LAND ART
GENERATOR

RENEWABLE ENERGY CAN BE BEAUTIFUL

landartgenerator.org

Return to the Source (2019)

Elizabeth Monoian and Robert Ferry
LAGI Founding Co-Directors

"Never" does not exist in the human mind...Only "not yet."
—Thea von Harbou

If the great energy transition was a long movie, today we would be at the intermission. The movie began in 1988 when the Intergovernmental Panel on Climate Change (IPCC) was founded and James Hansen gave his statement on the greenhouse effect as Director of the NASA Goddard Institute for Space Studies.[1] The end of the 1980s marked the introduction of climate change into popular culture.[2] We may not have known it so precisely then, but the clock was already ticking leading up to 2050—the year that scientists tell us we must draw down carbon to sustainable levels or risk catastrophic impacts.

Here at the end of the second decade of the 21st century, we are living at the midpoint: three decades after scientists, world leaders, and corporations fully understood that our greenhouse gas emissions were on an unsustainable trajectory and three decades until we have to be near zero net carbon to limit global average temperature rise to 2 degrees Celsius. At the intermission of this movie, we are far from where we need to be. Year-on-year global emissions continue to trend upward, closely tied to economic growth.[3]

While it is easy to be cynical about what little progress has been made in reducing carbon emissions, it is also clear that today we stand at a tipping point for renewable energy. A rapid shift away from carbon sources for electrical power production is inevitable because it is something we simply must do.

From the debut of the first movie that dramatized a lunar mission as a distinct possibility (*Woman in the Moon* by Fritz Lang,[4] October 1929) to when we actually landed on the moon in July 1969[5] was 40 years. The halfway point in that story was 1949. At that point we had only recently broke the sound barrier. In terms of the energy transition, we are beyond breaking the sound barrier. All the technologies we need to solve the climate crisis already exist and they have been field-tested. In the next few years we can be in orbit if we have the will. It is a good time to get on board.

In April 2019, for the first month in history, renewable energy power plants provided more electricity in the United States than did coal-fired power plants.[6] The following month, the United Kingdom went an entire week without any coal-fired electricity.[7] Given the plummeting costs of solar and storage technologies, it will not be long until the same will be said for renewable energy versus natural gas. In fact, in new construction power purchase contracts, solar with battery storage is beginning to outbid natural gas power plants. As of the writing of this essay, the Los Angeles Department of Water and Power is set to purchase 400 megawatts of solar and 300 megawatts of energy storage with a 25-year agreement at a fixed price of under 2¢ per kilowatt-hour (3¢ with storage)—far below the ability of natural gas, nuclear, or coal-fired power plants to compete. Solar for less than 2¢ per kilowatt-hour is the new normal for large-scale solar projects such as those in the UAE and Saudi Arabia. Wind power is making similar strides in market price dominance over conventional energy, with onshore purchase agreements also at around 2¢ per kilowatt-hour.

Looking Ahead

The April 2019 report from the International Renewable Energy Agency (IRENA), headquartered in Masdar City, indicates that the current rate of adoption will result in 86% of power generation from renewables by 2050, at which time we will rely on electricity for at least 50% of our energy, whereas today it is only 20%.[8] If we are serious about meeting the targets of the Paris Agreement, we will need to accelerate that trend significantly.

By 2020, we will need to be on the downside slope of "peak carbon" and see an average of 3.5% reduction each year for thirty years.[9] Remember that today we stand thirty years from the start of global awareness. When this same number of years passes again, we must be at functional zero-emissions, where the natural carbon uptake from forests and oceans (perhaps augmented slightly by our own direct air carbon sequestration) is sufficient to offset our annual global emissions without ocean acidification, leading to a balancing and eventually to a decline in parts per million of carbon dioxide in the atmosphere.

To get there, we will need to invest the equivalent of 2% of global gross domestic product in new energy infrastructures.[10] That translates to an average of $3 trillion to $4 trillion per year over thirty years. Of course, the economic cost of not transitioning from carbon-emitting fuels will be far greater, with the additional risk of catastrophic social collapse from mass human migration and food shortages.

We need to make this investment. And that is a good thing for future humans. In fact, if planned correctly, this scale of infrastructure investment will be a great boon to employment and quality of life around the world. One of the main reasons that it is becoming difficult to compete with solar and wind for power purchase agreements is that the feedstock is free once you build the power plant. To make electrons, you do not need to consistently buy petroleum, coal, or natural gas at the price set by the market—it comes to your power plant for free on sunbeams and wind gusts. The other side benefit is that by not combusting carbon fuels our air and our water will be far less polluted.

