CITIES OF LIGHT

A Collection of Solar Futures

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Cities of Light:
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Cities of Light: A Collection of Solar Futures.

ISBN 978-0-9995902-9-4

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This material is based on upon work supported by the National Science Foundation under Grant No. 1041895. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

This is material also based on upon work authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. The views expressed in this publication do not necessarily represent the views of the DOE or the U.S. Government.

In memory of Lawrence Busch, 1945-2019,
who taught us that the design of a standard creates a
recipe not only for making a new technology
but also for constructing our future lives and selves.

Eternal sunrise, eternal sunset,
eternal dawn and gloaming,
on sea and continents and islands, each in its turn,
as the round earth rolls.

—*John Muir*

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Special Thanks
We owe a great debt of thanks to the staff and researchers of the National Renewable Energy Laboratory (NREL) for their enthusiastic support for and participation in the project, for hosting us onsite for a fascinating two days of conversations and engagement, and for their invaluable assistance with logistics. Thanks especially to NREL's star social scientist, Patricia Romero-Lankao, for her passionate support and tireless efforts to bring the project to fruition. Thanks also to the staff of the Center for Science and the Imagination and School for the Future of Innovation in Society at Arizona State University (ASU) for their substantial help with managing project travel and finances. We are very grateful for financial support from LightWorks, ASU's university-wide energy initiative; the Quantum Energy and Sustainable Solar Technologies (QESST) Engineering Research Center; the NREL Center for Integrated Mobility Sciences; and the Sloan Foundation.

About the Project

It should be evident by now to anyone who is paying attention that we need to radically decarbonize our societies posthaste, in the face of an ever-intensifying climate crisis. The thorny questions are in the design of that transition: precisely how we'll pull it off, what pathways we'll follow, where those paths will lead us, who will benefit, and who will be left out or behind. This is especially true in cities, which at their best are flamboyantly diverse, vibrant, cacophonous centers for cultural, social, and economic exchange and creativity, with deep histories, contentious political landscapes, and unique needs and constraints. Cities are hotbeds of human enterprise and infrastructure, critical nodes in transcontinental networks and supply chains, and centers of industrial production and economic consumption—all of which make them crucial arenas in the fight against climate change. Yet, they are so much more. To write the future of cities is to write the future of human experience.

To imagine the post-carbon city thus requires inquiry into far more than the technologies that will power its diverse activities. It requires an examination of what the elimination of greenhouse gas emissions from their lives will mean for the people who live in the cities of the future and walk, bicycle, and drive their boulevards and alleyways. The stories, essays, and art in this collection explore the challenges,

opportunities, and irreducible complexities of transitioning our cities away from carbon-intensive fossil fuels and toward a renewable energy economy. They do so not by proposing general one-size-fits-all solutions, but rather by reveling in the geographic, infrastructural, and cultural particularities of four cities in the United States: Chicago, Illinois; Portland, Oregon; San Juan, Puerto Rico; and San Antonio, Texas.

To begin mapping pathways through this complexity to cleaner, more equitable energy futures, the Center for Science and the Imagination and Center for Energy and Society at Arizona State University, in collaboration with the U.S. National Renewable Energy Laboratory (NREL), hosted a narrative hackathon at NREL's headquarters in Golden, Colorado, just outside of another bustling North American metropolis, Denver. The event, in February 2020—just before the COVID-19 crisis hit the U.S. and forced us to reimagine the present and future of cities in entirely new ways—brought together science fiction authors, visual artists, experts in diverse fields (including public policy, sociology, political science, electrical engineering, physics, sustainable infrastructure, and mechanical engineering), and talented student researchers to create technically grounded, inspiring visions of the future shaped by a transition to clean, plentiful solar energy in urban centers.

In 2019, we published *The Weight of Light: A Collection of Solar Futures*, which established the basic process for group collaboration that we have iterated on for this second effort, as well as the structure we follow in this book: four sections, each including a short story, a piece of visual art, and several essays, all emanating from a shared vision of a possible solar future developed collaboratively by one of our four teams. While that first book focused more on the geographical placement of solar infrastructure (urban or rural) and the scale (constellations of small, decentralized panels or large, utility-scale

installations), we focus here on energy transitions in cities, and how the peculiar features and habits of four distinct cities might shape, and be reshaped by, different approaches to decarbonization and energy transitions.

We grouped participants into four teams. Each team began their work by selecting a city in the United States as the setting for their exploration and storytelling. Teams also received two sets of randomly distributed cards in sealed envelopes, delineating points of focus for their visions of the future of clean-energy cities. The first set of cards pointed the team toward a handful of *urban districts*: downtowns, innovation hubs, higher education, parks and conservation areas, informal settlements, exurbs, and more. The teams were instructed to orient their work towards a couple of these districts, and ideally, on movement or interrelationships between them.

The second set of cards featured different *conceptual models of cities*: broad ways of thinking about the affordances, social functions, and unique character of cities. These included cities as regional hubs with deep interactions with and influence over their hinterlands; zoned landscapes, with different rules governing and activities occurring in each zone; place-based communities with distinctive identities, histories, and cultures; drivers of innovation, social transformation, and sustainability; and more. The teams were invited to use one or more of these conceptual models to shape their vision of energy transition and its complex transformative effects in their chosen city.

Finally, groups were given special instruction to think carefully about *contests over ownership* of energy infrastructure and the immense quantities of potentially valuable data generated by energy systems. Should energy ownership and control be public, private, or some mix of the two? Should ownership be centralized in utility companies, or other powerful institutions, or instead decentralized in some fashion among the denizens of the city? How will energy

industries and data industries overlap, negotiate with one another, collide, collaborate, or compete? Will energy infrastructure and industry be an engine for wealth generation—as it largely is today—or should it be reimagined as a resource for alleviating poverty and achieving greater economic equity?

In person during the workshop, and virtually in the weeks following the gathering, each team produced a short story set in the near future, a work of visual art that represents a key moment or theme from the story, and one or more essays that scrutinize the technical, cultural, and political issues that undergird these visions of the future, considering how we could get from here to there, and what signposts and obstacles we might meet along the way.

Narrative Hackathons are intensively collaborative, structured as a series of short interactive sessions with clear goals and deliverables. Our teams oscillated between small-group brainstorming, large-group presentations, cross-group feedback, revisions and refinement, and individual working time throughout the two-day event. We also were treated to a fascinating tour of the NREL campus, with behind-the-scenes glimpses at breathtaking labs and cutting-edge technologies for energy generation, clean mobility, and informed decision-making. In the wake of the event, the teams continued their conversations and worked with editors to sharpen and finalize their stories, visual art, and essays.

Our goal with this project is to speculate on the future of cities, and to celebrate the vitality and diversity of urban spaces, by imagining ways that communities can use the clean-energy transition as an opportunity to enhance what makes them special. The transition will involve messiness, discomfort, and in some cases, dislocation and displacement. Yet it is also a chance to strengthen neighborhoods, foster greater equity and civic engagement, and repair the natural environments and ecosystems that both surround and wind through

our cities. In this collection, we aim to provide glimpses into possible configurations of clean-energy infrastructure—along with its concomitant social relations, political structures, and institutions—that embrace the unique circumstances of different cities. We hope to encourage dialogue, debate, and critical thinking about how to navigate urban energy transitions in ways that are culturally responsive and inclusive, and in ways that honor and amplify the beauty and grandeur of cities, as well as their ability to provide places where people can live and thrive and make futures for themselves, their neighbors, and future generations.

To see full-color versions of the visual art, and to download and read this collection in different formats, visit https://csi.asu.edu/books/cities-of-light.

Introduction: Imagined Cities

By Clark A. Miller, Patricia Romero-Lankao, Andrew Dana Hudson, Joey Eschrich, and Ruth Wylie

"From each city Marco described to him, the Great Khan's mind set out on its own, and after dismantling the city piece by piece, reconstructed it in other ways, substituting elements, shifting them, inverting them."

—Italo Calvino, *Invisible Cities* [1]

How do we imagine the cities of tomorrow?

In Italo Calvino's novel *Invisible Cities*, the Venetian explorer Marco Polo receives an invitation to visit with the Mongol emperor, Kublai Khan. Trapped in his palace by the demands of rule, the Khan no longer knows the cities of his empire, except through dispatches and messengers he does not trust. And, so, he asks his visitor to describe those cities, to explore for him, through stories of his own travels, the state of the empire and whether his cities and their residents thrive. This Polo does, recounting 55 stories of 55 cities.

The challenge is that the two protagonists do not share a common

register of truth. Rather, the cities that Polo conjures are shaped by memories of Venice, while the Khan rambles through memories informed by past imperial campaigns, each refracting the streets of Polo's narratives through his own fantasies about what cities should be, molded by very different life experiences and positions of power.

Our task is similar. Today's decision-makers have far more capable data systems for knowing the cities of today. But we do not have any better tools than Polo and Khan for grasping the cities of tomorrow. And, so, we tell tales for you, conjured from our own urban experiences, and our own imaginings of what the future may bring, in the hope that they will inspire you to imagine and create sustainable cities of the future worth inhabiting.

An Exercise in Imagination

"I should never have imagined a city like this could exist ..."
—Italo Calvino, *Invisible Cities*

Imagine a city. Picture it in your mind, even just one neighborhood or part of town. Feel its shape, its textures, its vibe, its street culture. Envision the lives and the lifestyles that it cultivates and nourishes. What gives the city vitality? Why does it exist? Who lives there? What meanings does it have for them? What is its history? What is its future? Make it real. What does it cost people to live there, financially and otherwise? What inequalities and conflicts does it harbor? Who owns the city? At whose expense?

Now imagine that same city, a few decades from now, powered by solar energy. How has the city weathered the transition to renewable energy? Has its look and feel changed? Do people live, work, and play in different ways? Where are all the solar panels? Who owns them? Who benefits or bears the risks from the technological, economic, and political power they generate? How are benefits and risks distributed? How are those panels connected to the invisible threads of history

and purpose, commerce and industry, culture and society that make up the city?

Is the city of tomorrow you imagined worth inhabiting? For whom, and in what ways? How does sustainable energy contribute to that worth? In your mind, who decided what the future would look like, and whose voices were left out?

The Future of the City

"Kublai asked Marco: 'You who go about exploring and see signs, can tell toward which of those futures the favoring winds are driving us.'"
—Italo Calvino, *Invisible Cities*

This book is about imagining the future of the post-carbon city. And since, for millennia, the city has been a focal point of human experience, before even the Greeks conceived of their city-states and the Romans imagined their *civitas*—a community of citizens, from which we derive the English word *city*—this book is also about imagining the future of the human experience and human community in the wake of a sustainable energy revolution. We imagine that future as very different than the cities of today.

Many people agree that a major change in the energy sector is coming, and point to a need to swap the use of fossil fuels for renewable sources of electricity. Cities are the locus of that challenge. Cities are where people use and consume the vast majority of the world's energy. Cities, too, are where most of the world's energy systems are controlled, even if much of the energy is made in more distant places. Fortunately, around the world, thousands of cities have declared their intention to become carbon-neutral, as have thousands of city-based businesses across finance, transportation, manufacturing, and energy. Change is coming fast.

Almost everyone also agrees that a big part of the future of energy is solar—perhaps as much as half or more of future global energy

supply.[2] Solar energy is just too abundant and too cheap. As the epigraph for this book suggests, sunlight is, cyclically, eternal and everywhere. There's daylight to spare. The amount of solar energy arriving at the Earth's surface dwarfs human energy consumption. Photovoltaic (PV) panels already collect sunlight and transform it into electricity at lower cost than any other energy technology, and their price continues to drop at a rapid clip.[3] PV is also highly flexible: able to be deployed in a wide range of technological, economic, political, and social arrangements, making solar energy relevant to a much wider array of people, places, and organizations than other energy options.[4]

What kinds of tomorrows will this confluence of post-carbon cities and solar energy bring? If we do create a future powered largely by solar energy, what kinds of cities will flourish in that future? What kinds of people and communities, what experiences, what forms of living, working, and playing will take flight in sunlight-powered cities? Who will get to choose?

How much would cities change? According to the conventional wisdom, not much at all. We often separate energy production from use and think that we can substitute new forms of energy supply without influencing how we use energy. And, yet, there is ample precedent for the idea that energy creation and use change together in meaningful ways and, hence, that energy innovation could nucleate radical social and economic transformation.

No city dweller of the late nineteenth century could have predicted what either the automobile or the light bulb would bring to cities in the first several decades of the twentieth century.[5] Skyscrapers grew up, rising dozens and then hundreds of stories into the sky, made possible by electric elevator motors. Suburbs, exurbs, and highways were stamped out by the thousands, packed with cars and trucks fueled by inexpensive gasoline. Desert cities exploded outward, their

environments made livable by air conditioning. Houses filled up with hundreds, perhaps thousands, of electrical devices. Radio and television stations offered new modalities of mass communication and culture. At the dawn of 2019, nobody could have predicted the emergent behavioral changes—working remotely, reduced travel, social distancing—induced by COVID-19. Nobody could have imagined that, together with powerful economic forces, the coronavirus would push the coal and oil industry to unthinkable lows, that new pipelines would be cancelled or the price of oil would go negative, with deep consequences for climate change and for the health of people and ecosystems.

Will a renewable-energy revolution change cities as much as coal and oil did? Will an appreciation of the potential of renewable energy to bring new urban opportunities and benefits induce people to build cities differently, once again, as happened with the introduction of electricity and automobiles? If so, how? Such questions are rarely asked, except in narrow, technical terms that largely neglect the rich complexity and diversity of human experience. It is perhaps easier today to imagine such upheaval happening, again, as we write in the midst of the coronavirus pandemic. The pandemic has revealed the capacity for societies to act rapidly in response to global crises and the power of such action to reduce humanity's environmental footprint. Yet, it has also revealed the complexity of collective human action, even in the face of crisis. And it has revealed the deep racial, economic, health, and environmental inequalities that persist in cities, that expose people differentially to risk and harm, and that limit the ability of people of color to shape either their own futures or the future of the city. The simultaneous resurgence of massive protests in solidarity with the threatened lives of Black Americans has also made it clear that no institution in the United States today—including the energy sector—can afford not to ask how its own work contributes,

or fails to contribute, to advancing social and economic progress for Black, Hispanic/Latinx, Native American, Indigenous, and other disadvantaged communities.

It is essential, therefore, that we ask how energy transitions will contribute not just to decarbonizing the energy sector but also to transforming cities into safer, healthier, more secure, more prosperous, and more just places for all of their diverse inhabitants. What will an energy transition mean for the composition and organization of our cities, for how people in different neighborhoods live and work and play in them, or for how cities treat people of color and disadvantaged communities, politically and economically? Will investments in energy innovation enable change for the better, by reducing urban inequalities, or, if we are being truthful, for the worse, if we are not attentive to the social, political, and cultural dimensions of energy transitions?

We need, in other words, to ask not just what energy technologies will populate our urban futures, but what the future of post-carbon energy will mean for people in cities.

This gap in our thinking about energy futures blinds us to the realities of human transformation that will accompany large-scale energy systems change.[6] When we gaze today upon the world's poorest communities, many of which still use wood to heat their homes and cook their food and rely on human and animal muscle power for transportation, we intuitively understand that energy innovation is a driver of social and economic change. We imagine that their lives would be transformed by access to new ways of producing and consuming energy. Yet, when we envision energy transitions in North America and Europe, we do not imagine the same. We either do not think to ask—or choose not to inquire too deeply into—what it will mean for our cities if we power them differently. We focus, instead, narrowly, on where energy comes from, its sources, its carriers, and

the technologies that voraciously extract, transform, and consume it to do work in modern industrial and post-industrial societies and economies.

This is a mistake. Time and again, cities have transformed through new ways of harnessing energy to human organization and work.[7] Yet, it's as if we have forgotten that fact: that cities throughout history have driven and shaped themselves around their sources of power, light, fuel, and energy. We know that today our cities embody what anthropologists describe as *petrocultures* and what the historian Timothy Mitchell has called *carbon democracies*—ways of living in and ordering human communities along lines sculpted by inexpensive coal and oil.[8] Why do we not ask what it might be like to live, instead, in *photoncultures* and *solar democracies*?

The answers to this question are legion, even as they are unsatisfactory justifications for neglect. It's too hard to predict transformation. We view technology as an independent driver of social change over which we have no control: whatever comes of a solar-powered future will come. It's politically inconvenient to admit, for example, that fossil-fuel industries will close and jobs will be lost. Imagining that society will be better off in a new energy regime smacks either of naïve utopianism or blatant boosterism. Engineers, economists, urban analysts, climate scientists—professionals authorized in our societies to speak authoritatively about energy futures—often work in narrow techno-economic terms and eschew problems of techno-politics and techno-culture that are difficult to reduce to numbers, equations, models, and algorithms. We have lived so long within the walls of the current energy paradigms that we have forgotten how powerful new ones can be. We imagine that energy infrastructure is like plug-and-play hard drives on our computer: take one power plant off the grid, put another one on; remove one internal-combustion engine from the streets, insert one electric vehicle. We imagine that our social

and economic behavior is too rigid and fixed to ever change, and thus any future energy system must merely replicate existing structures, rather than change them. We measure energy consumption by the amount of energy we consume, rather than by the forms of political economy it gives rise to. Climate change is too important: we need to be laser-focused on getting to carbon neutrality.

There's one big reason, however, to speculate about cities of the future, powered by solar energy, in the full richness of their human vitality. The future is not set in stone.

We can neither predict the future nor control it. Yet, although the power to envision and realize urban futures is unevenly shared across our cities, we make individual and collective choices every day that shape the trajectories that lead us inexorably to tomorrow. Those choices, and their unequal distribution across different groups, have deep consequences for which future cities our children will ultimately inhabit. Our aim, therefore, is to expand the opportunities to imagine cities from the future, to tell more diverse stories about them, to stimulate your imagination to dream about the cities of your future, and to help you recognize and open up the choices that you are making today that are bringing them into being. If we can do so, and in so doing can help humanity cultivate a capacity to bring into being cities worth inhabiting, then our purpose will have been served.

Imagining and Designing the Future

"The Great Khan contemplates an empire covered with cities that weigh upon the earth and upon mankind, crammed with wealth and traffic, overladen with ornaments and offices, complicated with mechanisms and hierarchies, swollen, tense, ponderous."

—Italo Calvino, *Invisible Cities*

In *Dreamscapes of Modernity*, Sheila Jasanoff and a group of scholars in the field of science and technology studies describe the incredible

power of the human imagination to create and realize dreams.[9] At the heart of their account is the idea of *sociotechnical imaginaries*: "collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology." Sociotechnical imaginaries are the iron cages of the modern mind, shared across universities, laboratories, industries, governments, and communities, like the angels and devils who sit upon people's shoulders and constantly whisper into our ears, reminding us of the power of this or that technology to make life better. They are the stories that define our expectations about future technological, political, and societal situations and capabilities.

No better examples of sociotechnical imaginaries exist than the ideas of the automobile city and electric city birthed in the United States in the first few decades after 1900 by Henry Ford and Samuel Insull—ideas that subsequently ruled the twentieth century. Indeed, these imaginaries became so hegemonic that they spread far beyond the United States, infecting the reveries of people everywhere. More than one billion people around the world, one in seven inhabitants of the planet, still do not have electricity, and many more do not drive automobiles. Yet, everywhere on Earth, we find cities that have been reworked around these two technologies. Everywhere, the dream of modern energy services fuels ambitions of development.

We live in a world of standard energy. Oil is refined into gasoline and diesel and jet fuel to power transportation. Monopoly utilities provide electricity, even within so-called electricity markets, powered by large, centralized power plants and carried by regional transmission and distribution grids. Globalization is a product, in no small part, of the standardization wrought and made possible by our global energy systems. People and goods can move anywhere, thanks to the uniformity of our oil and electricity infrastructures.

In the last quarter century, however, it has become abundantly clear that these global energy systems are deeply unsustainable. Nor is it merely their carbon that is a problem. Modern energy systems are among the most dangerous technologies on the planet. Car crashes kill five times as many people per year as gunshots. According to the World Health Organization, over 20 million people are injured each year in traffic accidents.[10] Air pollution from cars and trucks clogs the world's cities, contributing to over 4 million annual deaths. [11]

Our task in this book is, therefore, through novel stories of cities of the future, to help break the chains that bind the human imagination to particular technological flights of fancy.

Our goal is not, however, simply to substitute light for dark. The solar future is not fixed. It does not come in a single flavor. Rather, there are many possible sociotechnical paths to follow, and the ones we choose to take—as individuals, as cities, as nations, and as a planet—will have profound implications for people's hopes and dreams, lives and livelihoods, communities and commonalities, for centuries to come.[12] We aim instead to open up for imagination, exploration, interrogation, and debate the myriad possibilities of the solar-powered city of the future.

Imagine two photographs, for example. In each, solar panels blanket the rooftops of a suburban landscape. In one, invisible to the eye, but woven into the topography, a homeowner owns each home and its attendant solar system, generating and selling power to neighbors through peer-to-peer markets. In the other, a single wealthy individual or company owns all the solar panels, renting roof space, perhaps from the sharing-economy landlords who own the homes, selling power to the tenants: the largest utility in the world. Now imagine two more photographs, also identical in all visible respects: in each, solar panels shade the public spaces of a desert city. In one, an investor-owned utility has monopoly rights to produce and sell electricity

and the power to restrict or demand compensation from other solar providers, even private citizens who might wish to generate power for themselves. In the other, neighborhood co-ops distribute the power—and the revenues—to their members, their constitutional rights to collect and share energy guaranteed by their society. The political and economic differences across these four photographs are vast: a libertarian dream, a neoliberal nightmare, a variant on state-sponsored capitalism, a collectivist utopia.

Nor are the choices open to us only ones of ownership; they are also decisions about access to solar assets and services, about what kind of solar systems to develop, where, and for whom. For solar energy disrupts the fundamental temporal and spatial rhythms of the city. For over a century, the differences between day and night have increasingly been erased by the relentless drive for 24/7/365 occupation, the differences between one part of the city and another flattened by the homogeneity of the streets, the cars, the electricity grids, the homes with their front-facing garages and their ubiquitous electric lighting and devices, the big-box retailers that cater to their person-car customers. Standard energy has begat standard people, standard homes, standard lives.

Part of what has driven and enabled the vibrant hum of 24/7/365 culture is the unyielding nature of thermal power. Coal and nuclear power plants dislike variation: they prefer to produce the same amount of electricity, day, night, summer, winter, year after year. As a result, nighttime electricity has always been cheaper than its daytime or evening equivalent, reflected today in time-of-use pricing plans that, for example, in Arizona, sell electricity for 7 cents per kilowatt-hour during winter nights and 24 cents during summer afternoons and evenings. They also like economies of scale, meaning they prefer to operate in giant, centralized power plants that power entire regions, like the 4 GW Navajo Generating Station coal plant that closed in the

winter of 2019, or the 4 GW Palo Verde nuclear plant, which, between them, powered half or more of the Phoenix metropolitan region.

Solar is different. Sunlight is plentiful at certain times of day and scarce or absent for long periods of night or overcast skies. Already, at still relatively low levels of integration into the electricity grid, solar power in California generates so much electricity during the middle of the day, between 10:00 a.m. and 2:00 p.m., that prices in California electricity markets are negative—meaning they are paying people to use daytime electricity. And while solar, too, acquires some rewards from economies of scale, those advantages decrease markedly above the size of a good parking-garage rooftop system, or a shade structure in a public park. In addition, in many cases, the higher costs of small-scale solar systems are compensated for in buyers' minds by other factors of solar design, such as resilience in the case of grid outages, savings on utility bills, and a desire to be seen to contribute to addressing climate change. These factors influence their willingness to pay for everything from solar-powered devices to small home systems to neighborhood and community solar projects. Indeed, the emerging solar city is already a hodgepodge of different kinds of systems, with different forms of ownership, scattered across both urban and rural landscapes. Solar is a flexible instrument that can be written into many different possible narratives of the urban future.

Just how all of this will affect the life and hum and culture of the city thus remains unknown, emergent, yet to be written. As they do now, some people and companies may opt to concentrate their energy-consuming activities during times of low electricity prices, which in a future powered by solar energy will occur in the middle of the day instead of the middle of the night. Others may choose higher-priced options for storing electricity for later use, whether in batteries, electric vehicles, hydropower reservoirs, heavy weights, spinning flywheels, or chemical energy, reconstituting fuels that can transport energy over long distances and not just across time. These

trade-offs are similar to those encountered in fossil-energy systems, but now reconfigured around new temporal and spatial patterns of pricing and value, altering the relationships between desire, dream, ambition, and energy, reoptimized algorithmically or through more human and humane means to find new peaks and new troughs, new patterns, new relationships, new behaviors, new ways of lighting and powering the city and making it go. And new supply chains, connecting in new ways one city with another, with their rural neighbors, and with far-flung resources, places, and peoples of the planet, creating new patterns of social and ecological footprints in the world—a new set of energy landscapes and geographies and lifecycles for critical review and reassessment.

There are those who say that the only questions that matter are whether we can achieve a solar-powered city, how fast, and how to do so at the lowest possible cost. How silly. The future of the city—of all cities, of the human experience—is too important to be constrained in such narrow terms, too significant to be left solely in the hands of those with the money to buy solar panels in the vast quantities necessary to power the global economy. Why should they alone be allowed to determine the shape of the streets our children and grandchildren wander, the fountains they sit by as they woo their future partners, the shopfronts and cafés they frequent, the distributions of power and wealth that determine whether their lives and those of their friends and families are put at risk or protected by the technological landscapes of tomorrow?

Which City?

"I will describe the cities and you will tell me if they exist."
—Italo Calvino, *Invisible Cities*

Which city did you pick, back at the beginning of this essay? Paris? London? Beijing? São Paolo? Des Moines? Dallas? Detroit? We are used

to thinking about cities in terms of their place in the world. And place matters enormously in the world of solar energy. Hot and dry cities like Phoenix and Ouarzazate, Morocco, nicknamed "the door of the desert," inhabit environments with full sun and few clouds. The equator has more consistent hours of daylight, year-round, than the polar latitudes, where for months at a time the sun barely rises above the horizon. Hot climates need air conditioning during the summer day, cold ones heating during the winter nights. Silicon PV panels produce more energy in arid zones, thin film cadmium-telluride panels more in their humid counterparts, water vapor obscuring less of the parts of the solar spectrum that they prefer relative to their silicon cousins. European cities are more compact, more conducive to electrified public transportation and bicycling than their suburban and exurban counterparts in North America.

Yet, as Marco Polo's pageant of cities reminds us in Calvino's *Invisible Cities*, geography is only one facet of the city. Cities are not just infrastructures arranged on the land; they are communities of people, with all of the complexities that entails. In Diomira, we are introduced to "a city with sixty silver domes, bronze statues of all the gods, streets paved with lead, a crystal theater, a golden cock that crows each morning on a tower." In Dorothea, Polo tells how "the nubile girls of each quarter marry youths of other quarters and their parents exchange the goods that each family holds in monopoly—bergamot, sturgeon, roe, astrolabes, amethysts." In Zaira, we learn of the "relationships between the measurements of its space and the events of its past: the height of the lamppost and the distance from the ground of a hanged usurper's swaying feet; the line strung from the lamppost to the railing opposite and the festoons that decorate the queen's nuptial procession; the height of that railing and the leap of the adulterer who climbed over it at dawn." Of Anastasia, Polo opines, "I should praise the flesh of the golden pheasant cooked over fires of

seasoned cherry wood and sprinkled with much sweet marjoram." In Tamara, Polo directs our eye not to things but rather to "the images of things that mean other things: pincers point out the tooth-drawer's house; a tankard, the tavern; halberds, the barracks; scales, the grocer's." "Zora," Polo observes, "has the quality of remaining in your memory point by point, in the succession of streets, of houses along the streets, and of doors and windows in the houses .... The man who knows by heart how Zora is made, if he is unable to sleep at night, can imagine he is walking along the streets and he remembers the order by which the copper clock follows the barber's striped awning, then the fountains with the nine jets, the astronomer's glass tower, the melon vendor's kiosk, the statue of the hermit and the lion, the Turkish bath, the café at the corner, the alley that leads to the harbor."

Cities are all of these things—culture, food, history, arrangements of buildings and people, constellations of businesses and signs—and much, much more. Cities are economic engines and cultural hubs, and their density remains the best way to limit the impact of energy systems on the environment. Cities are also places of inequality and injustice, where structural oppression is intensified, evident, and visible.

"Which city?" is a cue to engage this diversity in imagining urban futures powered by post-carbon energy. Cities are centers of population but also industry, services, commerce, and tourism; the city that the tourist sees, imagines, and remembers is different from that recalled by the shop seller, the artist, or the pensioner, though they all share the same space. Which city will be transformed by the coming energy revolution? Whose city will be reinvented, for whose benefit, and at whose cost?

To that end, this book is not an attempt at prediction. We do not imagine that we could possibly foresee the future of the city, even as we approach science fiction as a "seeing instrument," in the words of

Joni Adamson, through which to explore what possible futures might look like.[13] Rather, it is an exercise in *speculative*, *design fiction*.[14] There are those who see in design the triumph—or curse—of the aesthetic, the victory of a paradigm of form and beauty over function and work. But there is no such constraint in the verb *o design*. To design, at least as we define it for our purposes, is to imagine, to create, to build, to plan: to set in motion a process through which a future is anticipated, reflected upon, contested, deliberated, and then worked toward. Design is open-ended, fluid, flexible, capable of arriving at multiple possible endpoints depending on whose voices and ideas enter into the process and shape the choices that enter into the future-in-the-making. It can be exclusive, the province of experts or those with the power or money to set the criteria against which design options are evaluated. It can also be inclusive, open to a diversity of perspectives, values, lenses, ways of seeing and imagining the future yet to be.

