and services, limited access to technology, and low investments, all due to unstable and limited electricity supply.

Ethiopia is located on the horn of Africa, in the east of the continent, located between the equator tropic of cancer and is one of the few

countries in the world where the electricity grid is nearly 100% supplied by renewable energy sources. Ethiopia's population as of 2020 was 120 million and its growth rate is 2.4% annually with a projected peak year of 2025. The World Bank states that Ethiopia's current power generation capacity is 96% hydropower, wind energy 7.36%, and solar energy is 0.19%, and that the rate of access to electricity is lower than it could be. A UN report named Ethiopia among the nations with the largest electricity deficit with over 85 million unserved people. This is the reason why we chose Ethiopia as our location to pilot the *Power Africa* strategy.

In the energy inequality tracking report of 2021, the Ministry of Water Irrigation and Electricity in Ethiopia highlighted their renewable energy potential as:

- **Geothermal** potential is 5,000-10,000 megawatts
- **Solar** potential is an average daily irradiation that could produce electricity at around 5.5 kilowatts per day
- **Wind** potential is also very large. Wind speeds greater than 7m/s has the potential to produce around 10,000 gigawatts (about 30 billion kwh/year)

In summary, the gap between the unmet energy needs of Ethiopia and its abundant renewable energy resources documents that the energy needs can be met, and met with renewable sources.

Figure:1- Students studying at night under a candle

Figure 2: Extension of power lines in rural arears of Ethiopia

Figure 3: Small wind power generator in Ethiopia.

Images source: https://www.worldbank.org/en/news/feature/2018/03/08/ethiopias-transformational-approach-to-universal-electrification)

Preferred State

The US Congress *Electrify Africa Act 2015* was to encourage Sub-Saharan Africa to develop an appropriate mix of power solutions for more broadly distributed electricity access. Here, the *Power Africa* strategy goes further: A preferred or ideal state for Africa is one where:

- 100% of Africa having *access* to energy,
- That energy supply is based on more *resilient* energy systems,
- *Poverty is eliminated*, *education* and *health care* facilities brought to global state-of-the-art standards
- Economic *growth increases*, millions of *new jobs* are created,

- Robust *markets* for power are developed,
- Cross-border *trade* of renewable power increases,
- *Reliability* increases, blackouts and brownouts are eliminated,
- There is full *access and use of state-of-the-art technology*,
- Local and foreign *investment increases* to the levels needed to finance the electrification of all of Africa.

Figure 4: A view of streets and high-rise apartments in Ethiopia

Figure 5: A rural community watching television after getting access to electricity.

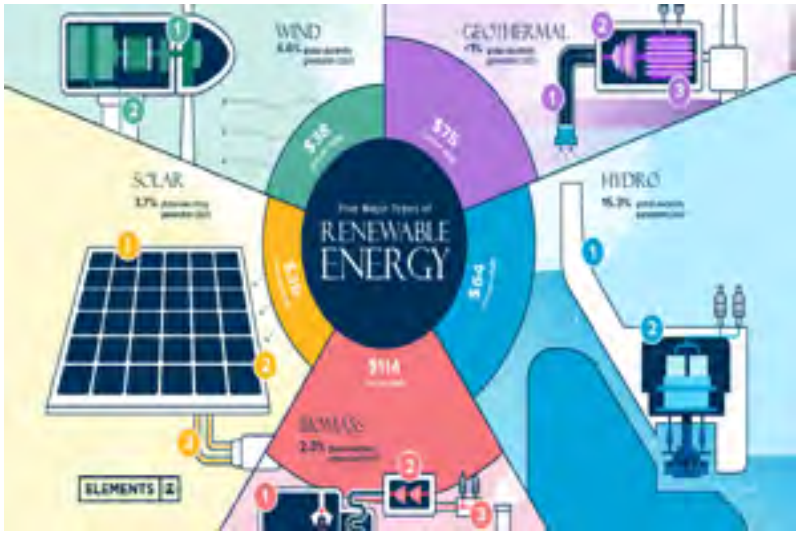
Strategy

The *Power Africa* strategy is first focused on Ethiopia as a demonstration of what is possible for all of Africa. It calls for the creation of a *Power Africa* NGO. Its mission will be to diversify Ethiopia's power supply sources by increasing the production of wind and solar energy. The goal of this is the development of zero-emissions of carbon dioxide, reduced dependence on hydro-energy sources (or fossil fuels in other parts of Africa), the protection the water resources, a better protected environment, and an electrified Ethiopia that benefits all its citizens.

Renewable Energy

Renewable energy technologies harness the power of the sun, wind and heat from earth's core and then transforms it into usable forms of energy like heat, electricity, and fuel. Combining all these sources will lower the cost of energy and increase access to power all over the globe.

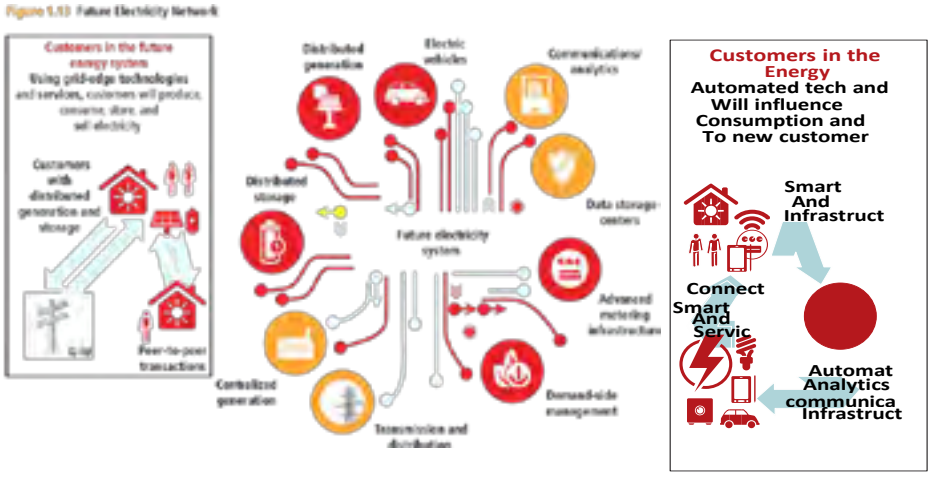
Figure 6: The Major Types of Renewable Energy



The Future Of Electricity

With increased development of renewable energy sources, adaption to grid technologies, government, business and NGO support, and direct involvement of customers, Ethiopia and Africa in general will be fully electrified.

Figure 7



SOURCE: https://www3.weforum.org/docs/WEF_Future_of_Electricity_2017.pdf

The vision behind the strategy:

Resources Needed to Implement the Strategy

Material and technological resources :

Wind resources:

Steel comprises 66-79% of total wind turbine mass
Wind turbine blades are most often made of fiberglass, and are 11-16% total wind turbine mass
Other materials needed include:

- Iron (5-17%)
- Copper (1%)
- Aluminum (0-2%)
- Another essential material are magnets used in the power generators.

Solar photovoltaic resources:

- Solar cells and panels
- Inverters/charge controllers, batteries
- Local mini-grids and large-scale/long distance grid systems

Human Resources:

- Engineers in renewable energy sources
- Administrators
- Public relations officers
- Investors
- Community leaders

Sponsors/Investors/Partners

Potential sponsors, investors and partners will collaborate with Power Africa. These organizations will include:

- **Ethiopian government**. *Role*: support total renewable energy through their Electrification Program
- **Businesses.** *Role*: support and utilize the new system in their day-to-day operations, and develop and bring to market sustainable products
- **Foundations**: *Role*: fund renewable energy development in Ethiopia. Example: Michael Bloomberg plans a $242 million investment in clean energy, the former mayor of New York City and foundation director will fund programs in 10 developing countries (footnote) Other foundations around the world need to follow this lead.
- **Ethiopian communiti**es. *Role*: get involved with electrification of your entire community.
- **World Bank**. *Role*: continue supporting Ethiopia's efforts through Ethiopia's Electrification Program (currently over $375

million), and focus funding on renewable energy and mini-grids.

Costs

(Source: *Optimizing renewable-based energy supply options for power generation in Ethiopia*, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0262595)

The chart above was done using an open-source energy modeling systems with a planning horizon from 2020 to 2050. It points out that that if projected power demand increases as anticipated, Ethiopia will be required to expand the installed power capacity to 31.22GW, 112.45GW and 334.27GW to cover the current unmet needs and achieve lower, medium and higher middle-income status by 2030, 2040 and 205 respectively. To do this Ethiopia will need to invest about US $70 billion on power plant investments for the period 2021–2030 to achieve the lower-middle-income electricity per capita consumption target by 2030. (In order to reach upper-middle-income electricity consumption rates by 2050 cumulative investments in the order of US$ 750 billion from 2031 to 2050 will be needed.)

These investments can be financed by:

- The Ethiopian government through its current revenue streams, additional revenue from a carbon tax, non-sustainable/pollution causing business activities tax, elimination of subsidies to all fossil fuel use and other non-sustainable activities, and loads from the African Development Bank, The World Bank and other

loan sources.
- Local communities who can reduce their energy costs by investing in the electrification of their community
- Businesses who can invest in local energy development.
- Foundations and other philanthropic sources whose mission and funding priorities match the needs of Africa for clean, reliable and abundant energy.

Conclusion

The rapid, total-country electrification of Ethiopia using abundant, clean, reliable, and affordable renewable energy sources will have profound impacts on the people, general economy, employment opportunities, educational and health care systems, and well-being of the people of Ethiopia. It will also serve as a model and testing ground for what can be done throughout Africa.

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2. EM-POWER AFRICA

By: Ella Blanco, Sean Bell, Marius Birindwa, Louis Conway, Barry Hunsberger, Zula Oliveira, Imaad Uzun

"Africa is simply tired of being in the dark.
It is time to take decisive action and turn around
this narrative: to light up and power Africa."
- Akinwumi Adesina

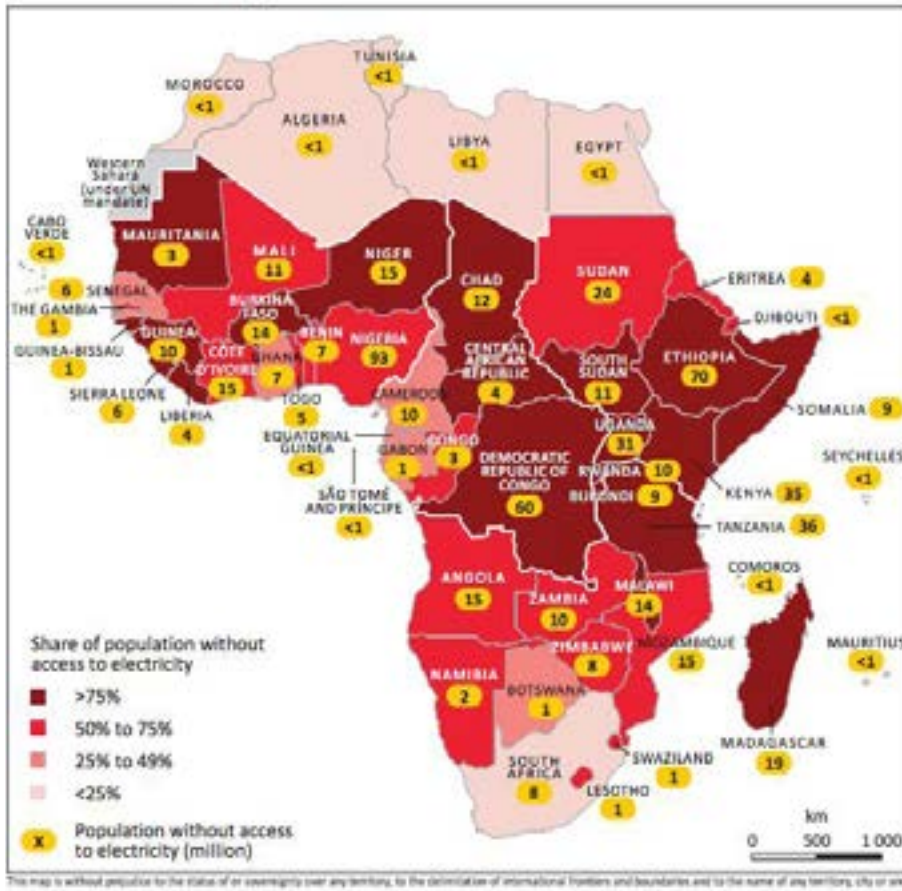
Strategic Summary:

Access to electricity, or the lack of it, affects economic vitality and inequality, health, education, general well-being, and environmental quality in Africa. Out of the almost 1.5 billion people who live on the African continent, over one-third of the population lives without electricity. To address and mitigate these issues, this report looks at both small- and large-scale renewable energy options but focuses primarily on small scale micro-grids as they will impact the most-in-need the quickest and at affordable costs. Africa's lack of infrastructure can be best dealt with by small-scale renewables like off-grid solar and micro-grids, as they are the best option— they are quick, actionable solutions that do not put added pressure on the main power grid. In addition, they build community, are affordable and clean, and can supply the needed electricity from the continent's abundant natural resources.

Introduction

Currently, according to the International Energy Agency, "more than three-quarters of all the people in the world [who] lack access to electricity" live in the African continent. Six hundred million sub-Saharan Africans have no access to electricity and, in addition, a World Bank report finds that sub-Saharan Africa, including countries such as Botswana and Namibia, "represent the world's most unequal region" in terms of income and household inequality. Due to the effects of growing poverty, only 46% of sub-Saharan Africans had access to electricity in 2019--only 13 percentage points higher than in 2010. With climate change threats no longer on the horizon, but now upon us, these countries and their governments must either "navigate a complex, difficult policy environment" or "increase their reliance on renewable energy sources."