When we look toward a time a few decades hence when we will be nearing the finish line of the great energy transition, we see that the world has cleaner air, good jobs, and cheaper and more egalitarian access to energy. But what does $4 trillion worth of new infrastructure physically look like, and where does it get installed?

Energy Landscapes to Power Our Cities

When we think of renewable energy infrastructure, we often imagine dark blue photovoltaic rectangles carpeting the landscape or large three-blade horizontal axis wind turbines marching along mountain ridges or into the sea. We think about grid reliability and consumer cost per kilowatt-hour, or we think about the climate change apocalypse that we will impose on future generations if we fail to act swiftly.

All of these elements are important from technical and policy perspectives, but there is something missing that will be key to success if we are to meet the goals for decarbonization that we have set. We must recognize the importance of human culture to the realization of change.

Global solar capacity today is about 400 GW. The International Energy Agency (IEA) estimates that at current rates, we will install another 575 gigawatts of solar capacity by 2025, which will require land area nearly the size of Kuwait. IRENA estimates a global capacity of 8,500 GW of solar and 6,000 GW of wind will be needed by mid-century if we are to meet the goals that the IPCC has established. A solar array of 8,500 GW is the size of the entire United Kingdom.[11] But the good thing about renewables is that they do not pollute. You can live right next to them. If we focus on building energy infrastructure in our cities, we can leave undeveloped sites to nature.[12]

What is certain is that over the next few decades, solar, wind, and other renewable energy installations will be distributed across rooftops, farmlands, vacant lots, greenfields, and sites of every scale around the world. These installations will have an impact on our cities and rural landscapes like nothing else since the construction of the automobile superhighways of the mid-20th century. The more we can generate clean energy through distributed energy resources in urban areas, the more natural and agricultural sites we can retain, and the more resilient our electrical grid will become to large-scale outages.

While the vast majority of our renewable energy infrastructure will be utilitarian installations designed to meet the most competitive power purchase agreement (LADWP did not break the 2¢ per kilowatt-hour barrier by focusing on aesthetics), the energy transition also offers the opportunity for creative expression at more cherished sites and in instances where community engagement will be key to permitting and to long-term project success. In these cases, how can clean energy technology weave itself into the cultural landscapes of our cities?

Here is where we can begin to fully engage the general public and get people excited about the renewable energy transition. By using clean energy technology as the medium for public art and creative placemaking, we can beautify our cities while making them more sustainable. We can educate and inspire a diverse public, and get people excited about the beauty of a renewable energy future.

When our grandchildren look back upon the glorious things that we have built over the next three decades, what will they see? They will see solar farms, wind turbines, and transmission pylons. They will see facilities dedicated to zero waste, anaerobic digesters, and biochar plants. They will see net-zero water treatment facilities and sustainable transportation hubs. But what exactly will this infrastructure look like, how will it relate to human culture, and how will it impact the aesthetics of our cities and our rural landscapes?

It might be useful to look back on another storied period during which more than a trillion dollars was invested in new public infrastructure. When Americans look back today at the infrastructures that "the greatest generation" built in the 1930s and 1940s, what do they see? They see the Hoover Dam, providing 4.2 terawatt-hours of clean electricity every year, and all around it they see the artwork of Denver artist Allen Tupper True and Norwegian-American sculptor Oskar J. W. Hansen. They see murals on civic buildings like those by Acee Blue Eagle in Oklahoma. They see the murals of John Augustus Walker, a native of Mobile, Alabama, that tell the history of his city. They see the work of 10,000 artists who were employed by the Federal Art Project of the WPA to gild the power and water infrastructure and public buildings with their art, defining the era with stories, beauty, relevance, and creativity.

We can do the same for the great energy transition. With 1% for the arts[13] applied to trillions of dollars in renewable energy investment, we can bring about a transformation of our cultural landscapes along with the transition of our energy landscapes, making new artistic landmarks for this critical time in human history. We can bring renewable energy projects into the fabric of our neighborhoods in ways that increase livability and quality of life. With artists and creatives helping to guide decision-making, we can help ensure that those who lack political power are not exploited as an unintended consequence of drawing down carbon.

If we are going to convince governments to get behind such a massive investment in renewable energy infrastructure, we must have popular support behind it. To be successful, the great energy transition needs a cultural motivator with the message that it is going to be better than OK.

If we are to respond appropriately to the science, we must already be entering an era when we no longer commission any new major carbon-emitting infrastructures. We must start to radically decommission those presently in operation with a goal of 45% reductions by 2030 and global net zero emissions by 2050.