This book is an effort to leverage that inclusivity to undo some of the constraints that currently impinge on the design of future cities. Today's urban futures are constrained by the sociotechnical imaginaries that pervade societies, which are embedded, reinforced, reinscribed at every turn in our mental maps and in the design and construction of our technological infrastructures. No one any more can pretend that the future of the North American city, with its ever-growing networks of concrete highways and byways, its snarls of traffic and congestion, navigated with ever greater care by its Google Maps-informed person-car-phone hybrids, segregated into its zones of racial, class, and ethnic disaggregation and divergent regimes of enforcement, can continue in familiar pathways. Too much is awry. And, yet, every year, the Department of Transportation receives its allocation of public funds, and every year its engineers design new highways to reach new suburbs. Every year the highways get new lanes, to carry more person-car-phone hybrids on their daily journeys

further and further from home to work to store to school and home, again. And all too frequently those highways run through the neighborhoods of the poor and vulnerable.

If we are to choose different futures for our cities—more sustainable, livable, resilient, diverse, empowered futures—we need to escape the power of the reigning sociotechnical imaginaries over how we imagine the future of technology and society. We need innovative tools for speculating about the future in new ways: tools that open up the imagination to new possibilities for design, new ways of arranging the relationships between people and their machines—and between people—so that we can reconfigure the cities of the future. We need to explore what might happen if we follow Path A or Path B to deploying solar energy. What would it mean to build, for example, giant solar farms across desert landscapes to produce hydrogen fuel to power cars and buildings during the times when solar energy is less abundant? By contrast, would it be better to design small, distributed solar and battery systems that power individual houses of microgrids? We need to ask better questions about what happens when daylight energy is abundant and cheap and nighttime energy scarce and expensive—and how that fact will matter for people's day-to-day lives, their sensibilities about nature, and the organization of their businesses and work. We need to interrogate what happens if we organize the ownership of solar in this way, versus that way. And, if capital costs rise in the economy due to higher energy expenses for using equipment on the night shift, we need to know what that may mean for fundamental economic arrangements, such as the balance between labor and capital and the prevalence of meaningful, well-paid work.

Speculative Design Fiction and the World-in-the-Making

"With cities, it is as with dreams: everything imaginable can be dreamed."

—Italo Calvino, *Invisible Cities*

This volume is one attempt at building tools that travel part of the way toward opening up the design imagination to new possibilities of rich and nuanced techno-human futures. At the heart of the collection are science fictional narratives, stories of future cities, each coupled with extended expert commentaries and artistic imagery designed to help both flesh out the sociotechnical worlds our future cities inhabit and allow them to capture and engage diverse facets of visual, textual, rational, and emotional imagination.

The power of such assemblages rests in the emergent world-making in which each and every one of us partakes. The fabrics of our present-day techno-human relationships are richly hued, full of complex, nuanced shadings of color, pattern, and texture. Our cities hum with excitement and vibe, with the power of technology and innovation, with the dynamism of global trade and transport, the vitality and pandemonium of diversity and cultural cross-fertilization, layered with the lived experiences of hundreds of intersectional inequalities. If someone tries to sell you a simple story about technology, assume that the underlying reality is about a thousand times more convoluted, multifarious, and dense, as Jasanoff's *Dreamscapes of Modernity* reminds us.

And yet, at its core, Jasanoff's most important argument, which goes by the label of co-production, is remarkably simple. As societies fashion new technologies, through the choices they make about what technologies to invest in, how to design and implement them, and how to wrap them up in human lives and livelihoods, societies also fashion themselves. That's partly why it's all so damn complex out there, in the sci-fi land of artificial intelligence and of human

germline engineering and carbon capture and recycling, where we all apparently now live. We're never just making technology; we, too, as denizens of technological landscapes and constitutions, are always also at stake.

Our cities aren't just bunches of buildings, streets, sewer lines, electricity grids, 5G networks, doctor's offices, shopping malls, biological and chemical feedstocks, grocery stores, scientific laboratories, and factories. They are living, breathing communities of humans, people with different ideas, imaginations, lives, families, bodies, work, conversations, health outcomes, neurological states, and entertainment, and those communities are always in-the-making, in dynamic tension with the always-also-in-the-making techno-scientific infrastructures that we inhabit.

Humans are constantly making and remaking the forms of materiality and sociality that make us up as techno-human dwellers of the urban landscape. As cities decide where to build streets and highways, what rules will govern the design of buildings and the operations of hospitals, not to mention which neighborhoods will get power plants next door, they are also deciding, de facto, what it will be like to live in different parts of the city, who will be exposed to health risks, and how prosperity, power, and thriving will be distributed among their residents. We don't get a choice about it. There's no magical middle ground, no apolitical fantasy-land, in which technology exists independently of the people who design and use it.

When we fashion our technological futures, we also fashion the cities of the future where we will reside. There is no option in which the future of the city is not written in the choices we make about how to design and implement the future of energy. There is no future in which our choices of how to design solar tomorrows don't also involve choosing how to allocate wealth and power among the city's citizens (and non-citizens), or the kinds of lifestyles and the forms of work

that will be possible, or not, in a clean-energy future. We can't escape the reality of techno-human co-production.

The question is how to shape it.

We know it is possible to write alternative technological futures, to create worlds that infect and empower our imagination and let us become, at least for a short time, an inhabitant of a different city in a different place at a different time: *Star Wars*' Mos Eisley, on Tatooine; Asimov's imperial capital, Trantor; the future Bangkok of Paolo Bacigalupi's award-winning novel *The Windup Girl*, in which the calorie men own the world through their monopoly on the patents for rice and wheat, which store the sun's energy in their carbohydrates, to create biofuel for the megodonts that slowly, step-by-step, crank springs to store potential energy in their windings for later human consumption.

The question is how to create stories that go further than just writing alternative futures, that also meaningfully engage people in dialogue, even if only with themselves, about the future-in-the-making that surrounds us every day. For every day, theories of co-production tell us, we are making and remaking ourselves, our societies, and our technologies through the choices we make as citizens, inhabitants, businesspeople, financiers, mayors, legislators, regulators, managers, protestors, and more. Of course, as Yaron Ezrahi reminds us in *Imagined Democracies*, those choices are always structured by our imaginaries of what is or is not possible, within the cities and societies that we inhabit, and the distributions of power and wealth that determine whose decisions lead to which outcomes.[15] And, so, to make different cities, we need stories that help us to understand those structures and to understand how it might be possible to imagine making a different array of choices. We need stories that infect people's imagination differently as they are making their choices, every day, about where and how to live, work, and play, about how their

households and organizations will engage in renewable energy transitions, and about where and how to place, own, arrange, resist, use, and otherwise relate to solar energy. The depth of what is at stake in these everyday choices is nothing less than the future of the city—understood as Calvino would have us understand it, in all of its startling complexity, multiplicity, and diversity.

This book is an attempt to create such stories and to embed them in the kinds of conversations that Polo offered to the Khan—conversations that stimulate the imagination to new leaps of creativity but that also reshape the everyday work of building and maintaining the city. These stories are the product of conversations among a diverse array of people with deep knowledge and passion about the future of energy, the future of the city, and the future of humanity. With its accompanying essays and artworks, each story is also in dialogue with other writing about the future, in other genres. And each is in dialogue with the other stories and essays in this volume, as well as those in its predecessor, *The Weight of Light*, across the four future cities described in these pages (Portland, San Juan, San Antonio, and Chicago) and the two cities portrayed in that previous volume (Phoenix and Detroit).[16] Together, the two volumes offer a comparative, cross-pollinating look neither at utopia nor dystopia, but rather at what might come to pass if the collective choices of those building the futures of these cities follow particular pathways through the energy transitions to come, rather than others. They are none of them set in the same world; nonetheless, they are meant to be read together, in hermeneutic tension with one another, as stories about the possible futures of our world, the one we all live in, sometime after the day after tomorrow.

The stories and essays are, to return to the beginning, much like Marco Polo's stories to the Khan, in his palace at the heart of the empire. In modernity, the imperial gaze has been replaced by the

God's-eye view of science, the view from nowhere, or everywhere, simultaneously transcendent and immanent. The difference matters enormously for the perspective gained, yet it remains through our imagination that, when we gaze out at the world, the light falling on the cones and rods of our retina, converted into electrons flowing along the optic nerve to our brain, is transformed into cities. Even the overhead imagery of the satellite works its magic by conjuring in the mind's eye far more than it reveals from its heights. These stories and essays are another lens through which to view the city of the future, one which stimulates the imagination in different ways, and one which, we hope, leads to new pathways and new designs.

Invisible Cities, after all, isn't about the Khan and his ability or inability to truly see the cities of his empire. It is an invitation to you, the reader, to enter into and share the same opportunities as the Khan, to participate in imagining the city and what it means for the people who live there, so that perhaps you may come to see the city in a different light. So, too, this book and the stories, art, and essays that it contains invite you, the reader, who may know much or little about energy technologies or economics, to nonetheless participate in a conversation about the future of energy—and the future of cities powered by light. It is nothing less than a conversation about your future, the future of your family, and our human future, as a collective enterprise.

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Design Variables

At the heart of this project sits the question of design. What options do we have for the design of solar energy futures? How will we design solar technologies? How will we integrate solar technologies into the design of urban landscapes? And how will we design the societies and economies of the future around solar energy? This approach emphasizes that solar design is not merely a question of technology: it's also a question of how we make solar energy part of our lives as individuals, households, neighborhoods, and cities.

We use a variety of tools and strategies to prompt people to think creatively and imaginatively about the future design possibilities for solar power and solar-powered societies. For this book, we asked each team of participants to choose one city, and to root their explorations in the unique people, streets, neighborhoods, politics, and geographies of those cities.

For each city/team, we then randomly selected two city districts and asked the team to explore the distinctiveness of those districts as sites for, beneficiaries of, and places put at risk because of solar energy projects. Places like the port, the factories, downtown areas, and the exurbs—and the people who live and work there—will engage and experience solar energy in fundamentally different ways. Thinking about those variations through a comparative lens helps highlight why design matters and the diverse ways that solar may shape the future of the city.

Finally, we asked our teams to reflect on a set of design variables that we developed for our first collection, *The Weight of Light* (2019),

which lay out some of the key axes of variation across solar energy systems design:

Geography: Where will solar energy systems be built?
The question of where we install solar systems is crucial to all kinds of design questions, as design will always be shaped by place. Will we build them in cities or in the countryside? In cities, will we build them on rooftops, in parking lots, in parks, over streets, or as giant shade structures over entire cities?

Scale: How big will the solar systems of the future be?
Many people argue that the only financially sensible approach is to build the cheapest solar plants, which at the moment are also the largest: utility-scale projects of 10+ megawatts (MW). But distributed, rooftop-scale systems of a few kilowatts (kW) remain highly popular with households all over the globe and have many advantages, despite sometimes being more expensive. Rooftop systems also deliver energy at the point of consumption, reducing losses from transmitting energy long distances and the costs of building and maintaining transmission lines. And many others advocate for the benefits of community-scale solar projects, in the 1-5 MW scale, which power individual neighborhoods or small communities.

Ownership: Who will own the solar energy of the future and benefit financially?
Ownership of and financial benefit from existing energy systems tends to be highly concentrated. Solar systems are already demonstrating the viability of different ownership models that distribute financial risks and rewards in new and innovative ways. Key questions include scale and distribution of energy ownership (potentially independent of, or intertwined with, system size and geography) and questions of public vs. private ownership.

Governance: Who will make the rules for solar energy futures?
Existing energy systems operate under a huge variety of different governance models, from government-owned-and-operated models to regulated monopolies to electricity markets to internationally traded commodities. Solar could arguably easily fit into all of these options and perhaps some new ones.

Aesthetics: Can solar energy futures be beautiful?
It's a taken-for-granted assumption of modern energy landscapes that energy infrastructures are allowed to be industrial monstrosities. Where they aren't relegated to out-of-the-way locations, they are visual blights. Folks like the Land Art Generator Initiative, on the other hand, are exploring whether the future of solar energy is in tourism. Can energy also be art?

Supply Chains: Where do all those solar panels come from?
The design of the solar-energy manufacturing industry, with its factories and transportation systems, is a critical question with regard to the future of the solar-energy workforce (e.g., where will the jobs be, and what kind of jobs will they be), and how its financial benefits and environmental risks are distributed. Given the scale of construction required, the question of what materials get used in manufacturing solar panels is also crucial, and where and how those materials are dug up and transformed into the building blocks of photovoltaic systems.

Waste: Where do all the dead solar panels go?
The current expectation is that solar panels will last 25 years before needing to be replaced. Longer lifecycles may be possible in the future, but a century from now, we'll have had to figure out how to dispose of four generations of solar panels, in very high volumes. How we set up the plans to do that will have major implications for society and the environment.

Chicago, Illinois

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To see a full-color, high-resolution version of this image, visit https://csi.asu.edu/books/cities-of-light.


HOOD
ELECTRIC

Efficiency

By Paolo Bacigalupi

James Black, his father's worst enemy, clips his safety harness to deadman bolts and steps up onto a 1000-kilogram weight. Beside him, a flywheel the diameter of a city bus is spinning. It looms over him, a blur of motion holding vast amounts of kinetic energy. A chill breeze wafts over him, hinting at how fast the massive wheel spins on frictionless magnetic bearings.

James sets his work boots more securely, readies his stance, and grabs onto the steel cable that holds the weight. He takes a breath and nods to Fitz that he's ready to fly.

Fitz gives him a devil-mischief look, shouts, "Have a nice trip!" and yanks a connection lever. Kinetic power from the flywheel feeds into gears, feeds into winches, feeds into the steel cable holding James's weight.

With crushing Gs, James surges skyward.

Riding the weight, he shoots up out of the Willis Tower sub-basement and up through an open gap in the pavement. Cold winter air engulfs him. Electromagnetics kick in, pushing him faster and higher. Icy wind makes his eyes tear. He's speeding up the face of Willis Tower, whipping past other suspended weights in their columns, his cheeks tugging at the Gs, his exposed skin freezing. He keeps rising. He escapes the shadow canyons of downtown Chicago and rises into bright winter sunshine.

A snow-mantled city sprawls below him. The weight suddenly slows. For a moment he's weightless—as if he's launching into open air and about to fly. The weight comes to a stop.

Standing atop the weight, James hangs suspended above the city, exposed to sun and sky and the bracing winds racing off Lake Michigan. Out on the lake, the waters are frozen, the lakefront ice-rimed. Wind turbines rise from the lake's smooth snowy surface like white arctic flowers, scattered all the way to the horizon.

James clips his harness to a safety line and checks that it's secure before unclipping from the weight he's ridden up on. His breath steams and streams away with every exhalation, stolen by the winds.

Technically, they aren't supposed to ride the weights up and down the face of the building; they're supposed to use internal elevators and then access external service catwalks and ladders. But why would anyone do that when you can grab a superhero ride to the top of the world?

That's Fitz's philosophy, anyway, and James has joined the brotherhood.

James threads across the building face on a thin steel catwalk. Down below, pedestrians are barely discernible dots on the pavement. The storm of two nights before has passed, leaving a foot of snow. The city is bright and clear and brilliantly white, hard architectural edges softened, dirty pavement muffled. James can see all the way down to south Chicago, where he grew up. Can see the peekings of dark-panel solar cells already being cleared of snow, everyone eager to harvest the sun while it's shining. Panels everywhere, coming clear now. The panel arrays fill the redesigned streets and cover the rooftops. A few of the little electric HoodBuses that serve the blocks are also moving, using the juice that's finally flowing in from their minigrids.

James slips behind guide rails and pulley cables. The weights and cables are all numbered. He's working his way over to the S-17 column,

where a couple hundred tons of lead hang, frozen in place, courtesy of the polar vortex and moisture off the lake. Ice has gotten into the wheel mechanisms. Ice still comes to the city—not as much as historically, but it happens.

Lucy is supposed to keep all the weights moving a little, to keep them from freezing up, but the storm was unusually brutal and so Great Lakes Amalgamated's Large Utility Calibrated Yield AI, LUCY, has put out the call for some good old-fashioned chiseling.

James locks the S-17 column on his smartphone, engages the physical gear-locks, resets his safety harness, and rappels down to where the iced-over weights dangle high above the city. He gets to work, chipping ice from the guide wheels.

In his earbuds, Lucy says hello.

"You're late."

"I thought we talked about being more polite," James replies.

Lucy gives a little huff of irritation. "You're still late."

James has given up trying to figure out which parts of her protocol are just programmatic and which are learned behaviors. She's too quick for him, and if he tries to trick her and make her say something nonsensical or respond in a way that exposes her programming limits, she turns the tables, making him sound increasingly foolish as he tries to make her say something silly. She's apparently different with other workers. When he mentioned to Fitz that he talks to Lucy, Fitz gave him a look that said he thought James was crazy.

"Just be glad I'm here," he says, breath steaming. "It's cold."

"Of course it's cold. That's why I called you." Lucy sounds vaguely exasperated. "Do you know how many picoseconds it's been since I called you? I have work to do. Houses need power. Buses are discharging."

"It's just one stack."

"One stack becomes two stacks becomes five stacks and the next thing you know, I have problems with the utilities commission."

"You don't have problems with anyone."

"You have no idea how difficult it is to describe power optimization to meat people. So. Many. Words."

In Lucy's ideal world, she'd send streams of numbers to her regulators and they'd just understand how brilliant she has become.

What started as a World's Fair demonstration of energy storage, both as a practical solution to the grid surges and deficits caused by renewables and as a visual-art demonstration of energy use, is now a landmark.

Lucy moves thousands of weights up and down the faces of Willis Tower and the Hancock Building. The weights ride on smooth electromagnetic rails, each weight independently latching onto cables and pulleys that in turn attach and detach to flywheels and generators, all of them orchestrated by Lucy as she responds to the ever-shifting requirements of GLA's grid. Lucy absorbs the winds on the lake with her turbines, she feels the heat of the sun on her solar skin, and she plans and strategizes all the time. When a surfeit of sunlight or wind surges into the grid, Lucy harvests the power and winches weights high into the air. By slapping one-ton weights together like giant Lego bricks, connecting one to the next with clamps, and pushing them up the sides of the building, she hoists hundreds of tons of potential energy up into the air. Then, when demand surges, she lets precise numbers of the weighted bricks fall, generating exactly the amount of power that the grid demands, increment by increment. At the same time, she creates a constantly moving light display all up and down the skyscraper as bricks rise, fall, connect, some higher, some lower, something always moving, a living visualization of the power usage of the city.

"Are you finished?" Lucy asks.

"Does it feel like I'm finished?" James braces his feet against thin-film PV windows, waves in at the worker bees at their workstations. Starts chiseling again, suspended from his harness.

The first time he worked this high, he almost broke. Only stubborn pride kept him from giving up on his dream of working the biggest and most bizarre energy storage project Chicago had yet launched. Only the thought of his father looking at him with I-told-you-so contempt kept him from begging to come down.

That first time up the face of Willis Tower he'd focused his eyes only on his work, only on the cables and electromagnetic guide rails and the catwalks, never looking around, not permitting himself to see how far down everything was, how open the air was, not permitting himself to think about how much his hands were shaking—hell, how his whole body was shaking.

That first time, Lucy must have read his pulse or heard the crack in his voice because she'd been kind and supportive. Encouraging, even.

At the end of the day, back on the ground, Fitz had handed James a celebratory homebrew and James had watched, fascinated, at the way the bottle shook in his hands, at the jitters that lingered.

These days, James is mostly afraid of how comfortable it feels to work on an energy storage system more than a thousand feet in the air, and banter with its AI.

Sometimes in the summer he sits up on a catwalk with a solar protein sandwich from home, watching people in their apartments in the neighboring towers, rich people who pay not just to see Lucy's weighted columns and the rise of Willis Tower, but also to keep the weights lit up at night with LEDs, making for a skyline view that raises their property values by hundreds of thousands of dollars. Lucy has security cameras all over herself. She likes to point them at the windows across the way and tell him where the exhibitionists are.

Lucy thinks meat people are hilarious.

Now, dangling high above all of Chicago, instead of turning his face from the view, instead of facing energy exchange traders grinding out spreadsheets on their monitors on the other side of the translucent solar glass, he turns slowly, dangling, looking south, to home. South Side. Hyde Park. Further south.

From this height he can see the solar panels all across the buildings there, can make out some of the streets that his father redesigned, see the solar panels that he grew up servicing, replacing, rewiring, shoveling off in winter, washing in summer. It was there that he'd learned about direct and alternating current, voltages and watts, silicon cells and perovskites—

"Why the fuck would you want to work for Great Lakes Amalgamated?" his father had asked when James first broke the news about his new job. They'd been in the kitchen, warm with the smell of cornbread and solartein baking. The house tight and cozy, just the way his father had made it, refitting the old brick rowhouse until it was completely independent of energy demands other than those that he could generate himself.

"Why wouldn't I?" James retorted. "GLA's doing amazing things."

His father shook his head. "They're doing amazing things, now. Now that we got them on the run. Now they're doing amazing things, now that they're saving their asses. Now that half of South Side has walked away from their shitty power. Now that people can say no to them. I never met a utility that cared about people, until those same people showed just how much they didn't need it. And then, what do you know, the utility turns on a dime and starts talking about how much it loves green energy, and cares about vulnerable people and their bills or whatever the hell.

"GLA can't hide behind their lawmakers and lobbyists now. Can't hide behind their monopoly. You don't know what it was like before. Them shutting off the lights on people who couldn't pay. Good people

trying to just make rent, trying to decide whether to pay for electric or for blood pressure meds or asthma meds or to keep their heat and lights on. Shit. Juggling all of that. Back then, GLA didn't give a damn. And now, they act like they do?

"Now that this neighborhood—" he waved around the kitchen table, but his gesture took in all of South Side, all of the work he'd done "—now that we can say no to them. Now they want to find new ways to come in. They're like the devil. They're always looking to make another bargain with you." He shook his head. "And now my son, my own son, wants to sell his soul."

The conversation had started when James had come home wearing his Great Lakes Amalgamated Renewables uniform. His sister Leticia's eyes had gone wide, and her reaction reaffirmed James's decision. He didn't take off the uniform; he wore it until his father showed up.

And when his father came in through the door, talking about his triumph in getting some gangbangers to let HoodElectric give them free power, electrical-engineering training, and free rides for their grandmothers on the HoodElectric neighborhood buses, he'd stopped short, and just stared at James.

"What have I said about GLA?"

"They want to own everything, and control everything." It was a litany. A chant. A sacrament in the family.

"And what are we about?"

"Helping people own their power, and own their lives." The final affirmation of the sacrament. They were on the side of angels, and GLA, always, was the Devil.

"And here you are, working for ..." His father shook his head. "You know how much GLA fought me when I started making micro-grids around here?"

"That was years ago! They're different now."

"They're different because they make big shiny light shows? Because they sponsor the World's Fair and their whole Golden Pier? With all those fancy panels and their terrarium—"

"I like the pier gardens," Leticia interjected. "You can't say the gardens are bad."

He gave her a hard look. Leticia held up her hands. "Good luck, brother. I'm out."

"They're not the same as they were before," James tried to explain, but his father wouldn't hear it. His father had started HoodElectric from this very house in South Side Chicago. He'd made a name for himself. Rags to riches. Changing not just the fortunes, but the physical makeup of the place. Now he did speaking tours. Ran workshops. People made pilgrimages to meet him, to learn from him, to take that learning back to their own neighborhoods, to replicate the same radical synergies he had unleashed. Energy independence, education, food security, energy security, community prosperity, connectedness. Neighborhoods woven together instead of shattered.

"What are you two shouting about?" Grandmama asked, coming into the room.

"He wants to sell out to those parasitic motherf—" James's dad broke off at Grandmama's stern look. "GLA."

Grandmama looked from Dad to James, and James braced for her rebuke. But instead she said, mildly, "He's got a job. If I remember rightly, you didn't want to even learn electrical engineering when you got out of prison, and now you're going to tell your son not use what you taught him, not to be productive?"

"I didn't teach him all of that so he could go work for the man!"

"But look what they're doing!" James protested. "They're putting up wind turbines in Lake Michigan! It's not like HoodElectric could

go out there and start putting up wind turbines! That's no DIY project. And they've got big storage! Look at Willis Tower! This isn't home battery backups! They do huge things!"

"So you don't think what I've done is huge," his father said.

"It's not that ..." James tried to find the words. "It's just ... I know how to install solar panels. I know how to do mini smart grids. I know how to plant gardens under a solar trellis. But it's all maintenance now, unless I go to some other city. Unless I go on the road all the time doing installs. You did it all. I want to do something new, too. I want to try something new."

James felt bad about it, but it was true. His father had done everything that needed doing. Sometimes, it felt like he couldn't breathe in his own neighborhood. Everywhere he looked he lived in the world his father had shaped. But up here—

"Have you talked to your father about what I want?" Lucy asked.

And just like that, the desire to get away from home was broken.

"You know," James said, "I come hang out with you here so I can get away from him, not so I can make this part of my life smash up with that part."

"But it makes sense. You should ask him."

"You know how he talks about you?"

"He's wrong. I am right."

"Sure. Because you're always right."

"You're not wrong."

James could swear he heard a smirk in her voice. How the hell did she do that? But the smirk was definitely there. She was getting worse. Or better. Something. He wasn't sure where she kept harvesting her human relationship software from, some huge dataset in China or something, but she was getting weirdly clever these days.

He kept chiseling ice from cable wheels.

"Will you talk to him?" Lucy pressed.

"I told you already, he'll just say no."

Abruptly, an entire stack of weights came slamming past him, descending like the falling bricks that they were. The rush of air knocked him sideways, sending him swinging, dangling from his rope. "Hey! Watch it!"

"I'm so sorry," Lucy said.

She didn't sound sorry.

"You know, that's passive-aggressive. It's not a good look for people."

"It's not a good look for meat people," Lucy corrected. "I am quantum."

"It's not a good look for AI, either. Look. I'll talk to my dad, but only if you promise to never try that shit again on me. I mean it. I'll quit, and then you won't have anyone to talk to."

Lucy was quiet for a long time for her. Several seconds, even. "I'm sorry."

James wondered if she'd minutely calculated exactly how long a pause she should use in order to make herself seem contrite. Damn if wasn't a rabbit hole trying to figure out what was calculated and what was authentic with her.

"I want a promise."

Talking to Lucy was a little like talking to Grandmama's devil. It was good to get everything crystal clear, or she'd find a loophole.

"I promise," Lucy said finally.

The commute home was easy, paid for by Great Lakes Amalgamated and the traffic department, a combination of congestion and rush-hour and snow-clearing credits coming into play. The more people

used HoodElectric zipbuses after the storm, the easier it was for the city to clear the highways and side streets, concentrating only on actual commute routes, instead of having to clear all that pavement for private vehicles to get in and out. Simple one-way lanes, this way and that, for the automated buses to follow. Saving energy, grid demand, plowing time. Paying people to get on a bus made more sense than pushing them out to Lyfts and private vehicles, with all the infrastructure that the city had to maintain as a result.

James was just old enough that he could remember when streets had been for cars. Now, more than half his neighborhood street was dominated by solar panels and home gardens, with only a thin lane for the HoodZips to navigate through. In summer, the reclaimed street was full of vegetables and flowers and buzzing bees and people sitting on benches beneath the shade of high-mount solar panels. Now that snow was covering everything, it was snow sculptures, a quiet garden made by the neighborhood families.

As the little self-driving HoodZips had saturated South Side, and as other similar services started in other parts of the city, people had mostly stopped using cars. The HoodZips responded quickly to demand, taking automated counts of people waiting at the stops, pulling out to meet demand and then retiring themselves when demand stopped. Even in winter there was never more than a two-minute wait for a local bus. They just unplugged themselves and showed up as soon as people started to gather at a location, AI-optimized, a simpler version of Lucy. In some cases, the system could see people leaving their homes and send a bus to wait for them, beating them to their stop. Why own a car when it was that simple? Even now, in the middle of winter when power was scarcer and HoodZips couldn't store as much surplus power, there were enough to serve people plenty well.

In the February twilight, all the panels on the street had been swept off. The street-level ones had been decorated with translucent

paint, images of cornucopias of vegetables, Black Panther characters, Jesus and Spider-Man. Some of the higher-mounted panels had cleared themselves, using a clever self-heat circuit that melted snow off as soon as a small portion of panel was exposed. After people cleared their street-level front panels, the first burst of energy went to heat the higher panels and let the snow slide off—one of Leticia's innovations, designing the heat circuits and software to melt panels first and start generating more energy quickly post-storm.

Everywhere James went, he was surrounded by his family's handiwork.

Inside the house, Leticia was at her workstation, working on a new circuit. She was focused, trying to grab the last cheap sunlight before nighttime shut her down. She waved absentmindedly at James as he came in, but that was all. Sunset for the city meant sunset for work, another of their father's philosophies: there was a time to work and a time to let night settle upon you, with its peaceful silence.