Figure 1.6 ▷ Number and share of people without access to electricity by country, 2012



(Source: International Energy Agency, https://www.vox.com/2014/10/13/6970513/africa-electricity-620-million-people-map-gas-coal-solar)

Present/Problem State

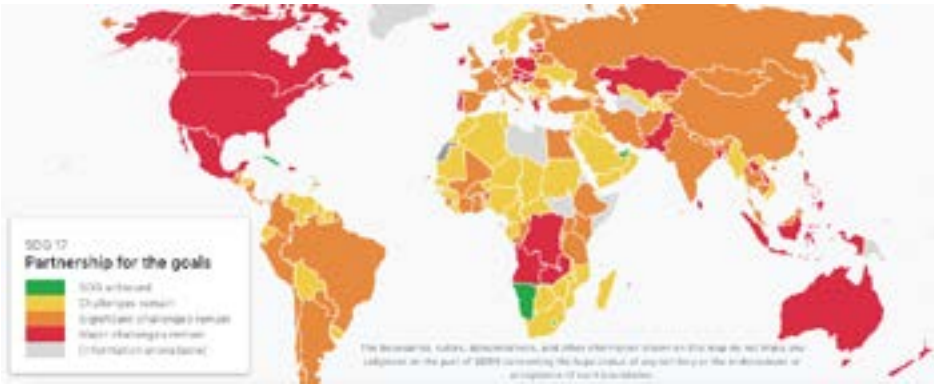
The most pressing problems that the African electricity market faces include:

1. Foreign-owned, private-sector organizations that monopolize the majority of the power sector spending and value short-term solutions that result in immediate profits rather than long-term projects that emphasize the development and well-being of all the citizens of Africa.

2. Sub-Saharan Africa funds only 25% of their own "power sector spending" and the continent's total capital flight, from 1970 to 2018, totals about US $2 trillion ($42 billion per year).
3. An inequitable distribution, control, and use of its natural resources is "among the most central issues for the daily lives of the majority of Africans".
4. Vulnerable, costly and unreliable energy systems, especially in sub-Saharan Africa.
5. Lack of cooperation between African governments, businesses, non-governmental organizations, and communities to accelerate action that gets electricity to poorer communities.
6. Lack of community control, which leads to reliance on weak and insufficient governmental action, or control by corporate entities.

And specific to our case study example:

7. Namibia's drought, new weather trends, and power cuts from Eskom, a South African power company on which Namibia relies heavily, contributes to the country's lack of access to electricity.



(Source: SDG Index and Dashboard Report, https://www.sopact.com/perspectives/sdg17-most-important-sdg*)*

Preferred State

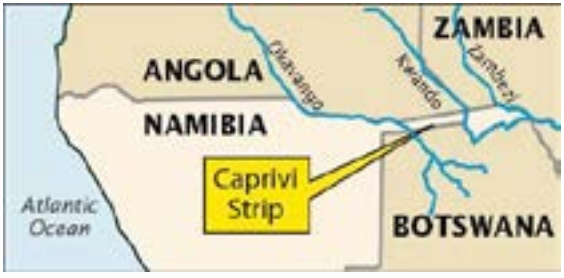
The preferred state that our team envisions works toward a world where all communities in Africa not only possess easy access to clean, reliable, and affordable electricity but also control and have significant ownership of *their* energy system to derive economic benefit. There are five essential conditions needed to accomplish this:

1. Majority domestic—or Africa—owned power sector investment
2. Equitable distribution of Africa's resources
3. Renewable and clean energy sources
4. Trans-boundary cooperation
5. Community engagement, ownership, maintenance, and improvements to their energy systems

This preferred state will be possible if EM-Power Africa's electrical grids are owned by the people of African countries themselves or a transboundary, possibly all-of-Africa, non-profit entity. If communities control how much power they generate and what they use it for, and that energy comes from "their" local solar and other renewable energy installations, there will be a more equitable distribution of power throughout the community and region. In addition, the community needs the power to decide how much of any surplus they give, sell, or receive from a grid connection. With this in place, communities will become increasingly self-reliant and prosperous. This arrangement will also encourage trans-boundary cooperation between communities and regions. In addition, if the communities control their own power, they will be able to continuously improve the most economical, resilient, clean, and adaptive mix of energy available to them, helping to unleash their full economic potential.

Strategy: Case Study Example

Location



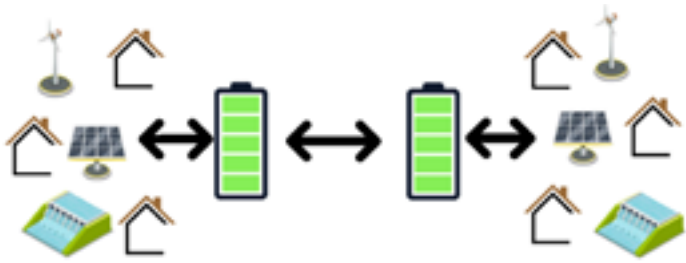
(Source: Adventures of Gandt,
https://adventuresofgandt.com/2022/01/17/crossing-the-caprivi-strip-to-ngepi-camp/*)*

The Caprivi Strip, a panhandle of Namibia that extends to the borders of Angola, Botswana, Zimbabwe, and Zambia, is a good region to prototype and test EM-Power Africa's strategy. There are

approximately 80,000 people living in 11,500 households in the region. Roughly 40% of Namibia's population, 47% of Zimbabwe's population, 28% of Botswana's population, 53% of Angola's population, and 55% of Zambia's population are all without electric power. The Caprivi Strip has a high potential for solar, wind, and hydroelectric generation, and with these resources, the region's internal renewable resource supply is capable of meeting all of its electricity needs. Even though the Strip is geographically remote, it offers a central access point to Namibia's neighboring countries to promote the easy flow of communication, cooperation, collaboration, electricity exchange, and good relations.

Overview

EM-Power Africa's strategy will initiate local electricity production and sharing through its non-profit organization. This organization will help small developing communities become increasingly energy self-reliant and sufficient by the production of solar, wind, and hydro power. The energy generated will be used locally and surplus will be stored in "hubs," — electricity storage locations— which will also serve as the community's connection to the region's microgrid. Once a community is connected to another community through its hub and local grid, it can share its surplus and receive other communities' surplus when in need. When a community has its renewable energy production technology and hub connected to the microgrid (and is then regionally self-sufficient), it will be considered and certified an "EM-Powered Community." The strategy to transform a community into an "EM-Powered Community" focuses on two main aspects: community building and grid building.



(EM-Power Africa)

(EM-Power Africa)

Community Building

A core feature of EM-Power Africa's strategy lies in community building. This is to ensure that control and ownership of the energy system stays within the community.

Before EM-Power Africa can begin its work it needs to find a community thst commits to a strategic vision aligned with EM-Power Africa's regional development and grid vision and strategy. A project of this magnitude, with its goals of community empowerment, cannot function without forming real, working, trusting partnerships in the community and region. It is a recipe for failure to enter a community, initiate a project without a shared vision, using unwanted or not-understood technology, and then leave. A more successful approach is to facilitate a process that empowers a community to realize their full potential as *they* see it.

EM- Power Africa will bring expertise to help evaluate an area and community for what energy source, or combinations of sources and the technology for harnessing them, will be the most effective, given the needs and desires of the community. If an area has a large enough river as well as ample sunlight, for example, EM-Power Africa and the community may determine that the most beneficial sources of energy will be small-scale solar and hydro. Once enough power is generated by a given community, the Energy Hub is built, and every energy user in the community is connected to the Hub, EM-Power Africa will connect communities, via a microgrid, one Hub at a time— thereby, after meeting the electricity needs of the community, selling and distributing surplus energy to other communities.

In addition to helping communities meet their electricity needs, it is also part of the EM-Power Africa vision (and everyone's self-interest) to

help raise the quality of life for everyone in the community. Abundant, affordable electricity access will help with this. Improving existing infrastructure, such as wells, farmland, roads, and other essentials for each community with whom EM-Power Africa works will be important next steps. It is also important for the EM-Power Africa mission to encourage better education and health care and equality of opportunity throughout the community.

Grid Building

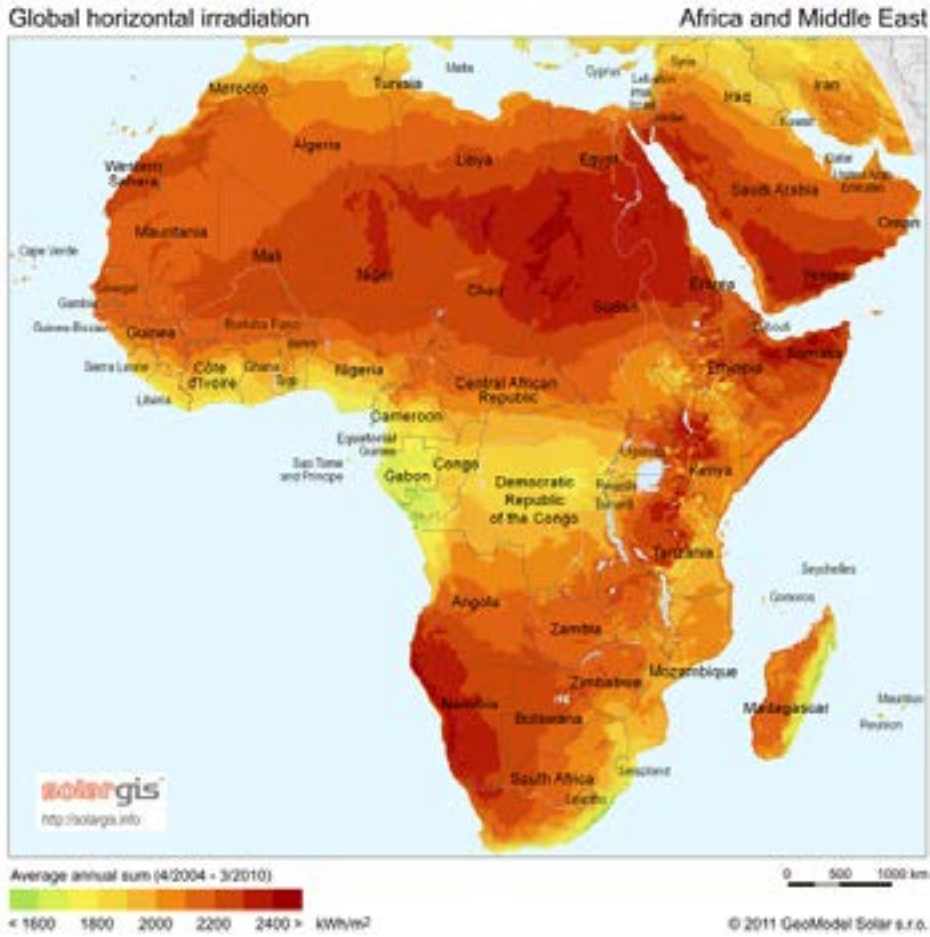
Once the community has been identified and its most efficient and affordable renewable energy source(s) determined, EM-Power Africa's next step is to help the community obtain and install the electricity-producing systems. Using its experience and expertise, EM-Power Africa will buy materials and needed technology, train community members in installation and maintenance, and begin the installations needed to supply the community with the electricity it needs.

Meanwhile, EM-Power Africa would also, with community workers, build the energy storage Hub in the community and the needed links to every household. The first community will be off a regional/multi-community grid. The energy it produces will be linked to the EnergyHub and then back into homes, schools, health clinics and other places the community decides need energy produced by their energy system. Once EM-Power Africa has established one EM-Power Community, and that community's energy production is sufficient to meet the community's needs plus a surplus, EM-Power Africa will repeat the same steps with other communities. Starting with the second community, the community's will be connected via their Hubs. This microgrid will be self-sufficient and independent from the national grid.

Once enough communities have been connected to the regional microgrid, and production is sufficient to meet additional needs, surplus energy will be shared between additional communities. Any additional surplus energy can be sold for profit by the communities, thereby providing communities not only clean electricity but also revenue to meet other needs.

Engineers, and renewable energy experts (possibly from the African Union or area Universities) will be employed by EM-Power Africa and the community to train community members so that they can help with the entire process. When EM-Power Africa is assisting the next

community, there is a growing body of community-based expertise that can solve problems that occur. In addition to maintenance, the engineers will train and educate members of each community on how to be efficient with their energy use. EM-Power Africa's strategy ensures that communities stay independent and are increasingly self-reliant yet linked to one another.



(Source: 'Estimating the Renewable Energy Potential in Africa: A GIS-based approach, https://helioscsp.com/irena-estimates-africas-concentrating-solar-power-csp-potential/)

CAPRIVI STRIP CASE STUDY AND PROTOTYPE

Funding

Providing power to the 80,000 people living in the Caprivi Strip will not be "easy" or "cheap". *Not* providing electricity to this region will be even harder on the local and regional economy and the well-being of people of the region— and more costly.

Part of the EM-Power Africa strategy is to fund its non-profit economic development organization with start-up funds from international foundations and a consortium of the governments surrounding the Caprivi Strip region (Namibia, Angola, Botsana, Zimbabwe, and Zambia). It will also seek funding from the U.S. Agency for International Development and its *Power Africa* program and that program's private sector partners. |

With funding secured, EM-Power Africa will begin its *Stage One* mission, that of initiating a process that brings electricity to every community and the approximately 11,600 households in the Caprivi Strip. [12] *Stage Two* will expand this base to the surrounding countries, and then, at *Stage Three*, scale this effort to the whole of Africa. Sustainable funding will come from a small percentage of the profits that come from the sale of electricity throughout the expending grid.

Funding for the solar panel, micro-scale hydro, wind energy and EnergyHub technology will come, during Stage One, from the resources of EM-Power Africa coupled with affordable investments from the benefitting community. Stage Two and Three funding will come from the sale of electricity through the expanding grid and outside grants and investment.

Additional expenses will involve staffing of EM-Power Africa, outreach and trust-building with each community, training community members as installers and maintenance staff, and ongoing operations.