We have the technology today to make this transition, so why are we not doing it? Inaction cannot be explained by illiteracy on the subject of climate science. Dan Kahan, a professor of law and psychology at Yale Law School and his colleagues have shown that "divisions over climate change stem not from the public's incomprehension of science" but rather from a personal conflict between the "interest individuals have in forming beliefs in line with those held by others with whom they share close ties, and the collective interest they all share in making use of the best available science to promote common welfare."[14] In other words, some people prefer to maintain allegiance with the views of their own peer group rather than form new opinions based on peer-reviewed scientific findings. Learning more about the science only helps those who are inclined against its implications to better define and argue against the position of the "other side" of the debate.

How do we circumnavigate this unfortunate situation wherein greater climate science literacy only serves to entrench previously held cultural beliefs? How do we motivate people to act across the cultural divide? The recent history of climate communications may have taught us that people are not motivated to action through apocalyptic warnings and threats. Rather, we are driven to act by the desire for a new and better world. Something captivating is needed to convince us that the transition to a post-carbon world has a happy ending, and the story it tells us must be culturally relevant.

What if we could change the climate crisis message of fear and disaster—drowning cities, green fields turned into deserts, mass extinctions—into one of hope and optimism? What if rather than show apocalyptic images to run from, we instead design a future that people desire to run toward? What if we change the conversation about gloom and doom to one of beauty and cultural transformation?

The Land Art Generator design competitions seek to present real answers to these questions by engaging our imagination.

LAGI and the UAE

In January 2007, the idea of the world's most sustainable city was announced at the World Future Energy Summit (WFES) by Masdar (the recently formed renewable energy subsidiary of the Abu Dhabi Government's Mubadala Development Company, now known as Mubadala Investment Company). However, it was not until the next year's WFES that Masdar City captivated the imagination of the world, unveiling a physical model and publicizing the renderings with descriptions of the design approach and technologies used. Jean-Paul Jeanrenaud, director of WWF International's One Planet Living initiative, told Khaleej Times, "Today Abu Dhabi is embarking on a journey to become the global capital of the renewable energy revolution. Abu Dhabi is the first hydrocarbon-producing nation to have taken such a significant step toward sustainable living."

The architectural renderings generated by Foster + Partners in response to Masdar's brief demonstrated what it might be like to live in a city that is in carbon balance—exciting, beautiful,

and sustainable at the same time. Moving beyond reliance on carbon as our primary source of energy need not involve individual sacrifice, nor turning our backs on progress. Rather, it can reinforce a thriving Arab culture of art, hospitality, learning, and largess.

As new residents of the United Arab Emirates in the summer of 2008, it certainly captivated our imaginations. As we learned more about Masdar City and other net-zero cities being designed around the world, we wondered: How can the design of our cities, public spaces, and public art directly support the energy transition? We imagined visiting 21st-century "wonders of the world"—cultural landmarks that would provide a profound experience for visitors while powering our economy in a way that does not upset the balance of nature.

Considering the land use requirements for solar, wind, and other renewable energy resources, are there opportunities to conceive of these installations through the cultural lens of art outside of the gallery? Perhaps we could accelerate the cultural embrace of a post-carbon world by demonstrating how clean energy can contribute to and enhance the everyday lives of the inhabitants of sustainable developments such as Masdar City.

We also learned that there were Emirati artists working in the genre of Land Art. Mohammed Ahmad Ibrahim, Emirati Land Artist, shared the following with us through an email interview:

> At that time in the 1990s, I was aware of the work of some artists like Robert Smithson, James Turrell, Joseph Beuys, Richard Long, and others in the beginning of the 1970s. I liked their work, and I found the expression of the human relationship with the surroundings of the natural environment very powerful. Where I grew up (in the region of Khorfakkan) the characteristics of differing environments, where the mountains surrounding the city from three directions and the sea on the fourth side, has led to a denial of sunset[15] and formed a kind of challenge and provocation to the visual field. The characteristics of the geology near Khorfakkan that gave rise simultaneously to jagged ridges and softened plains created a conflict that instilled in me a determination to work against and provoke the land through my art.

The UAE was the perfect landscape in every way to launch the Land Art Generator Initiative. The ambitious nature of the place, the rich landscape, the abundance of renewable resources, and the history of Land Art propelled us to conceptualize our first LAGI competition in 2010.

Throughout 2009, we visited sites around Dubai and Abu Dhabi and settled on three areas for teams to design within, one in Dubai and two in Abu Dhabi. The sites were urban gateways—interstitial open areas on the way to and from denser developments—and would make provocative canvases for large-scale, permanent public art.