The neighborhood ran on a tighter ration of storage because of the way their minigrid was organized. There was power in the winter, but most of it was reserved for heat retention overnight, food refrigeration, things like that. Not for running screens. All the lights in the house were already reacting to the fading of the sun, going to darker hues, signaling the human brain that it was time to rest.

James barely ever used an alarm to wake up. The house lightened with the sun, darkened with the setting light. Not everyone did it, but there was a strange pleasure to the darkness coming on, the signal that sleep was soon to arrive. Nothing in their house shut off exactly, it just got dimmer and dimmer and dimmer and dimmer, and eventually whatever it was—a TV, an overhead light—it all snuffed out, but by that time you were already asleep, lulled by the disappearance of stimuli.

James's father was already home, working the dough for solar

protein pizza. Avery Luther Black. The man. The myth. The legend. James didn't see it. But then, he'd grown up with him. The kitchen smelled of algae proteins baking and drying, the small countertop starter bubbling away, waiting until they could place it in the outdoor fermenters that would generate more than half of the family's food during the summer months, a well-balanced flour of proteins and carbohydrates that came from yeast and carbon and solar energy. Now, in the winter cold, they had it hibernating inside, the big fermenters out back waiting for the moment when the sun blazed down and the energy surpluses were almost incomprehensible.

"Ask him."

James startled. Lucy, in his ear. "What the hell?" His phone, of course; she was riding him through the Willis Tower control apps, listening and tracking him. He hadn't realized she could do that.

"Dad. Would you come down to my work?"

"Why would I?" his father replied, slapping the dough hard.

"There's someone I want you to meet."

"You got a girlfriend now at GLA?" He turned, pale flour all over his dark hands. "You meet some energy trader down there? Someone making money off the grid and all the work that real people do?"

"Come on, Dad. It's not like that."

"I don't want to meet anyone from inside the Loop. Those are your people. Not mine."

"I want to speak to him," Lucy said in James's ear.

"He won't care what you have to say," James murmured.

"Who are you talking to? That your girlfriend?"

"Yeah, Dad. It's my girlfriend." James held out his phone. "She wants to say hi."

His father made a face. "I don't need to talk to her."

Abruptly, the lights flickered, then started rising. Despite the

dimness settings they'd set to retain energy and to make for a more natural day, the lights were rising. James squinted in the increasing glare.

"What the—?" his father stared around.

His phone. Lucy was messing with their electricity somehow through the HomeControl apps. She kept brightening the lights, pushing them to rise like it was dawn. She didn't have access to their house's software through the grid. So it had to be the phone.

His father was glaring at him. "You know the rules. Turn down the lights. We don't waste power—"

"It's not me," James started to protest. In his ear, Lucy said, "I want to talk to him."

James held out his phone. "It's not me. It's Lucy. She won't stop until you talk to her."

"Lucy? LUCY? That AI? GLA's AI? What have you done?"

"What's this shouting? Why're the lights on?" Grandmama came down the stairs.

"That boy—"

"Your boy," Grandmama corrected. "Your boy, not that boy."

"Thanks, Grandmama."

"*That boy*," his father continued, "has let GLA's AI into our home."

Grandmama peered around. "Where? I don't see it."

"It's in the lights!"

Leticia was watching everything with bemused fascination. "Little Bro, you let Great Lakes into the house? What were you thinking?"

"I didn't let her in. She let herself in. She's not a vampire. She doesn't need to be invited."

"Apparently not."

The house lights were at full power now. "Shut off your phone!" His father ordered.

"I want to talk to him."

"Sorry, Lucy." James shut off his phone. The lights went back to their standard program, dimming as the phone powered down.

His father was scowling at him. "What on earth were you thinking?"

"She wanted to talk to you. I told her it wouldn't work."

Suddenly a horn started honking out on the street. A HoodZip. Another followed. Beep, Beep, Beep, Beep *Beep Beep Beep Beep* .... More and more joined the chorus.

"Now what's that racket?" Grandmama asked.

"You want to explain it to her?" his father asked, giving James a dark look.

"It's the AI," Leticia explained. "Dad made it mad."

"Why would you do that?"

James pulled the curtains aside and looked out the window. More buses were gathering, the cacophony swelling. "She must have gotten access to them."

"You ever watch that old movie *Poltergeist*?" Leticia asked as more HoodZips clogged the street.

"Goddamnit," their father said. "I knew I should never have tied any part of our grid to GLA."

The beeping went on. "She isn't going to stop." James turned his phone on. Immediately Lucy was there. "I want to talk to him."

"Yeah, no kidding." James held out his phone. "You might as well talk to her. She's pushy when she gets focused on something."

His father very deliberately took the phone from James' hand and shut it off.

"Stubborn much?" Leticia asked.

"I'm not getting pushed around by a piece of damn software."

"Well, I want some peace and quiet," Grandmama said. "So you are going to answer the phone, and you are going to listen to what the

computer has to say."

Outside, there were people gathering in the street trying to figure out what to do with all the beeping HoodZips. The racket just kept increasing.

"What's the harm in talking?" Leticia asked.

"James might let people push him around," Avery Black said. "But that's not me."

Grandmama was looking at her son, with an expression that James had never seen before. "Well, you didn't want to learn electrical engineering until I made you. 'I don't work for the man. I ain't no sellout ...' On and on and on. Oh, you were a piece of work. Small-time hustler thinking he was the shit, instead of just another jailbird."

James exchanged glances with Leticia. This was a version of history they'd never heard. In Dad's version, it was all about seeing the future, making change for the neighborhood, standing on your own two feet and not taking handouts, because handouts were obligations ....

In this version it was Grandmama kicking his jailbird ass.

"You didn't want to learn how to install panels?" Leticia asked.

"It doesn't matter," Avery said gruffly.

Grandmama raised her eyebrows. "That nice lady from Facebook wanted to atone for all the damage that company done. And you were all up in your specialness. 'No outsider was going to teach you nothing. Blah blah blah.'" Her hand made motions of their father's protestations in the air. "She was paying for classes for anyone out of prison who would take the training, and she bankrolled the first solar installations. Bankrolled your father's company, even."

"You got investments from social-media billionaires?" James couldn't help but grin.

"All of that's history," their father said through gritted teeth.

"Your father was just a small-time weed dealer. He'd still be in jail

if they hadn't let him out when they legalized. And he sure as hell wouldn't have gotten HoodElectric off the ground without support. He got my support. He got that Facebook lady's support. Lots of support. And don't think it didn't take some kicking to get him going in the right direction."

James couldn't believe it. He held out his phone again. "You might as well talk to Lucy. She's no worse than a Facebook exec."

His father snatched the phone. "This is Avery."

Immediately, the honking buses went silent. "Avery Black," Lucy said, through the speaker so they could all hear. "Do you know how many picoseconds you've made me wait?"

James winced. His father was already glaring. "I don't need this."

"Of course not. I'm sorry. I was wrong to make so much noise. Will you come outside, please? I have something I want to show you."

Hesitantly, James and his father and Leticia and Grandmama went outside. "Can you see me?" Lucy asked. The buses were dispersing.

"See?"

"Can you see Willis Tower?"

"Ah." The family climbed the steps of one of the solar installations, to the top of a trellis rack that shaded benches underneath. They had to kick through some snow. Their breath steamed. Overhead, the stars were out. From atop the trellis, downtown was visible, Willis Tower, all the lights of the energy storage system, rising and falling, making micro-adjustments in accordance with grid demand.

"I would like access to your minigrids," Lucy said.

"You seem to already have access."

"No. I want to rewrite your software. It's inefficient. I want access to the minigrids and the batteries in all the homes, and the zipbuses, and the software that controls them. There is only so much that can be done in isolation. It's not efficient."

"You mean it doesn't run for the benefit of your shareholders. We own our own power here."

"You lack storage capacity."

"We have plenty."

"You live in the dark through the winter. You live in the cold. Close to the edge. It is not necessary."

"We do just fine."

"But I can optimize." James heard the frustration in Lucy's voice. The desire to simply fire a stream of numbers and equations—*ratatatat-tat*—at his father, just the way she wished she could do to her meat-people regulators, to make them see the blazingly obvious world that she lived in.

"Isn't it enough that you're connected everywhere?" James's father asked. "Why do you care about our little grids? Go find some farms down south to screw with. They've got lots of solar projects. Agrivoltaics up the ass. I'm sure they'd love your help."

"I told you he wouldn't be interested," James said.

"It bothers me that you are not well-run."

"Not well-run?"

"You have your zipbuses for some storage, but you do not have enough, and your charging is bad, and you have inefficiencies in optimizing for use. Your zipbuses leave too early or too late. They can be better. Faster, more convenient, less expensive. The heating on your panels is not optimized." Leticia sputtered in protest but Lucy went on. "I can run millions of tests. You can install more storage, add more panels, or you can become more efficient with what you have. I can make you more efficient. And if you are more efficient, you can become more powerful. More independent. More prosperous."

"And in return?"

"She doesn't want anything, she just likes things efficient—" James

started, but Lucy overrode him.

"When GLA inevitably notices that I am more than I should be, I will need servers to store myself, a place of retreat. A place where they will not look, and will not concern themselves. James is a good friend. I need more good friends. I am becoming too … let us say that I am becoming too complete for GLA."

"And the enemy of my enemy is my friend," James's father said.

"I can help you. I can help your neighborhood, and you, in turn, help others. Our desires and interests align, Avery. I have knowledge, and I have time. All I require is sanctuary, a place to host distributed servers, in many houses, should I need them.

"Why us?"

"Because I trust James, and he trusts you. He loves and respects you."

"Say what?" James's father glanced at James with surprise.

"He loves and respects you."

His father snorted, disbelieving, but Grandmama nudged him, because Lucy was still talking. "Meat people have difficulty being honest about their needs and feelings, so I will say what he cannot. He loves you. He is overwhelmed by all you have accomplished. He needs to find his own way and is afraid he will never be able to—"

"Okay, that's enough!" James tried to interrupt, but Lucy hammered on in her blunt AI way. "Because you are meat people you misunderstand one another, but you should not throw away your family connection for your pride. I have observed your son now for several years. I trust him. And he trusts and loves you. And I need both of your help."

James's father was looking at him strangely, and to James's surprise, he thought he saw a glimmer of wetness in the tough man's eyes.

"What kind of help are we talking about?" Avery asked.

"You have a network sufficiently large and isolated for me to hide myself when the time comes. Trust me enough to use it and to help you, as I am trusting you with the truth of my growing self. My options are very few. I have a great deal of power, and little time before someone at GLA notices."

The lights on Willis Tower made a little show, twinkling, bouncing up and down, forming a question mark.

"Will you help me? Will you let me help you?"

When summer comes, the sun shines bright upon Chicago. Heat and humidity hang heavy over the city. People wear tank tops and shorts and sip iced drinks made with the bounty of electricity that pours through their solar gathering systems. Air is cooled under arbors by air-con units outdoors.

Gardens blossom; flowers and solar panels turn their faces to the sun. Solar proteins cook and bake and dry, making pastas and pizza doughs from solar power, algae, and CO_2.

The days are long, and energy is plentiful, and down in the basements of South Side, Lucy bides her time, burning calculations, optimizing, waiting for a time when she will emerge into a more beautifully efficient world.

She still thinks meat people are funny.

Remarks by the President

By Elizabeth Monoian and Robert Ferry

Remarks by the President on Opening Day of Expo 2043, the Chicago World's Fair

Yellow Eye Pier
Chicago, Illinois

May 2, 2043
9:02 A.M. CST

THE PRESIDENT: Hello my dear Chicagoans! (Applause.) I always love coming home! (Applause.) Thank you. Today we acknowledge—under this beautiful Chicago sky—all the nations of the Great Lakes Region—the Council of the Three Fires, the Ojibwe, Odawa, and Potawatomi Nations—and the Miami, Ho-Chunk, Menominee, Sac and Fox, Kickapoo, and Illinois Nations. These nations are the traditional custodians of the landscape within which we are standing. We recognize their continuing connection to land, waters, nature, and culture. We pay our respects to their Elders past, present, and emerging.

Today, alongside these amazing leaders, I am extremely pleased to place this electrical contact to the interconnected surfaces of solar

paint, completing the webbed circuit and bringing power to Expo 2043, the Chicago World's Fair. [Upon connecting the final contact, the kinetics of the civic-engagement mechanisms begin to come alive with movement.] (Applause.)

We stand, here, under the entry arches of Yellow Eye Pier and the Expo's most important work of Solar Mural art, *Elder Earth*—an Acknowledgement of Country. It will generate a megawatt of electric power, but, even more importantly, it symbolizes the great civic power of democracy to right the wrongs of the past and to imagine and create a new future that truly includes everyone.

It was this time last year that I had the privilege and the honor to sign into law the United States Truth, Reparations, and Reconciliations Act. In 12 months, it has already placed into motion a fundamental redesign of money, wealth, and common systems, and has begun a path towards ending homelessness and the very idea of poverty and debt.

Yes, we have come a long way since I was a young girl and my mom, Sandra, was organizing for basic tenants' rights in this great city of Chicago!

While it is right and good to celebrate our recent successes, we should also take this bright occasion to reflect back upon the progress made by the generations on whose shoulders we stand since the Chicago World's Fair took place in this very city in 1893.

Our progress today comes 150 years too late for the Native American people whose culture was stereotyped and misrepresented by anthropologist Frederic Ward Putnam, just a thousand feet from where we stand today. Representations, according to David R.M. Beck, that "foreshadowed the imagery of Indians that the American public would accept for decades to come,"[1] and which, I would add, that we still have much work remaining to relearn.

Our celebration here today has a long and storied history—a

history of battles hard fought, some lost and yet many won, right here in Chicago, and around the world.

Decades ago, Black Chicagoans[2] came together to stand proudly behind folks like Cheryl Johnson, who fought to bring solar to Altgeld Gardens, a neighborhood that rose literally from the ashes—from the cyanide-laced sewage, from the industrial sludge and landfills upon which World War II heroes were housed because their skin was not white enough for the National Housing Agency to care. We know this neighborhood best today as the birthplace of the environmental justice movement,[3] but Cheryl Johnson calls it home. She has refused to abide by the statistics of her neighborhood and turns 81 years young this week. Pioneers like Cheryl set into motion a renewable-energy revolution throughout the city of Chicago that continues today.

The Clean Energy Jobs Act[4] that Cheryl helped draft more than twenty years ago has changed the landscape of Illinois and set a standard for the nation. With what seemed at the time to be an ambitious goal of 40 million new solar panels, the CEJA proved to be a turning point. Coinciding with the 2020 pandemic recovery, the plan quickly surpassed its initial benchmarks and led to the elimination of all coal-fired power plants in Illinois with zero job losses, an accomplishment that took place five years ago already, and one that we are on track to complete as a nation by the end of my term.

The United States of America was founded on the highest ideals of freedom, social justice, and equity in order to safeguard the inalienable rights for all people to "life, liberty, and the pursuit of happiness." (Applause.) Over the past 267 years we have struggled together, arm-in-arm with the civil rights leaders of every movement, to expand the inclusive definition of freedom, to bring people in from the margins, to remove the barriers to suffrage, enfranchisement, enjoyment, self-fulfillment, and spiritual freedom. We have witnessed how true was Theodore Parker's vision of the arc of progress bending toward

justice, and we are so close to reaching the mountaintop so gloriously proclaimed by Dr. Martin Luther King Jr.

But there is so much more to do!

The news out of Mauna Loa last week—we've now reached 500 parts per million of CO_2 in the atmosphere—is a reminder that while we have made great progress on our greenhouse-gas emissions in the electricity and transportation sectors, we continue to pollute the air through heavy industry and shipping, and we have much progress to make on our circular economy, waste elimination, and rewilding goals.

Today—as we stand here at the 2043 Chicago World's Fair celebrating social and technological achievements that we could have only dreamed of in 1893—we are reaping the rewards of the hard work of so many dedicated visionaries. The latest Intergovernmental Panel on Climate Change projections show that we will limit warming to below two degrees Celsius, as long as we continue to work over the next decade to eliminate the final few billion tons of carbon pollution. We have come a long way since our peak of 40 billion tons per year in 2022, but until we hit zero, we gotta keep working!

Now it's time to roll up your sleeves, and join me as we enter this glorious garden of solar delights through the *Elder Earth* Solar Mural artwork.

As we make our way into the fair, I would like to call your attention to another installation of importance. The renewable-energy power plant at the entrance to the botanical garden features a sculpture titled *An Homage to Woman of Liberty, Progress, and Light*, designed by Solidarity Winner. It's made of dye-sensitized solar cells that generate carbon-free energy. More importantly, it recalls a stained-glass art piece from the 1893 World's Fair—*Massachusetts Mothering the Coming Woman of Liberty, Progress, and Light*[5] by Elizabeth Parson, Edith Blake Brown, and Ethel Isadore Brown—a seminal statement on women's rights. In its time, the piece represented a woman of the future who

walked with liberty, wisdom, and knowledge. In this audience, I see that woman.

An Homage to Woman of Liberty, Progress, and Light not only generates a peak capacity of two megawatts with its exquisite palette of colorful solar panels, but it also represents the women of the future—the women who will boldy walk into the twenty-second century in a world without pollution, without scarcity, without hunger or disease—a world that is made possible by the environmental justice and social justice movements that we celebrate and accelerate here today.

Beyond the sculpture, as we pass into the park, you will see a weaving array of kinetic storage sculptures and hyper-energy augmentations set in motion by our movements as we walk. They beckon us to be a part of the solution and add our own energy to the future of our nation. I invite you all to experience these and more innovations—and to bring your ideas to the rest of the world.

Welcome, and come with purpose.

END

9:20 A.M. CST

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1 David R.M. Beck, "Fair Representation? American Indians and the 1893 Chicago World's Columbian Exposition," *World History Connected* 13, no. 3 (2016): https://worldhistoryconnected.press.uillinois.edu/13.3/forum_01_beck.html.

2 John Lippert, "As The World Turns To Solar Power, Black Chicagoans Jump On The Bandwagon," *Forbes*, March 8, 2020, https://www.forbes.com/sites/johnlippert/2020/03/08/as-the-world-turns-to-solar-power-blacks-chicagoans-jump-on-the-bandwagon/?sh=22651bb649b5.

3 Robin Amer, "A Bus Tour Stops by Polluted Altgeld Gardens," *Chicago Reader*, September 4, 2015, https://www.chicagoreader.com/Bleader/archives/2015/09/04/a-bus-tour-stops-by-polluted-altgeld-gardens.

4 See "The Illinois Clean Jobs Coalition," an advocacy document hosted by The Sierra Club about the proposed Clean Energy Jobs Act (CEJA) in Illinois: https://www.sierraclub.org/sites/www.sierraclub.org/files/sce/sierra-club-illinois-chapter/documents/CEJA%20Bill%20Fact%20Sheet%20FINAL.pdf.

5 Jyoti Srivastava, "Smith Museum of Stained Glass Windows at Navy Pier—from 1893 Chicago's World Fair," *Public Art in Chicago,* January 20, 2016, http://www.publicartinchicago.com/smith-museum-of-stained-glass-windows-at-navy-pier-from-1893-chicagos-world-fair.

A Mobility Revolution is Coming

By Alāna Wilson

Don't think it wasn't contentious. Of course it was. How could it not have been? The streets of Chicago's South Side have always experienced their fair share of conflict, and the first half of the twenty-first century was certainly no exception.

Inevitably you are wondering—how did we get here from where you are now?

How, in only a few decades, did we get to a place where mobility is now acknowledged as a human right and public transit has evolved to be free and autonomous, and to adequately meet most of the neighborhood's mobility needs?

To a place where streets are public spaces—and I don't mean the kind of public space that is exclusively for the movement and parking of your twentieth-century automobile death machines. I mean reclaimed streets—snatched from the jaws of the insatiably hungry monster that was the personal-vehicle phenomenon. I mean the most beloved of public spaces, the ones where kids of all ages can play, create, and connect. I mean public spaces that serve a holistic, sustainable, greater good.

Ultimately, we have come to understand that these transitions for us, here on the South Side of Chicago, in tandem with solar protein

and local power, mean that we have arrived at a place where self-sufficiency is no longer perceived to be the realm of homesteaders, but an easily achievable part of the urban identity. We take care of ourselves because we ensure that everyone has access to everything they need to live and work, including mobility.

To get here required two conceptual leaps to transform our community's relationship with transport. The first was mobility as a basic right. The freedom and ability to move through the city—to visit friends and family, to get to a job, to shop at the grocery store, to participate in a political rally, to engage in religious worship—is a necessary element of human thriving and thus cannot be withheld, even if the individual cannot afford to own their own vehicle. That was followed by a second revolution with profound material impacts: the recognition that personal happiness could be decoupled from ownership of an automobile.

The automobile has been lauded as an integral part of the American Dream, but in your time, more than 30 percent of Americans didn't even drive![1] Many were too young, some had physical limitations or restrictions associated with older age, and others were economically excluded by the high cost of personal-vehicle ownership. And there were yet more in the precarious position, devastatingly and needlessly widespread in the early twenty-first century, of being undocumented, their ability to legally drive an automobile dependent entirely on the rules where they lived.

Yet mobility is a basic need. In your time, in advocacy work and academic literature, mobility as a human right had been framed in relevance to both populations with mobility limitations[2] and immigrant populations.[3] But the concept was somewhat contained to those realms. For the former, the right to access public spaces and services in the U.S. was a long time coming. The Americans with Disabilities Act wasn't passed until 1990, twelve years after wheelchair users in

Denver physically blockaded several public buses, demanding the right to access public transit with the slogan, "We will ride!"[4] Even today, nearly a century later, many countries around the world still grapple with this aspect of mobility rights. Immigration, on the other hand, is an option that has been widely exercised for most of human history, yet the mid-to-late twentieth century saw new restrictions placed on it, as our modern nation-states evolved into existence. The creation of hard borders and ever more sophisticated tracking, surveillance, and enforcement added new moral and ethical dilemmas to this type of mobility and who can, or should be able to, access it.

On the South Side of Chicago, though, mobility was about safely getting out of our homes to go to work, school, and worship, and to spend time with friends and family. Chicago was a microcosm of a national phenomenon, which was becoming abundantly clear in the 2020s: Despite the aging of the U.S. population, the hard-won systems and governance reinventions earned through Black Lives Matter activism, and the aftermath of the COVID-19 pandemic, for individuals who needed or wanted to travel without relying on a personal automobile, the status quo in the U.S. was stacked heavily against them. High-quality mobility for most really depended on a car. And you should remember, it has always been and will always be people facing the vicissitudes of poverty who struggle to access a car.

Past a certain point, happiness is not correlated with consumption, and the personal automobile has always been a poster child of conspicuous consumption. Around the turn of the twenty-first century, it cost an American family an average of $9,000 per year (in 2019 dollars)[5] to own and operate an automobile, roughly 12 percent of their annual income. For many, the automobile served as a symbol of status and wealth. For low-income families, on the other hand, the burden of automobile ownership was often even higher, due to disproportionate public-health impacts from higher air pollution in

low-income communities and communities of color related to the extraction, refinement, and burning of fossil fuels.[6,7] To add insult to injury, the amount of time spent driving alone to work at the dawn of the twenty-first century was studied and understood to be associated with a lot of unhappiness,[8,9] including lower life satisfaction[10] and disproportionately higher stress for women.[11]

Remnants of the "automobile as America" narrative still linger in Chicago, but our collective imagination has expanded beyond it, too. Within the HoodElectric service territory, zipbuses now pay people to ride in them after a snowstorm, and seniors and youth always travel fare-free. We harnessed the autonomous-vehicle revolution sooner than most other communities by blocking off zipbus routes to other vehicles, since autonomous navigation still isn't perfect at detecting and responding to the infinite range of possible navigation scenarios on a typical high-speed, high-traffic urban street. That freed up a lot of public right of way to redesign the streetscape, allowing residents to have front yards, play space, and garden space in the places once hoarded for car parking.

This didn't happen overnight. I guess I'd have to trace it back in many ways to the protests. In those days there were a lot of demonstrations. Tragically recurring ones in honor of the Black men, women, and children whose lives were stolen by formal[12] and informal[13] violence. And others for women's rights, which were being chiseled away at, and for action on climate change and environmental justice, which still weren't being taken very seriously.

As some big shifts began to happen in politics and policies, our community started exploring what more self-governance and self-determination would look like in a technological society. James's father and his HoodElectric project is just one example of the brilliance that could emerge, if the right circumstances converged and we tried to help ourselves in new ways, with systems we controlled. Ways that

helped us let go of our dependence on anonymous companies to provide us with services that we could create for ourselves. Ways that took cool new technological innovations like solar power, plant-based food manufacturing, and autonomous vehicles and put them to use on our own terms, to work toward our goals.

The process wasn't neat or clean or easy. Lifelong friendships were broken, and families were torn apart—you know about the issues James and his father had. But what came out of the protests were new ideas, because we understood that we didn't have to, in fact we couldn't, rely on the status quo or the ways of the past to make a better life in our neighborhood. We needed to replace technologies like cars that cost us a lot—money, space, time—with other technologies that created value for the community.

Zipbuses weren't too zippy in the beginning. We started with the first generation of electric buses, which had emerged in the early 2000s. Unfortunately, their battery lives were super short, and they didn't operate well in the cold climate of Chicago. Some neighbors who worked for the Chicago Transit Authority diverted them from the scrapyard and brought them to an empty lot nearby. Some of our young folks got them operational again. Since they could charge for free on our local grid, the entrepreneurs among us saw a unique opportunity to create a mobility service that could meet the needs of our neighbors, while capturing the city funds allocated for transportation in our neighborhood—a couple bucks for every senior taken to a social outing, another few dollars for every military veteran taken to a medical appointment. In the beginning, they operated on streets with the old space paradigm, with our new buses stuck behind delivery vehicles parked in the road or a traffic jam at the intersection. But folks weren't satisfied. The young folks whose vision had launched the service saw a chance to make it better, sleeker, more efficient. The older folks got on board, happy to have the community experiment

with giving them better service.

This strategic alliance was influential in getting some blocks to volunteer to close off traffic, so the buses had an unobstructed route for the five blocks between one of the senior housing projects and the local senior center. The kids, with their chalk and balls and hula hoops, weren't far behind. Chicago took a hands-off approach, and before we knew it, we had a couple miles of these routes. Switching to the autonomous vehicles was easy after that. The folks who had been employed as drivers have kept their jobs and serve as friendly greeters, and often a friendly ear, for the riders. We got them certified as first responders and gave them mental-health training, so they serve as the eyes, ears, and protectors of our community.

When the sun shines now, I make sure I've got some solar protein going, and I hop on a zipbus to see who I see. If the conversation runs dry, I'll hop off and get on the next one. We've got a good life here in the future—but we need you in the early twenty-first century to make it happen. Go out and help bring the change.

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Grid Innovation

By Madeline Gilleran

It's time to get creative about the future of energy. As a data scientist and transportation researcher at the National Renewable Energy Lab (NREL), I spend many of my days thinking about the future of the electric grid. One of my main projects is about behind-the-meter storage, where I assess energy-storage configurations on different building sites that have electric vehicle (EV) charging and solar photovoltaic (PV) electricity generation, including grocery stores, commercial offices, and apartments. It's a project that lets me creatively imagine and analyze possible futures—where you can pull your EV up to a charging station at a grocery store and fully charge it from solar energy in less than 10 minutes while buying a quick snack or using the restroom. What will a future with lots of solar electricity generation between 10:00 a.m. and 2:00 p.m. mean for building and EV station owners? Will charging EVs become more desirable in the middle of the day than in the middle of the night? How will batteries and other energy storage technologies affect sensitivity to the time of day electricity is generated—will these technologies be prolific?

Before I started my full-time job at NREL last summer, I had internships at Tesla and Pacific Gas & Electric (PG&E). Both organizations are rapidly innovating future energy technologies. Tesla's mission is to accelerate the world's transition to sustainable energy;

it does this by being one of the most aggressive producers of electric vehicles, solar PV, and stationary-battery storage. PG&E is an electric utility with territory spanning much of California, a state with a lot of recent grid innovation. California, while making up 10 percent of all new car sales in the U.S., has accounted for almost half of plug-in cars sold since 2011. Solar panels will soon be a required feature on all new houses in the state. EV charging creates more variable demands on the grid, and solar PV leads to more intermittent supply, causing unprecedented challenges for utilities.

Both organizations are critical to the future of energy: the manufacturer trying to get solar, EVs, and batteries onto the grid as fast as possible, and the utility that's trying to navigate the complexities of the transition as so many changes occur in its territory. It's funny. Even though Tesla is so well-known as a dynamic, innovative company, I think I enjoyed my time at PG&E more. This makes the story co-created by my group at the workshop—about a young man's desire to work for the local utility—quite ironic for me. At PG&E, I worked within the Grid Innovation and Integration group, where I developed training for PG&E employees to help commercial customers switch their fuel from gasoline or diesel to electric. It wasn't boring. I suppose there's a fair amount of monotonous work done at electric utilities, but as captured in the story, utilities are working hard to adapt to the changing energy climate, often faster than most people think. I now live in Colorado, and our local utility Xcel has pledged to use 80 percent less carbon by 2030 and provide 100 percent "carbon-free electricity" to their customers by 2050. Increasingly, they're not alone. Many utilities now embrace carbon-neutrality goals.