The following provides a very general overview of initial funding needs:

Item	Per Year*	5 Year Total
EM-Power Africa start-up (staffing, equipment)	$1.5	7.5
EM-Power Africa start-up (energy technology)	$3	$15
EM-Power Africa start-up (community building)	$.5	$2.5
Travel	$.5	$2.5
Total	$5.5	$27.5

* In million $

Timeline

Six months from funding: EM-Power Africa begins working with one or more communities in the Caprivi strip.

One year from funding: The first EM-Power Communities are producing power and meeting the electricity needs of all the households in their community. EnergyHubs are beginning to be interconnected. Within two years, electricity is being distributed between communities. Communities increase their communication and cooperation.

Three years on: Electricity sharing between communities is common practice. Nearly half of the households in the Caprivi strip communities have electricity. EM-Power Communities are receiving income from the sale of their surplus electricity. Working together, the EM-Power Communities have a robust, productive, and reliable energy mix and are expanding rapidly to other communities in the region, including into the bordering countries. Education and women empowerment rise in the EM-Power Communities.

Ten years on: EM-Power Communities and energy sharing between communities is the norm in the four contiguous countries. The EnergyHub network is connecting, via an enlarged grid, into the other countries on the African continent. With the constant integration of new or improved clean forms of energy into the grid, the EM-Power Africa sphere of influence increases the affordable access to water,

food, electricity, health care, and education.

Twenty years on: All of Africa has access to clean, abundant, reliable electricity. Coal and other fossil fuels have been phased out, and the African continent is leading the world in clean energy.

Conclusion

EM-Powered Africa's proposed strategies are an economic and technologically achievable way through which energy-poor communities can become increasingly self-reliant centers of clean and affordable energy. Through cooperation between people, communities, companies, and government, together Africa can reach the United Nations' Sustainable Development Goal Number 7 and ensure access to reliable, connected, and clean energy.

And in conclusion, the words of the newly elected president of Kenya:

> *"We have immense potential for renewable energy, and this abundance of wind and solar energy can power the development of Africa. Rather than trudging in the fossil fuel footsteps of those who went before, we can leapfrog this dirty energy and embrace the benefits of clean power. A transition to clean energy is a no-brainer. It will create jobs, protect local economies, and accelerate the sustainable industrialization of Africa."*
> —William Ruto, President of Kenya

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3. ELECTRIFYING AFRICA: SOLAR MINI-GRID ARE THE BEST ALTERNATIVE ENERGY SYSTEM FOR AFRICA

By Solomon Chafamo Abiye

Strategic summary:

Solar mini-grids are the best clean energy source to address Africa's energy needs. Africa suffers due to the lack of clean energy. Yet, it is also the wealthiest continent in resources to fulfill the energy needs of its people. This report addresses the problem state, preferred state, and alternatives for meeting the need for abundant, clean, and affordable energy. The report focuses on showing how solar mini-grids are the best alternative due to the abundance of sunlight, the nature of habitation of African communities, cost-effectiveness, and ease of fast-tracking. Further, it is proposed that the governments of the African states play a leading role in implementing the project. In addition, a proposed budget for the project is included, along with sample locations for project implementation.

Solar Mini-Grids: The Best Alternative Energy System for Africa

Solar mini-grids are the best option for supplying clean, abundant, and affordable energy for meeting Africa's energy needs. All of Africa suffers from a lack of energy. No single country has been able to meet the energy needs of all its people, much less meet that need with clean energy. Yet Africa is the wealthiest continent in terms of resources to fulfill the energy demand of its people. Africa is also ranked number one globally with its clean energy alternatives. The continent is blessed with several energy sources, such as solar, wind, hydropower, geothermal, biomass, tidal, and wave (El Bassam, 2021). However, having all these alternative energy sources, nearly half of its population, 600 million, live without electricity.

Further, most of the households in the continent depend on polluting, health and environmentally damaging energy sources like biomass, for cooking, which exposes millions to smoke-related illnesses that kill over 7 million people annually, most of them in Africa (Kouao et

al., 2019). According to Kouao et al., over 700 million people in Sub-Saharan Africa depend on unclean cooking energy sources, contributing to too many smock-related deaths compared to the other developing economies. According to Mukoro et al. (2022), the number of households dependent on unclean cooking energy sources in Africa is even higher, 85%. The United Nations estimate brings the number of people lacking clean cooking energy source in Africa to 900 million (https://www.un.org/africarenewal/magazine). The problem of the lack of clean energy issues does not end there. Its consequence is increasingly resulting in far reaching climate change problems that threaten humanity's very existence. The continent is losing its forests faster than any other continent globally because trees are cut down for firewood. Wildlife endemic to Africa is being destroyed due to the unprecedented deforestation rate of forestry for firewood and related energy.

The distributed nature of African settlements are one of the factors that make it difficult for government and other stakeholders to reach everyone in Africa with conventional ways of supplying electricity. More than 85% of the African population are rural dwellers. They live scattered in small numbers, occupying different places in every country. Even though urbanization is increasing at an unprecedented pace, Africa has a long way to go before centralized energy production systems will be able to meet the needs of a centralized population. It will take many years to close the energy gap between urban and rural populations. The solution is not to move rural people to urban areas so they have electricity, it is to bring electricity to rural areas. To meet the energy needs of everyone in Africa governments, business, and communities need to develop rural, and urban, solar mini-grids as an alternative way to provide everyone in Africa with a clean source of abundant, reliable and affordable energy.

The Problem State

Problems directly or indirectly caused or made worse by the lack of clean, reliable, affordable energy include:

- Increased maternal and infant mortality due to lack of electricity at health care facilities
- Smoke related deaths due to cooking with firewood
- Lower life-expectancy in the general population
- Lower access to labor-saving and job-creating opportunities
- Slower economic growth

- Increased workload for women
- Excessive urban population growth due to lack of rural electrification and economic opportunity
- Expensive electricity slows economic growth and social well-being

Preferred State

The preferred state for electricity access in Africa is where:

- 100% of the people, in every country in Africa, have access to clean, affordable, reliable, and sustainable (CARS) electricity.
- Every health care facility in Africa has abundant supplies of CARS electricity
- Every school and educational facility has abundant supplies of CARS electricity
- Every home and community has abundant supplies of CARS electricity
- Economic activity, innovation, employment, productivity, resilience, and growth are accelerated by abundant supplies of CARS electricity
- Pollution, health and environmental issues caused by fossil fuel use and wood burning are eliminated
- Regional cooperation and collaboration are increased to such a degree that they become the new normal.

Strategy for Reaching the Preferred State

Africa has a huge opportunity to meet its electricity needs and reach the above Preferred State. At the center of this strategy for reaching the Preferred State are solar mini-grids.

Why Solar Mini-Grid the Best Strategy for Electrifying Africa

There are four compelling reasons why solar mini-grids as the best strategy for supplying electricity to all of Africa: Accessibility of sunlight, the nature of African habitation, cost- effectiveness, and rapidity of implementation.

Accessibility of Sunlight

Africa gets sunlight most of the year. For more than 300 days a year, most African countries receive an abundance of solar energy (Ahmed et

al., 2019). The World Sunshine Map confirms that Africa receives more sunshine for more days of the year than any other continent in the world. This huge resource was considered a hindrance to development in Sub-Saharan Africa and remained unutilized. Solar energy's ubiquity and the rapidly decreasing costs of harnessing it to produce electricity makes this the best possible option.

The Nature of African Habitation

African ways of habitation are unique. Tribal communities live side by side in a very diverse manner. The scattered nature of the African living habitation structure makes it difficult and expensive for supplying electricity via "conventional" electricity provision methods (fossil fueled centralized power plants and large electric grids). These methods are more suited for concentrated population centers. Dahunsi et al. (2020) noted in support of this view that "Considering the highly dispersed nature of most rural settlements across Africa, grid connection and subsequent electricity supply are technically difficult and expensive" (p.2). Ulsrud et al. (2015) indicated solar energy's importance in bringing energy justice to dispersed communities. The writers noted that "solar power and other decentralized off-grid electricity systems at the village level may potentially provide sustainable electricity supply to a variety of users in a more democratic way" (p.34). Thus, considering the dispersed nature of settlements in rural Africa, the off-grid solar energy source is the best option.

Cost Effectiveness

Cost-effectiveness is another important aspect of solar mini-grids. The upfront cost of solar panels is high for poorer African households, but low labor for installation and repair makes it easier and more affordable for low incomes rural communities over time. The disperse nature of African rural communities make it challenging to cope with the cost of distributing electricity from the large-scale power plants. Ahmed et al. (2019) noted that "utilizing solar energy to electrify rural communities is cost-effective and feasible as the technology can be instantly used to supply households that cannot be linked to the grid" (para.9).

A household using a solar system of 20 W costs around USD $225 and of 1 KW costs between USD $725 and $1270 per year, whereas a hypothetical un-electrified household spends about USD $84 to $270 per year to fulfill energy needs such as kerosene lamps, candles and batteries.

According to the above hypothesis, the amount of money spent on unclean energy sources is more than the cost of the solar, either immediately, or when viewed in a few year's time frame. If we take $270 as a threshold, the non-solar alternatives are $45 higher or 20% more expensive than 20 W of solar energy. Supplying 1 KW of solar will take about 2.5 years of supplying no-solar energy. These costs do not include the negative externalities delivered by non-solar energy—the costs of the time spent collecting, purchasing, and using non-solar energy, plus the negative health impacts of using traditional unclean energy sources. The cost-effectiveness of solar mini-grids, when all the costs of non-solar energy use are counted, are compelling.

It Takes a Short Amount of Time to Utilize

Solar mini-grids take very little time to implement as long as technology is available. A solar mini-grid is a viable, quick to deploy, cost-effective energy alternative. On the contrary, mega projects like huge solar parks, off-shore and on-land wind farms, hydro-electric dams and other energy sources take a longer time though they have advantages when it comes to usage for fulfilling industrial energy needs and large-grid energy needs of urban centers. For example, some countries in Africa seem determined after developing large energy producing power plants, to export electricity to neighboring countries and get income, rather than meeting the electricity needs of many of their rural populations. There is definite mis-match between large, centralized energy plants the needs of rural people, and the lack of a grid that extends to each rural location.

Currently, Ethiopia is building a mega dam, the Great Ethiopian Renaissance Dam (GERD), which is the largest in Africa as well as one of the largest in the world. Once completed, it is expected to supply energy to neighboring countries and meet some of the needs of Ethiopia (Blackmore &Whittington, 2008). Given the long development times, such mega-size energy projects are not a good solution for saving the millions living in energy poverty or dying due to a lack of clean, affordable energy.

Solar mini-grids are the best alternative to address the energy needs of the people of Africa in a short period— as well in an affordable, reliable and community-building manner.

Figure 1
Example Solar Mini-grid

Off-Grid solar energy at Wayo Atingagorme, a remote Island in Ghana. Photo by: John Deyegbe/Resolution Ltd.

What Needs To Happen
What Governments Need to Do

Solving the problems of African nations is one of the responsibilities of the continent's government leaders. People elect leaders to help them with collective economic, social, political, health, education, and other problems that hinder human well-being and progress. The issue of electrifying Africa is a topic that needs all of Africa working together. Full government representation and participation is needed. Dagnachew et al. (2020) indicated the importance of creating synergy between stakeholders to meet the 2030 sustainable development goal (SDG). Working towards addressing the need of clean cooking energy sources will improve "child health, (SDG3), reducing greenhouse gas emissions (SDG13) and reducing deforestation, land degradation and biodiversity loss (SDG15)" (Dagnachew et al., 2020, p. 11).

The governments of all African countries need to collaborate on meeting the energy needs of all of Africa. Among the actions needed by such a collaborative effort are:

- Setting a collective, Africa-wide priority for meeting the energy needs of the poorest segments of Africa society, in as short a time as

possible, which is only eight years away from the years 2030 SDG,
- Developing and implementing collective action plans for doing this,
- Working with NGO energy organizations, investors, and energy corporations, as a unified group (including seeking financial resources from international donners, the World Bank, International Monitory Fund, European Union, United States, and other developed countries, etc. to support financing the solar mini-grid initiatives), and
- Setting up and empowering an independent, all-Africa, corruption watchdog organization that makes sure there is no corruption in the implementation of the electrifying Africa program.

What the International Community, Private Investors and NGOs Can Do

International actors and NGOs can play an essential role in helping to meet the energy needs of Africa. Still, unless they collaborate with governments, their role will not be as effective as is needed.

The international community should not be the leading actor. Africa's problems need to be solved by the people and leaders of Africa. The "outside" can play the important role of empowering African-led initiatives with financial investments (not ownership), technology-sharing, and experience, but not in initiating them.

There are more than enough benefits in getting Africa all the energy it needs to be a productive, wealthy, healthy, creative force in the world— as well as the result that Africa's use of clean energy is beneficial to a greener and cleaner world.

African governments delegate substantial development activities to NGOs (Amankwah-Amoah, 2015). It is essential that governments have a mechanism that utilizes NGOs and private national and international developers in electrifying Africa. As Amankwah-Amoah (2015) stated, state-led NGOs can play a significant role in the process of quickly electrifying Africa.

Costs

Based on current cost factors, Table 1 shows the amount of money needed for bringing electricity to differing number of households and countries in ten countries in Eastern Africa.

Table 1

The Cost Estimate to Electrify Ten Countries in East Africa via solar mini-grids

No of countries will be covered	Timeline	Number of people /annual/country	Total Cost/customer	Total cost/year/ country	Total cost/year / ten countries	Total cost/ ten/ten counties
10 countries	2023-2033	100,000/country	$1000/customer	$1million dollars	$100 million	$ 1Billion dollars

NOTE: The following is only relevant is the Table is dealing with solar mini-grids): The above chart indicates that supplying electricity from solar mini-grids will cost $1,000 per customer. Assuming that there are 84 million "customers" (500 million people without electricity in 83 million families of 6 people each), the total cost for getting electricity to the people of Africa's without electricity is $84 billion. Meeting the energy needs over a 5-year period will cost $16.8 billion /year. Over a ten-year period, the cost will be $8.4 billion/year.