To explain the idea of a "land art generator" installation, we developed a few provisional concepts of our own, for example, the Ibn Al Haytham pavilion for Mushrif Park that uses concentrator photovoltaics with Fresnel lenses and celebrates the beams of concentrated sunlight as the media for the artwork.

The design brief functioned as a way to codify our land-art-as-clean-power-plant manifesto, and the launch of the 2010 Land Art Generator Initiative design competition was a literal call to the world to respond to its challenge.

Masdar hosted the LAGI 2010 exhibition as an integral part of their exhibit at the 2011 World Future Energy Summit in Abu Dhabi, where Ban Ki-moon was guided through and told, "Renewable energy can be beautiful." The first place award was presented by Dr. Nawal Al-Hosany to Robert Flottemesch and team for Lunar Cubit, a simple gesture of frameless solar panels cladding a set of pyramids that produces 3.5 gigawatt-hours of electricity, while tracking the cycle of the moon and illuminating its phases.

One of the design sites for LAGI 2010 was near Masdar City, at a highway interchange just across International Airport Road. Masdar City at that time was just beginning construction—already a world leader in sustainable design innovation. Just a decade later, the city is expanding beyond its iconic first phase buildings with a massive second phase that will begin to reveal the larger sustainability goals behind its master plan.

Masdar City and LAGI 2019

The master plan of Masdar City at the pedestrian level is inspired by the ancient walled Arab cities that channel the prevailing winds into narrowing lanes, rapidly circulating the air for a passive cooling effect.[16] A network of personal and group rapid transport vehicles—including the autonomous NAVYA shuttle— provide on-demand, destination-based transportation services which meander through a shaded and naturally cool podium and to the wider Masdar City area. Massive arrays of solar panels above the buildings and

cantilevering over the sidewalks augment the clean energy provided by the landscapes that ring the city's perimeter, where areas of next-generation agriculture are mixed with recreational spaces.

One of the most striking features of the master plan as viewed from the air in the earliest renderings from Foster + Partners are the "green fingers." The fingers weave through the entire city like wide rivers, inhaling the wind from the northwest and channeling it into the city along park-like public spaces. As Masdar City continues its development into Phase 2, these green fingers are ready to take form. Because this advancement in the city's construction coincides with the development of a comprehensive strategy for "public art of the sustainable city,"[17] the first section of the green fingers open space was aptly suited to be the site of the LAGI 2019 Abu Dhabi design competition. The LAGI 2019 design site is a gateway to Masdar City, its largest public park, and the start—the source—of the green finger network.

Return to the Source

Masdar is the Arabic word for "source." As the name of Abu Dhabi's multifaceted renewable energy company and most ambitious low-carbon development, it is a reference to the sun, the source of energy that sustains life on Earth and drives the wind and waves. Over millions of years, the sun has powered the transfer of ancient carbon dioxide out of the atmosphere and into the ground, creating a climate habitable to humans.

"Source" also has meaning within the context of the Land Art Generator Initiative and LAGI 2019. We were returning to the place that had first inspired us in 2008 to launch a design competition for renewable energy as public art.

This year's special edition is in partnership with the 24th World Energy Congress, the largest and most influential global energy event that has been a forum for innovation and dialogue on energy issues for 95 years. This year (2019) marks the first time that the World Energy Congress (WEC) is being hosted in the Middle East.

The goal of LAGI 2019 was to bring forward a portfolio of feasible concept designs that push the boundaries of what is possible using today's renewable energy technologies. To ensure that the proposals are constructible, this was the first LAGI design competition that provided a capital cost restriction as a part of the design brief.

The limit was set to coincide with the approximate cost per watt of installed solar photovoltaic panels as it existed in 1992, the year of the first United Nations Framework on Climate Change meeting (the Earth Summit in Rio de Janeiro).

Since then, the cost of installed solar has fallen more than 85%. Celebrating this achievement, which has placed solar at parity with fossil fueled electricity, LAGI 2019 participants were asked to reinvest this cost margin into the artistic elements of their proposal.

As you will see in the pages of this book, the proposals met the challenge with innovative approaches to renewable energy infrastructure, including tessellated solar canopies, self-sustaining oases that use the sun to pull water from the air, modular devices for turning desert into forest, massive solar sculptures, and diaphanous solar membranes to help the city "breathe."

The entries to LAGI 2019 make us optimistic that we are witnessing the early stages of a shift from a culture of consumption and exploitation of nature to a culture of sustainability and stewardship of nature. In places like Masdar City, art in public spaces will be designed regeneratively to give back to people and to the planet. Such artworks will provide not only beauty, wonderment, education, and storytelling, but will generate a part of the energy that will sustain us, making possible our 21st-century technological, social, and cultural achievements.