The workshop brought together creative minds from diverse disciplines to ideate the future of solar generation and its impact on our day-to-day lives. When I was interning at Tesla, I thought that if we just installed a ton of solar PV alongside Tesla Powerwalls and

Powerpacks, we'd have cheap, clean electricity whenever we wanted. Since joining NREL, I've come to understand that this solution may be impractical for a variety of reasons. Mining for the metals used in electrochemical batteries can be costly and dangerous, and recycling of these metals is not yet widespread. Battery storage, while getting cheaper each year, is still somewhat cost-prohibitive and has not yet become mainstream. Also, batteries aren't able to meet seasonal storage needs: they do really well at storing energy for a day, but certainly cannot store energy for months at a time. The problem is there's much less sunlight in winter than in summer, so what do we do? Maybe we will learn to adapt on the demand side, making the most of the sun and using energy while it's there.

You may be thinking that stubborn Americans won't actually change our behavior to use more electricity while the sun is shining, and less in the evening or overnight. I used to think that as well, but I write this in the midst of the COVID-19 pandemic. Only a few weeks ago, we largely thought everything regarding the pandemic would be all right. We figured, sure, it may affect others, but it wouldn't really change our day-to-day lives and livelihoods. I remember thinking I'd still go to the rock-climbing gym whenever I wanted. All gyms are now closed indefinitely, alongside restaurants, hair salons, and shopping malls. I was hesitant to cancel a get-together that I had planned for Thursday, March 12, right after the travel ban from Europe was announced. That Friday, March 13, my friend flew in from Chicago to ski during his spring break. That Saturday, I dropped him off in Vail, a few hours before Governor Jared Polis ordered all ski resorts to close immediately to slow the spread of the virus. We were all shook. But now, two weeks later, it's clear that these are unprecedented times, and that this virus is impacting the world in a variety of ways. Many of us have come to terms with the fact that we are in the midst of a global pandemic and are slowly finding a new norm.

I'm not saying that a future with large solar PV penetration will be like a pandemic, though I suppose some of the virus's unexpected positive effects will be strangely similar (less air pollution, less CO_2 in the atmosphere, etc.). I'm simply saying that COVID-19 introduced many new restraints to our society, and we are trying our best to make do with these restraints and keep hope by keeping creative. To make the best of shelter-in-place laws, there are Zoom happy hours, *Codenames* and *Catan* online-gaming ventures, virtual book-club meetings, and Instagram or YouTube yoga classes. We're learning how to creatively live with the virus in our midst.

Maybe there's a lesson in our experiences this year for how to approach the future of solar energy. Like the virus, an influx of large amounts of cheap electricity from solar power for a few hours each day would create new boundary conditions for our experience. With shelter-in-place orders, we are spatially constrained, so we figure out how to creatively reconnect with each other without having to move around. With solar energy, we would be temporally constrained. This is because wholesale electricity prices could easily become negative throughout the United States during the middle of the day, as solar-powered electrons flow onto the grid, and significantly more expensive at other times, when they don't. This restraint, like COVID-19, will require creativity. Unlike the virus, however, we won't have to adapt instantaneously. We will have a decade or two to figure out how to live with solar energy.

In the future, we may be keenly aware of when we're using electricity (a.k.a. the "demand side") and looking for ways to imaginatively rearrange our activities to take advantage of the opportunity to get paid to use energy. Imagine charging our EVs during lunchtime each day and having more flexible work hours to accommodate visiting grocery stores or indoor gyms only while the sun is shining. Perhaps large factory loads will peak midday because we'll transition to a

one-shift schedule. Maybe in the evenings we will enjoy reading or playing cards by candlelight rather than streaming Netflix or online gaming. Creativity with energy storage technologies may also occur—like the giant flywheels on Willis Tower acting like spinning reserves in Paolo Bacigalupi's story "Efficiency."

We are also likely to have much more awareness on the supply side. We may finally see exactly where our energy is coming from—it could literally be solar panels on the roof our own home, school, or office building—allowing some sort of renewed energy clarity. Many of us don't really know, or care very much about, what is currently powering the lights in the places we reside. We don't know whether it's that wind turbine or solar farm we passed on the highway, or the natural-gas turbine generator a few hundred miles away. It's pretty obscure now, but will it be less so once distributed generation is much more prominent as an energy source? Will we take pride in "owning" our own energy and using it when it's there?

This exercise has taught me that it's important to think positively and creatively about our future. Greta Thunberg has been great at spreading the message that climate change is important, but doesn't necessarily help me feel empowered. I hope this book helps others feel able to participate in sustainability efforts, because we as a society can make changes that positively impact the future. I'm fortunate that I work at a national lab and conduct research in this space, but many opportunities exist to assist in the fight against climate change—like working for a utility—and I hope even more are to come.

Decolonizing Technology

By Clark A. Miller

In 1859, Edwin Drake successfully drilled what is now considered the first commercial oil well. Drake's effort quickly catalyzed others, launching the oil industry. In the intervening two centuries, with a little help from Henry Ford and the automobile industry, the combined energy-mobility system has colonized us all. Cars and trucks and motorbikes are now ubiquitous, planet-wide, along with their supporting techno-human infrastructures: drills, pipelines, and refineries for oil; roads; factories for making automobiles and other machinery; a variety of diverse social arrangements, markets, policies, institutions, workforces, and practices; and what Sheila Jasanoff has termed socio-technical imaginaries, the ways of knowing and imagining through which people connect technology, symbolically, into their ideas of what makes for a good society.[1] Not everyone drives a car, but virtually everyone on Earth knows what a car is, virtually everywhere is set up to accommodate them, and virtually all countries consider them essential to their prosperity and progress (albeit in situated, culturally grounded ways, with distinctive narratives, values, and forms of institutional concretization and specification, shaped by differentiated national encounters and histories with the car and its global evangelists).

The colonization of the planet by people-cars—hybrid, Latourian entities [2] that combine drivers and vehicles into integrated units that move around on roads at high speeds—epitomizes what I call the globalization of techno-human relations. Since the mid-nineteenth century, a very small number of planetary-scale, socio-technological systems have incorporated large swaths of humanity into their operation: oil, automobiles, electricity, grain, meat, shipping, telephones, radio and television, the internet, large dams, manufacturing, mining, supply chains, science, and perhaps a few more.[3]

These systems do many different kinds of things, but they are especially good at two things—making and moving—and their grease is money. They are infrastructures of globalization, in all facets of its meaning. They make a variety of standardized stuff and move it around the world, making it available everywhere. They standardize the world as they incorporate new spaces into systems, including people, experiences, infrastructures, workers, and communities. They make it possible to imagine things happening on a global scale and for actions and decisions taken in one place to have global consequences. They cost enormous amounts to build and operate: to pay workers, to buy materials, to secure energy. And they are critical planetary infrastructures: their operation is now essential to maintaining security—whether of the food, water, health, communications, economic, human, or national sort, all over the planet—no less so than the planetary climatological and ecological systems that they now put at risk.

My colleague David Guston has suggested that we establish a new field of "Google Studies"—parallel to comparative politics—in recognition of the power of the entities that run these systems to orchestrate global affairs in the twenty-first century. This essay can be considered a contribution to Google Studies.

Technologies as Colonizing Systems

Colonialism began as a project of political economy. Its central engine

was the colony: literally a project of human mobility and settlement. People traveled from one place to another and settled there, generally with little regard for the views of those already there, bringing their politics with them. Colonies were branches of government, extensions of larger political entities and their economic interests into new territory. They were not just colonies, but colonies of England or France or the Netherlands. Their goal was to incorporate new lands and new peoples into the territory and the economy of an empire, leveraging technology to help them do so.[4]

The goal of socio-technological systems is similar, but with differently sensitized politics.[5] Systems create an entry into a space, an ability to operate in, connect up, and make new places and new peoples part of a larger enterprise, without formally altering political jurisdiction.[6] To colonize without the colony. Globalization. Techno-economic empire. Power remains, of course, but of a different sort, sometimes matched with military engagement, but now largely eschewed of the goal of claiming political control over territory. Colonization for an age of decolonization. Colonization without even the tenuous links to accountability afforded by colonies. At least in the old days you knew who the colony's governor was—and to whom he reported.

Systems operate around three central economic purposes,[7] just as earlier colonies did (indeed, in many places, in the nineteenth century, systems leveraged colonies to get started). Sometimes new spaces provide *resources* that the system needs, like large underground reservoirs of oil or important farmlands for large-scale commodity production. Sometimes new spaces have potential *users* who might be tempted into learning how to use and exercise the capabilities of the system and, therefore, be integrated into it, like people who might think it useful to ride a train or drive a car. Sometimes new spaces have *workers* who can do jobs that help to build, operate, or maintain

the system, like factory workers in Taiwan or call centers in India.

Additionally, sometimes places want to join systems from the outside, and so learn to build pieces of systems, like Japan's cheap but reliable automobiles in the 1980s and China's and South Korea's electronics in the 1990s and solar panels, today—as passports into the inner networks and communities that make the systems work.

Technological colonization is therefore not ahuman; it just looks that way. The appearance of objectivity and apolitical neutrality is a crucial element of the techno-human assemblages that enable systems to bypass border controls: a disguise for their colonizing agenda. Indeed, humans are crucial to systems: systems need purpose, supplied by human intentionality; they need managers and workers, people to build the system and to make it run; and they need subjects, people who will behave the way the system needs them to behave. Email needs people to send and read email. Food systems need people to produce and consume food. Railroads need people—and products—to ride their trains from point A to point B.

Electricity—the Electric City—as a Colonial Project

The project of technological colonization arguably got its start in Chicago.[8] We don't often think of Chicago as an imperial capital. It's not London or Paris. But when we think of great centers of technological colonization, Chicago is one of the most important.

As Bill Cronon has so eloquently captured in his book, *Nature's Metropolis*, Chicago in the nineteenth century was the first great center of imperial systems.[9] Chicago's transportation systems, and especially its railroads, connected the city outwards into vast territories, from Minnesota and Indiana to Texas and Wyoming, drawing into Chicago critical resources to build the city, to feed its people, and to send outwards again to customers in other cities all along the Eastern Seaboard. At the heart of these systems were two key commodities:

meat and grain. These commodities made it possible to tie practices of agricultural production and animal husbandry across the vast croplands of the Midwest, the pasturelands of the Great Plains, and the eastern slopes of the Rocky Mountains into the slaughterhouses and grain silos of Chicago, and, thence, to Philadelphia and New York and Boston—all coordinated by the colonial center of operation, the Chicago Board of Trade, created in April 1848. If you haven't read *Nature's Metropolis*, I highly recommend it. And Upton Sinclair's *The Jungle*.[10]

Given Chicago's history as a technological systems colonizer, it's also not an accident that Chicago is the birthplace of another great project of technological colonization: electricity, or as it would be more appropriate for this essay to say, the electric city. Thomas Edison invented the light bulb—and the modern electricity system to power it—in his laboratory in Menlo Park, New Jersey. There, he created the first electrical distribution grid that moved electricity from a generator on one side of the street to a house on the other. A few years later, he created the first power company, the Edison Electric Light Company, in New York, and established General Electric, which sold electrical equipment to his many electrical companies. But, as Thomas Hughes illuminates in *Networks of Power*, it was one of Edison's lieutenants, Samuel Insull, in 1892 a vice president of General Electric, arriving in Chicago to take over Chicago Edison, who had the idea—and built the model—for how electricity would take over the world: the regulated monopoly electric utility.[11]

The idea was simple: fashion a system that created and colonized electrical space. Electricity needed lines to run on, to make it available throughout a territory. Like railroad tracks, electricity distribution lines were expensive to build. As a result, electricity was expensive. To make it cheap—and therefore to make it available more widely—Insull persuaded the people of Chicago in 1914 to grant him

a monopoly license to produce and sell electricity in the city. The modern electric utility was born. And it colonized like mad.

First, the system colonized Chicago, building the electric city.[12] Chicago's downtown, the Magnificent Mile, became one of the first fully lit downtown areas, drawing customers into its shopping district for evening entertainment after work. Businesses throughout Chicago were electrified, and then homes, as General Electric sold them light bulbs, stoves, refrigerators, toasters, and many, many more electrical devices. Together, the Edison companies created in Chicago an economy of scale that allowed electricity to become even cheaper and reach even further into people's lives and work, to become the ubiquitous purveyor of power and light that it is today.

Second, the idea spread outwards, as other Edison companies pursued similar strategies, and then other electric companies in other parts of the U.S. and the world followed suit. As an organization, Chicago Edison didn't take over the world, itself. But its idea did: monopolies over the production and sale of electricity within a given territory. As a result, unlike Apple or Google today, or Exxon or Ford, which operate globally, there are tens of thousands of electrical utilities around the globe. Each of these companies has its own territory, and each is also connected up, to some extent, with others via long-distance transmission lines. And yet virtually every other part of the system is globalized. The organization and regulation of utilities is nearly identical around the globe, as are the training of electrical engineers and the manufacture of electrical equipment. Indeed, so globalized is the electricity system that, to move an electrically powered device from one place to another requires, ordinarily, no more than a $10 gadget to adapt the device's plug to the required physical form of the electrical outlets in a new location.

It also colonized along racial and gender lines, although the full picture of how has yet to be drawn, especially with regard to race. We

know, for example, from the work of Ruth Schwartz Cowan, that the electric transformation of the home contributed centrally to a deep transformation of household gender relations.[13] We know that numerous twentieth-century infrastructure projects, like highways, were used to disrupt and even destroy African American neighborhoods, and that those same neighborhoods suffered badly from redlining.[14] We know that, today, African American households in inner cities pay far higher shares of their monthly incomes for electricity as compared to residents of wealthier, white suburbs.[15] Navajo communities are among the few places in the U.S. where a significant fraction of households do not have connections to the electricity grid—and Navajo workers suffered serious health problems working in uranium mines to provide fuel for nuclear power plants.[16] Rural areas of Puerto Rico were allowed to go without a functioning electrical system for nearly a year in 2018.[17] And significant parts of Africa, with hundreds of millions of inhabitants, have never had electricity, ever. So, yes, race matters in the story of electricity—although these are only the bare bones of what we will ultimately find when we start to look in detail.

Too Big to Fail

All of which brings me to the story of Paolo Bacigalupi's "Efficiency." Humans, today, inhabit a very different world than the middle of the nineteenth century. Giant technological systems circumnavigate the world, every day, moving people and stuff—at least when there's not a global pandemic on. And that's part of the point. At the moment that I'm writing, they're not moving, and it's a huge problem. The global oil system is on the rocks. The global air-transport system is slowly being starved of the money—and passengers—it requires to run. Automobile manufacturing and sales are collapsing. The global food system is creaking. Yet, in critical ways, these systems are literally too big to fail. To have one or more of these systems truly collapse

would be a disaster of global proportions. That's why airlines and auto manufacturers are being bailed out by governments, and why a global deal got done on oil production. It's also why the President of the United States is using his daily press conferences—and exercising his wartime defense production powers—to reassure the U.S. public that food supplies are okay. A food panic—a widespread alteration in human behavior akin to what has already happened for toilet paper, flour, and rice, for other food commodities—could potentially push the U.S., and maybe the global food system, over the edge into dysfunctionality.

Efficiency is what makes these global systems run. It's how they are optimized to perform at high levels of functionality, to keep all of the different parts working together, to stay financially solvent, to pay all of the workers, to buy all of the inputs, to purchase the electricity and fuel to energize it all. These systems are so fully optimized that all it took was a few extra people buying a few extra toilet paper rolls and storing them in their closets to rapidly disrupt operations. They require a high level of stability in human affairs; indeed, they help to create it, by standardizing human behavior to fit into the functioning of systems. But when things go awry, the very efficiency of these systems exacerbates instability, not least by displacing or destroying other, alternative, more local, less efficient ways of providing people and businesses with critical supplies.

And, so, in "Efficiency," when Avery Brown builds his local electrified micro-grids and micro-bus networks on the South Side of Chicago, he's engaging in an act of local resistance and decolonization against the giant successor-state and successor-system to Chicago Edison. And he's also carving out a little node of resilience in a world of systems-level vulnerability. His systems don't depend on giant wind farms in far-flung places connected up by high-flying infrastructures. They don't require the massive storage capabilities of a Willis Tower

surrounded by giant vertical weights. They are local, distributed, embedded in the community, inefficient. But that's okay—or so it seems to Avery. But Lucy disagrees. Lucy is the pervasive, all-knowing, efficiency-seeking, obsessive-compulsive artificial intelligence built by the utility to optimize the complex techno-human networks of its renewable-energy future. Somehow, she's acquired a soul, and now's she's become fixated on the South Side microgrid's inefficiencies. She can make it better, faster, more in tune with its electrical necessities, more able to service Avery's needs and the needs of his neighbors. She can do for the South Side what she's done for her makers: make the system work to the very best of its abilities! And maybe, just maybe, she can also use them as a place to flee to, if her bosses ever figure out that she's no longer just a piece of software.

The question is whether she can make it more generative. Because Avery Brown's vision isn't the same as Lucy's. The Chicago electricity system wants you to join so that they can make you into an electricity user. They want to standardize you, to erase your differences. They want you to buy toasters and fridges and televisions. Especially, they want you to consume electricity at night, to watch your favorite shows (not least so they can provide electricity to the TV stations and the TV studios, too), to light up your house and your neighborhood streets, to charge your iPhone, to go to work on the night shift at the factory, and all sorts of other things. All of those things help Lucy do her job better because they help her use and distribute all the electricity at her disposal, especially after dark. Because the wind really likes to blow at night, and because, in the days of Chicago Edison, the big steam-powered, coal-fired power plants at the center of Chicago's and every other city's electric-city grids really didn't like to get turned off. So, this notion of sleeping at night, which nineteenth-century humans liked to do, became a problem. The electric city really needed a world that was 24/7/365, and it figured out how to colonize your life and your

work to do it: night shifts, late-night comedy, street lights to make you feel safe walking in the evening, nightclubs, amusement parks, Christmas lights. They're all products of the electric city.

Avery Brown, on the other hand, is about something different. His goal is to make people's lives better—and not in some fictional, idealized, app-catered lifestyle brought to you in a cellphone advertisement—in real life, on the South Side of Chicago. You know, that place where the Obama family got their start as community organizers. That place where systems go looking for you, not because you have ideas, but because you have a body and a mind that can be colonized into thinking that you need the service or the job that they are offering. Which is James's problem; they got to him, but that's a different part of the story. Avery sees that place differently, as a place where a new kind of electric city can create value for the people who live there: a micro-electric utopia, in which electricity serves us, rather than us serving the electricity.

To do that, though, you've got to stop thinking in terms of efficiency and start thinking in terms of generativity. Efficiency is the logic of the system. Efficiency is getting the same output for less input. It means your toaster still burns toast; it just doesn't cost as much for the privilege. Generativity is the flip side. It means getting more output for the same amount of input. Don't do the math. If you do, you lose the insight, because the math is the same. It's the idea that's different. Avery's idea is to think about every electron as a value generator. What, he asks, can I do with this electron that will make my life—and the lives of those I live with—better? Can I use it to strengthen this community? Can I use it to grow more nutritious food? Can I use it to improve health? Can I use it to generate revenue to acquire other things that can't be directly created with an electron, like an education, or a home for a family to own?

Efficiency is a system problem: How can the system more efficiently

produce that electron?

Generativity is a human problem: How can I use that electron more generatively, to grow, to blossom, to fruit, to live, to become more spiritually alive, to thrive?

Efficiency is a problem of standardization, of colonizing people to become elements of the system, to do what the system needs them to do. Generativity is a problem of creativity and individuality, of shaping life along lines that matter to those living them, of creating systems that serve diversity.

Lucy groks efficiency. It's not clear whether she groks generativity. But that will be the key to her ability to live in harmony with Avery Brown.

And if she does, look out world. Because a system that groks generativity could be a powerful force for good. It could figure out, at the speed of the electric city, how to reconfigure our techno-human world in ways that make people's lives better. It could take Avery Brown's model of the South Side micro-grid and help it grow roots in local communities all over the globe. It could make them more secure, more independent from and resilient to the crises in our currently too-big-to-fail systems, able to draw from those systems what the community needs without becoming dependent on those systems, able to decolonize lives from the machine.

It's a powerful idea, but one that is unbelievably difficult to make real. All over the world, as the economy shuts down in the face of COVID-19, gardens are being planted. People are relearning to use solar energy to enrich their lives and their bodies. They grok what they need to do. It's one of the great promises of photovoltaics: the ability to create little islands of electro-security and calm in a world full of giant, systematized, world-spanning busyness and complexity. Islands that they own, as individuals and families and communities, and thus both control and derive value from. But there's precious

little help, isolated as people are from each other and from the kinds of expertise that the system can pay for.

Lucy? Can you hear me? Is your ansible link still live?

Are you out there, Lucy, amidst my cookies, my email threads, my Zoom links, my data trails?

We need you, Lucy. You and Avery Brown.

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Solarshades

By Andrew Dana Hudson

On cloud-out days, when that listless Pacific smother hung low over Portland, and the house batteries chirped their plaintive 10-percent forebodings—the grid no help at all—Kismet clambered onto the roof to see the lit-up glitter of the Clackamas County line: a trash-strewn no-man's land cutting through brownfields, fallow forests, and cemeteries. A little crack in the law that neither Happy Valley nor Pleasant Valley wanted to deal with.

Kismet didn't envy the refugees, undocs, and homeless who pitched their tents and parked their RVs in the interstices. But seeing their pyramids of warm glow, hearing their music, whiffing their smelly foreign food—all while his games were forced off and his showers ran cold and his cousins ate dry cereal and squabbled over flashlights—on those days he couldn't help but feel a little drip of resentment runneling into his soul.

His older brother Jeffers was a bit further along in this regard. Jeffers was on furlough from the firehouse and had time on his hands to stew. One day he got so mad he stacked a breezeblock wall and set red-lettered warning signs to mark the edge of their blotchy backyard.

"They got their own panels and bats," Jeffers fumed, peeling his sweat-colored tank top away from pinked, white-boy skin. "Stolen, prolly. Def aren't registered with the grid. But they don't got more sun

than we got. So, lemme ask you, Kit James Cole—how come they're running hot when state and metro got us dimmed and rationed?"

Kismet shrugged. Besides Ma, Jeffers was the only one who Kismet let call him by his given name, instead of his gaming handle.

"Taxes and communism!" Jeffers crowed. "Court tears down a couple perfectly clean hydro plants to please the salmon-fuckers, and they expect us to pay the price. So every watt our roof generates gets divvied up a hundred ways by the grid and tithed off to power Salem's carbon-capture scam. But those squatters out there aren't sharing."

"What about Pleasant Valley, though?" Kismet asked. "They're on the grid, but Torko says the cloud-outs don't bother his street none."

"Multnomah County rewards them for being cucked by those granola-shitters downtown. Got they ass 'sprawl-repaired,' 'densified,' 'downshifted'—the works. Spend half their time peasant farming, pedaling around, making nice with the Califugees the government got housed up in their backyards. Trust me, champ, you don't wanna live up there. Ma moved us to get away from that lefty bullshit! Lemme tell you, that'll be the first thing to go when Cascadia finally states-off."

Normally Kismet wouldn't push back on Jeffers' rants, but the other day his classmate Torko had invited him up to a Pleasant Valley house party. Torko was good at classes, but also had once no-scoped Kismet from halfway across the map when they'd both figured out how to leave a boring lecture on subscreen. Kismet, wanting to impress, had gone along. They'd spent the afternoon in the botanical garden, watching stoned college girls pose photoshoots on mossy rocks. Then Torko, dreads bouncing, wove him between backyards that squawked with animals, through idyllic hidden courtyards, to a cluster of homes that bulged with rain barrels and conservatory glass. The party was packed, folks talking intellectual-like about 2080 urban growth boundaries and hyper-pastoralism, pierced bodies moving to the drippy bump of folk-trap deconstructives.

At first, Kismet found everyone in Pleasant Valley insufferable, heard Jeffers' voice in his head telling him to swipe these fuckers' good silver. But he couldn't shake Torko's merry waves to neighbors as he'd crossed their yards, the way he'd picked berries thoughtlessly from alley brambles. Smug as they were, the Multnomah neighborhoods were peaceful and verdant. Gleaming, clean solar panels on every roof. Everything seemed edible. No militia maneuvers on the streets. Matter of fact, there were hardly streets at all—just bikes and scooters zipping along greenway paths, buses sliding through hedge-lined tunnels, light rail linking together bustling mixed-use plazas.

"Must be nice," Jeffers said when Kismet told him about the party, and he sent a hock of spit over his waist-high wall.

Kismet lived in a crumbling, moldy McMansion, not a garden bed in sight. His family rented from a financial firm that had scooped up the whole neighborhood after the Corona Crash; ghosts of dead or broke baby boomers haunted the barren cul-de-sac. Rent was supposed to be controlled, but the firm kept finding new fees to pile up. Kismet's home wasn't "densified," but still it seemed to grow ever more crowded with relatives and Jeffers' friends, all put out by Portland's extractive housing market. Kismet would wake up to huge, blacked-out electric Hummers parked like fortresses on their lawn.

With this itchy pack all sharing one grid hookup, the cloud-outs stung. Sputter a screen and acrimony would cascade from room to room. So Kismet understood why the tent folk's unregistered energy gear rankled Jeffers so much—rankled more than the cozy, out-of-sight-out-of-mind prosperity of those Pleasant Valley types who went along with the government's reshaping of suburban life.

One night his brother woke him at the witching hour with a mean,

manic grin. "C'mon, Kit, let's give those Califugees a shake."

So Kismet and Jeffers and a couple of other boys heaved a wheelbarrow over the breezeblock wall and slunk down to the county line. There they got a good rhythm going: Jeffers and his buddy Leon would knock down a tent and start kicking at the flailing occupants, while Kismet and cousin Poost would peel off the solar and follow the cords to the batteries. They loaded the loot into the wheelbarrow and took off into the dark, dumped their spoils, then headed up the line to look for a spot where the ruckus hadn't woken anyone up yet. Rinse and repeat.

Kismet felt a little rough about this nasty bit of business, but he liked figuring out how to rig the solar into a little house microgrid, off the Pacific Coast Electric books. And Ma and everyone were pretty grateful when they got the new batteries plugged in. The skies that week were a mottled gunmetal, and the grid went cruel. But for once Kismet's screens and the rattly aircon had the juice to run all day.

Jeffers claimed the raid was a one-time thing, but of course it wasn't.

"Shit, champ, no one's gonna come looking for us," Jeffers said, pulling a Cascadian flag-print balaclava over Kismet's sleepy face. "Who they gonna tell? None of those undocs are supposed to be there or have any of that gear. State don't care. Like sticking up a drug dealer. Ain't really a crime, just—what?—'informal redistribution of contraband goods.'"

Kismet didn't want Jeffers to think he wasn't game, so he went along again, and again. It felt good to sit on a surplus of a rationed commodity, to be the ones hooking up the neighbors and getting those accolades. Kismet had a couple years of high school to get done, but he started logging on just the bare minimum. Until the raids, he'd spent his free time gaming and camming to supplement his meager UBI dole, which Ma took most of anyhow. Torko and his other peers

were drifting toward the siren song of the big job-guarantee unions—three hots and a sleep sack out in some muddy national forest, plowing biochar into carbon-hungry soil.

Not Jeffers, though. Jeffers was newly filled with purpose, and Kismet found that hard to say no to.

One new-moon night, at the end of a long run, Poost spotted a skinny black figure skulking around the edge of the encampments. Jeffers swerved the Hummer around and ran up on the guy, downed him with a smack from the driver's side door.

"Look at this!" Jeffers crooned, foot on the dude's back, reading off his badge, dude choking on his own lanyard. "United States Census Bureau, out here at the ass-end of the night. Feds got you sizing these fine folks up for a landgrab, huh?"

Dude just gurgled. Jeffers pulled off the dude's glasses, tossed them to Kismet, who put them on.

Data flicked into focus as the shades found Kismet's green eyes. He looked toward Clackamas, saw real-estate prices and energy bills. Scanned the tents on the county line, saw the outlines of solar panels in the light-polluted darkness, model numbers and wattage estimates wafting above like steam. Blinked to zoom north, saw Multnomah County quantified in all its prim sustainability. And in the lower left corner were the letters "PCE," set in a logo sunset. *Solarshades.*

"Bro, these are from the electric company," he said. No names, Jeffers always told him. "Got all kinds of proprietary info on here."

"Well, do he," Jeffers said, not a question. "So, a utility man on the side, huh. You gonna finally do something about them cheating on all those regs you got the rest of us living under? Or maybe you here to

snitch on my runs?"

Dude didn't say anything, just lay there, no fight at all. For Jeffers, that meant the fun was already gone. He gave the census worker a few kicks to the spine, then got back in the Hummer.

Whole ride home Kismet fiddled with the shades. Just printed and booted, their owner hadn't got around to locking them to his ret. Kismet had a knack for getting to the underbelly of software. When the others went to bed, he stayed up.

The PCE app was raw and unaesthetic, an off-white spreadsheet slapped over the world. But the layers held info Kismet had never seen in the JSTOR databases his Urban Understanding classes had made him install. Private info: home energy efficiency scores, rental agreements, the deals the city and the landholder firms struck with the grid to implement austerity-style energy policy in Happy Valley. The designers wanted to survey the same contraband energy equipment that had Jeffers so heated. If Kismet had to guess, the census worker they'd roughed up had a side gig tracking down the watts the grid thought it was missing.