Funding Source

Local resources, and therefore local control, needs to be the main funding strategy for funding the solar mini-grid initiative. African governments can play a major role in funding solar mini-grid clean energy projects, as long as the project is "owned" — meaning designed, operated, maintained and where any profits, if there are any, go. Revenue for this funding can come from a carbon tax and fossil fuel subsidies that are re-purposed for the solar mini-grid initiative. Governments can set up the solar mini-grid program so that local business owners and recipients of the electricity from the solar mini-grids cover a small percentage of the costs through the money they will be saving by using the energy from the solar mini-grid instead of paying for kerosene, candles, cooking fuel, etc. This payment is intended to provide a real sense of ownership of the solar installation.

When governments are committed to addressing the lack-of-energy problem with a genuine project such as the installation of solar mini-grids at scale, the people of Africa and the resources to which they

have access can be enough to support a project contributing to their community's well-being. One example of this is the Great Ethiopian Renascence Dam (GERD). The GERD is a mega project fully funded by Ethiopian communities. It is an example that African people can develop their countries through their resources.

The main thing African governments need is a workable strategy and listening to their people. They need to trust the potential in their people to build even mega projects like the GERD. The government should create a proper and workable tax system to reach this goal. It is also essential to encourage philanthropic habits in countries where people should be encouraged to develop their countries.

Proposed area of Implementation

Ten counties in East Africa can be used as a getaway for the all-Africa project of solar mini-grid implementation. The countries include Burundi, Kenya, Rwanda, South Sudan, Sudan, Tanzania, Uganda, Somalia, Eritrea, and Ethiopia. The areas proposed are those in green in Figure 2 below. To achieve the Preferred State in these areas it is critical to work closely and in collaboration with all stakeholders, create a dependable local workforce; mobilize and educate local communities to create awareness to play a role and fully own the projects; and to create R&D centers to manufacture solar panels locally.

Figure 2

Selected countries in East Africa to first implement the Solar Mini-grid Project

Conclusion

The purpose of this paper is to document that solar mini-grids are the best alternative clean energy source to address Africa's energy needs. Africa is the one of, if not the wealthiest continent resources-wise, yet more than half of its inhabitants suffer due to a lack of clean energy sources. Access to sunlight and solar photovoltaic panels is more than enough to address the continent's energy demands. Having abundant sunlight, cost-effective energy-harnessing technology that is in sync with African patterns of habitation, the governments of Africa can address the continent's energy needs. Further delay, and not saving the millions dying every year due to lack of clean energy, is irresponsible. African governments need to work together to meet the needs of Africa, and to negotiate with the international communities to help fund the electrification project.

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4. ELECTRIFYING AFRICA THROUGH HEALTHCARE: PHASED ACCUMULATION OF SOLAR POWER PRODUCTION

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Strategic Summary

Health and healthcare are compromised when there is no, inadequate, or unreliable access to electricity. Electricity is required for the proper function of medical equipment, refrigerator storage for vaccines, and air circulation systems. Without reliable and safe electricity, services like childbirth, emergency care, and vaccinations cannot be confidently provided at local healthcare facilities[1]. In Sub-Saharan Africa only 40% of the healthcare facilities have access to electricity[2]. This lack of electrification mirrors the availability of electricity in Africa's general population. The nearly 600 million people without electricity in Africa are nearly all located where health clinics are not electrified[3,4]. The strategy in this report presents a design and plan for not just electrifying all the health facilities of Africa, but the surrounding homes, shops, schools, and other non-electrified parts of Africa. It does this through a modular, phased implementation of solar panels and control systems connecting the surrounding community.

Introduction

In 2018, only 40% of health facilities in Sub-Saharan Africa (SSA) had access to electricity[2]. Of those, just 28% have had reliable access—with power being unavailable for up to 540 hours per year across the entire region[2]. A few leading causes of low electricity access include inequitable distribution across Africa, inadequate buy-in from local and federal governments, and poor infrastructure.

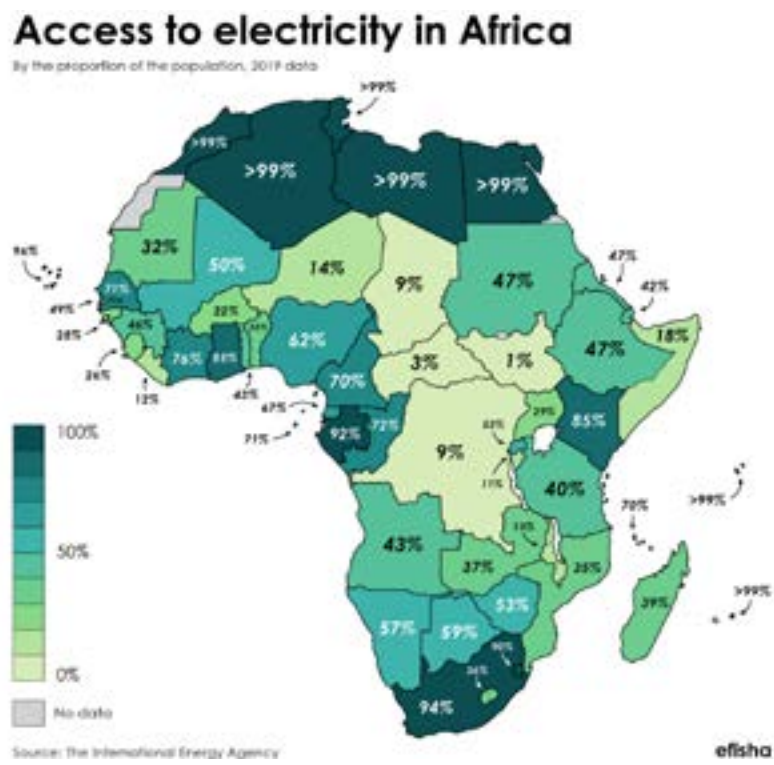

Figure 1. *Access to electricity in Africa by country. Countries in North Africa, as well as Gabon, South Africa, and outlying islands have high access rates. Landlocked countries and those with expansive rural areas experience lower energy access*[3].

In SSA, there are large disparities between urban and rural areas in per capita consumption of energy. Those residing in cities most often have better access to reliable, affordable, and modern forms of energy compared to those in rural areas. North African countries and South Africa experience the highest rates of electricity access (Figure 1), with more than 99% of the population having access in Morocco, Algeria, Tunisia, Libya, and Egypt and 94% of the population having access in South Africa. Countries with more rural areas, such as Niger, Chad, Central African Republic, Democratic Republic of the Congo, and South Sudan have greatly lower electricity access rates (Figure 1). The average person living in SSA consumes as little as 200 kWh/year of electricity[2]. In North African countries and South Africa, the

average electricity use per person is 1,442 kWh/year and 4,148 kWh/year, respectively[2]. In rural areas of SSA, electricity use can be as low as 50 kWh/year per person, just enough to charge a mobile phone and power minimal lighting for a few hours a day[2].

Almost 50% of African countries do not have an officially approved electrification plan[4]. Energy access is a complicated goal to achieve, as access alone cannot be a stand-alone objective. Countries need to be looking to achieve a productive use of electrification[4]. Oftentimes, and especially in rural areas, this requires investment in other infrastructure at the same time as energy and electricity. This makes energy investment even more expensive, labor intensive, and time consuming for governments. The countries in Africa that have produced an electrification plan have reported success in improving their national electricity access rates, attributing this to a thought-out strategy that addresses institutional, technical, and financial aspects of electrification[3]. Nevertheless, at the midpoint of the United Nations' Sustainable Development Goals, 600 million people in Sub-Saharan Africa are without access to electricity[5].

The energy sector comprises several areas—generation, transmission infrastructure, distribution, operational management, etc.—and each of those areas must receive financial investment and strategic framework in order to equitably and sustainably improve the energy situation[4]. In addition to the physical infrastructure of the energy sector, there are several complementary factors that, when properly invested in, will increase the viability of an energy system, and translate electrification into jobs and higher incomes. While support and modernization of large and informal economies surrounding energy and investment in skills is helpful to the sector and general public, it may not be a prerogative for private investors and not financially attractive for governments[4]. While governments may invest money in electrification via the private sector, not enough governments invest time into enabling the business environment and sustaining a proper political environment for electrification.

It is important for governments to invest time and money into electrification and its complementary factors due to poor existing infrastructure in many African countries. It is common that power connections are informal, as a lot of people cannot afford to pay for electricity[2]. Low financial influx from customers results in missed revenues by the local power suppliers, creating an unreliable business

environment in the energy sector. Due to unreliable buyers and high costs of replacing infrastructure, final end users (healthcare facilities, businesses, and homeowners) see increased costs of electricity[2]. Increasing access to electricity across Africa is difficult due to irregular household income, high connection charges, tedious application processes for energy infrastructure, and issues with structures that do not meet the requirements for connection to the main grid[4].

Electricity access is important in creating a healthy economy and living environment. Lack of electricity creates constraints on economic activities, public services, adoption of new technologies, and quality of life[5]. In the healthcare sector, limited access to electricity restricts continuity in medical operations, the storage of vaccines, operation of medical equipment, as well as other essential medical tasks[2]. According to the World Bank, energy access is defined as the "ability of the end user to utilize energy supply that is usable for the desired energy services"[2]. Simply, users should be able to use power when they want to and only pay for what they use[5].

Figure 2. *A healthcare clinic in Tanzania. The clinic was renovated in 2009, as it previously had no electricity, no water, and no toilets. Medical waste was burned outside the clinic, and the nearest water source was five miles away*[6].

Preferred State

The authors of this report want to see a world where 100% of healthcare clinics and hospitals in Sub-Saharan Africa (SSA) have access to *clean, reliable, affordable, and abundant energy.* While it should be a goal for all sectors in all countries to have equitable access to energy, the focus of this report will be on the healthcare sector in SSA. The energy system implemented to address the needs of the healthcare sector will be:

- Built from materials easily sourced in the operating country,
- Owned by the local community,
- Delivered with training on operation, maintenance, and troubleshooting.

The energy system will also be designed to address the systemic barriers that have kept Africa from equitable access to energy.

Strategy

To address the need for electricity in the healthcare sector, the government, private sector, and healthcare facilities need to implement energy systems that stimulate investment, integration of technology, and holistic community well-being and growth. The strategy proposed here focuses on cost-effective, phased developments that grow with a community's identified needs and capacities. There are many electrification projects that occur across Africa that supply a large amount of energy over one or two project phases. These projects may over (or under) estimate the amount of electricity needed by a community, as areas in rural Africa do not have many devices requiring electrification (since it is not often available). However, the healthcare facility would obtain—and benefit from—such devices if electricity is available. Focusing on supplying small amounts of electricity in phases to communities will facilitate greater change across Africa, faster, in a way in-tune with economic development and needs, and in a more cost-effective manner.

A sustainable strategy that supplies clean, not fossil-fuel based, electricity would begin with targeting communities with identified needs, existing healthcare infrastructure, and appropriate geographic conditions for solar systems. The strategy builds upon and partners with one or more Non-Governmental Organizations (NGOs) in the surrounding areas, leverages current infrastructure, and develops additional opportunities for local residents and business owners. The strategy will be tailored to the characteristics of the operating areas

in order to provide the best results for each partner community. The strategy focuses on solar energy providing electricity to healthcare facilities, although the general idea and principles can be used with wind, hydropower, and other green electric systems. The strategy, the *Solar Growth System* (SGS), has five stages: Community Assessment, Stand Alone Systems, Micro-Grids, Mini-Grids, and Distribution.

Figure 3. The systematic, cyclic strategy of the *Solar Growth System* (SGS).

Community Assessment

The Community Assessment stage (Stage One) requires the implementing entity—whether it be a large NGO, the local or federal government, an international organization, a self-organized community, or healthcare facility—to complete a full evaluation of the target healthcare facility and community. This would include but is not limited to understanding current energy systems and access, current and future energy needs of the community, current infrastructure, community leadership and access to capital, and where necessary, the politics of the area.

Developing an energy system that can provide a rural African health

facility with enough electricity to power the needs of 100 hospital beds, heavy duty lighting, and hundreds of electric medical devices might be a good goal but is not in line with the current medical infrastructure of a typical rural clinic in SSA. Clinics in rural SSA are often open-air, have few electric devices, capacity for just tens of patients, and only a few medical staff. Clinics in different geographical areas may serve different quantities of people and some may currently have some energy access—which needs to be evaluated for integrity, reliability, affordability, and safety. Technology and material availability needs to be assessed, taking stock of where parts can be sourced and ensuring local businesses will benefit. Sophisticated parts (for large solar systems) will most likely not be immediately available locally, but the community assessment stage will assess the business environment for its ability to grow to procure and sell these parts and materials. After taking into account these characteristics, the implementing organization will be able to confidently develop a successful electrification plan for the healthcare facility and surrounding community.

Stand-Alone Solar System

Stage Two (Figure 4) of the *Solar Growth System* (SGS) is to construct a stand-alone solar system for the clinic for whom the Community Assessment has been done. After considering the current and anticipated energy needs and aligning these with available funds, the first modular system is built. It could consist of just one solar panel on the ground, one battery, and a simple control system. When the clinic's energy needs grow or it secures more funds (or both), the health care facility can begin to upgrade their solar system. By adding one or two solar panels, followed by more batteries and upgrading the control system, the system will grow to accommodate greater energy needs while becoming more sophisticated. The SGS strategy considers systems under 1 kW, or three 380 W solar panels, to be stand-alone systems. During this stage, the clinic will be able to power handheld devices, or up to 60 light bulbs for a period of a day[7].