Before jumping forward to see the submissions, please take the time to read through the essays that add context from the perspective of sustainable development (Chris Wan), urban planning (Lukas Sokol), a brief introduction to Emirati Land Art (Naz Shahrokh), and the cultural and social ramifications of our current energy shift (Clark Miller and Andrew Hudson).

This portfolio of work represents 72 of the nearly 300 submissions from 75 countries that responded to the LAGI 2019 design brief. The futures they have designed are a look at what could be—and what we might desire. LAGI 2019 Abu Dhabi continues the journey that began in the UAE in 2008. We look forward to the next act in the great energy transition.

[1] James Hanson, "The Greenhouse Effect: Impacts on Current Global Temperature and Regional Heat Waves, Statement of Dr. James Hanson, Director, NASA Goddard Institute for Space Studies," Presented to the United States Senate Committee on Energy and Natural Resources on June 23, 1988, **https://www.sealevel.info/1988_Hansen_Senate_Testimony.html**.

[2] The first scientific paper linking CO_2 emissions and average global temperatures was published in 1896 by the Swedish chemist and physicist Svante Arrhenius, but the world was not yet ready to listen.

[3] United States Energy Information Administration, **https://www.iea.org/geco/emissions**.

[4] The film is based on the novel *The Rocket to the Moon* by Lang's collaborator and wife, Thea von Harbou.

[5] The year of this publication coincides with the 50th anniversary of that remarkable occasion.

[6] United States Energy Information Administration, **https://www.eia.gov/todayinenergy/detail.php?id=39992**.

[7] Amit Katwala, "Great Britain just went two weeks without using coal. Here's how," *Wired UK*, May 31, 2019, **https://www.wired.co.uk/article/uk-coal-power-energy-renewables-new-record**.

[8] "Global Energy Transformation: A Roadmap to 2050," International Renewable Energy Agency, 2019 edition, 11, **https://www.irena.org/publications/2019/Apr/Global-energy-transformation-A-roadmap-to-2050-2019Edition**.

[9] Ibid., 22.

[10] Ibid., 11.

[11] Sean Ong, Clinton Campbell, Paul Denholm, Robert Margolis, and Garvin Heath, "Land-Use Requirements for Solar Power Plants in the United States," National Renewable Energy Research Laboratory, US Department of Energy, Technical Report NREL/TP-6A20-56290, June, 2013, **https://www.nrel.gov/docs/fy13osti/56290.pdf**. The article lists 7.2 acres per MW, which equals 29 km^2 per GW). Therefore: 8,500 GW × 29 km^2 = 246,500 km^2. UK land area = 242,495 km^2 according to Wikipedia.

[12] Klein Goldewijk, Kees & Beusen, A & Janssen, Peter, "Long term dynamic modeling of global population and built-up area in a spatially explicit way: HYDE 3.1," *The Holocene* 20 (2010): 565–573. 10.1177/0959683609356587. **https://journals.sagepub.com/doi/pdf/10.1177/0959683609356587**. Their research finds 0.5 million km^2 of built-up area, or half the rooftop area we require for those 8,500 GW of solar. 0.5 million km^2 is also roughly equivalent to the area required to power the world with solar energy alone based on a total global annual consumption of 678 quadrillion Btu. "Surface Area Required to Power the World," Land Art Generator Initiative, 2009. **https://landartgenerator.org/blagi/archives/127**.

[13] Many cities have policies that require one percent of a development project to invest in the arts. Often this equates to a direct investment in public art.

[14] Dan M. Kahan, Ellen Peters, Maggie Wittlin, Paul Slovic, Lisa Larrimore Ouellette, Donald Braman, and Gregory N. Mandel, "The Polarizing Impact of Science Literacy and Numeracy on Perceived Climate Change Risks," *Nature Climate Change* 2 (December 23, 2012): 732–735. **https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2193133**.

[15] The mountains block our view of it.

[16] "A Virtual Tour of Masdar City," *The New York Times*. Video. February 4, 2008. **https://www.nytimes.com/video/multimedia/1194817114256/a-virtual-tour-of-masdar-city.html**. The promotional video by Foster + Partners appearing in *The New York Times* was one of the first glimpses the world had of the Masdar City concept.

[17] This is the subtitle of the publication that documents the first Land Art Generator Initiative design competition for Dubai and Abu Dhabi in 2010. Robert Ferry, Elizabeth Monoian, Rachel Koh, ed., *The Time is Now: Public Art of the Sustainable City*. Singapore: Page One Publishing, 2012.