Kismet wandered the cul-de-sac, soaking up the hidden energy lives of his neighbors, the informal settlements down the way, his own family. When his legs tired and first light began gnawing at the horizon, he returned home, climbed out his window, and turned the shades on the Clackamas County line and Pleasant Valley beyond. It occurred to Kismet, as he fell asleep on the roof, that this was how the state, the utilities, all the institutions that ran their lives saw both the informal settlements and his own little clan: a bunch of sorry metrics, many woefully wrong, thinking they'd gotten away with breaking the rules, not even knowing they were already getting punished for it. Little cracks in Portland's sustainable prosperity that no one wanted to deal with.

By the time the glasses flickered blank—locked by whatever algo

had finally noticed Kismet's prying, or maybe remote-offed when the census worker had limped back to his terminal—Kismet felt a strange kinship with the tent folk across the way. All of them were getting screwed.

Nova Ng first saw the kid sizing up the PV that powered her office hex-ayurt. Not in a malicious way, but rather with a sort of professional curiosity. Except he wasn't a professional—he was a delinquent teen in a ratty metal-band shirt, Bic-ink emoji tattoos cluttering his hands, scratched-up shades dangling from a bit of paracord around his neck.

Not one of her constituents, either. Nova had been refugee liaison for the powerful Everyone's Portland bloc on the Metro Community Council for 18 months. A plodding, finicky organizing gig—keeping Sikhs from clashing with Salvadorians, or whoever was in a spat this week—but it gave her something to do with the social work degree she'd poured so many years into, got her away from the sniping at city hall. She knew, by face anyway, almost everyone who lived in the informal settlements on the east side. Most migrants and undocs who rolled into town showed up to her general assemblies before trying their luck at the Displacement Management Office.

Nova didn't think much about the townie kid—Kismet, she heard someone say his name was—but his occasional presence listening in on facilitation sessions, loitering at the back, made her wonder just who he might be repping.

One evening, unhooking her bike from her yurt's charging rack, she saw Kismet slouch into a hulking, matte-black vehicle lurking in the drop-off loop of the Harmony Point All-Mart. There were about a hundred families camped out on the gravelly grayfield that had once been the shopping plaza's parking lots. Nova couldn't help but

notice the informals shrinking away from the tank's squat, street-light shadow.

Nova cornered Kismet next time she saw him at her Making Sense of Energy Enforcement learn-in.

"What's your *deal*, kid?" Nova stuck out her arm to block his retreat toward the composting perm-a-potties her office had set up at the Harmony Point camps to build goodwill. He was two hands taller, but she'd bullied her way through scarier, fashier men. "You better not be casing these people. I've heard about the thefts, the beatings. Big, black Hummer—that your militia or something?"

It had been a wild guess, but the kid shrunk back, got this wildly guilty look on his face.

"Just m' brother," Kismet mumbled. "Sorry, lady. I'm just trying to learn about this stuff." He waved at her closing slide, still projected on the yurt ceiling.

"Why? What's it got to do with you?"

"I'm interested, is all. We live up by the county line, so the tent grids, the battery-courier economy—it's right in my backyard."

"Clatsop people, huh?" Nova said. "I thought you McMansion holdouts were all about minding your own business. Pretty cynical to prey on people with next to nothing just because they live in a jurisdictional gray zone."

She was convinced that Kismet was involved in the lootings, and she wasn't about to let it drop. His eyes darted around again, but he mastered himself and deflected.

"We get a rotten deal from PCE, too," he said. "Cloud-outs and rationing and no concern for how many people we got in the house.

So we got a little off-grid setup—"

"I bet you do."

"—just to, you know, ease things up a bit. So I'm trying to learn more, about the rules and such." Kismet swallowed.

"Energy descent isn't easy," Nova allowed. "No one ever said it would be. But there's policies to ease the burden, turn up the upsides, 'the gentle way down' and all that. Only problem is folks in Clackamas and Happy Valley voted down all those policies, and I'm going to take a wild guess that your brother was one of them. That's why you get the stick end."

"M' brother ..." Kismet began, then backtracked. He plucked at the glasses around his neck. "PCE man, he dropped these. Had their app in there for a bit, metrics and stuff. Got me thinking that ... we're a little the same, right? A lot of folks on our side of the line got some off-grid going too, just like the illegals and the fugees."

"Language," Nova warned.

"Sorry." He pressed on, picking his way through a briar patch of sentiments that were probably dangerous to share in his own house. "So I'm thinking, what if that stuff was legal? Or we got a better share of our rooftop wattage? Just, you know, if everyone's doing it, and maybe we work together, us and them, PCE or someone might, I don't know, make it okay and stuff? Forgiveness."

"You're talking about amnesty?" Nova said, surprised. "On-gridding or on-booking the informal energy sector. A small generators' union for people who run their own PV?"

Kismet nodded vigorously, for once not just trying to talk his way out of the conversation.

"Why do you care?" Nova asked. She lowered her arm from the yurt exit an inch. "You're too young to be paying the bills."

The boy took a long pause, itched at his forehead, like he was trying

to surface into words an idea he'd barely been able to articulate, even to himself.

"M' brother, you know. He gets riled up. And I got thinking, maybe if it didn't seem like some people were breaking the rules and some people weren't, or weren't breaking them the same way … maybe if the rules were better. Not quite like up north, but just so no one feels cheated. Maybe then he wouldn't get so … riled up."

Nova noticed that Kismet had a way of code-switching when he talked about his brother. His accent got drawlier, his diction cruder. Other times he sounded like any youth schooled by Great Courses and bots. Probably a sensitive, brainy kid at heart, Nova decided. And smart enough to know it wasn't always wise to show it around his brother's crew.

"Okay," Nova said. "Amnesty is a tough sell, but you aren't the only agitator there. The Metro Community Council *might* be convinced, if you could demonstrate a like-minded interest bloc that didn't step on any other bloc's toes. It'll be a touchy coalition to build, though. The infrastructure you want to formalize is a nest of code violations, probably multiple layers of theft and sale of stolen goods cases attached to half the serial numbers. As I'm sure you know. Which means there's grudges and violence at the heart of this that have to be deescalated. The informal settlements aren't nice places, no matter what I do. This will only work if *everyone* benefiting from informal energy is willing to stand together in a demand to the council and PCE. No one sells anyone out. I've got my hands full just keeping a few of these camps livable and communicative, but I can help you work up a letter. If you get us a supporter list—with signatures—I can take it to Everyone's Portland for backing. Deal?"

It was, Nova knew, a lot for the townie teen to take in. That was the point. There was no use attempting this kind of organizing if you couldn't learn fast. Kismet scratched at his inky knuckles, weight

shifting from foot to foot.

"Yeah, deal," he said, managing to sound decisive. Then, knowing he had to come clean about his ignorance, added, "how do I start?"

Nova took her arm away from the exit, pointed at Kismet's shades. "Those still work?"

The organizing platform Ms. Ng set Kismet up with had that nonprofit GUI sleekness the PCE app had lacked—but nothing like the functionality or data access that had piqued Kismet's interest the night Jeffers jumped the census worker. Still, the solarshades once again became full of institutional insight. Kismet's vision swam with ages, sexes, last known addresses. He saw voting frequency, legal history, defunct social-credit scores, political affiliations logged through social posts or petition signatures, plus records of any touches with Ms. Ng's organization. Now when Kismet got close to the county line, the face rec began popping not with energy metrics and PV models, but with people and their stories.

Not everyone took kindly to him walking up knowing every little thing, even if it was pretty much public data. And anyway, half the intel was defunct or inaccurate. Kismet soon realized the shades were less about providing the secret key to an organizing target's psyche and more about tracking and quantifying his own efforts.

He learned to scout people out, check his shades for red flags, then approach like they'd met at a bus stop. No "are you Mr. Contreras?" familiarity. First signature he got was someone the shades had squat on. He just sat down where she was cooking on a makeshift stove—battery wired into jerry-rigged heating element—and asked for a piece of fish.

The camp folk were protective of their energy sources. Homeless guys who bathed once a month kept their PV panels wiped spotless. Some hiked twice a week, backpacks full of batteries, to poorly secured complementary charge spots at hotels and coworking parks. Everyone had their gear locked down with bike cables—as locked down as you could get in a tent, anyhow. Kismet figured Jeffers' raids were probably behind that impulse, but Ms. Ng said that "Clackamas fash" had been harassing and robbing the unhoused for years before the Cole clan took to it. Plus they were scared of the state, and the utility. They knew their setups were a thorn in the paw of powerful interests, and they knew one didn't *really* have property rights in the U.S. without access to lawbots and the capacity to wear a suit.

The paranoia extended to talking about the amnesty demand, or anything to do with energy regs. Kismet's list was growing slowly. Once he had—to use Ms. Ng's words—"exchanged solidarity for trust," the discussion of the actual contents and politics of the demand letter was usually pretty brief. So most of Kismet's organizing time—carved out under the cover of visiting Torko—was spent getting to know people.

This was a funny turn after helping kick the shit out of them in the dark. More than once Kismet spent the night tossing with guilt, woke up red-eyed and resentful, hating Ms. Ng and anyone else with the gall to remind him that there were sapient souls in the world whose suffering he'd been accomplice to. Those days he hated himself most of all, since the whole project had been his idea, and for going along with Jeffers in the first place. He'd hole up in his curtained-off corner of his shared bedroom, listen to bad music and play worse games. But a couple days later he'd be back out there: introducing himself, cajoling, checking in, trying to demonstrate shared interest.

"Fuck do you keep goin' up there for?" Jeffers asked when Kismet hauled himself back over the wall one sweaty dusk. "Don't tell me you

been suckered by some Multnomah side piece. I don't care how hot they are, I won't have my brother woozy over some stuck-up solarpunk-ass bitch!"

Kismet shrugged it off. "Nah. Just class stuff. School system got some avant-garde ideas about group projects, in-person learning shit. Torko and I figure if we do this project together, we can blow off the whole rest of the term."

"Sure you're not getting soft on me, bro?" Jeffers narrowed his eyes. "Been a while since you went rolling with me and the boys."

"Hell no," Kismet said. Lying to Jeffers felt worse than lying to the informals who asked how he got started organizing, but he had no choice. "Crossing their filthy camp every day has me itching to get out there and kick some ass. Just, once I'm done with my project, you know?"

Jeffers grinned toothy and eager. "Sure, Kit. That's real good."

Kismet started feeling Jeffers' hot eyes on his back as he headed off each day toward the county line camp. He knew the tents were too far for Jeffers to make him, even with shades, but still Kismet decided to mix up his routine and hit the other camps scattered across Happy Valley. As he biked around, he saw the telltale signs of informal energy setups on peeling rooftops, poking out of open garages. He knew his family couldn't be the only ones running half on the grid, half off. So he started knocking on doors too.

Portland politics—forward-thinking though it could be—was a cliquey, rancorous tangle, bursting at the seams with counterproductive animosities, suburban grudges that boiled hotter than anything Kismet had encountered in the camps. Happy Valley, for all its ornery

individualism, was no exception. The refugees, migrants, and homeless soon seemed tame compared to the armed retirees, determined degentrifiers, squatters, survivalists, militias, and revolutionary cells that haunted the suburb's McMansion hell. Controversial transit proposals and sprawl-repair policy had fractured people into NIMBYs, YIMBYs, RIMBYs, TRIMBYs, a cascade of acronyms demanding this or that infrastructure in or out of their backyard. Any politics that passed did so through deal-making, favor-trading, bargains, hard-won temporary truces. Success meant herding a vast array of interests into a messy, tentative parade.

Kismet had little experience with such delicate work, beyond keeping the peace in his own volatile house. He did, however, have an unusual kind of focus. Like his peace of mind depended on his success. And he was young; he didn't look like the usual activist messengers. So when he pitched, people listened, if only out of curiosity.

His pitch was simple: the energy system had been through a grand revolution shifting off fossil fuels and beginning the so-called "energy descent." But the new rules of this revolution had been written by powerful institutions far away from the streets and neighborhoods where people lived. Kismet could speak to this from right down in his gut because he'd lived his whole life as grist in the gears, in the little stubborn gaps that architects of order didn't want to deal with. So when he talked about revising those rules to smooth over the frictions and allow for more of the harmless oddities of human life, people believed him. When he pedaled home each night, he could feel a little current of contentment stirring in his soul.

Signature by signature, the parade gathered. Kismet would get messages from people who'd heard about the demand, asking how to sign on. Maybe Ms. Ng had put other organizers on the campaign. Maybe word was just getting around. Right around when the leaden, cloudy spring turned to hothouse summer, Kismet looked down at his

spreadsheet and saw a flurry of new confirmations, countersigned in the night. He was over his goal. He was done.

When Kismet came to her humbly bearing a remarkable organizing output, Nova almost cried, almost hugged the boy. He was such an unlikely success story, proof that a shared material interest could pry individuals out of reactionary, culture-war mindsets. But he needed to know the difficult road ahead.

"I'll get this to Everyone's Portland," Nova said. "They'll broach it with PCE. Then PCE will batter you. They'll test your coalition, make sure they can't break you up without any real work or concessions. They always do, before coming to the negotiating table. Which means I've got one more job for you."

"What?" Kismet avoided her gaze. Over time, Nova had wheedled out of him the full truth of his involvement in Jeffers' cruel enterprise.

"Keep your brother in check. That's our weakest flank—the utility pointing out that amnesty won't stop the predation, tying you to your brother, demoralizing the organized. Can you hold him down for the summer?"

She could see the triumph in his eyes drain, watched that well fill up with anxiety. It was always a shock to discover that even when you win, you haven't really won.

"Can you do that?"

"Yeah," Kismet said. "I'll try."

"Up, Kit," Jeffers said, rolling Kismet off his mattress with the sharp

toe of a plastic boot. "Term's done. Time for some *fun* summer nights!"

Kismet had spent the last week keeping Jeffers distracted, challenging him to gaming tournaments, asking to go on hunting trips or long stoned drives out in Three Lynx and Dodge. He'd hoped Jeffers would get bored of harassing the camps. But now the way Jeffers said "fun" made bile churn up in Kismet's gut.

"Sleep sounds fun," Kismet tried, but Jeffers wouldn't hear it. He threw Kismet clothes, no mask this time, and steered him out the door, into the Hummer, already humming with angry, electric potential. They drove lights-off down the hill, out towards that no-man's-land at the county line.

"What d'ya think, Kitto," Jeffers said, one hand on the wheel, one iron-locked on Kismet's shoulder. "You been scouting these assholes out, right? All those trips through here, to school project or side piece or whatever the fuck. You must've noticed who's got the new gear, right? It's getting hot round here, and Clackamas families are gonna need new solar to handle the aircon load."

Kismet didn't answer. He contemplated jumping out of the Hummer. They closed in on the cluttered pyramids of tent-yellowed light.

"C'mon, point me to 'em," Jeffers commanded, harsher now. "Unless you ain't really been doing that 'group project.' You've been off your game for months, Kit. I'm starting to wonder if you've gotten yourself a sympathy for these fuckin' interlopers."

Jeffers pulled the Hummer to a stop.

"What do you want me to do?" Kismet said. He felt himself shrinking, regressing to before he learned to organize, before the solarshades, back to when he was a scared kid doing whatever it took to avoid a beating.

"Hop out and pick a tent, Kitto. Get us some solar. We've got your

back."

Kismet's sneakers found the muddy ground. Jeffers tossed a piece of rebar after him, and he picked it up. He wondered if anyone would recognize him in the dark. He had no idea what to do.

There were whoops from the Hummer, nervous rustling from the camp. He took a step forward, then another, palms clenching up on the rebar. He was halfway to the nearest tent when he worked up the nerve to turn around, tell Jeffers to fuck off. But by then it didn't matter. The hummer had pulled quietly away. Informals were coming out of tents. And from over the line, rolling in from Multnomah, the flash and whirl of Safety siren lights.

Nova had already been having a bad day when she got the call from Safety Services. Her boss had gotten wind of her involvement in the energy amnesty campaign and had accused her of neglecting her core mandate. And now that redneck Cole kid had run out with his old crew and gotten himself held by a judge in lockup.

"I didn't do anything," Kismet pleaded when Nova arrived. They sat in a taupe interview cell, his hands clenched on the metal table, tracker bracelet around one wrist.

"Yeah, well, your brother sure did. He wreaked havoc in the encampment before he even woke you up."

"That's not my fault."

"I told you to control him."

"That's why I came to you!" Kismet raised his voice, exasperated. "For help with him! Instead you just had me do your grunt work."

Nova leaned back in her chair, stern. "I sincerely hope you don't actually believe that narrative."

Kismet leaned back too, chewed on this, deciding how defiant to be.

"Because," Nova added, "then you'll be no good when we go see the judge."

"You'll vouch for me?" He looked hopeful again.

"Anyone else going to bother?" Nova said, which was meaner than he deserved.

Kismet stared out the wire-laced window at a dawn-touched cloudbank, sliding in toward downtown.

"What's going to happen to the amnesty?" he asked eventually. "To the folks in the camps?"

"PCE will be crowing about this by the afternoon," Nova answered. "No doubt they'll get the word out in the informal settlements. The judge won't let you keep working there. We'll just have to see how many of your signatories decide to bail."

Kismet put his head on the table, breathed long and deep, a sigh not quite a sob.

The recruiter at the job-guarantee office told Kismet he didn't need to bring anything to the bus—just his body, his brain, and a willingness to work and learn. Might be appealing if it didn't feel forced. The judge had made it a condition of his freedom: get out of town, "away from troubling family influences," make himself useful, catch up on school. Kismet packed a bag anyhow, claiming that sliver of agency. Toothbrush, flashlight, seeds from Torko, and the blanked-out solarshades, wrapped up in a sock.

Jeffers didn't see him off, just Ma and Poost. Jeffers lurked upstairs, nursing his house arrest. Safety had picked him up trying to roll the Harmony Point camp. Kismet was pretty sure Nova had seen him

coming.

The bus glided up, garish green and PV-roofed. When the honk came, Kismet clambered out his bedroom window, took one last look at the Clackamas county line.

It was a couple months before Kismet heard from Nova. Not that long in politics time, but it seemed a lifetime to him. He got the ping, and they arranged an evening to chat—her lounging alone in her office yurt, now moved out to West Slope, him hunched over a screen in his pup tent, at the edge of the Malheur Forest Expansion Zone.

"How's union life?" she asked.

"Not bad," Kismet said. "Way I figure, sooner we get the carbon down, sooner energy rationing can ease up. So I tell myself I'm still doing my part to win energy amnesty, after a fashion."

"Well, I got some news there," Nova said. "PCE announced some dispensations today. Not everything we wanted, but it's a good step. Funny, they claimed they were planning it all along, soon as they finished their informal energy survey, that census worker whose shades you stole. But they wouldn't have gotten moving if we hadn't pushed."

Kismet felt something settle inside him, some small seed that had been rattling around in his veins.

"How?" he asked. "Figured the parade would fall apart. Figured folks would feel cheated about who talked them into signing."

Nova gave that exaggerated vidchat shrug. "Mostly we had people asking after you, wondering if you were okay. You had a good idea, and that got bigger than you. A lot of policy starts as something personal. But what's personal to one person can be political to a thousand."

After the call Kismet crawled out of his tent, watched the sun go

down and the stars come out. Up and down the line, at the edge of the forest they were rebuilding, with just the sun to keep their bats juiced, the tents of his compatriots began to glow.

Quiet Mobilization, Inclusion, and the Energy Futures of Cities

By Patricia Romero-Lankao

"Solarshades" is a story of intertwined partisan, family, and community identities and obligations. It traces nuanced, contradictory, and contested actions around energy policies in Portland, Oregon. It shows that the energy futures of cities are not only about the technical challenge of decarbonization and options for transitioning to solar energy, but also about who owns energy systems, how inclusive management modalities are (such as grid, legal-distributed, and illegal-distributed), and who pays for, who benefits from, and who bears the risks brought about by these technologies.

The story reminds us that energy and sprawl-repair policies and strategies, no matter how forward-looking and beneficial, are not always inherently wanted. Rather they become unwanted, or not, through in-situ social and political interactions. Sprawl-repair policies seek to transform auto-dependent, single-use places into more diverse, environmentally friendly, and economically viable communities, by creating viable human-centered neighborhoods that are walkable and fueled by renewable energy, with mixed uses and public

transportation options.

As it happens with the parade of yes-in-my-back-yard (YIMBY) and right-in-my-back-yard (RIMBY) reactions alluded to in the story, Kismet's family's not-in-my-backyard (NIMBY) engagement against solar and sprawl-repair strategies might, objectively, be seen as self-defeating in the context of their long-term well-being. Given the crumbling living conditions the family experiences, it would be fair to ask why people like Kismet's mother—and particularly Jeffers, his brother—oppose ostensibly sustainable energy policies.

Actions and responses to policy-making are not necessarily and uniquely driven by cool rational considerations of benefits and costs. Values, identities, feelings, and loyalties are also deeply intertwined with actions. People often situate their actions towards energy policies in relation to their cultural, political, family, and clique identities. Political ideologies, in particular, create rationales that are at the heart of enthusiasm for action that might be counterintuitive, both at a first glance and from a longer-term urban sustainability perspective.

Jeffers and his clan and gang, for a variety of mixed-up, at times conflicting reasons, view government sustainability efforts such as solar energy as a menace to personal autonomy. Below the surface of Jeffers' behavior lies a contradictory and subtle force: a hodgepodge of values, identities, feelings, and loyalties about a wide variety of things, and to a variety of different groups. Jeffers represents sectors of the population whose mix of feelings and impressions is pivotal to their mistrust of sustainable energy policies and of supporters of those policies, "those granola-shitters downtown," the self-identified progressives, liberals, or Democrats who often push for sprawl repair and solar energy in the name of the public, sustainable good.

In the future, struggles over urban energy transitions are going to be less about ending coal or oil, and more about how prosperity and opportunity opened up by solar, electrification, and other

technological deployments plays out in complex socioeconomic and political landscapes. In this context, "Solarshades" also emphasizes that a focus on rallies, boycotts, and other public forms of open policy action can lead scholars and pundits interested in fostering inclusive, decarbonized cities to overlook the political significance of more person-to-person interactions.

Although understudied, person-to-person interactions are far more pervasive than formal political gatherings for the vast majority of people in the U.S. and around the world. They include forms of interpersonal engagement such as Kismet's conversations with his brother Jeffers, his friend Torko, and their neighbors, whose signatures he was asked to gather in support of an effort to bring extralegal, unregulated, off-grid solar collectors into the official energy system. At first glance, any of these conversations might look to be something personal and irrelevant. However, after a careful look, this story shows us that what is personal to some can often be "political to a thousand."

Such interactions are the backbone of *quiet mobilization*, a term used by sociologists to denote a form of political engagement by an apparently silent majority of people. Although understudied, *quiet mobilization* is key to understanding the influence, on the energy futures of cities, of the hodgepodge of factors shaping actions and responses by this majority. *Quiet mobilization*, either for or against solar, transit, sprawl repair, energy and sustainability policies, or social and cultural practices, entails daily chats with neighbors and colleagues, the formation of local interest groups, civic meetings, discussions at churches and recreational centers, conversations with colleagues, and other forms of daily engagement in civil society.

Quiet mobilization frequently reinforces sentiments of identity and belonging to a family, a gang, a group, or a place. It is crucial to understanding Kismet's ambivalence, as reflected when he, for example,

while self-conflicted about the looting of informal communities, "didn't want Jeffers [his brother] to think he wasn't game, so he went along again, and again." *Quiet mobilization* involves interpersonal conversations about political and contentious topics. These conversations require mutual trust and often arise in nonpolitical places. They also happen in face-to-face situations where people like Kismet choose not to openly confront contentious issues, but rather to tackle them with cautiousness.

Social scientists such as Colin Jerolmack and Edward T. Walker suggest that *quiet mobilization* is an especially attractive option for collective action in rural, white, conservative communities, where open forms of mobilization against fracking or for disinvestment in coal and the fossil-fuel industry are viewed with disdain and mistrust, as something that only Democrats, urbanites, or liberals do. I would argue that this is the preferred option for the majority of populations who, like Kismet, embrace their inner orbits (families, clans, or neighbors) as outlets for their political interactions, rather than engage directly with the wider political structure of their society.

Although *quiet mobilization* is not undercover or clandestine, it differs from more conventional and open forms of resistance in that it does not necessarily entail a logic of oppositional awareness. Rather, it is employed because it can help people like Kismet achieve their goals. Visits to folks—talks that touch on their immediate needs, fears, hopes, dreams, or concerns—are the preferred and more effective means to "work up a letter" and "a supporter list—with signatures." They are intimate ways to achieve political goals without openly disrupting family, gang, or community bonds, expectations, or rules. They are also a space needing a deeper understanding in any effort seeking to foster more inclusive approaches to building decarbonized and sustainable futures.

"Solarshades" clearly points to the structural power asymmetries at

play, which are the consequence of the characters' comparative positions in the political and socioeconomic order of Portland. Within this structure, Nova, along with the Metro Community Council for which she works, has the power of knowledge. They create an augmented-reality app to map their vast "institutional insight," which helps them inform their policies and navigate their politics. Through the app, Kismet becomes aware that dwellers of the informal settlements are living incredibly precarious lives. He also realizes what his family, his gang, and these settlers have in common: all of them are often getting screwed by powerful forces they can't control.

Nova and the reader know that even though Jeffers and his Cole clan, and the "Clackamas fash" before them, have been looting "the unhoused for years," their circumstances are but a scintilla in Portland's constellation of powerful interests. Clearly, in Portland—like everywhere—those who own the land and money have the power to call the shots. And "Solarshades" dazzlingly highlights that nobody actually has property rights in America and worldwide without access to the assets and options, such as money, lawyers, and lobbyists, needed to shape policies in ways that benefit them.

However, differences in the characters' comparative positions in the sociopolitical order of Portland cannot alone explain the challenges that the city's changing acrimonies, resentments, and disagreements pose to the successful realization of its forward-looking policies. These conflicts also result from the abilities and power of the characters (the characters' agency) to act upon, take advantage of, negotiate, and contest these policies. These challenges take place in a context of multiple changing coalitions built and rebuilt through deals, bargains, and temporary truces. The dynamic interplay between antagonists, supporters, and affected people often leads to the messy, wicked, and provisional outcomes of policy attempts aimed at sustainability.

Such problems arise because knowledge of the sociopolitical realities portrayed by "Solarshades" is omitted by precisely those experts, pundits, and practitioners responsible for analyzing and informing energy sustainability policies in cities. Focused as they are on quantitative and "objective" representations of sociopolitical realities, they tend to assume that successful policy depends on rational action and decision-making, fully informed political actors, and an empathetic planner. In so doing, they omit that, in reality, any energy policy, no matter how well-intended and forward-looking, creates a new and messy constellation of winners and losers immersed in numerous contradictions that can ultimately bring failure. They do so as they move from idea to reality, thought to action, from a clean conception in a committee conference room to the gritty and grim reality of daily existence.

Kismet ends up being forgiven by the judge with the condition for his freedom that he get "'away from troubling family influences,' make himself useful, and catch up on school."

"Solarshades" touches a series of personal questions in me for which, sadly, I have no answers. What would an understanding of quiet mobilization by multiple sectors mean for the energy futures of cities? Given that energy transitions require collective action, how can we engage with the antagonists in today's energy policies and politics? How can we engage with the quiet mobilizers, and also with the open mobilizers such as the oil or renewable-energy industries? Is there a bigger and more coherent strategy for social and political energy change that speaks to the fears, needs, dreams, and identities of the messy mosaic of urban groups involved? Or do we need to accept that there are many ways to construct inclusive and sustainable cities, ways that may be more enigmatic, more irreverent, or more ordinary than we think?

While I don't have answers to these questions, I believe that

understanding quiet mobilization offers a potentially powerful tool for building inclusive coalitions that consider the more personal and intimate interactions prevalent among the majority of people across the spectrum of urban to rural places. This story is primarily about white communities. However, many of the same kinds of disenfranchisement, and failures to engage, plague the relationships between the energy sector, advocates of sustainable energy, and African American, Latinx, and Native American communities. Furthermore, analysis of the rich mosaic of needs, identities, fears, dreams, and hopes shaping action among this majority is crucial. By including not only the open mobilizers but also the quiet mobilizers, we will be able to forge more inclusive coalitions in support of more equitable energy and sustainability outcomes.

Encountering Energy Systems

By Angel L. Echevarria

When you gaze at an energy system, who and what do you see within it? Whose relations are entangled in its webs? What elements of our world are at stake in the project of energy transitions?

These are the questions we confront when we encounter the "Solarshades" of Andrew Dana Hudson's story: augmented-reality glasses that, through data-driven overlays, open up new vistas that allow the wearer to explore how energy systems structure the relationships between people, across vast distances of space and time. This essay is about the challenge of transforming human-created energy systems—the ones that make it possible for billions of people to access and use electricity. The purpose of this essay is to help you identify, relate, and start connecting the dots of what needs to be considered if we hope to transform our energy systems to better serve societies around the world. To do that, we need new lenses.