Figure 4. *An example of a maximum capacity stand-alone system. The solar panels will be placed on the ground. The control system and batteries would be nearby, in a protected and shielded area.*

The implementing organization will provide technical support and training to the clinic staff on how to set up and maintain their Solar Growth System. Eventually, the system's technical requirements (regarding maintenance and safety) will grow to be greater than the clinic staff can support. At this point, the implementing organization will provide technical support to the Stage Two communities. It will provide training to the needed number of local community members to maintain the system. Once trained, the new "Solar Mechanics'' will be supported financially by the clinic (funded by their own revenue sources, government, or private funding).

Micro-Grid

As the clinic's energy needs grow, they will continue to upgrade their *Solar Growth System* (SGS) at their own pace (dependent on their energy needs and funds). Eventually the system will reach micro-grid status. This is an energy system producing between 1 kW and 5 kW, using up to 15 380 W solar panels. The Micro-Grid is Stage Three (Figure 5) for the SGS. A 5 kW system can power basic appliances, like a washing machine, air conditioner, fridge, water heater, oven, and TV[7]. A 5 kW system is satisfactory to power a four bedroom household in the United States[7]. At this stage, the micro-grid will require more control devices, like a transformer, due to the higher voltage and current in the system. With this growth, clinics will have the ability to add solar generators. The solar generators will be connected to the solar grid and be stored to

use in case of overload. The batteries will be upgraded to a battery array. As the solar panels increase in number, they will be moved to the roof of the clinic.

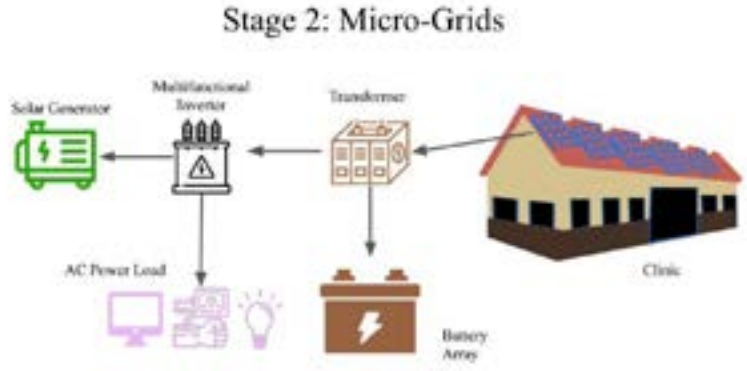

Figure 5. *An example of a micro-grid system. The control system will be upgraded to more sophisticated components that can support higher levels of energy. A solar generator can be added to increase the system's capacity during outages.*

The solar generators, control devices, and upgraded batteries will result in a more sophisticated system. A solar generator is a single device (with solar panels, battery, charger, and control devices) that can capture, store, and distribute energy. Solar generators allow for mobile energy production (and direct connection to a solar grid, depending on the model) in the event of grid overload or outage. If there is a greater need for energy one day, reduced level of sunlight, or damage to the main solar grid, the healthcare facility will be able to function as normal. Solar generators are also portable; in the event of a disaster, they can be taken into the field to perform healthcare services.

Mini-Grid

In Stage Four (Figure 6) of the *Solar Growth System* (SGS), the system will reach its maximum energy production of 25 kW and be considered a mini-grid. The cyclic process will continue, adding equipment until it reaches this maximum capacity. At this point, the clinic will have the ability to power tens of medical devices, a large air conditioning unit, lighting, computers, and provide power to outlets. A 25-kW system has enough power to fulfill the requirements for a medium-sized commercial business in the United States[8] At this point, the clinic will have a surplus of energy, even at their full patient capacity.

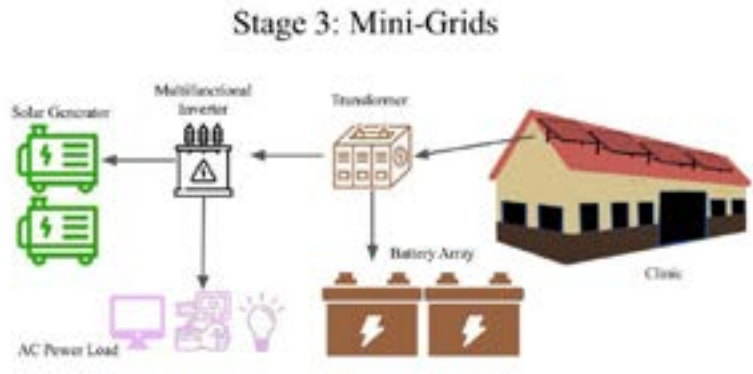

Figure 6. *Stage Four of the SGS, encompassing a mini-grid system. From the micro-grid, additional batteries and generators are added to increase the capacity of the system. This is the highest production capacity of the SGS.*

Distribution

The fifth and final stage of the SGS is Distribution (Figure 7). At the three major production phases of the SGS—stand-alone system, micro-grid, and mini-grid—surplus energy will be available. The first occurrence (and quantity) of surplus energy will depend on the clinic's energy needs and use. Energy that is collected at the clinic—and exceeds its needs—will be sold to the nearby community. The clinic can distribute energy either through direct connection or portable batteries. The revenue generated from selling electricity can be applied to loans or put towards future purchases for the expansion of the Solar Growth System.

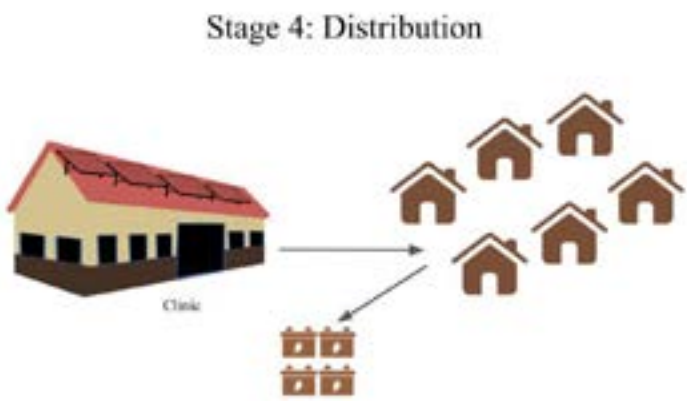

Figure 7. *Stage Five of the SGS, distribution of electricity. Distribution can occur either through direct household connection or the sale of portable rechargeable batteries.*

Costs

The cost of the stand-alone, micro-grid, and mini-grid systems are $2.61, $2.38, and $2.15 USD per watt respectively (see Appendix A for details). The cost measures what it takes to implement the system compared to how much energy is being produced. In the United States, the average cost per watt of a solar system in 2023 is $2.95 USD[9]. This cost is before rebates and incentives and includes installation costs. The costs of the SGS do not include installation estimates.

The cost of solar panels, and therefore solar systems, are decreasing (Figure 8). The cost of the three stages (stand-alone, micro- and mini-grid) included in the SGS were calculated using figures (as many as possible) from African countries, mostly South Africa. This gives a more accurate estimate of the cost of implementing the SGS in Africa, represented in US Dollars. The costs will vary from country to country, depending on the economic climate and availability of solar resources.

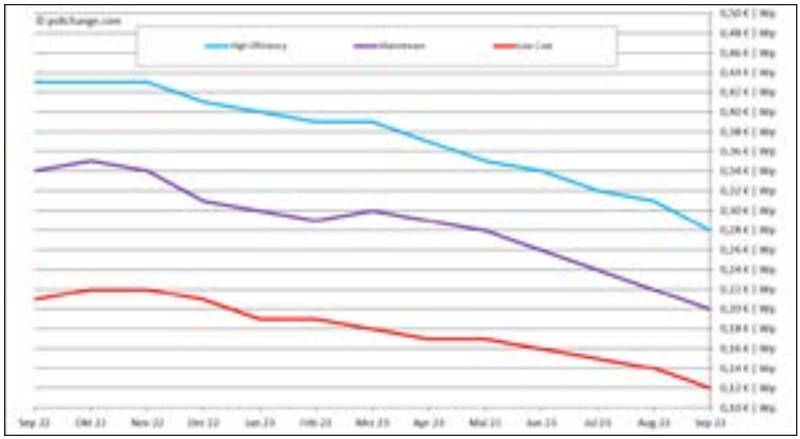

Figure 8. *Solar panel price falling, with no end in sight[10]. Price per watt produced, in euros, from September 2022 to September 2023.*

When the healthcare facilities have excess energy, they can choose to sell their electricity. Electricity can be sold either to the local community or back to the main grid (if there is a direct connection or ability to accept solar batteries). If sold in packages of 1, 10, 100, and 1,000 kWh in a pay-as-you-use model, the surrounding community would have access to electricity and the healthcare facility would generate funds for reinvestment in their SGS. Charging a cell phone uses 0.02-0.06 kWh, and a 60-watt LED light bulb requires only 10 kWh for an entire year (using for 3 hours a day)[11], community members in rural areas would not require a large amount of energy at the introduction of the *Solar Growth System*. However, the SGS acts as a catalyst for the introduction of electricity, electric devices, and economic growth, and the energy needs of the community can only be expected to grow.

In the United States, if electricity is sold back to the grid, consumers can expect a profit of $0.10-$0.30 USD per kWh sold[12]. Applying this to the *Solar Growth System*, if the healthcare facility sells 10,000 kilowatt-hours of electricity, or 10 kWh to 1,000 beneficiaries, they will generate enough revenue to repay a loan for a stand-alone system ($1,000-$3,000 USD). By selling 100,000 kWh of electricity (100 kWh to 1,000 beneficiaries), the clinic will generate enough revenue to purchase all of the technology needed to upgrade a micro-grid to a mini-grid ($30,000 USD), with the exception of solar panels (which will cost $23,100 USD for 70 panels, see Appendix A).

Conclusions

Electricity access is crucial for healthcare. It allows for the proper function of medical equipment (like ventilators and incubators), refrigerator storage for vaccines, computers, and air circulation systems[1]. Without reliable and safe electricity, services like childbirth, emergency care, and vaccinations cannot be confidently provided at local healthcare facilities. At least 912 million people across Latin America, the Middle East and North Africa, South Asia, and sub-Saharan Africa are served by healthcare facilities with no access to electricity or an unreliable supply[2]. Non-hospitals, like clinics, only require energy systems of around 15 kW or greater to power the most basic equipment[1]. Taking advantage of small-scale technology to energize these facilities before the grid reaches them is the most resilient way to improve lives.

In the current state of Africa's electrification plans, 1 billion people will gain access to electricity on the continent by 2040[2]. However, with population growth, harsh economic conditions, and other factors, it is possible that the current efforts will be outpaced[2]. The number of people without access to electricity could *increase* by 600 million by 2040, with Africa being home to 75% of the world's population without energy[2]. Implementing sustainable and resilient electrification strategies is a way to take effective and quick action. Small healthcare clinics require electricity for lighting, small medical devices, refrigeration, and charging. Energy production for these uses can be achieved through small-scale systems, before connecting the clinic to the main grid (Figure 9)[2,13].

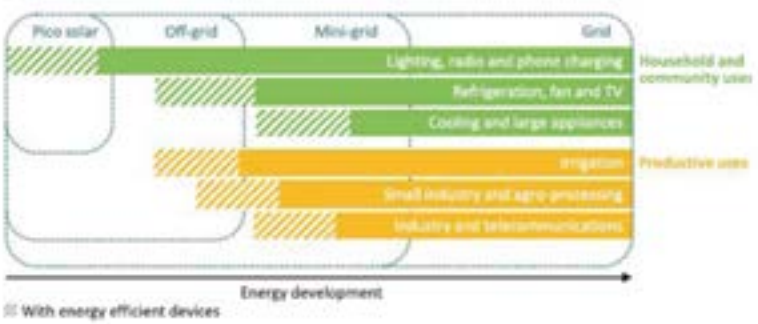

Fig. 1.7 Means of electrification and their possible uses. *Source* © OECD/IEA 2017 World Access Outlook (World Energy Outlook Special Report). IEA Publishing

Figure 9. *Means of electrification and possible uses*[13].

Providing electricity to households and areas of small businesses have many short- and long-term impacts. In the short term, electricity brings social impacts (such as education, health, communication, and economic opportunities) as well as opportunities for micro-, small- and medium-sized businesses. In the long term, electrification brings a new level of human development and economic transformation[3]. Providing electricity to both healthcare and their surrounding communities is a winning strategy for all—a cost-effective two-for-one move that electrifies Africa, increases health outcomes and economic vitality while meeting real needs without fossil fuel use and minimal environmental impact.

Appendix A: Costs for the Solar Growth System

The following is the compiled costs for the three stages of the *Solar Growth System* (SGS). The costs (where possible) were sourced from African countries, to give the most accurate estimate of cost to implement. Due to less availability, the price of components in Africa is typically higher than in North America or Europe.

The control system for each system considers the following in the price estimation:

- Stand-Alone System:
    - 1 kW 24VDC Inverter ($375 USD)[14]
    - 1 kW 24V 30A Lithium Battery Solar Charge Controller ($329 USD)[15]
    - Wiring ($100 USD, estimate)
- Micro-Grid
    - 5 kW 48V Multifunction Inverter (19,000 ZAR or ~$1,020 USD)[16]
    - 5 kW 120V 30A Lithium Battery Solar Charge Controller ($879 USD)[17]
    - 5 kW Transformer ($329 USD)[18]
    - Wiring ($100 USD, estimate)
- Mini-Grid
    - 30kW Inverter ($3,725 - $6,000 USD, assume a mid-range cost)[14]
    - 20 kW 220V Lithium Battery Solar Charge Controller ($2,459 USD)[19]
        - Pricing for 30 kW model not available

- 20 kW Power Phase Converter ($3,500 USD)[20]
- Wiring ($100 USD, estimate)

Note that a standard 30A (12V or 24V) Controller sells for 900 ZAR (~$50 USD) in South Africa[21].