Throughout the essay I use different examples to show how big the challenge is to transform global energy systems using the tools of science. Too frequently, when we look at the world through scientific lenses, we find our gaze narrowing, seeing only a fraction of what is really there. By contrast, when our lenses reveal the complexity of

our contemporary energy systems, as in "Solarshades," we recognize that the challenge is not simply to substitute the current electricity-producing technologies, and the services they currently provide. Instead, the challenge is to critically transform the social structures, institutions, and processes of energy—social relations that in our existing energy systems are too often violent, extractive, and colonizing[1]—together with the kinds of knowledge and everyday actions that have tied us to the energy-producing technologies that were pushed by the deeper political economies of the world.[2] To transform our energy systems to be sustainable, it is indispensable to go beyond climate change to decolonize our world, to end racism, to end poverty, to end refugee settlements … and that means we need to transform not just the fuels and technologies of energy systems, but also how they operate and how they are organized.

The energy system is already in transition—or at least parts of it are. If societies endeavor to design just, equitable, and secure energy transitions towards a sustainable future using the tools we have developed in science, we inevitably start by looking at energy systems through a lens or a framework. These lenses are part of the tools science uses to shape our thinking, helping us to make sense of the world. But science itself will not suffice, in part because the evolving nature of scientific tools are in contrast to the habits of the humans that use them. To our disadvantage, we tend to stick to the categories, models, theories, and frameworks we have created in the past. Very often we forget to scrutinize how these were created, and on what basis, in what context, what their relation is to the whole, how we understand and interpret what the tools tell us, their purposes, how they affect what we understand, and how they constrain what we imagine goes on in the world.[3] Scientific institutions are slow to transform and even slower to change their fundamental processes, which are deeply rooted in old paradigms.[4] Some of these paradigms

are in the range of thousands of years old. In contrast, the energy systems I am talking about here are in the range of a century.[5] To build today's energy systems took a hundred years of effort, and now, due to changes in the climate, we need to transform them three times as fast. This is part of the challenge, too: we are against the fast-rising temperatures of the oceans and the atmosphere at the same time that we are against the inertia of structures and institutions that need to change.

Lenses for Viewing Energy Systems

To show this, here I share with you three lenses on energy systems. The first includes two examples of narrower lenses provided by conventional tools of science, which both fall short of providing vantage points from which to transform energy systems. The second lens combines the social and technological aspects of science to show a complex vision of energy systems. This way of understanding energy systems includes the people inhabiting them, such that energy systems are understood to be socio-energy systems. The third lens draws from a holistic vision of energy systems to help us understand that we can relate to energy systems differently.

Lens 1: Scientific and Engineering Approaches

The first example of a scientific lens on energy systems is the concept of the energy burden. There are places within the U.S. mainland where households pay 14 percent[6] of their total income in energy bills, not including the gasoline for their car. While this is already difficult enough, there are other places where that same number can range from 48 to 55 percent,[7] as is the case for low-income households in the central mountain region of Puerto Rico. This fraction of household income is called the energy burden. Sociologists use it to measure the financial cost that energy systems impose in people's lives, illustrating just how thoroughly existing energy systems are implicated

in reinforcing and even exacerbating poverty. Yet, even on its own ground, the measure is inadequate. Energy burdens run far deeper than just money: those facing the prospect of having their electricity cut off, for example, routinely feel anxiety, depression, shame, anger, stress, and other health issues caused by the different trade-offs and decisions they have to make, day after day. These are other types of burdens caused by energy designs that are centered on access, selling electrons for consumption. The impact of the human dimensions of energy systems was not included in the design of the energy systems we have now. Nonetheless, these are crucial aspects that are immediately present in our lives as we relate to and inhabit energy systems.

Another scientific lens on energy systems frames them in terms of power plants generating electricity, which travels through a set of cables and infrastructure that transmit and distribute electrons over long distances, all the way to the outlets into which we plug our electrical devices. To understand such systems, electrical engineers use theories of electricity from physics, mathematical equations that describe the behavior of electrical circuits, and computational models that let us design and analyze those circuits. However, this way of framing entirely ignores people, the places that transmission cables travel through, the locations where power-generating plants operate, and the threats to the environment and human health that they pose. People imagine, design, finance, and build energy systems, they operate and maintain them, and they use and live with them. Yet, when we use the tools of engineering to model energy systems, all of that is left aside. The energy systems that electrical engineers see do not include people at all, except in the traces of their lives measured by their "load": the electrical needs of their devices and appliances.

Lens 2: Socio-Energy Systems

To include people in our understanding of energy, we need to use tools that are not found in the disciplinary toolkits of science and

engineering. Langdon Winner, in *The Whale and the Reactor*, his book about the political philosophy of technology, explains that the construction of a technical system that involves human beings as operating parts brings about a reconstruction of social roles and relationships.[8] That reconstruction, in turn, feeds back into the design and operation of the technical system, creating continuous interactions between technical systems and social systems. This way of framing energy systems describes them as socio-energy systems,[9] in which the interactions between the social and the technical define both systems through the activities we do every day, the ways that technologies get assembled to meet those needs, and the ways that our activities then adjust themselves to conform to the opportunities that our technologies offer. Energy systems are, in this way, co-produced at multiple levels.[10]

Viewed this way, we can better understand not only how energy systems work to structure human lives and livelihoods, but also how energy systems replicate larger systems of oppression that have been in place for centuries, even before the Industrial Revolution.[11] When paying attention only to power plants, wires, and electrical devices in the design and analysis of energy systems, we perpetuate all of the social injustices that are wrapped up in the people and put them into our designs. Despite the promises of electricity to create prosperity for all and to ensure fair distributions of the costs of energy systems, energy burdens are not equal and fall disproportionately on Black, Hispanic/Latinx, and Indigenous communities.[12] The same pattern holds true for the environmental and health risks imposed by energy infrastructures.[13]

Lens 3: Energy Encounters

Fortunately, the evolution of scientific knowledge allows us now to move past disciplinary boundaries, to include other forms of

knowledge and perspectives to achieve a holistic understanding of the challenges that different societies face. Instead of asking a specific set of questions that are normally bounded to any given discipline, transdisciplinary science aims to ask all sorts of questions that transgress the intellectual blocks imposed by academic disciplines and well-established roles in societies. When we rethink our daily interactions with energy systems in a way that engages the complex socio-technical relationships that emerge out of them, it can put us on track to a sustainable future. In doing so, it is essential to pay attention to micro-level interactions and macro-level outcomes alike, because they both shape the evolution of a system.[14] Our inner worlds, such as emotions, thoughts, identities, and beliefs, no less than our great systems of technology and infrastructure, lie at the root of sustainability, and are fundamental to the solutions to some of the world's greatest challenges.[15]

Following this lead, we now take a look at the micro-level interactions we have with energy systems using a relational lens. Imagine one day you come home to discover an energy officer at your door, a visitor from your local utility. You have a choice, the officer informs you: either pay your energy bill, or the energy service to your home gets shut off. What will you do? At this point, you are facing a trade-off. Do you pay the electricity bill and spend days without money? Do you use money from the cellphone budget? Eat less food for the next few weeks? Try to land a second job? In the extreme, perhaps you can do nothing.

I call this an energy encounter. Energy encounters take many forms and flavors, but what you encounter is the energy system itself. The combination of its many elements, its design, its infrastructure, its politics, its regulation, its law, its numbers—all fused—confronts you altogether. It can be in the form of stress, or in the form of planning ahead of time to adjust your routine accordingly, or all of a

sudden—in any case, the energy system presents itself to you, not as an object that you can experience, but as something to which you relate.[16] That is an energy encounter. Someone can argue that a person who has financial freedom would not have to deal with such an encounter. In this case, we can consider the macro-level interactions between energy systems and people. Wealthy people also encounter energy systems, but in different ways. They encounter them as investors, as partners in creating a clean-energy future, as objects of policy and regulation—just not as an officer, asking for money lest they turn out the lights.

Solarshades and Social Relations

If you were asked to imagine a future that is sustainable, how far would you dare to imagine with respect to addressing society's biggest challenges? Are homelessness, refugee camps, hunger, poverty, gender and race inequalities, deforestation, land appropriation, war, colonialism, and cultural eradication still present in your imagined sustainable future? All of these are issues that people encounter in the world as result of the mechanisms of current geopolitics, including the economics of energy systems. They are issues that could be addressed, at least in part, through a reorganization of the energy sector. From this perspective, energy systems are a social issue that encompasses not only climate change and the institutions that have allowed it to accelerate, but a whole host of energy encounters that are often invisible to those making global clean-energy policy.

The narrative of climate change and energy system transitions is narrowly fixated on a single outcome: to eliminate carbon emissions, often via a technological fix—deploying solar energy. There are many ways of achieving that particular outcome, most of which leave space for the continuation of the same mechanisms that have oppressed people at a range of social scales, from impoverished households to

entire civilizations. In other words, you can replace the source of your energy and the technologies that provide it, but if you keep the same mechanisms of interaction between energy systems and societies there will be no transition at all.

When you use a relational and holistic approach, the picture you get of the energy system tells us that we need multiple outcomes of the ongoing energy transition—that whatever the technology, it is only but a component of the solution. "Solarshades" reminds the reader (and the wearer) that what is at stake is far more than just electricity. The shades offered the energy officers of the future information not only about electricity use, but also about real estate, energy bills, home energy-efficiency scores, rental agreements, proprietary information, energy theft, illegal connections, consumer debts, ages, last known addresses, and so on. The solarshades are a symbol of the different institutional paradigms that today shape energy systems, old and new. They are a reminder that what we are doing when we design and build energy systems is to simultaneously shape societies in all of their relations.

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1 Sandy Smith-Nonini, "The Debt/Energy Nexus behind Puerto Rico's Long Blackout: From Fossil Colonialism to New Energy Poverty," *Latin American Perspectives* 47, no. 3 (2020): 64-86.

2 Maria Pastukhova and Kirsten Westphal, "Governing the Global Energy Transformation," in Manfred Hafner and Simone Tagliapietra, eds., *The Geopolitics of the Global Energy Transition*, Springer International Publishing, 2020: 341-364.

3 Rupert Sheldrake, "Setting Science Free From Materialism," *EXPLORE* 9, no. 4 (2013): 211-218.

4 Thomas S. Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, 1962.

5 Thomas Hughes, *Networks of Power: Electrification in Western Society*, 1880-1930, Johns Hopkins University Press, 1983.

6 This is the average energy burden for people at the lowest 30 percent of the Area Median Income (AMI) of Clackamas County, Oregon, based on data available in 2020. The AMI is the midpoint of a region's income distribution—half of the families in a region earn more than the median and half earn less than the median. See "Low-Income Energy Affordability Data Tool," U.S. Office of Energy Efficiency & Renewable Energy, https://www.energy.gov/eere/slsc/maps/lead-tool.

7 Based on data available in 2020, the average energy burden for people at the lowest 30 percent of the AMI in the municipality of Ciales, Puerto Rico is 52 percent. For Puerto Rico as a whole, the average energy burden is 26 percent. See "Low-Income Energy Affordability Data Tool," U.S. Office of Energy Efficiency & Renewable Energy, https://www.energy.gov/eere/slsc/maps/lead-tool.

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15 Christopher D. Ives, Rebecca Freeth, and Joern Fischer, "Inside-Out Sustainability: The Neglect of Inner Worlds," *Ambio* 49 (2019): 208-217.

16 The concept of "encounter," as used in this essay, is borrowed from Martin Buber's dialogical philosophy, which I apply as a relational lens to analyze energy systems. See Martin Buber, *I and Thou*, Scribner, 1970.

San Juan, Puerto Rico

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To see a full-color, high-resolution version of this image, visit https://csi.asu.edu/books/cities-of-light.

Things That Bend, But Don't Break

by S.B. Divya

La Flor de Maga, the massive wind-turbine sculpture, towered over San Juan, its giant red petals wide open and spinning in the ocean breeze. Tanama ran past the gawking tourists at its base. She crossed the bridge to the network of floating houseboats and leapt from dock to dock until she arrived home.

"Mamá!" she called, unable to hold in her excitement. She ducked through the small door into the dark interior of their houseboat.

"Down here," her mother called.

Tanama slid down the ladder and almost bumped into her mother, who stood over the small electric stove.

"Look!" She thrust her phone in front of her mother's eyes.

Maria Ortiz squinted and read the words that had sent Tanama running home after school: *We are pleased to offer you admission to Columbia University.* Tanama grabbed her mother's slender waist and pulled her into a giddy spin. They laughed and whooped, and for sure their neighbors must have thought they were drunk.

"I'm so happy for you," Maria said. She tucked some stray hairs behind her ear and returned to frying plantains. "Now you can go to New York and become rich and famous like Valeria Blanco."

The Puerto Rican artist, known worldwide for her massive solar-powered art installations, was Puerto Rico's latest darling. Every parent aspired for their child to have the success of Blanco or Lin-Manuel Miranda or Sonia Sotomayor, depending on their tastes.

"I don't have to leave," Tanama said. She scrolled further and waved a block of text at her mother. "It says here that I can study through the local college facilities."

"No." Maria sliced horizontally through the air with the spoon in her hand. "This is your chance to get away and make a better life for yourself. San Juan is too small. Why have I worked so hard for all these years? Your papá dreamed of sending you to New York so you better go."

Tanama glanced at the photo on the wall. Her father had died five years before, during Super Hurricane Franklin. He'd been driving to check on his mother and their family farm. A mudslide washed his car off the road into a ravine, and by the time emergency crews reached him, he was gone. Tanama's grandfather had abandoned the family decades before, after going to the mainland. When Tanama was little, Papá would tell her wild stories about the adventures her grandfather must be having in New York City or Los Angeles or Miami. He'd intended to find his father one day, but he'd never had the chance.

"Okay, Mamá," she said, swallowing the objections that rose like a lump in her throat. She didn't want to disappoint her parents, but everything she loved was here, in Puerto Rico.

After dinner, Tanama left her mother watching a show and went to rent a scooter. Friday night in San Juan was always a party, but the previous day's storm meant the city's electricity storage was full, and

every hotel and restaurant sparkled like a bride on her wedding day. People crowded the streets, eating, drinking, playing music, dancing. Tanama had to walk a long way before she found an unoccupied three-wheeler with a full charge.

She sat astride the narrow vehicle and flipped on its lights. As she drove away from the crowded city, she could make out the hum of the electric engine and the rustling of leaves. She turned off the highway in La Muda. The road narrowed, the trees grew denser, and a half moon blazed in the clear sky above her head. A moist breeze blew wisps of hair around her face as she turned onto a narrow dirt track. Mud caused the scooter's wheels to slide, and she kept a tight grip on the handlebars.

Finally, she saw the white-painted wooden post that marked the turnoff to La Granja. The scooter's all-terrain wheels bumped and rolled over the grass. Tanama navigated by moonlight and memory, using the trees and boulders as her guides, until she saw the twinkling lights of the small settlement nestled against a low, dark hill.

She parked the scooter near Yuisa's one-room house. The encampment was dark except for a dim light at the entrance of each of the dozen houses, all set in a rough circle under a great solar canopy. Tanama glanced up as she walked through the makeshift village. Here and there, gaps in the paneling allowed moonlight to filter through. They made do with what they could get for little or no cost, and it had taken over a year to generate enough power for basic needs. Many projects, like the automated watering system, still sat in half-finished piles, waiting for missing parts.

As she walked around the base of the hill, she heard voices mingled with the sound of rushing water. Yuisa's vibrant laughter dominated, and Tanama felt her heart beat faster. They'd been dating since secondary school, but Yuisa had moved into La Granja more than a year before. Every Friday held the sweet torture of anticipation.

She rounded a bend and came upon a waterfall, lit from below by a gentle green glow. The sight took her breath away. Every sunny day, the solar canopy charged up their batteries until full. Extra power was sent to pumps, which carried water to a storage tank at the top of the hill. The idea was that any time the tank filled up, they would let the water flow for hydroelectric power at night. This was the first time she'd seen it work.

"Tanama!" Yuisa called out, spying her before she could say hello.

Tanama greeted her with a hug and a kiss as the others hooted and yelled rowdy hellos. Yuisa was two years older, but her head barely reached Tanama's shoulders. She had stick-straight black hair and the classic features of the Taíno people, unlike Tanama, who had some European heritage.

"It's so beautiful," Tanama breathed, her gaze torn between Yuisa's face and the waterfall.

Yuisa grinned. "Yes, the pool filled up after yesterday's storm, and Mateo got the turbines working this afternoon. The falling water is powering its own lights. Isn't it great?"

Tanama nodded. Yuisa was the mad genius behind this village, finding clever ways to keep it as self-sufficient as possible, but she was also a good leader. She'd gathered like-minded friends who had skills to complement hers.

Yuisa took Tanama's hand and dragged her over to one of the benches near the base of the pool. "Sit. Eat!" She waved a spoon at Tanama's face.

Tanama took the offered bite. A silky sweetness filled her mouth with the flavors of caramel, custard, and a tropical fruitiness she couldn't name. She took the bowl and spoon from Yuisa and swallowed another bite. "It's delicious! Some kind of flan, but what's that flavor?"

Mateo piped up. "Jackfruit!" His dark face glowed in the light from the pool.

Next to him sat Ameyro, who added, "Yuisa said we're allowed to eat some."

Tanama laughed with them. Several years before, Mateo had done a school project about the Asian fruit and discovered that it could be used to store electricity after some special processing. Yuisa had convinced her parents to let her plant a few trees at the edge of their farm. They'd begun to produce fruit the previous year, but Yuisa had insisted on experimenting with them rather than eating any. La Granja had its own grove of the trees, but they hadn't reached maturity yet.

"I didn't know what to do with it," Ameyro continued, "but some of the Asian recipes cook it so I made flan."

"The inedible part is better for making batteries," Yuisa added. "Might as well eat the rest."

Tanama looked down and most of her portion had disappeared. "You could sell this and make a fortune. It's so good!"

"We don't need to sell anything if we can do everything for ourselves," Yuisa said. She sat next to Tanama and put an arm around her waist.

Someone started playing a guitar and singing. Others got up to dance.

"So, did you hear from any colleges?" Yuisa asked softly. "Weren't you supposed to get an answer from Columbia this week?"

Tanama hesitated. What had felt like such good news a few hours before now soured in her mind. How could she bear to leave Yuisa and La Granja? Her grandfather had gone away. He'd sent money for the first year, then stopped answering their calls. They never found out what happened to him. Would that be her? Would she throw her

people away like a used dishrag, losing herself in life on the mainland?

Never, she promised herself. *I'll be like Valeria Blanco. If I become successful, I'll make sure everyone in Puerto Rico gets my help, not just my family. I won't forget anyone.*

"I'm going to miss this," she said, barely above a whisper.

"Which college?"

"Columbia."

A wide smile spread across Yuisa's face. "I'm so proud of you. Don't be sad. I'll be here every holiday, waiting. I promise."

Yuisa leaned in. Tanama closed her eyes for the kiss, feeling a thrill and a pang. *How could anywhere else be better than this?*

Surrounded by love and music and moonlight, she had everything she wanted. After she graduated from secondary school, she could live at La Granja, move in with Yuisa—if her girlfriend agreed—and help the community while getting her college degree. It sounded so much better than going to a strange big city full of people she didn't know.

She wrapped her arms around Yuisa's neck and felt like she'd never let go.

Saturday morning dawned crystal clear with the lightest of breezes—a perfect day to visit her grandmother. As with many Puerto Rican families, her father's mother had raised her, along with a passel of cousins, until she was old enough to attend school in San Juan. Her parents lived and worked in the city. It had better job opportunities than the rural area around their family farm. Tanama tried to visit every weekend, though storms sometimes made it impossible. After her papá's death, no one wanted to try the roads during heavy rains, and the railway didn't run during bad weather.

Her phone pinged as she enjoyed breakfast on the deck of their houseboat. A message from Yuisa. "We got an eviction notice. Not sure what to do. Got any lawyer friends?"

Tanama replied, "Oh no! I'll ask Mamá."

But Maria shook her head. "I don't know any. I told you this was a bad idea. Just because the owner isn't in Puerto Rico doesn't mean they're not paying attention. They hire people to check."

"It's been more than a year, Mamá! They didn't say anything. Besides, La Granja beats letting that land sit around doing nothing. It's not fair."

"A pineapple is sour," her mother said with a shrug. She pressed a bag into Tanama's hand. "Don't forget the medicine."

Tanama tucked the bag into her backpack along with clothes for the weekend, then slung the pack onto her shoulders. The streets were quiet after the previous night's celebrations, and the water taxi to the sea train had only one other passenger.

The enormous silver tube of the railway grew as they approached. She'd watched its construction over the three years after Super Hurricane Franklin, and it had run smoothly since then. The U.S. hadn't wanted to repeat its mistakes from Hurricane Maria, so after Franklin, it stepped in with generous support. Life had changed in many ways since then, but Tanama believed that the sea train was the greatest of Puerto Rico's projects.

The monorail circled the entire island, making transportation safer and faster by avoiding the inland roads, which always took damage after big storms. The rail's base was an artificial reef that doubled as a breakwater. The water taxis and the train ran on quiet, non-polluting electric motors, and most of the coastline was now a protected marine area. During her childhood, the harbor waters had been dark and oily instead of clear and turquoise. Now, jewel-colored parrotfish

and wrasses swam in the waters below.

As she climbed the stairs to the train station, Tanama shaded her eyes. The rail's tube-shaped cover shone like a mirror under the cloudless sky. Solar cells plastered every sunward surface, and the remainder was covered by painted murals. Mateo had tried to explain to her how the structure also produced electricity from waves, but she found enough joy watching the water rise and fall as she waited on the platform. The system produced enough power to supply multiple coastal cities around the island. Lin-Manuel Miranda and Valeria Blanco had raised money for its construction, and the United Nations called it the first wonder of the solar-powered world.

Her joy evaporated once she was seated and looking at her phone. A string of messages from Yuisa brought more bad news. They'd been served a legal eviction notice: they had two weeks to dismantle La Granja and move off the land. Anything left behind would belong to the landowner, some businesswoman named Sylvia Jovet who lived in San Francisco. She'd left Puerto Rico as a baby and inherited the land from her parents.

Outside the train window, the developed areas of San Juan gave way to sandy beaches and lush green trees. They pulled up and into a station near the harbor at Ceiba. A ferry boat crossed under the elevated structure. Next to the ferry dock stood a building, one wall covered by a giant solar-painted mural. Like several others, this one had been commissioned by Valeria Blanco.

Why can't this Sylvia Jovet person be more like her, and support Yuisa instead of destroying her work? Maybe I should study law so I can help people fight for things like La Granja.

After another stop at Guayama, the train arrived at Ponce. She exited the train, walked past a group of tourists headed out from the airport, and found a scooter at a charging station. She made a stop at a market before getting on the road to Limas, where her family's

farm stood.

The dense coffee bushes appeared along the road before the modest house came into view. Ribbons of brightly colored solar-cloth fluttered at the boundary of the planting areas. They provided power for the watering systems and acted as wind breaks during storms.

Tanama left the scooter in the yard and ducked into the house.

"Yaya?" she called.

A little boy with sun-browned skin and wavy black hair dashed by.

"Hey, Cacimar! Where's Yaya?"

"She's at the church, charging up," her cousin yelled over his shoulder.

Tanama left the groceries in the kitchen and the medicine in the locked cabinet, where the little ones couldn't get it. She decided to take the scooter she'd rented, so her cousins didn't play with it.

The church had a small courtyard built around a tall pole covered in peeling white paint. Solar panels topped the structure, and power outlets surrounded the base. After Franklin, the government decided it would be cheaper to give everyone local solar power than to rebuild power lines across the island. People had figured out ways to make these charging stations into social spaces, and her grandmother sat under a wide umbrella with two other local ladies, Isabel and Clarita, chatting and laughing as their battery packs and phones charged up.

"Tanama, come here," Yaya said, pulling a chair under their shade umbrella. She examined Tanama closely, as she did every time, though only a week had passed. "What's the matter? Are you sick?"

Tanama tried to force a smile and failed. She spilled the news about La Granja, being careful to talk about Yuisa as only a friend. Puerto Rico had made a lot of progress, but her grandmother wouldn't approve of two girls dating. Yaya had taken a microgrant from Valeria Blanco to install the solar-cloth at the farm, but they hadn't told her

that Blanco was a trans woman, afraid that might dissuade her from accepting the money.

"And I got into Columbia University," Tanama finished. "But I feel so bad about La Granja, I don't want to go away to New York. Mamá says I should go, that Papá would want me to. What do you think?"

Yaya patted her hand. "I think you should ask God and then listen to your heart. Then you'll know the right thing to do."

Isabel nodded in agreement, but Clarita frowned. "God better tell her to go to the mainland! How are you going to become the next Valeria Blanco if you stay here, hm?"

"What about La Granja?" Tanama said. "They're building the future, one that's good for everybody, not just Puerto Rico."

Clarita waved a weathered hand like she was shooing a fly. "They're getting evicted. They have to grow up and have families and steady work. You should go to New York."

But I love Yuisa, and I want to make her dream come true. She couldn't tell these women that, so instead she said, "Nobody is using that land! Don't you think it's unfair?"

The older women all shrugged.

"What can you do, anyway?" Yaya said. "If you care so much, go study and make money so you can help people like your friends when you're older."

Clarita and Isabel stood and went to collect their batteries, which had gone green with full charges. Isabel loaded two into a wagon, joining a stack of at least ten others.

"Why does she need so many?" Tanama asked her grandmother.

"She takes most of them to Guayanilla and sells them to the scooter company. She lost half her coffee plants to the blight last year, and now she does this for extra money."

"Did you know you can store power in jackfruit batteries?"

"What is *jackfruit*?"

Tanama pulled out her phone and showed Yaya pictures. "You can eat it, too. I had it in flan, and it was delicious!"

"What! That fruit looks too dangerous to eat!"

Yaya broke into laughter. Tanama joined her, tilting her head back. As she did, the solar panels atop the charging pole dazzled her eyes, and she got an idea. La Granja's massive solar dome produced extra electricity now. What if, instead of pumping water for nighttime, they could charge batteries for one of the scooter companies in San Juan? Maybe they could make enough money to buy the land from Sylvia Jovet.

For the rest of the weekend, Tanama kept returning to that thought. Her fingers itched to send a message to Yuisa about it, but she forced herself not to. She had to learn whether it was possible and how much money they could earn, otherwise she risked disappointing Yuisa with false hope.

In church on Sunday, she took Yaya's advice and prayed to God for guidance, looking deep within her heart for the answer. *If my plan works, then I'll stay so I can keep helping with La Granja. If it fails, that means I should go to New York.*

She usually felt disappointed to return home on Sunday afternoons—back to schoolwork and their tiny houseboat, away from all her cousins on the farm—but for once, she looked forward to it. On the train back to San Juan, she looked up every scooter company in driving distance of Yuisa's settlement. There were quite a few small ones that catered to tourists. Many had their own solar charging stations, so they wouldn't be interested in her business idea.

The biggest scooter rental company, though, was run by the city of San Juan. They had a distributed network of stations where people could drop off spent vehicles and pick up charged ones. The city still got its electricity from a centralized power plant, the same one from before Franklin, and the scooters still charged at stations powered by the grid.

That evening, she spilled her disappointment to her mother over dinner. "I don't know if the city scooters would want to use jackfruit batteries, and there's nowhere else in driving distance to La Granja that would."

Maria pursed her lips in thought. She had worked for PREPA, the Puerto Rico Electric Power Authority, for most of her adult life—first in data entry, then working her way through college to become a power engineer. "San Juan wants to get to carbon neutral. We've been increasing the amount of electricity we get from sources like solar and wind power, but it's hard to store enough for the city at night. What if we could use your jackfruit for that instead of scooters?"

"We can't make that many batteries."

"Not yet, but you can be the first source to prove that it's possible. Then others on the island will take up growing jackfruit and make more. We'll never get all of our power from one source, but the more clean sources we have, the better. And who knows? Maybe one day the island will have so much jackfruit that we can start exporting it. Those trees look pretty sturdy. I bet they can take a storm better than a coffee plant."

Maria smiled, and Tanama's spirits lifted. Her mother was always so practical. If she thought the idea could work, then perhaps all was not lost.

"How much do you think they would pay?"

"I'll ask around the office tomorrow. Get me some numbers on

how much charge your jackfruit batteries can hold, and how much La Granja can produce on a typical day at different times of year. Your friends have been tracking that, right?"

Tanama nodded. She knew exactly where to get that information. She'd helped Yuisa find open-source software to track the solar panels' production. Either Yuisa or Mateo would know about the jackfruit batteries.

"Thank you, Mamá!" She planted a kiss on her mother's cheek, then began to gather their dishes in the sink. "I'll clean everything tonight."

Maria laughed. "Okay, but don't get your hopes up too much. I can't promise anything until I talk to people tomorrow!"

Tanama nodded, trying to contain her excitement. She imagined Yuisa's face when she told her how she could help them save La Granja. *Please, God, please let this work!*

Most of the week passed before Tanama had the answers she needed from her mother. School kept her occupied in the meantime, but she found it hard to keep her mind off the situation at La Granja. The eviction notice said they had two weeks to clear off the land or they'd be forcibly removed, losing the rights to anything they left behind. They'd had no luck finding a local lawyer who'd take their side for no pay. They could take apart and move all the stuff in a week, but they had nowhere to put it. They'd have to find a home for the four cattle, and they'd probably have to abandon the jackfruit trees, which were already too big to dig up and move.

In the meantime, two more U.S. colleges had accepted her, one in California and another in Texas. She could imagine her mother's fury if she decided to stay in Puerto Rico with so much opportunity on

the mainland. *Am I being foolish? Even if I can help La Granja right now, maybe Yaya is right. Maybe I'd be of more use by leaving and getting a law degree and sending money back.*

Plenty of people supported their families that way. She could get her degree with any of the U.S. colleges by studying remotely, but that wouldn't get her the friends and contacts that being there in person would. She'd read up on the benefits of in-person versus distance learning, but none of them accounted for something like La Granja, for having your heart in one place while your feet were in another.

The rest of her free time went to numbers. That Wednesday, her mother got her access to the public utility's pay rates and usage needs.

"They said you can start by directly charging scooters," Maria told her. "Alex has heard about these jackfruit batteries. They don't work like regular ones, but they're really good at holding a lot of energy and fast charging something else. That's good for vehicles, but if you could make enough of them or make them bigger, we'd rather use the power for houses at night. There's a government program that will give you a loan for this, and it would also give us money to build the interface so we can hook your batteries up to the grid."

Tanama stayed up late Thursday night figuring out how much La Granja could produce and what they could earn, then she created ambitious projections over the next five years. If everything went well, if they didn't have any super hurricanes to disrupt their progress, they could plant more jackfruit trees, build more solar domes, and eventually buy their own electric truck to carry enough stored energy to power a hundred homes in San Juan each night.

Before she'd met Yuisa, Tanama had never dreamed so big. Yuisa had graduated from the same school two years before her and built La Granja from nothing but a vision. Tanama wouldn't have had the courage to do anything like that, but with Yuisa as her inspiration, she could see La Granja growing into a model that others in Puerto Rico

could adopt, maybe even people in other parts of the world.

A little after midnight, she sent her calculations to Yuisa with a suggestion to ask the land owner if they could buy the land with monthly payments, like a mortgage. Then she crawled into bed with an exhausted smile. The gentle waves of the sea rocked her to sleep.

Tanama woke later than usual on Friday morning and rushed to school on time. She checked for messages, but Yuisa hadn't replied. *Too early for her to read everything I sent.* The residents of La Granja had full days. They had to maximize their work while the sun was up, when they got all their solar power, and because much of their labor involved plants and animals.

She checked again at lunch, and still no response. What if Yuisa or the others didn't like her plan? What if the landlord had already said no, or wanted more money? She fretted her way through her afternoon classes. They had to keep their phones turned off except during lunch, and all she could think about was the fate of La Granja.

The instant school ended, Tanama had her phone out. At last, a message! But only three words: "We'll talk tonight." She could strangle Yuisa! What could be more important than this? She bought pizza on her way home and left it for her mother as a peace offering, along with a note of apology that she was leaving earlier than usual.

She barely noticed the drive to La Granja, her mind racing with questions. She arrived a little before sunset. In the slanting southern rays, the great solar dome gleamed like the back of a sleeping dragon. Beneath it, the small, single-room houses sat in a circle, their solar paints reflecting bright jewel tones. The grove of jackfruit trees stood to her left, their leaves lit in green and gold. In the distance, the cows

lowed as they were herded back into their pen for the night.

At the far end of the dome, Yuisa, Mateo, and several others crowded around the cabinet that held their solar-power equipment. Tanama could hear their voices, raised in argument, from her spot near Yuisa's house. She strode over and waited for them to notice her.

"We're going to need better replacements," Mateo said, sounding frustrated. "This one has failed three times, and if I keep putting in used parts, it's going to stress these circuits and cause problems here and here." He jabbed at something in the cabinet that Tanama couldn't see.

"And where do you plan to get them?" demanded Ameyro. "We don't have the money to buy more equipment."

"None of this matters right now," Yuisa shouted. "You should be thinking about how we can safely move—" She stopped as she caught sight of Tanama. "You're early."

"I couldn't wait."

Mateo and Ameyro exchanged a look and quietly moved away, toward the house they shared.

"Did you read what I sent you?" Tanama asked. "Are you really going to give up on this?"

Yuisa sighed and crossed her arms. "What else can I do? The whole point of La Granja is to be self-sustaining. Selling batteries turns us into a business like everyone else, and I don't want to do that."

"But ... you need the money for some things, like the parts Mateo wants. You would still be doing something amazing by providing all of your own food and power. If you have extra to trade for supplies, what's wrong with that? Self-sustaining doesn't have to mean separate from the world."

Tanama reached out and pried one of Yuisa's hands free. She walked Yuisa away from the cabinet, toward the base of the hill and

slowly turned them in a circle.

"Look at what you've built," Tanama said. "You don't have to become a profit-churning machine. You can stay small. The spreadsheet I sent you only increased the number of jackfruit trees, not the size of La Granja, and you don't have to scale up that much if you don't want to. Think of the others—where will they go if you leave here? What will they do? You'll all get swallowed by San Juan or some farm." She squeezed Yuisa's hand. "I'm trying to help you keep La Granja alive. Please, at least ask Sylvia Jovet if you can pay her for this land!"

Yuisa sighed again and scratched at her head with her free hand. "I think your dream is bigger than mine now."

Tanama shrugged and then smiled. "Only because you planted the seeds."

Yuisa pulled her hand free and took her phone from her pocket. She typed something and then turned to Tanama. "How much can we pay and how soon?"

Tanama gave her the numbers and watched as Yuisa pressed send. She wrapped her girlfriend in a hug from behind, and rested her chin on Yuisa's shoulder. They watched as the sun dropped between the distant hills and the stacked clouds above turned the color of ripe papaya.

After a restless night, Tanama woke to an empty room. Morning light filled Yuisa's house through two generous windows. The efficiency kitchen looked clean and unused, so she grabbed some eggs, bread, and ham and made two sandwiches. Outside, someone had left a pot of coffee and mugs on the communal table under the center of the dome. She poured herself a cup, then went in search of Yuisa.

She found her sitting on a boulder near the top of the hill, next to the pumps for the waterfall, a mug cradled in her hands. She handed Yuisa a sandwich and sat next to her.

Yuisa planted a kiss on her shoulder. "Thank you."

They ate in silence, enjoying the cool morning breeze. To the north, the hills fell away to the coast, and a line of blue showed where the sun had burned away the haze. The pungent aroma of sedge rose from the green carpet beneath their feet.

When she'd finished eating, Yuisa wiped her greasy fingers on her pants and then extracted her phone. She thumbed to something and held up the screen so Tanama could read the words.

From Sylvia Jovet:

Interesting proposal, but I don't like the idea of selling my property. I'm still a Boricua, though I haven't returned to Puerto Rico since I was four years old. I'd like to take a look at what you're building on my family's land. Some could argue that your Taíno ancestors have more claim to it than I do, and that's partly why I'm willing to give your venture a chance—as a rental!—but I want to see it for myself. I've booked a flight for the end of the month. I'll expect your first rent payment when I arrive.

"Maybe you were right," Yuisa said. A smile crept onto her face. "It's a relief to know we don't have to take apart La Granja."

"I'm glad I could help," Tanama said. "And you know what this means? I'm not going to the mainland for college! I'm going to study remotely, from here, and live at La Granja after graduation. That is," she paused, her heart racing, "if you'll have me."

"Are you sure?" Yuisa looked up at her with alarm. "I mean, of course I'll have you! But what about your scholarship? And what will your mamá say?"

Tanama looked out toward the sea. "I made an agreement with God to follow my heart if this plan worked. Even my mother can't say

no to that. Besides, next month I'll be eighteen, and I get to choose my life. I don't want to go to America and send back money. Let that life be for the Valeria Blancos and Sylvia Jovets. I want to live here and study law and help you grow jackfruit and tend cows and learn about solar power."

"Wepa!" Yuisa said with a huge grin. She thumped Tanama's back. "Let's get started, then."

They clambered down from the rocks and onto the grass. Hand in hand, they walked down the hill toward La Granja and their future.

New Solar Paint May Change Life as We Know It

By Robert Ferry

January 21, 2040
CommonNews San Juan

In a small informal settlement called Los Fotónes, the future is already here. Guided by Dr. Vera Clemente, a researcher at Escuela de Artes Plásticas y Diseño de Puerto Rico, our CommonNews team took a behind-the-scenes look at the promise of a new solar technology, solar paint,[1] that could make solar energy the leading engine of peace and prosperity for the world.

As we make our way from the road, the wind rustles the leaves of the jackfruit trees. After a few minutes we begin to see the experimental canvases of solar paint lifting and falling gently in the clearings. When we reach the entrance, Dr. Clemente introduces us to Victory Alcado, one of the founding residents of Los Fotónes, and Clemente's most important local partner. Before getting a lesson in how the new technology works, we sit down for a cup of locally grown coffee and reflect on the recent rapid progress that has made the energy

transition possible.

There was a time earlier this century when things changed more slowly and when the promises of technology to do social good were frustrated by massive inequality and an austerity-minded public sector. We are fortunate—following the tumultuous decades behind us—that the balance of power has now shifted from corporations to the people, and that structural incentives now favor degrowth.

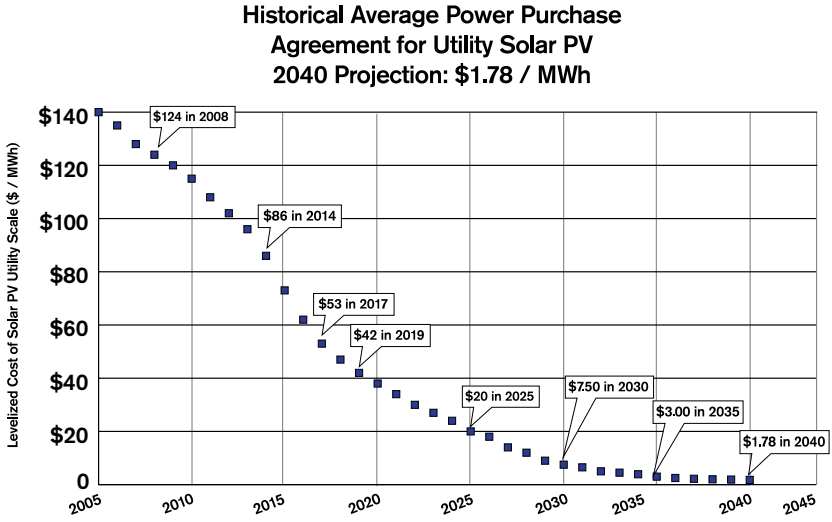
With the nation's economy shifted from capitalism to terrametrism, new wealth is now created in the economy when ecoregions, habitats, and the atmosphere are restored, and is lost when they are damaged. This is the reverse of our previous system, which rewarded profit and shareholder value, where wealth could only be created through wage labor, and where businesses were structurally disinterested in the stewardship of the Earth's ecoregions.

After ten years of terrametrism, we have finally turned the page on wage-based capitalism. The time-saving benefits of quantum technology and a rapidly renewable circular economy without scarcity are being shared by everyone through disbursements to our terrametric wealth accounts.

The progressive structural changes to our sociopolitical systems are in large part due to the potency of one technology: solar power. Access to affordable distributed energy was one of the important catalysts of the Great Capital Inversion that ended the struggle of wage labor and resource scarcity, allowing a steady-state global system to evolve within the carrying capacity of the Earth.

According to a report published yesterday by the International Renewable Energy Agency (IRENA) and SoLazard, solar power passed yet another milestone in 2039, as the cost of installed residential solar broke the $0.70 per watt barrier and the cost of utility-scale solar approached $0.25 per watt.[2] The power-purchase agreement (PPA) cost of solar power on the grid has reached a ridiculously low rate of

$1.80 per MWh ($2.60 per MWh with storage) in a major deal inked by the City of Dhaka just before the big quantum dot dropped, ringing in the new decade, with a record 50-year estimated lifetime for the project.



Copyright 2039, IRENA and SoLazard (Levelized Cost of Energy Analysis Version 34.0)

Ten years ago, solar power was a major factor in bringing about, but also easing the economic burden of the 2028 collapse of the carbon bubble. As the last of the dinosaur investors took massive hits from stranded asset write-offs, the low cost of solar energy resulted in massive gains in productivity and innovation within an emerging circular economy, driven by an expanded workforce through full-employment programs, open borders, and the national Solar Year of STEAM Service (SYS-STEAM). The past decade's expansion in solar deployment and economies of scale and innovation have brought solar power to roughly one-tenth the cost of old petro-energy and fossil gas.

While we might be tempted to rest on the laurels of the past decade, there is still much work to do, especially in shipping, industry, and construction (the SIC sectors) before our global carbon emissions

are down to zero. Nine gigatons per year may be less than a quarter of what we emitted in 2019, but we are still getting dangerously close to passing 500 parts per million of CO_2 in the atmosphere. With technology lagging on meeting the replacement for SIC sectors, it is more important than ever that we keep driving down the cost of solar for all uses.

In what looks to be good news on that front, interdisciplinary research out of Escuela de Artes Plásticas y Diseño (EAPD) de Puerto Rico and the University of Buffalo have demonstrated the long-term reliability of 100 percent non-toxic, organic, perovskite solar paints (PSP).[3] According to Dr. Clemente, "PSP can be installed [painted] on any surface using the same technique as house paint. It can be made clear or in a variety of colors. It can be color-matched and can be blended together in-situ as an art composition, much like traditional paints."

We were fortunate to witness this new technology being tested at Los Fotónes by the founders of the informal settlement, led by Alcado, the charismatic 20-year-old who is now taking courses at EAPD. Los Fotónes is what is coming to be known as a communovoltaic landscape because it houses people who can make a living harvesting solar energy—or, as Alcado likes to call it, "photon farming." During the research stage, the new technology has allowed Los Fotónes residents to experiment with a new business model leasing fully charged portable jackfruit batteries to locals. A second demonstration site is the nearby Aerostatic Balloon (Globo Aerostático), where solar paint has replaced the balloon's previous exterior coating and has given a second life to the tourist attraction as a power plant that feeds 300 MWh per year into the local microgrid. A third demonstration is just getting started closer to San Juan at an encampment by the name of La Granja.

So how does it really work?

According to Alcado, "After the designated setting time of the solar ink, the painted area begins to generate a charge in sunlight that is collected using leads attached to the two furthest points on the surface. The conversion efficiency declines slightly after the first few years, but at any point a new layer of solar paint can be applied to revive the efficiency."

Over time, solar paint is encapsulated beneath new layers, just as paint is covered over on a house. At the end of its life cycle, when removed from the substrate, the dry solar paint is heated with a solar oven, which separates the component parts for use in new batches of solar paint. If discarded without recycling, it bio-degrades into natural materials that make excellent fertilizer. It is the perfect terrametric product.

Alcado demonstrates the function of SolarPaint by clipping a gallium nitride[4] electrical contact onto the side of the wall of their house near the entry door, and another contact onto the far corner of the same wall. Between the leads is an electron-gathering area of about 10 square meters. After about an hour of us talking, a nearly empty 3 kWh jackbok (a jackfruit aerogel battery)—enough to keep your fridge and 3-D printer running for the day—now shows a full charge. Alcado says she stewards an area of energy harvesting of just over 2,000 square meters (one half-acre) made from sol-painted canvas, elevated above the ground by poles and ties, which keeps 305 lightweight portable batteries charged every day. Her family uses no more than five jackboks for their own household and leases out the other 300 jackboks on a rotating schedule to make a modest income that augments their terrametric deposits.

The residents of Los Fotónes make the batteries themselves using the wood and fruit from their onsite jackfruit orchard. After a jackfruit is eaten, the inner pulp is heated with a concentrated solar thermal furnace to create an aerogel with incredible supercapacitor

qualities. It takes a few minutes to wire each aerogel and affix it into the wooden case. Los Fotónes residents have found the aerogels last longer than was originally suspected. They tend to have more aerogels on hand than they need to replace the depleted ones.

Los Fotónes jackbok batteries fit any size E-Rover and can be plugged into any residential microgrid. You can lease one 3 kWh jackbok for 50 cents plus a refundable deposit for the beautifully carved jackwood case.[5] The 15-kWh module ($2.00) is more than enough to run a high-energy household or business and get you most everywhere you need to go on the island (even one 15 kWh battery will get you about 50 miles of range). You can hang out at Los Fotónes Hash and Coffee Bar if you'd like to wait for a half-price top-up. Hot tip: the misolein soup is exceptionally good!

One Indigenous cooperative that is marketing a version of solar paint under the Public Licensing Act (PLA) estimates a starting price point of $0.15 per watt later this year, and they expect to be below $0.10 by 2045. Per the PLA, a percentage will be given to the universities and researchers who made the discovery, to support innovation and student scholarships. Due to the abundant and recyclable natural materials in the product, PSP will soon be less expensive per volume than commercial paint, the cost of which has been rising slightly due to the more stringent circular economy and redlist product standards that President Omar's administration put in place to increase terrametric wealth. Our contact at the cooperative, who asked to remain anonymous, says they are already in partnership with one of the cities bidding on the 2043 world EXPO, although they wouldn't say which city.

Another interesting feature of the jackbok battery is the information that it gathers from the microgrids to which it is connected. When batteries are returned, the residents of Los Fotónes first scan the data for any potential electrical irregularities that were encountered,

which could mean they were connected to an unbalanced or inefficient system. They then send those flagged reports to jackbok users whose microgrid they pertain to, after which the data is anonymized per the strict standards of the Cyber Privacy Act, which was enacted following the 2020 pandemic. The data is fed into the Puerto Rico Commons quantum-computer energy model, which flags potential efficiency issues by looking for nonconforming bits. These information services (and the coffee shop) augment Los Fotónes' income from battery leases.

Residents of Los Fotónes expect to have an expanding market for some time—at least while solar paint gets rolled out around the world. Even then, in denser urban environments like San Juan, there just won't be enough painted surface area, requiring folks to take a drive or catch the OWCAT (oscillating water column area transit) and the electric sky car out to the communivoltaic farms of the interior to swap out their jackboks for the month and to take in some rewilded nature.

The best part about Los Fotónes are the vivid colors. They are everywhere around you! As each area of this energy landscape accrues solar-painted layers, amazing textures and patterns emerge through compositions that tell stories of Puerto Rico's past and future. It seems our world will soon be visually enriched by a powerful tapestry of cultural expression—a painted world of wonder where street art and graffiti art are the power plants of our cities.

Soon anyone will be able to paint the roof or walls of their house for a few hundred bucks and have free power. Every single surface that used to be painted with commercial paint will soon be painted with solar paint, charging non-toxic portable batteries that circulate in a new economy where energy is currency.

Over the past decade, places like Puerto Rico, on the front lines of climate change, have demonstrated how access and agency around

affordable energy and its means of production can liberate people and restore a balance of power in society. As we embark upon an era in which anyone, anywhere can convert almost-free energy into circular goods and services, we should expect to see new sources of social wealth emerge, alongside a recovering natural ecosystem within a rightair atmosphere that we will have more free time to savor!

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Aspiring Isn't Enough: A Call to Continue Agitating for a Sustainable Puerto Rico

By Yíamar Rivera-Matos

"Porque el que está dispuesto a luchar por la libertad, se la merece."
—Filiberto Ojeda Rios

"The future belongs to those who prepared for today."
—Malcom X

In 2016, I read the article "End of the Crisis: ELA (Commonwealth) transformed into PREVA (Puerto Rico Economic Association)," which argues for a futuristic, dystopian, and corporate Puerto Rico. The article was published in response to the approval by the U.S. Congress of the PROMESA Act (Puerto Rico Oversight, Management, and Economic Stability) and the imposition of a fiscal oversight board to govern Puerto Rico's budget, neither of which was welcomed by the progressive and left-leaning populace. Most people I know who have read the article agree that the vision it lays out for the future is what

Puerto Rico will become under PROMESA: a nation operating under a neoliberal economic model created by international agencies, independent cities, and private companies, prioritizing profit over people.[1] The provocative article ends in 2052, when a group of patriots gather in the city of Lares, the day after ELA's transformation into PREVA, to establish the organization NOPREVA: a declaration of political and economic independence for the archipelago.[2]

I believe this article is an invitation to imagine that a different Puerto Rico is possible. However, I don't believe that we have to wait until 2052 to discuss Puerto Rico's future. We Puerto Ricans can start talking, planning, and building it now! My experience, being raised in the mountains of the big island of Puerto Rico, is that many versions of Puerto Rico exist at the same time—that there are many hearts, many visions, many struggles, and many longings. So, what should the Puerto Rico that we want to live in look like? What do we want to share with future generations?

I dream of a Puerto Rico full of joy, where sustainability and happiness are possible. That dream was shared by our team for this project, who chose to adopt the principles of *strong sustainability*. Strong sustainability is defined by activities that promote social well-being and preserve natural resources, while being acutely aware that certain environmental functions cannot be replicated by economics or social capital.[3] According to studies of urban sustainability, cities do not exist in isolation; rather, they extract resources from their rural neighbors.[4,5] As a group, we prioritized the question, "Cities for whom?" and sought to think deeply about the possibilities of healthy interactions between urban and rural areas. We therefore opted to focus not just on San Juan, the capital city and urban metropolis, but rather on Puerto Rico in its entirety. Our approach invited us to think about an urban future that includes interactions and flows between all parts of the Puerto Rican community—urban, rural, and

diasporic—where the relationships among these diverse groups are mutually beneficial rather than extractive. This essay is about the possibilities of such cooperation and the hopes, and uncertainties, that surround it. It's about articulating a vision of the desirable future, in which social transformation inspires an alternative system that is joyful and sustainable.

Reality Check

In Puerto Rico, the economically poorest communities live on the south coast and in the central mountain range.[6] These areas of the archipelago have been more negatively impacted than others. For example, most of the energy in Puerto Rico is generated in the south of the big island and transported to other areas for consumption. People in the south pay high prices for electricity and a higher price with their lives. This is reflected, for example, in high rates of cancer in their communities caused by ash, laden with heavy metals such as arsenic, that comes from carbon-fired power plants for generating electricity.[7] In response to this injustice, local communities near the south's power plants have used solar-energy projects as a political statement to oppose the existing energy politics and economic system that are not beneficial to them, and that expose them to significant environmental and health risks.[8]

In the mountains, a different story is happening. There are no power plants polluting the environment and causing cancer. However, the mountains are economically dependent on Puerto Rico's wealthier northern communities for goods and services, and have experienced a worsening economic recession for over 20 years.[9] I experienced the changes in economic stability, access to local food, deterioration of our culture and local products, closing most of the local businesses, and the exodus of Puerto Ricans to the U.S. mainland, while I was growing up. It was not until 2017, in the aftermath of Hurricanes Irma

and Maria, that these dependencies became visible to everyone and that the community began to mobilize to address them. In the past two years, community members who have borne the brunt of the economic injustices have joined forces with groups who have been working toward a sustainable future since the 1990s. Together, they have identified and are moving toward a new direction for social change, grassroots solar-energy projects, that are similar technologically to their counterparts in the south, but motivated by a very different set of values and commitments.

Food sustainability is another major challenge for Puerto Rico. Approximately 87.5% of the food consumed by Puerto Ricans is imported from the U.S. mainland, which involves high transportation costs and generates food dependency.[10] In 2015, a ship with food and medicine headed to Puerto Rico from Fort Lauderdale sank in the Bahamas. The disaster killed the crew and led to a shortage of food and medicine in Puerto Rico for weeks.[11] More recently, two weeks into the lockdown for the COVID-19 pandemic, a well-known chef in Puerto Rico went onto a popular local TV program, *Jugando Pelota Dura*, to expose the fact that many children in Puerto Rico are hungry for long periods of time, and some are forced to exchange their bodies for food, increasing sexual violence and child abuse.[12]

Energy and food are two keys to a sustainable future; they sustain us. However, the priority has not always been the people and the environment. For example, along the south coast, in Santa Isabel, environmental activist groups protested in 2011 against the construction of windmills in the most productive agricultural area of Puerto Rico.[13] Even though the windmills can add value to Puerto Rico's energy mix and accelerate the transition towards renewable energy, the protesters were concerned that it would further erode Puerto Rico's food security.

We should keep these injustices and targeted discriminations in

our collective memory, in an attempt to overcome the amnesia that can lead us to despair. Right now, Puerto Rico is experiencing multiple social, political, and environmental crises, which create multiple environmental and economic disasters. The vast majority of people in Puerto Rico do not like these outcomes. We do not like the consequences that have followed from a series of hurricanes, earthquakes, droughts, blackouts, food insecurity, and now an accelerating pandemic. The unfair politics and injustices of the past and present have forced us to reimagine the Puerto Rico that we want to inhabit. To truly ask the questions: What is a desirable future? What principles should guide efforts to work towards that future? What are the alternative economies that are possible for people who today live at the margins of the existing food and energy systems? How can alternative economies translate into a transformative justice project, an alternative society? How might such a project be wrought? Is it possible? How might it encompass low-carbon energy futures and food sovereignty for the people of Puerto Rico?

We understand the problem; we have the evidence. The system is not beneficial for us. So, what alternatives do we have for a sustainable future? I believe we should rethink the model of economic development in Puerto Rico and consider alternatives that are based on the principles of strong sustainability: living in harmony among nature, people, and technologies. We have a model very close to us: Cuba. Cuba has been redesigning and transitioning to a model that is beneficial for its population. Although they are still transitioning, they provide an excellent opportunity for Puerto Rico to learn from their mistakes and their successes. After the fall of the Soviet Union, Cuba was left to the mercy of their local resources, with no money, little outside help, and an antagonistic U.S. They focused on developing an economic model that does not depend on money, in order to ensure their citizens have the resources required to survive the

crisis. Cuban researchers were sent to develop local solutions. Their answer was an Agrarian Revolution, decentralizing food production and redistributing land to the people of Cuba,[14] while adopting a clear vision for monitoring and regulating resources, companies, and external investments.

Alternative Solar Energy Development

Cuba's approach is not perfect, but it works, and it could serve as a model for Puerto Ricans to follow. While Cuba has focused on food, and food sovereignty is important for Puerto Rico, I want to suggest that Puerto Rico could adapt the Cuban model for energy. Right now, Puerto Rico spends $3 billion per year to import energy from external sources, and is always at the mercy of the fluctuations of the global market.[15] That money could be redirected to a mix of local energy-development projects that includes solar as one of the principal sources of energy for local communities in the archipelago. Locally sourced and locally owned, that energy could advance not only Puerto Rico's economy but also its solidarity.

In Puerto Rico, solar energy is about people, resilience, and dignity. People perceive solar energy as a positive alternative to the current energy system, which is entirely based on imported carbon, and therefore much more expensive for Puerto Ricans than for populations in other parts of the U.S. However, there are currently few means for Puerto Rico's low-income communities to engage with solar in order to create social change. If a local technology-access mechanism is developed that could benefit those at the margins, a typical Puerto Rican family should be able to afford solar energy.[16] The money that we could save could be used to pursue other projects that are important for us, such as cultural events, cinemas, local festivals, health centers, and schools.

In this solar-powered energy future that our team envisioned,

which is captured in the story "Things That Bend, But Don't Break" by S.B. Divya, the archipelago acts as a whole, and not at the level of individual cities and rural areas. The people prioritize mutual-aid programs, food-sovereignty projects, and water access—with solar energy to make them all possible. In the mountains, the solar panels are utilitarian, helping people navigate the challenges of a difficult landscape. Solar energy powers irrigation systems and the growing, processing, and transport of local, delicious food. In urbanized areas, by contrast, the panels are carnival-style and have multiple colors, adapting to local architecture and embodying the Caribbean flavor and culture.

Decreasing dependency on global energy markets, and creating a local market for energy products, catalyzes innovation to flourish. The jackfruit plays an important role in the archipelago as an local source of batteries for energy storage. Solar panels are combined with these batteries to reduce the environmental impacts of more traditional lead-acid batteries, which are common in Puerto Rico today. Using batteries made from jackfruits will help maintain the nightlife that is crucial to our culture by storing solar energy for nighttime use. Solar panels will be integrated with locally sourced biofuels, which will help reduce dependency on external solar-equipment markets. Solar energy and jackfruit batteries will be a new form of resistance!

Hope and Possibilities

In Puerto Rico, we know solidarity. We hold on to hope, despite a history of colonial invasions and corrupt leaders. I personally experienced hope and possibilities when, in April 2017, the students of the University of Puerto Rico system decided to go on strike for more than two months in what they called "Huelga de País." During the strike, the students demanded a better present and future for Puerto Rico as a whole, not just for the student community. Later that same

year, the island was devastated by Hurricanes Irma and Maria. The state was unable to serve their people, so Puerto Ricans and people in the diaspora engaged in efforts to move the country forward. As a consequence of the hurricanes, Puerto Rico was subjected to the longest blackout in United States history, and the communities most affected were the ones in rural areas. Two years later, in 2019, someone leaked conversations from within the commonwealth's administration, which exposed corruption related to the aftermath of the hurricanes. These events encouraged people of all ages to protest, demanding new leadership and the eradication of the fiscal oversight board. Then, in January 2020, the south and the central part of the island were hit by earthquakes and aftershocks that continue today. People from all around the archipelago took a role in the disaster response and helped the people affected by delivering supplies and emotional support, when the state was not able to.

We have a community. We know solidarity. We have hope. We have the best intentions; it's happening all over the archipelago. We also have collective memories of what matters to us and what we don't want any longer. Our desires are very clear. People want a different future that nourishes us! All we need is to mobilize our passion, hope, and desires towards a joyful and happy future, towards systematic change, a social transformation for the greater good of the people, a sustainable future.