The following batteries were selected as examples, using a desired capacity of double the production capacity:

- Stand-Alone System:
  - Vestwoods 12V 200Ah 2.4kWh LiFePO4 Battery (15,755 ZAR or $820 USD)[22]
- Micro-Grid
  - REVOV 2nd LiFe 200Ah 10.2kWh 51.2V LiFePO4 Battery (50,747 ZAR or $2,640 USD)[22]
- Mini-Grid
  - Freedom Lite Business 60-48 Lithium LiFePO4 Battery (411,541 ZAR or $21,420 USD)[22] or, for a more economical option, 5-6 10 kWh batteries.

Stand-Alone System (1 kW):

Item	Quantity	Unit Cost (USD)	Total Cost (USD)
Solar Panels (380W)[23]	3	330	990
Control System[14,15]	1	804	804
2 kWh Battery[24]	1	820	820
Total (USD)			2,614
Cost per Watt (USD)*			2.61

*Cost per watt of the 1 kW system is the total cost divided by 1,000 watts.

Micro-Grid (5 kW):

Item	Quantity	Unit Cost (USD)	Total Cost (USD)
Solar Panels (380W)[23]	15	330	4,950
Control System[16,17,18]	1	2,328	2,328
10 kWh Battery[22]	1	2,640	2,640
Solar Generator[24]	1	2,000	2,000
Total (USD)			11,918
Cost per Watt (USD)**			2.38

**Cost per watt of the 5 kW system is the total cost divided by 5,000 watts.

Mini-Grid (25 kW):

Item	Quantity	Unit Cost (USD)	Total Cost (USD)
Solar Panels (380W) [23]	70	330	23,100
Control System[14,19,20]	1	10,922	10,922
10 kWh Battery[22]	6	2,640	15,840
Solar Generator[24]	2	2,000	4,000
Total (USD)			53,862
Cost per Watt (USD)***			2.15

***Cost per watt of the 25 kW system is the total cost divided by 25,000 watts.

Endnotes

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5. ELECTRIFYING HEALTH CLINICS IN DEMOCRATIC REPUBLIC OF CONGO

By Nicholson Thamba Vuadi, Yves Thamba, Augustin Phambu, Blessing Nguama, Peter Kamango, Clayton Nzau, Isaac Tembo, Mysterdie Nzinga.

Strategic Summary

Health and healthcare are compromised when access to electricity is absent, inadequate, or unreliable. The World Bank estimates that 2.3 billion [(1)] people worldwide are served by health facilities with no or reliable electricity, affecting their ability to provide adequate health care. About 675 million [(2)] of these people live in Sub-Saharan Africa. The problem is particularly acute in rural and remote areas, where health facilities are often far from the central electricity grid.

By using solar energy, our solution harnesses abundant and sustainable renewable energy sources, including reliance on limited fossil fuels. The Health Center Electrification Project will be implemented in a rural area of the Democratic Republic of Congo, in the village of Ndingi. This region is characterized by limited access to basic infrastructure, including reliable electricity, which hampers the delivery of quality health services. The strategy promotes sustainable development and improved health service delivery across the region through the provision of electricity via solar energy systems, as well as energy efficiency measures, capacity building and community engagement. This approach ensures long-term benefits for health care providers, patients and the community at large, while contributing to better health outcomes and environmental sustainability.

Problem State

Health clinics in Africa without access to reliable electricity significantly hampers the ability of a clinics to provide essential medical services. More specifically, electrifying health clinics leads to:

- *Better, more comprehensive provision of health care*
  Many medical devices, such as incubators, diagnostic machines and life support systems, require a stable power supply. Without electricity, these essential tools cannot function, limiting the quality of care. Vaccines and some medications must be stored at

specific temperatures. Reliable electricity is needed to maintain refrigeration systems.

- *Operational Efficiency*
  Clinics can operate beyond daytime hours, providing emergency services and critical care 24 hours a day.
- *Working environment*
  A well-lit and adequately supplied clinic improves working conditions.

The symptoms of this problem include ineffective, inefficient and lower quality healthcare, potential life-threatening cases becoming worse, and more deaths. If there is a lack of electricity there is a lack of resources available for medical interventions that those in need would use to survive and/or increase their quality of life.

This can be measured by the number of deaths per year in comparison to other countries with electrified health clinics. Clinics that have the most recent and up-to-date technology and resources have better health outcomes that clinics with less.

The symptoms of the problem also include lack of electrification and power outages. The later causes critical medical equipment to shut down, delays surgeries, diagnostic tests, and other critical health services that need electricity to function. All this impacts patient survival, health outcomes, and the overall economic well-being of the community.

Our Team's experience living in Africa has enabled us to see this reality firsthand. We live in Africa, and it is a daily reality that our local clinics face.

This problem impacts over a billion of people throughout the world, but it is most severe in Africa. It also affects their friends and family overseas, as un-electrified health clinics lowers the quality healthcare and leads to additional deaths.

The World Bank estimates that 2.3 billion [(1)] people worldwide are served by health facilities without reliable electricity, impacting their ability to receive adequate health care. About 675 million [(2)] of these people live in sub-Saharan Africa and lack access to electricity. A significant share of these people rely on health clinics that also lack electric power. The problem is particularly acute in rural and remote areas, where health facilities are often far from the central power grid.

If there is nothing done to deal with this problem, there will continue to be a gap or divide in the distribution of healthcare in the world and

more people will die or have a lower quality of life than those with better accessibility to technology and electricity in the world.

In summary:

Without reliable electricity, essential medical services such as surgeries, emergency treatment, and neonatal care will continue to be disrupted. This will lead to higher mortality and morbidity rates, especially among vulnerable populations such as infants, pregnant women, and the elderly. Patients will receive less accurate diagnoses and inadequate treatments.

Preferred State

An ideal or preferred state of health clinics in Africa and the entire world is one where the health system provides:

- Equal healthcare for all, regardless of economic status
- Every health clinic in Africa is powered by clean, reliable, affordable renewable energy systems, along with improved infrastructure and training for health workers to use these systems that enables the provide high-quality health services continuously and efficiently.
- Africa, and the entire world, has the same access to life-saving technology and a reliable electricity supply to use it
- Existing clinics and health facilities receive updated health technology and better, Wi-Fi technology— resulting in:
  - Significant decrease in hospitalizations and deaths per year
  - Shorter hospitalization times
  - Quicker & easier solutions/ medical procedures for patients
  - Overall better health for the community, improved economic wellbeing.

What Will the World Look Like if This Problem is Solved?

Clinics will have the power to continuously operate essential medical equipment, while ensuring timely treatment for all patients. Proper neonatal care, safe deliveries, and effective vaccination programs will be the norm, thereby significantly reducing maternal and infant mortality rates.

Consistent power supply will support better sanitation and sterilization practices, reducing the spread of infectious diseases in health facilities.

Rural and remote communities will have the same level of access to quality health care as urban areas, reducing health disparities and promoting equity.

By using renewable energy sources, health clinics will contribute to environmental sustainability, reducing reliance on fossil fuels and decreasing carbon emissions.

Clinics will have the power to continuously operate essential medical equipment, while ensuring timely treatment for all patients. Will enable proper neonatal care, safe deliveries, and effective vaccination programs, significantly reducing maternal and infant mortality rates.

Our Plan for Achieving the Preferred State

Our plan is to partner with local non-electrified (or non-reliability electrified) health clinics in rural Democratic Republic of the Congo, and working with them and the surrounding community, to bring abundant, clean, reliable, and affordable electricity to them in the form of solar panels, inverters, and back-up battery storage— that enables high-quality healthcare services. The strategy combines renewable energy solutions with healthcare infrastructure improvements to ensure sustainable and reliable access to electricity for healthcare clinics.

If appropriate, given the needs of the surrounding community, the plan could include expanding the health clinic's solar power system to meet more than just the clinic's needs— thereby enabling the community to obtain its electricity from the clinic's electric system.

The Kuvuna Foundation, a non-profit organization based in the DRC and with over 25 years of experience there, will act as the organizer and implementer of this initiative.

The steps for achieving this include:

1. A test and proof-of-concept phase,
2. Followed by installations in 15 additional sites in the Democratic Republic of Congo,
3. Followed by roll-out at scale to all health clinics in DRC without access to any or reliable electricity,
4. Culminating in roll-out to other Sub-Saharan Africa countries in need of electricity for their health clinics.

1. **TEST / Proof of Concept** — One site: Ndingi village

This initial phase will serve as a proof-of-concept to validate the effectiveness of the solution. It will start with the lead organization, the Kuvuna Foundation, forming an alliance with a local health clinic. The project will be implemented in a rural area of the Democratic Republic of Congo, more precisely in the province of Kongo Central Province, in the

Bas-Fleuve District, Tshela Territory, in the Ndingi village. This region is characterized by limited access to basic infrastructure, including reliable electricity supply, which hinders the delivery of quality health services. *(This step has already been initiated.)*

Democratic Republic of the Congo and surrounding countries (Google Earth)

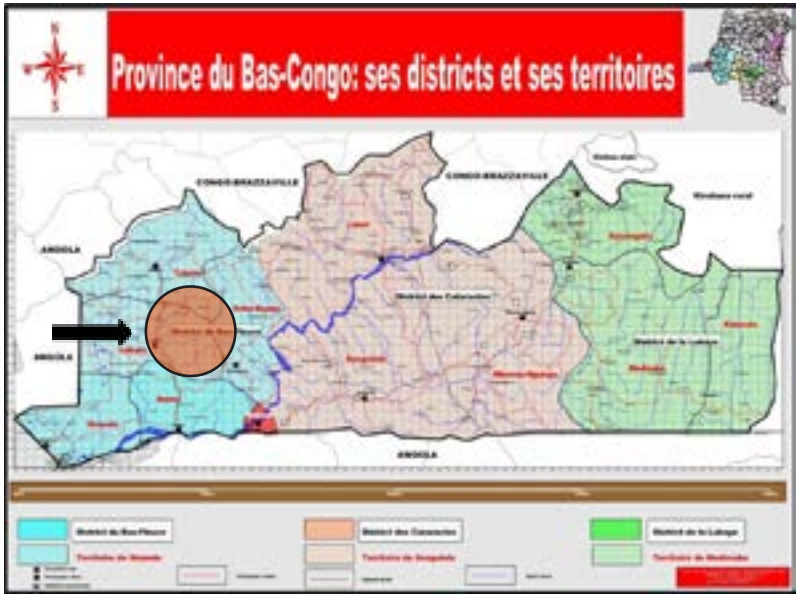


Image of the Province of Kongo Centrale (Ex. Bas - Congo),
Ndingi Village Location.

The solution will be implemented by a dedicated team, including:

- *Technical Experts*: Specialized in solar energy systems and health infrastructure.
- *Project Managers*: Responsible for logistics, schedules and resource allocation.
- *Community Engagement Specialists:* Responsible for community awareness, education, project approval, and stakeholder involvement.

After this the following steps will be taken:

- *Electricity Needs Assessment*: A comprehensive assessments to identify the specific energy needs of the Ndingi village health clinic, including current power consumption, if any, and critical equipment and infrastructure needs will be conducted.
- *Technology Needs Assessment*: A study to determine the best renewable energy solution for this clinic, taking into account factors such as electricity need, geographic location, sunlight levels, local climate conditions, building orientation, and surrounding community electricity needs will be conducted. *The technological resources needed for this project include:*
  - *Solar Panels:* High efficiency solar panels to capture and convert sunlight into electricity.
  - *Inverters:* Devices to convert direct current (DC) produced by solar panels into alternating current (AC) used by most medical equipment.
  - *Battery Storage:* Advanced battery systems to store excess energy generated during the day for use at night and/or on cloudy days.
  - *Backup power source:* Electric generator as a secondary energy source to ensure reliability during extended periods of low sunlight, or maintenance of solar system.
- *Installation of electrification technology— Solar Panels, Inverters, Batteries:*Install solar photovoltaic (PV) systems matched to the present and future energy needs of the Ndingi village health clinic. This includes installing solar panels on healthcare clinic rooftops or adjacent land to transform sunlight into electricity, a battery storage system to store excess solar energy for use during periods of low sunlight or when backup is needed or maintenance is scheduled and installing inverters and electrical systems to efficiently distribute electricity generated by solar panels to clinic operations. (For sources of this equipment see

Appendix 2.)

- *Training— Equipment use and maintenance.* Before installation of electrification technology provide training for local technicians on the installation, efficient operation, and maintenance of solar energy systems to ensure long-term sustainability and local ownership.
- *Training— Workforce.* Provide training for healthcare workers in the use of electrical equipment and energy conservation practices to maximize the benefits of new systems. *The human resources needed for this project include:*
  - Engineers: Electrical and renewable energy engineers to design and supervise the installation of solar photovoltaic (PV) systems.
  - Technicians: Local technicians trained for installation, maintenance and troubleshooting of systems.
  - Trainers: Experts to train healthcare personnel in the use of electrical medical equipment and energy conservation practices.
  - Health professionals: Healthcare workforce to implement and monitor the impact of electrification on healthcare delivery.
  - Project Managers: Individuals to coordinate and supervise project implementation, ensuring deadlines and budgets are met.
  - Community Liaison Agents: Staff to engage local communities and stakeholders, facilitating effective project implementation.
- *Monitoring and Maintenance.*Establish regular maintenance schedules and local maintenance teams to perform routine checks and quickly resolve any technical issues to ensure optimal operation and longevity of solar and electrical systems.
- *Proof-of-Concept Varication.* Establish monitoring system of metrics to determine cost-effectiveness, the quantity of electricity produced, its reliability, the use of the electricity (including lighting, and health diagnostic equipment), hours the clinic is open, number of people served, for what community residents have been treated, and the overall impact on healthcare services. Other variables such as school and work absences due to illness, maternal and child mortality and health will also be monitored and compared with pre-electrification of health clinic.
- *Partnerships and Funding.* With proof-of-concept data, seek funding from international and regional donors to support investments and ongoing operational costs for extending this program to 15 clinics in DRC and then the rest of the country. *The financial resources needed for this project include:*

- Financing for Equipment: Capital to purchase solar panels, inverters, batteries and other necessary equipment.
- Infrastructure Development: Funds to improve existing infrastructure to support new energy systems.
- Operational Costs, including Maintenance and Repairs.
- Monitoring and Evaluation: Fund for continuous monitoring and evaluation of system performance and impact.
- Training and Capacity Building: Financial support for the development and implementation of training programs for technicians and health workers.

Ndigi's Clinic picture

Right view

Back view

Cost Estimates for Implementation of Proof of Concept

To move forward with the implementation of our strategy a budget of approximately $8,500 is needed. It is crucial to plan carefully to maximize the long-term impact of the funds.

1. Equipment budget for one clinic

1. Solar PV System installation

Item	**Qty**	**Unit Cost (USD)**	**Total Cost (USD)**
Solar Panels (350W)	10	310	3,100
Inverter (5000W)	1	1,200	1,200
Batteries (200A)	5	200	1,000
Mounting structures and wiring	1	300	300
Regulator (80A)	2	200	400
Gasoline generator 5 KVA	1	500	500
Total Equipment (USD)			**6, 500**
2. Logistics costs (Transport of equipment, personnels and others)			2, 000
GRAND TOTAL (USD)			**8, 500**

2. Installations in 15 sites in the DRC

Given the success of *Phase One: TEST/Proof-of-Concept at the Ndingi village* site, our strategy calls for replicating appropriate variations of that installation at fifteen additional health clinic sites in rural DRC.

Implementing our strategy at scale involves expanding the infrastructure and capacity of several health clinics across the country, especially in rural areas. Here is an estimated cost breakdown :

Cost Estimate for Larger-Scale

Here is an estimated cost breakdown per-site and total for 15 sites:

Equipment budget for 15 clinics

1. Solar PV System installation

Item	Qty	Unit Cost (USD)	Total Cost (USD)
Solar Panels (350W)	150	310	46, 500
Inverter (5000W)	15	1,200	18, 000
Batteries (200A)	75	200	15, 000
Mounting structures and wiring	15	300	4, 500
Regulator (80A)	30	200	6, 000
Generator (5Kva)	15	500	7, 500
Total Equipment (USD)			**97, 500**
2. Logistics costs (Transport of equipment, personnels and others for 15 clinics)			**30, 000**
3. Logistics Contingency Fund for 15 Clinics			**7, 500**
4. Community Awareness Campaigns (For 15 Community)			**45, 000**
5. Project Management for 15 clinics			**60, 000**
GRAND TOTAL (USD)			**240, 000**

TOTAL ESTIMATED COST for electrifying 15 health clinics: $240,000

To implement our solution effectively and at scale, we will take a multi-faceted approach to secure the necessary resources and funding.

1. **International Aid Agencies**
   - Seek grants from international aid agencies that support sustainable development and health service improvement initiatives.
   - Benefit from development aid programs aimed at improving health infrastructure and services in developing regions.
2. **Philanthropic Foundations and NGOs:**
   - Apply for grants from philanthropic foundations focused on health, energy access, and sustainable development.
   - Work with non-governmental organizations (NGOs) specialized in the fields of health and renewable energy to pool resources and expertise.

Our solution will be implemented by a dedicated team, consisting of:

- Technical Experts: Specializing in solar energy systems and healthcare infrastructure. Their role will be crucial in planning the integration, installing, and maintaining the electrification

solutions. Majestic Construction (MC Service), led by Yves TSIKU THAMBA, one of the DRC Team members, will be particularly involved in this aspect due to their proven experience in the renewable energy sector.

Choosing his company has already allowed us to eliminate costs related to feasibility studies, thanks to the expertise of their technicians and their ability to carry out these studies in-house.

- Project Managers: Responsible for logistics, schedules and resource allocation (Nicholson THAMBA VUADI, Yves TSIKU THAMBA, Peter THAMUSIMI KAMANGO).
- Community Engagement Specialists: Focus on awareness, education and stakeholder involvement.

Our solution will be tested and implemented first in the **Ndingi** village, Democratic Republic of Congo, particularly in the Kongo Central Province.

This initial phase will serve as a proof of concept to validate the effectiveness of the solution.

The local on-the-ground partner will be KUVUNA FOUNDATION (TEAM DRC).

This partner brings :

- A deep understanding of the health landscape and energy needs in Ndingi (selected village in the Democratic Republic of Congo).
- Established relationships with local communities, government entities and stakeholders.
- Support in logistics operations, regulatory compliance and community engagement.
- Align objectives to improve healthcare delivery through sustainable energy solutions.
- Co-development of implementation strategies and timelines.
- A regular monitoring and feedback mechanism to ensure achievement of project milestones.

With KUVUNA FOUNDATION, we aim to leverage some of their local knowledge and networks to effectively implement and scale our solution, contributing to improved healthcare services and sustainable development in the Democratic Republic of Congo.

Detailed description of our implementation strategy

Our implementation strategy combines renewable energy solutions with healthcare infrastructure improvements to ensure sustainable and reliable access to electricity for healthcare clinics.

Here is a detailed overview of our strategy:

1. **Solar Energy Integration**
   - Solar PV Systems: Installing solar panels on healthcare clinic rooftops or adjacent land to capture renewable energy.
   - Battery Storage: Installing battery storage systems to store excess solar energy and use it during periods of low sunlight or when backup is needed.
   - Inverters and Electrical Systems: Upgrading or installing inverters and electrical systems to efficiently distribute electricity generated by solar panels to clinic operations.
2. **Backup Solutions**
   - Gasoline Generators: Providing reliable backup generators to ensure uninterrupted power during extended periods of low sunlight or in the event of an emergency.
3. **Energy Efficiency Measures**
   - Upgrading health equipment and appliances to energy-efficient models to minimize consumption.
   - Modernizing lighting, ventilation, and air conditioning (HVAC) systems to improve energy efficiency and reduce environmental impact.
4. **Capacity Building and Training**
   - Organizing training programs for local technicians on solar system maintenance, troubleshooting, and repairs.
   - Training Health Personnel on energy conservation practices and efficient use of electrical medical equipment.
5. **Monitoring and Maintenance**
   - Establishing a scheduled maintenance plan to ensure optimal operation and longevity of solar and electrical systems.
6. **Community Engagement and Education**
   - Launching community outreach initiatives to educate local residents on the benefits of renewable energy and sustainable health practices.
   - Workshops and Seminars: Organizing workshops and seminars for healthcare providers and community leaders to promote energy conservation and improved healthcare.

7. **Project Management and Governance**
    - Developing a comprehensive project plan with clear milestones, timelines, and resource allocations.
8. **Evaluation and Scaling-up**
    - Conducting regular performance assessments to measure energy savings, cost-effectiveness, and impact on healthcare services.
    - Using knowledge from the initial implementation phases to scale up the solution to other health clinics and regions in the Democratic Republic of Congo.

In summary, our implemented strategy integrates renewable energy solutions with health infrastructure improvements, aiming to provide sustainable and reliable access to electricity for health clinics in the Democratic Republic of Congo, especially in the Kongo Central province.

With a focus on solar energy implementation, backup solutions, energy efficiency measures, capacity building and community engagement, we aimed to foster sustainable development and improve health service delivery across the region. This approach ensures long-term benefits for healthcare providers, patients and the community at large, while contributing to better health outcomes and environmental sustainability.

Action Plan for the Next 6-12 Months

Over the next 6-12 months, our efforts will focus on preparing, implementing and then evaluating our implemented solution to provide sustainable access to electricity to the Ndingi village health clinic in the Democratic Republic of Congo.

Through strategic partnerships, rigorous planning and community engagement, the plan will achieve a measurable impact on healthcare delivery and environmental sustainability.

This action plan ensures that each phase is executed with precision and collaboration, laying the foundation for scalable and replicable success across the Democratic Republic of Congo.

Phase 1 : Preparatory Phase (Months 1-3)

- **Needs Assessment and Site Selection (Ndingi village)**
  Who: Project Managers, Technical Experts
  What: Conduct needs assessments at potential health clinics to

assess energy needs and feasibility of solar installations.
Where: The selected location is Ndingi village, located in Tshela Territory, Bas-Fleuve District, Congo Central Province, and Democratic Republic of Congo.

- **System Design**
  Who: Project Managers, Technical Experts
  What: Define panel size and capacity, orientation, and tilt. Component Selection: Select solar panels, inverters, batteries, and other essential components. Develop detailed plan and schematics for the installation.
- **Implementation Partnership Development**
  Who: Kuvuna Foundation, Project Managers, Partnership Coordinator
  What: Identify and finalize partnerships with International Agencies, NGOs for collaborative implementation.
  Where: Meetings and negotiations in regional offices.
- **Regulatory and Permitting Process**
  Who: Legal advisors, regulatory compliance team
  What: Navigate regulatory requirements and obtain necessary permits for solar installations and electrical upgrades.
  Where: Government offices and regulatory agencies in target regions.

Phase 2: Implementation Phase (Months 4-9)

- **Procurement and Installation**
  Who: Project Managers, Procurement team, installation teams
  What: Acquire solar panels, inverters, batteries, and necessary equipment. Begin installation at selected health clinic sites.
  Where: Health clinics identified during the needs assessment phase.
- **Training and Capacity Building**
  Who: Technical trainers, health educators
  What: Organize training sessions for local technicians on solar system maintenance and for health personnel on energy efficient practices.
  Where: Training workshops held at health clinic sites and community centers.
- **Community Engagement and Education**

Who: Community Outreach Team, Education Specialists
What: Conduct awareness campaigns and educational workshops to promote energy conservation and healthcare improvements.
Where: Local communities and health clinic catchment areas.

Phase 3: Monitoring and Evaluation (Months 10-12)

- **System Optimization and Testing**
  Who: Technical experts, monitoring team
  What: Optimize system performance; conduct testing to ensure reliability and efficiency of solar installations and backup systems.
  Where: On-site at health clinics.
- **Feedback and Adjustments**
  Who: Project managers, Stakeholder Engagement Team
  What: Gather feedback from healthcare providers, community members, and stakeholders. Make adjustments based on initial implementation results.
  Where: Feedback sessions at health clinics and meetings with stakeholders.
- **Planning for expansion and scale-up**
  Who: Project leadership, Expansion Strategy Team
  What: Develop plans to expand the solution to other health clinics and regions using lessons learned and positive results.
  Where: Strategy meetings and planning sessions at regional offices.

CONCLUSION

Over the next 6-12 months, our efforts will focus on preparing, implementing and evaluating our solution to provide sustainable access to electricity to health clinics in the Democratic Republic of Congo, especially in the locality of Ndingi.

Through strategic partnerships, rigorous planning and community engagement, we aim to achieve a measurable impact on healthcare delivery and environmental sustainability.

This action plan ensures that each phase is executed with precision and collaboration, laying the foundation for scalable and replicable success across the Democratic Republic of Congo.

To move forward with our implementation strategy with a budget of $50,000, it is crucial to plan carefully to maximize the impact of the funds.

Here is our detailed plan in several steps:

❖ **Assessment and Planning**

Feasibility Study: Site assessment, solar analysis, and energy needs calculation. Expert Consultations: Engage consultants for technical and financial advice. Permitting and Regulations: Ensure compliance with local regulations and obtain necessary permits.

❖ **System Planning and Design**

System Design: Define panel size and capacity, orientation, and tilt. Component Selection: Select solar panels, inverters, batteries (if needed), and other essential components. Detailed Plans: Create detailed plans and schematics for the installation.

❖ **Purchase of Materials and Equipment**

Budget: $25,000 - $30,000

Solar Panels: Purchase solar panels that fit within the budget. Inverters: Purchase inverters to convert DC energy to AC. Mounting and Fixing Systems: Materials to fix the panels to the roof or ground. Wiring and Accessories: Electrical wiring, connectors, and other necessary accessories.

❖ **Installation and Commissioning**

Budget: $8,000 - $10,000

Labor: Hiring qualified technicians for installation. Installation: Mounting the panels, connecting the power, and configuring the inverters. Testing and Commissioning: Verifying performance and connections to ensure proper operation of the system.

❖ **Training and Maintenance**

Budget: $2,000 - $3,000

User Training: Awareness and training on the use and maintenance of solar panels. Maintenance Plan: Establish a regular maintenance plan to ensure the sustainability and efficiency of the system.

❖ **Communication and Documentation**

Budget: $1,000 - $2,000

Reporting and Communication: Share the results and benefits of the project with stakeholders.

This plan will maximize the effectiveness of the $50,000 investment by ensuring a systematic and well-coordinated approach to the

implementation of the solar panels.

Immediate Actions to Advance Our Strategy

1. **Needs Assessment and Site Selection**
   - Description: Identify priority health clinics requiring energy retrofits.
   - Available Resources: Project team and internal expertise.

   Actions:
   - Conduct site visits to assess energy needs.
   - Use data collection tools to document energy needs and existing infrastructure.
2. **Partnership Development**

   Description: Engage in strategic partnerships with local stakeholders.
   - Available Resources: Existing network of local and regional contacts.

   Actions:
   - Organize meetings with international agencies, NGOs, and community leaders.
3. **Project Planning and Design**

   Description: Develop a detailed project implementation plan.
   - Available Resources: Project management and engineering expertise.

   Actions:
   - Develop detailed project plans, including timelines and budgets.
4. **Funding Research**

   Description: Seek funding and resources to support large-scale implementation. Available Resources: Expertise in developing funding proposals.

   Actions:
   - Prepare and submit grant proposals to funding agencies.

CONCLUSION

By immediately utilizing available resources and expertise, our team can take the first step toward advancing our strategy.

These initial actions lay the foundation for successful implementation and demonstrate the feasibility and potential impact of our solution.

By focusing on needs assessment, partnership development, project planning, and community outreach, we are laying the foundation

for effective and sustainable deployment of solar energy systems to improve healthcare services in targeted clinics.

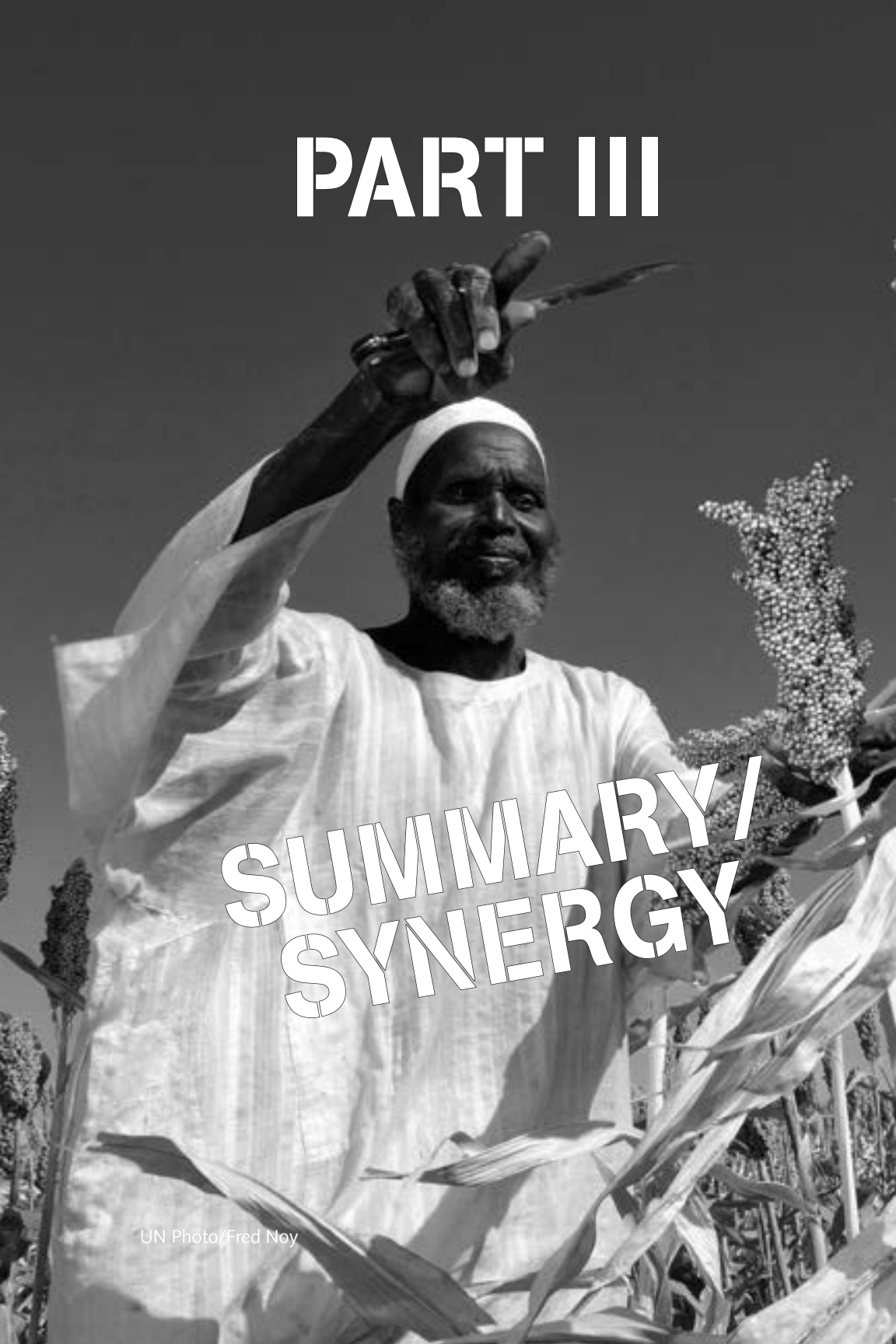
Endnote

(1) https://www.banquemondiale.org/fr/news/press-release/2023/06/06/basic-energy-access-lags-amid-renewable-opportunities-new-report-shows

(2) Ibid

PART III

SUMMARY/ SYNERGY



UN Photo/Fred Noy

SUMMARY/SYNERGY

The whole is more than the sum of its parts.

This book documents the explorations of many young people as they sought to understand our world and to figure out and design ways of making it work better for everyone. What is missing from the individual chapters or strategies are the interactions and resulting synergies of these parts as they combine into a whole that is exciting in its possibilities.

The preceding chapters describe a progression of technology, programs, policies and actions that, if implemented, transform the world as we know it to a world as we want it. Taken individually, each strategy can stand alone in making a significant contribution to improving some aspect of the human condition. Each strategy has links, interactions and impacts on the other strategies. Taken collectively, the strategies are more than the sum of their parts. They would, if implemented together, have a profound impact on our collective wealth, health, and potential. They would not only result in meeting the Sustainable Development Goals, but also go beyond them and transform the world in even more profound ways.

These strategies for transforming the world are suffused with a sense of values and vision that is bold, inclusive and caring—and which is for the entire world, not just a part of it. In some cases, the strategies are revolutionary and transformative, in others, "merely" dealing with critical problems. Taken together, all the strategies add up to a synergetic whole that is revolutionary, transformative and regenerative.

The whole, the parts and the interactions of the parts, creates a world where the most egregious forms of brutal poverty are eliminated, hunger and malnutrition eradicated, health, longevity and the quality of life are improved and the environment is allowed to regenerate. Where, in short, basic human needs are met, basic human rights fulfilled, and our environmental life-support systems are strengthened.

The global and local strategies described in this book help illustrate the creativity, values, vision, and commitment of the youth and concerned citizens of the world. They also represent what an

interdisciplinary, multigenerational group of non-experts can do when provided an opportunity and methodology for tackling the critical and complex problems facing the world.

Your feedback is most welcome—as is your ongoing participation in this evolving work. One way to do this is to send us your comments and suggestions by emailing us at info@designsciencelab.com. Those wishing to take part in upcoming Labs are urged to contact BigPictureSmallWorld at www.bigpicturesmallworld.com, or check in at www.designsciencelab.com.

Participants of the 2016 Global Solutions Lab presenting to the United Nations at the conclusion of the Lab.

APPENDIX 1: THE UN MILLENNIUM DEVELOPMENT GOALS

By 2015:

Goal #1: Eradicate extreme poverty and hunger

- Reduce by half the proportion of people living on less than a dollar a day.
- Reduce by half the proportion of people who suffer from hunger.

Goal #2: Achieve universal primary education

- Ensure that all boys and girls complete a full course of primary schooling.

Goal #3: Promote gender equality and empower women

- Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015.

Goal #4: Reduce child mortality

- Reduce by two thirds the mortality rate among children under five.

Goal #5: Improve maternal health

- Reduce by three quarters the maternal mortality ratio.

Goal #6: Combat HIV/AIDS, malaria and other diseases

- Halt and begin to reverse the spread of HIV/AIDS.
- Halt and begin to reverse the incidence of malaria and other major diseases.

Goal #7: Ensure environmental sustainability

- Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources.
- Reduce by half the proportion of people without sustainable access to safe drinking water.
- Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020.

Goal #8: Develop a global partnership for development

- Develop further an open trading and financial system that is rule-

based, predictable and non-discriminatory. Includes a commitment to good governance, development and poverty reduction—nationally and internationally.

- Address the least developed countries' special needs. This includes tariff- and quota-free access for their exports; enhanced debt relief for heavily indebted poor countries; cancellation of official bilateral debt; and more generous official development assistance for countries committed to poverty reduction.
- Address the special needs of landlocked and small island developing States.
- Deal comprehensively with developing countries' debt problems through national and international measures to make debt sustainable in the long term.
- In cooperation with the developing countries, develop decent and productive work for youth.
- In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries.
- In cooperation with the private sector, make available the benefits of new technologies—especially information and communications technologies.

APPENDIX 2: THE UN SUSTAINABLE DEVELOPMENT GOALS

By 2030:

Goal 1 End poverty in all its forms everywhere

Goal 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Goal 3 Ensure healthy lives and promote well-being for all at all ages

Goal 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Goal 5 Achieve gender equality and empower all women and girls

Goal 6 Ensure availability and sustainable management of water and sanitation for all

Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all

Goal 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10 Reduce inequality within and among countries

Goal 11 Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12 Ensure sustainable consumption and production patterns

Goal 13 Take urgent action to combat climate change and its impacts

Goal 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17 Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

For more information:
http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E)


Good Morning!



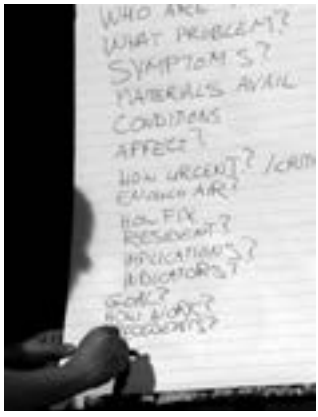











WHAT PROBLEM?
SYMPTOMS?
MATERIALS AVAIL
CONDITIONS
AFFECT?
HOW FIX
RESEARCH?
APPLICATIONS?
INDICATORS?
GOAL?


EDUCATION
STRATEGY
Internet
Connectivity
COMMUNITY
HUB
Mobile
Education
Prerequisites


Design Science Lab
Energy for the World


1
2
3
5
6
7


WORK AND DIVE
FEW CAN CHANGE

2005—The first Design Science Lab

2006 Lab

2007 Lab

2008 Lab

2009 Lab

2010 Lab

2011 Lab

2011 High School Lab

2012 Lab

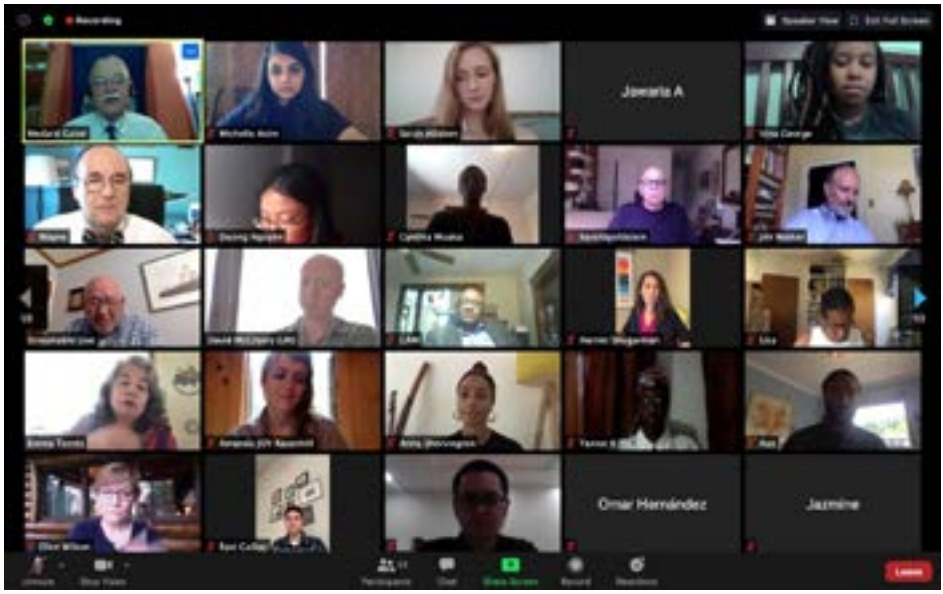
2014 Lab

2014 Lab

2016 Lab


SECRETARY
UNITED STATES
CO-CHAIR
UNITED KINGDOM
CO-CHA


NELSON
MANDELA
INTERNATIONAL DAY



2020, with the COVID-19 pandemic, brought the first virtual lab. It had the added benefit of being more accessible to participants around the globe, without the impediment of physically crossing borders.

2020 Lab

ABOUT MEDARD GABEL

Medard Gabel is the executive director of EarthGame. He is the author or editor of six previous books on the global energy situation (*Energy, Earth and Everyone*, Anchor Press/Doubleday); the global food situation (*Ho-Ping: Food for Everyone*, Anchor Press/Doubleday); the U.S. food situation (*Empty Breadbasket*, Rodale Press), multi-national corporations (*Global Inc.: An Atlas of the Multinational Corporation*, The New Press), strategic planning (*Design Science Primer*), climate change, and (*Climate Change—Take Action Now*, UNICEF). He is currently working on *Ten Billion Billionaires* that deals with global predicaments and prospects.

He worked with Buckminster Fuller for over 12 years and has been a consultant to UNEP, UNITAR, the U.S. State Department, Department of Agriculture, USAID, and the Governor's Energy Council of Pennsylvania, as well as Motorola, IBM, General Motors, Novartis, Chase Manhattan Bank and numerous other multinational corporations. The Global Solutions Lab is the integration of all he has learned from all his teachers, especially those listed in this book.

ABOUT GEM

Global Education Motivators (GEM) is dedicated to meeting the complex needs of bringing the world into the classroom. It has worked with students, teachers and administrators through on-site and distance learning workshops and classroom program support to promote a better understanding of the world and its people. Being convinced that international communication exchange is a key to future world peace, GEM delivers cross-cultural perspectives as an integral part of its unique global learning programs. An integral part of GEM's mission is to support the work and mission of the United Nations and the important role of civil society in today's world. It is convinced that global awareness is closely tied to global responsibility. GEM is located at Chestnut Hill College in Philadelphia, Pennsylvania, and was co-founded by Wayne Jacoby.

How do we make the world work for 100% of humanity in the shortest possible time, through spontaneous cooperation, without ecological offense or the disadvantage of anyone?

—Buckminster Fuller

This report, on the work of the 2005 - 2023 Global Solutions Lab held at the United Nations, UN International School, Chestnut Hill College, Drexel University, and online reveals what happens when solid methodology meets creative minds. Over the past 18 years, hundreds of people, most aged 18 to 26 (but a few as young as 55), have come together to look at the issues of hunger, poverty, education, health care, energy, climate change, water, women's rights, employment, the environment and other topics to find ways to make the wold work for 100% of humanity in the shortest possible time. We offer these creative solutions to you in this book.

—Medard Gabel

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