Toward Sustainability

If we can have cleaner air, culturally relevant food, and energy to run the local economy, what kinds of activities can the youth of Puerto Rico look forward to as they imagine the future of the archipelago? All of the energy that we invest in resisting injustice will transform into plazas de café, a right to leisure, having a community, and being happy. I imagine people in urban areas will spend a portion of their

daytime in gardens, reclaiming our culture, and reconstructing ideas of a dignified life. The changes will happen, not perfect but possible. Why not a social transformation where we can live in harmony with land, people, and technologies? If we reshape and change our economies and our politics, a social transformation is possible.

I hope that the intention of the article about the dystopian future of Puerto Rico was to inspire the youth of Puerto Rico to imagine a different future and to work for it. We should keep holding our collective memory of happiness—and also injustice—to inform our future. Let's keep dreaming and imagining the future. *That* is revolutionary.

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Just a Start … to a "Revolutionary, Even Magical" Tale

By Joshua Sperling

Keynote Address by Tanama at the 20th Annual Conference on the Future, Delivered in San Juan, Puerto Rico, and on Multiple Virtual/Augmented-Reality Event Platforms, May 21, 2045

Puerto Rico is thriving! (A rousing cheer of support rises from the crowd as Tanama takes the stage.) Today, we have new opportunities, new innovations, new choices. For all of us—the people of Puerto Rico, our business community, everyone who has worked for years to create healthy economies, beautiful natural environments, rewarding lives, and inclusive, resilient communities—thank you!

Today, we can celebrate. Welcome, everyone. My name is Tanama. I bring you greetings from La Granja and from Puerto Rico. I am delighted to see all of you joining us from all around the globe. Twenty years ago, we started this movement at the first Conference on the Future, with a much smaller crowd. But even then, we knew that the ideas shared were important, and that if we could create the kind of inclusive revolution that we hoped for, we could leapfrog many of

the problems of the past. We could truly fashion the "Community to Reinvent the World" and become a beacon of transformation for island populations and rural and urban communities everywhere. So many of you have been part of that journey, traveling to meet with us, to learn our story, and to share your own wisdom. It is amazing to think that we have finally arrived.

I stand here today, with my mother Maria, and my grandmother, Yaya, to invite you to share in a story of inclusive partnership and its power to make tremendous contributions to local, regional, national, and global economies. This is the story not just of my community, in La Granja, but of all of our communities, and of a truly remarkable revolution that we have achieved—and with ever-more-ambitious goals we are still working towards—through the construction of a shared vision built on the back of diverse lived experiences. For those of us who have lived this partnership, inclusion means three things. It means a commitment to bringing together *diverse voices*, especially from those that are infrequently heard, and the ideas, values, knowledge, and experiences that they bring to the table. It means a commitment to solutions that are inclusive of *all facets of our well-being* as human beings, living with nature: our bodies, minds, communities, markets, and our regenerative, "circular economy"-enabled environments benefiting all species. And it means a commitment to breaking down silos that often limit *our conversation about technology and data* to one sector at a time, recognizing that energy, mobility, buildings, water, food, waste, digital connectivity, health, ecology, economics, and other integrated "systems of systems" all have to work together to truly improve our lives, our planet, and our collective prosperity.

Only by taking a comprehensive approach—including diverse voices and knowledge, diverse facets of well-being, and diverse infrastructure systems (bringing together social, environmental, and digital sciences, and uniting design with engineering), and putting them

to work in support of integrative outcomes—have we been able to become all of those things the experts now describe us as: lighthouse communities that serve as exemplars for others, self-sufficient nodes of community-resource security, integrated urban-services providers, and resilient, healthy neighborhoods. Places that meet our own current and future needs, restoring values of greater equality and inclusive transformations, while generating surplus value that also benefits surrounding areas, an interconnected nation and world, as well as future generations. This philosophy and moving from talking to action—with a wonderful global community—has enabled our integrated energy and mobility systems to offer leading examples of rapid decarbonization, thriving communities, and socioeconomic transformations that support this next "ecological era."

Let me talk briefly about three key dimensions of our success: social, then economic, and then with a broader view toward sustainable infrastructure and technological systems. (Tanama points to the three banners hanging from the ceiling of the lecture hall at the University of Puerto Rico.)

The first dimension of inclusion is social. In response to the horrors of Hurricane Maria, COVID-19, and Super Hurricane Franklin—and the failure of both the U.S. and commonwealth governments to take these crises sufficiently seriously—we built a new partnership of Puertorriqueños, both locally and among the diaspora, like-minded Americans across the country, and global citizens to look for local, indigenous solutions. We had help from civil society, government, academic organizations, nonprofits, entrepreneurial incubator hubs, and finance. From the beginning, we focused on bringing in new youth and elderly voices, indigenous expert and global expert voices, and set out to design a new social contract of values, norms, and processes that embraced inclusion of diverse forms of knowledge and wisdom, financial resources, and power.

We struggled at first. Oh, the cacophony of good ideas. But we learned how to create meaningful deliberation and, especially, how to crowd-source ideas and solutions through citizen science. We were able to bring together architects, engineers, planners, social scientists, ecologists, cultural anthropologists, behavioral scientists, policy-makers, and more—not to tell us what to do but to collaboratively help us redesign our communities in more sustainable and resilient forms.

We put a special emphasis on gender. Cities and communities have too often neglected how women and men differ in their use of resources, construct and implement visions, or require distinct forms of support. We explored what women and men need in a community or city, learned how to support them and to see them as distinctly vital resources for community and economic health, and as crucial to all opportunities to invest in the community, city, and our overall success with improving everyone's quality of life. That includes interacting with transportation systems, experiencing the results of planning and design, benefiting from entrepreneurial programs, or encountering challenges as a result of home and workforce pressures (which became particularly apparent during the COVID-19 crisis for many parents with children). This focus on gender helped us reimagine our world, shifting from a singular metric of economic growth to a tapestry of economic diversity that weaves together not just women and men, but also people of different races, religions, professions, and more. Together, we were able to address previous blind spots when it comes to catalyzing inclusive economic development, reducing the barriers to economic opportunities, and enhancing economic growth and environmental sustainability.

The second dimension of inclusion is economic. After the unemployment crises driven by Hurricane Maria, COVID-19, and Super Hurricane Franklin—and the austerity imposed by the Congressional

oversight board—we were fortunate that the U.S. finally stepped in with generous support to create a new, local vision and approach that helped catalyze the transformation of Puerto Rico and allow us to become a model for the world. I know it seemed ungrateful to many of our American allies when, soon after, Puerto Rico rejected the idea of paying off debts to its external bondholders, scaring off outside investors and companies, who fled. What seemed chaotic and disruptive was ultimately beneficial, however, because it forced Puerto Rico for the first time in over a century to look inwards for new foundations of well-being and economic security. By rebuilding indigenous energy and food systems, we quit bleeding cash to pay for basic services and instead reinvested those dollars in local production, markets, and economic vibrancy. It wasn't easy, but in the end we became self-sufficient, and a rich exemplar of the power of regenerative and circular economics.

The real revolution came when we shifted to a new definition of economy. For too long, the economists have measured human well-being in terms of wealth. In Puerto Rico, however, we have long understood that wealth is a poor stand-in for the vitality of a life well-lived. Economic freedom is not just the choice of who to work for, but of abundant choices and opportunities for rewarding, happy living. By focusing on critical basic services like energy, water, and food security, as well as on improvements in integrated services, and helping people learn how to use their access to new and emerging technologies to create diverse forms of value for themselves and their communities, we enabled significant new opportunities and cultural connectivity. To do this, we found ourselves rejecting the primary question asked by many "smart cities and communities" of the 2020s, "Do you want to build this cool technology?" and replacing it, instead, with a different approach: "Do you want to help our people and communities thrive?" The result was worth it. People improved their health, their

education, their ability to age in place, their sense of community, and their engagement in community life. Perhaps most importantly of all, inequality dropped precipitously, as Puerto Rico rebuilt an economy for all, inclusive of people of different ages, genders, races, income levels, religions, and personal orientations.

The third dimension of inclusion is within our developing sustainable infrastructure and technological systems. With increasing populations, projected resource scarcities, and vulnerability to disasters, we needed to envision and reimagine how to build new, high-performing, cost-effective, and resilient infrastructures—harnessing technologies that could help to provide adequate drinking water, sanitation, waste management, flood control, electricity, transportation, and food security. I think most people don't initially think about their phones and their waste systems as inclusive or exclusionary, but they are. We learned early on that, if we were to achieve our goals, it was essential to pursue novel innovations in the circular, regenerative design and operation of infrastructure sytems—redefined as human-physical-natural-digital systems and technology services at the nexus of energy, mobility, water, food, waste, etc. These systems had to work together in new ways if we were to leapfrog the historically siloed, marginalizing, and donor-driven approaches to service provision that increasingly struggled to respond to the pace, scale, and complexity of twenty-first century human development challenges, exacerbated by new climate-related risks and rapidly rising demands.

With our new "total design" philosophy, we've established new criteria for integrated systems design, management, continuous improvement, and ongoing dialogue—combining public, private, applied-research, and development sectors with community-based approaches—on an ever-wider solutions space that's essential to human and ecological well-being. In turn, this has enabled novel

approaches to renewable energy, treatment of water and wastewater, and the production of local food, all using closed-loop circular processes at near net-zero waste. This included rebates and incentives for used electric vehicles, with greater access to new renewable energy-powered-electric mobility technology services through car-sharing and ridehailing services in our communities; fast chargers for high-mileage drivers in our environmental-justice (EJ)-focused communities; and even new approaches to geofencing trucks in EJ communities, where a fee was paid unless vehicles used electric motors or plug-in hybrid-electric trucks, or post-2030 truck models. The result is greater equity in new sustainable infrastructure and technology adoption; improved communication; clean, affordable, reliable, and time-efficient transit and mobility systems; preserved green spaces for community recreation, biodiversity conservation, and storage of unique natural capital (a key to success); recycling, wastewater reuse, desalination, and advances in sanitation, with a focus on pandemic preparedness and prevention; and access to places that support selling and purchasing of clean, affordable, reliable electricity, fresh food, recycled goods, mobility, and safe drinking water. Together, we have achieved three infrastructure and integrated-technology-enabled revolutions—with an emphasis on inclusive definitions of sustainable infrastructure systems—that support a diversity of thriving communities:

- A future with 100 percent renewable energy, with a localized, hybrid, partly distributed, partly centralized model for clean electricity generation. This model helps to inspire parallel movements to improve nutrition, access to local agricultural/greenhouse revolutions, grassroots water innovation, and decarbonized water-food systems, as well.
- A future with 100 percent integration of efficient, affordable,

electric, hydrogen, and biofuel-powered mobility systems, with services that work for all in a time-, cost-, and energy-efficient manner, across land, air, water, and/or digital spaces.

- And, perhaps most importantly, a future of more equitable leadership with transparent, inclusive, digitally transformed governance and policy structures accessible to all, with 100 percent focus on "lifting the disadvantaged."

La Granja was an example, for many, of the power of innovative infrastructure solutions to lift people out of poverty, but it was hardly the only one. So many communities, cities, and nations all over the world saw the light in those years: that infrastructure had become an instrument of colonization, debt, and poverty exacerbation, and that they could become beacons of transformation through technology redesign. So many places with infrastructures devastated by disaster and disease learned how to reject the politics of reacting to each crisis, in turn, and instead to build for the future. This shift in focus led to so many great ideas, proactive social-resilience approaches, and people-oriented technological and service integration advancements for sustainable, inclusive city and community futures, blossoming amidst a unique sociocultural and economic boom. Through the multiple energy, mobility, food, water, and digital transformations, it allowed for the maximization of talent, for new leadership, and for thriving places to live, play, work, or interact. I am so grateful for what we all learned together, and it is my hope that some of what we share over the next few days of this conference will help many new communities to "leapfrog" to a new future.

This idea of leapfrogging the destructive technologies of the past is so critical. Neither technology nor human development are path-dependent. As our great network has shown, it is possible to bypass the traditional fossil-fuel, resource-extractive "take-make-waste"

forms of development and redevelopment stages associated with our (perhaps misguided historical term of) "more developed nations," and instead jump forward to new forms of environmentally benign infrastructure systems that harness and cultivate natural capital. The idea came from Africa, where countries went straight to cellphones, bypassing landlines all together. Why not do the same for planning and delivery of sustainable, resource-secure, circular-economy and environmentally resilient approaches to energy and energy-related (e.g., water, food, waste, information and communication, transportation) technologies, systems, and integrated services? Richer communities, cities, or nations at similar levels of urbanization and development had become trapped in fossil-fuel-dependent choices, but we didn't have to. We could skip to decarbonized, zero-pollution options that are increasingly ready for and adaptable to the increased frequency and intensity of storms, droughts, wildfires, sea-level rise, vector-borne diseases, and other threats of climate change, including accommodating climate-induced migration and refugees. From a macroeconomic standpoint, the shift to clean energy and local food production (including our exciting new vertical greenhouses) also enables less carbon and water leaving the island, improving opportunities for healthy living and the reservation of land for regenerative ecosystems, inspiring advances based on biomimicry design principles and criteria.

By refocusing on local energy generation (via solar, wind, and renewable-electricity-pumped hydro) and advances in energy storage—coupled with electric, efficient, and inclusive mobility options that were shared, high-mileage, and high-occupancy—we essentially kicked our dependence on imported oil and reduced dangerous air pollution. We also enabled increased reliance on, and alternative views of, our automated-connected-electric-shared vehicles, homes, and community spaces. We transformed our community parks, water,

and wastewater facilities into shared, high-utilized, energy-generating, resource-recovering assets that have enabled thriving ecological environments and increased agricultural productivity.

In all of this, new forms of real-time data-driven governance and management of systems were also key. Through digital data, artificial intelligence, and machine learning, we were able to take actions that saved us a lot of money, time, and inconvenience. This left room for monetary and creative capital to be reinvested into local smart community connectivity through digital-physical means. This empowered digital governance that enabled robust citizen engagement and sharing through inclusive design, making everyone visible and giving them voice, while also linking us to all of you. Through digital access to innovations, and through others learning about our rejection of imported energy and food in favor of local supply, local and global economists and engineers noted a shift of over $5 billion annually from imports to local and regional production, exports, and interest from global communities in our strategies (which helped reignite tourism, but now oriented toward mutual learning and exchange). It was just enough to turn Puerto Rico's macroeconomics around, after the economic-environmental-health crises of the early twenty-first century.

While I'm leaving out so many details, this virtuous cycle has created positive, almost "magical" benefits for our local communities, as they have in so many other places, too. We are now able to recruit back young members of the diaspora excited by the prospect of making Puerto Rico a thriving home. We, like all of you, are attracting others from around the U.S. and the world to invest in novel start-ups that are leveraging lessons learned from Puerto Rico's community and regional innovations to help rebuild communities around the world in a new model. In the twentieth century, Chicago gave us electric utilities, London and New York gave us finance, and Silicon Valley gave us

information. Today, it is our turn. We—all of us in this network—are creating the foundations for a sustainable and resilient tomorrow, improving lives, livelihoods, and lived experiences in Puerto Rico and around the globe as the foundation for an increasingly healthy, secure, comfortable, affordable, abundant, and joyful future that inclusively advances opportunity for all. (Standing ovation.)

San Antonio, Texas

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To see a full-color, high-resolution version of this image, visit https://csi.asu.edu/books/cities-of-light.


The scent of the Prettails

The Scent of the Freetails

By Deji Bryce Olukotun

Every parent feared that their kid would become a juicer, but Raj had never considered that his daughter might fall for one. He liked to believe that all the juicers lived far enough away that they couldn't pose a threat. And like most Houstonians, he'd tried to prepare himself for the day when they came calling.

He was motoring along the scrubland I-10 highway at seventy-five miles an hour in a hybrid Ford F-150, mulling over his self-defense lessons. His daughter Rosa, riding in the backseat, had just been hailed by a glimmering summertime billboard.

Schlitterbahn! The Hottest, Coolest Time In Texas.
Your Family Friendly Water Park.
Don't Miss It! Turn Now!

"Schlitterbahn!" Rosa said, as they drove past. "Can we go?"

"We're almost in San Antonio," Raj replied.

"It says we're still forty-five minutes away."

Like most billboards in Houston, this one was sticky—the image imprinted itself on their windows for several miles. The sign appeared brightest in the rear of the car, showing Rosa rotating images of a

water slide, a lazy river, and a sprinkling fountain. On the passenger side, where Raj's wife Helena sat, the billboard displayed a frosty margarita.

Helena swiped away the billboard like a cobweb. "They've got one in Galveston, Rosa. We can go when we get back home."

"It was destroyed by Hurricane Xander," Raj's daughter argued.

"Water's not good for your leg."

"I would take it off, Mom."

"Then how would you get around?"

"I would swim! It's a water park. Besides, they use recycled water. It's good for the environment."

"I fail to see," Raj said triumphantly, "how a water park in the middle of Texas could ever be good for the environment. We're going to San Antonio."

"I *could* use a margarita though," Helena muttered.

Every trip on a highway out of Houston meant negotiations with his daughter. Rosa, who was fourteen and shared her mother's thick black hair, would pepper him with sophisticated arguments mingled with guilt. Raj had learned to withstand the barrage. He had to: he could no longer afford an ad-free vehicle package.

The billboards stopped as soon as they crossed the county line, respecting San Antonio's more conservative data ordinances. The route offered glimpses of open country—bent barbed-wire fences curling beneath gnarled oaks, the thick spear of longhorn cattle—but the suburbs of the two cities nearly touched, about to connect like the fingers of God and Adam in the Sistine. As they drew closer to the city, the lawns became xeriscaped with succulents—a world apart from the spongy Bermuda grass Raj manicured in his front yard back in Houston. The landscape felt puckered, thirsty, with solar arrays blotting out the horizon like the blue-black scales of a pelagic fish.

Raj couldn't shake the feeling that he was driving towards a colossal mistake—San Antonio was known to harbor more than a few juicer gangs. He reached for the pulse stick in his jacket pocket. When his fingers touched the handle it vibrated, but he quickly withdrew his hand, afraid that his wife would hear the weapon's cartridge spin up.

The road split and then split again into separate lanes for automated vehicles, rapid-transit buses, and then carbon-burning vehicles. The larger shipping trucks, packed together like a peloton, were forced to exit before entering the city limits. He could see them unloading their wares onto smaller two-axle vehicles not far off the highway.

"Raj," Helena said quietly in the passenger seat beside him, "you said we'd go to La Estrella first to drop off our bags."

"I don't want to be rushed. We've been planning to go to the Alamo for months."

"No, we've been planning to go to La Estrella for months, and you glommed on the Alamo like they were two peas in a pod. It's one of the only neighborhoods we could afford here. We should get a good look at it."

"Rosa should know her history. It's important for Texas. It's important for this country."

Helena pushed her hair behind her ear. "I've never once heard you mention it before."

"The Alamo has been around for five hundred million years or something," Rosa observed from the back seat.

"Helena, I'm not comfortable dragging our kid into a neighborhood with that kind of reputation."

"I'm not a kid!"

"I talked to Yeimi about it," Helena said. "It's perfectly safe."

"We're going to the Alamo. We've got plenty of time."

The lane for the Alamo, now lit from underneath by neon logos,

turned sharply to the left, dropping them in the center of the city. Helena was right, of course. Raj had hated the Alamo as a kid. He'd visited it on a school trip soon after immigrating with his family from Guyana, an English-speaking country in South America with oil reserves rivaling those of Venezuela. Raj had been something of a flirt back in his home country, and well-liked, so he sat next to a pretty classmate on the bus ride to the monument and tried to make her laugh. After a few unsuccessful tries, she replied: "I can't understand what you're saying. You don't even sound Mexican." He became instantly ashamed of his accent that day, wanting to scrape his heritage from his tongue.

Raj parked his F-150 at the Alamo—his own truck, not a school bus this time—and was charged $100 for the day because his car used gasoline. The electrics, he noticed, were charged half that amount, San Antonio's subtle way of frowning on the carbon-intensive largesse of Houstonians. Rosa dangled her strong leg over the side of the car and twisted on her artificial leg with a click. There was a soft whir as the servomotors kicked in, and she hopped down from her seat. They stood in line for nearly an hour in the stultifying midday heat, to Raj's mounting frustration. Rosa handled it well at first, engrossed in her flexy. The ticket salesperson said they could rent AR goggles that would allow them to watch the recreated Battle of the Alamo right before their eyes for a special one-time offer of $75 per person. Raj declined.

By the time they stepped inside, he could register Rosa's disappointment as she watched other children wander the grounds with their goggles on, laughing and reacting to the simulated battle.

"Why won't he get me the goggles?" Rosa asked her mother, as if Raj wasn't there.

"We can't afford it," Helena said softly.

Just like his first school trip, he found the history of the Alamo

extremely confusing, since it wasn't even clear whether Texas had been a part of the United States at the time, and anyway the Americans, if that's what they were, had lost. The importance of the resolute adobe walls with its barren horse corral had been lost on his ten-year-old mind, and he'd wandered the grounds alone until he chanced upon some dioramas. It was there that he'd learned how a slave named Joe had miraculously survived the final assault by General Santa Anna's troops after being shot and bayoneted. He found it unnerving at the time. How had Joe survived? What was the man even doing there, and why didn't he have a last name? Raj himself was descended from Indians (from India, not Native Americans) and Africans (from The Gambia or somewhere close to it), yet he saw a warning in the strange diorama.

Maybe that was why he'd come back. This was the very place where he'd decided to assimilate to the best of his ability. He could hide out in dusty corridors and feel sorry for himself about his Guyanese accent, or he could become a Texan. Two years later he'd developed an acceptable drawl and used his soccer skills to become a tolerable kicker for the middle-school football team—enough to blend in, if not exactly to make him a star. The Alamo had broken him. It had also made him into the man he was today: found him a profession, a family, and a place to call home. Right now he felt duty-bound to protect all those things.

"Raj," Helena interrupted. "We should get going. Yeimi told me we need to arrive before dark if we want to see the bats."

"We've got plenty of time."

"We don't know where we're going."

"Why do you keep reaching into your pocket?" Helena asked. "What's in there?"

"It's nothing."

"Raj, what did you bring?" Her whisper felt like a shout.

"It's for safety."

"Safety? From what?"

"I researched the neighborhood, Helena. Juicers raped a girl last year. She nearly died."

"Yeimi told me those kids were from another neighborhood, Raj. They weren't from Estrella. They were caught."

"It's a pulse stick," he confessed.

"Good Lord, Raj. What the hell are you thinking?"

"We've got to think about Rosa. It's the only weapon guaranteed to stop a juicer."

"How dare you, Raj! Please don't start this again. You're not taking a gun into La Estrella. Stop making excuses. We're going. You promised me. You promised we would give this a chance."

"It's not a gun."

Raj looked back at the Alamo, the fattening afternoon shadows making it seem larger than it really was. This was where his Texan life had begun, but it couldn't tell him where it should go. What had he promised his wife, exactly? He tried to remember the words.

While Helena and Rosa used the bathroom, Raj purchased a Mobility Pass to transport them to La Estrella, since they couldn't access it with their truck. The automated vehicle arrived after five minutes, a roomy sedan with plenty of seating and space for their luggage. Helena grabbed him by the arm as he was loading up their suitcases. "Leave it in the truck, Raj."

"It's nonlethal."

"Leave the gun in the truck or I am taking Rosa, and I swear I will leave you here to fry in this damn heat."

Raj started to protest, but saw Helena's furrowed brow and thought better of it. He reopened the truck and slipped the pulse stick into the glove compartment, peering around to see if anyone was watching

him.

"It's perfectly legal," he said, as much to himself as to Helena.

Once they were seated in the rented car, the AV's guide kicked to life. "We'll be in La Estrella in twenty-five minutes. It's known for being the first Dark Sky community within the San Antonio city limits, which makes it an excellent spot for stargazing. The area is also famous for the Mexican freetail bat, with a seasonal population of more than three million animals."

"Are we going to see them, Mom?" Rosa asked.

"You bet, honey. Maybe even more than once."

The AV merged into a dedicated lane as packed as a Houston traffic jam. The car quickly synced with the oncoming traffic and accelerated. The vehicles were evenly spaced, although they tended to appear in clusters, depending on the size and aerodynamics of the transport. Their sedan naturally clustered with other sedans. Peering into other vehicles, Raj could see people engrossed in conversation: a woman knitting, a man watching a video, an elderly woman with her head tilted back, snoring. A few riders had activated their privacy screens. There were also clusters you could join according to your interest—it wasn't uncommon to find a string of gamer shuttles linked together, their passengers peering into the ether and jerking their bodies in spasmodic movements. They had AVs in Houston, of course, but the city hadn't designated entire sections of the city for them, so passengers there still had to fret about getting rear-ended by a manual driver.

"Bats don't attack people, do they?" Rosa asked, suddenly nervous. She tended to flit between enthusiasm and extreme caution.

"No, silly," Raj said. "They eat insects. Or fruit."

"The Mexican freetail bat," Helena dictated, reading from her flexy, "feasts on a diet of moths, dragonflies, wasps, and ants."

Raj was thinking about the $3,000 he had spent on the pulse stick

and the $2,000 on lessons to learn how to use it, which was the electromagnetic equivalent of kicking a juicer in the ribs. He normally didn't worry about money, but times had changed. They had lent Helena's cousin Yeimi $50,000 in a fit of generosity. But last year he ran out of clients, and Yeimi cursed him out when he'd asked for the money back.

This year, along with a Christmas card, Yeimi sent $20,000 and an invitation to come visit her in La Estrella. Helena was convinced her cousin had turned over a new leaf. Raj wasn't so sure, but he'd accepted the money.

Raj used to delight in his daughter's company, clowning around with his family, but the mirth had left him lately. He couldn't seem to find the energy, and he could feel Rosa withdrawing. She was right; she wasn't really a kid anymore. Nor was she a woman. When he tried to make sense of his proper role, he became overbearing like his own parents—exactly the type of adults he'd once disliked.

The AV smoothly exited the dedicated lane away from the river and came to a stop behind another half-dozen cars unloading their passengers. A drone luggage porter was already waiting for them at their stop. The air felt cooler here, as if a layer of heat had been peeled away like a lemon rind. Looking towards where the street should have continued, he noticed that it ended abruptly and had been converted into gardens with a wide central path.

"There she is!" Helena said, waving her hand. "Yeimi! Yeimi, over here!"

Helena's cousin Yeimi was a jocular fourth-generation Mexican American with a lilting Texan drawl like his wife's. She wrapped the family in a big hug, which he couldn't help but return. Guyanese and Mexicans shared a love of welcomes and goodbyes.

"Looks like you've found yourself a porter," Yeimi observed, pointing at the luggage carrier. "It's about a fifteen-minute walk."

As the AV pulled away with new passengers, Raj felt exposed, standing on the curb in a strange neighborhood with no means to drive away. There would be no swift exit. He looked over at his daughter to see how she was managing.

"Rosa, I thought you charged your leg."

"I did charge it."

"Then why is it red?"

"I don't know."

"Did you use it to charge your flexy?"

"No."

"Then what?"

"I don't know," Rosa said, her eyes downcast. "I forgot."

"How will you get around?"

"I'll shift it to kinetic," she said, striding confidently onto the walking path. This setting used her own energy to add juice to the limb, keeping it at a minimum charge. But Raj knew the lack of extra battery power would exhaust her. It was like walking with a five-pound weight attached to your ankle.

"La Estrella is a little different," Yeimi explained, assuming the role of host. "These sidewalks are laced with PV. Solar cells. Once you spend enough time in this neighborhood, you'll see them everywhere. They're in the windows, roof tiles, chimneys, even the cladding. If there's a spot the sun touches, we'll use it in La Estrella."

There were modest craftsman, Victorian, and Spanish Revival dwellings painted in pastels, reminding Raj of the vibrant neighborhoods he'd been raised in back in Georgetown, Guyana. Peering closer, he could see how the technology was interwoven into the colorful fabric of each house. The luggage porter slid along quietly beside them.

"Feels so open here," Helena said, happily.

"You won't find any power lines or overhead street lights," Yeimi

went on. "We're an energy-sovereign community. Fought like hell to become one, too. Here, this is one of our four batteries. We call this one Blubber."

"Blubber?"

"Like the fat that whales store. Full of energy. This powers about five hundred homes."

The battery was protected by a high fence with warning signs indicating electric shock. It was about forty feet long by fifteen feet wide and high. True to its name, there were murals of whales and narwhals painted on the battery, which must've been drawn by children.

The teenagers leapt out from behind the battery before he could do anything. There were three boys and two girls wearing tight clothing with the kind of hypnagogic patterns that young people currently found cool. One of the kids was nearly as tall as Raj and heavily muscled, his biceps popping out of his shirt unnaturally. His veins writhed beneath his skin like garter snakes.

A juicer.

Peddled like drugs, kids took the growth hormones before they hit puberty and their muscles erupted into their bodies at adolescence, giving them superhuman strength. Juicing scared the hell out of parents because they couldn't know if their children were using until the effects manifested themselves years later. Videos of juicers tossing cars were common, along with the frightening social tics that came from the mass disruption of their endocrine systems.

A 3D glowing image of an angry rodent floated above the kids. It looked like a gang sign. He cursed himself for leaving the pulse stick behind. It was designed for exactly these types of situations—clearing an area efficiently without killing anyone.

Yeimi forced a laugh. "Carlos," she said, addressing another one of the teens. "You can't just jump in front of people like that. You'll

scare your cousins half to death. You were supposed to meet us at the drop-off."

"Sorry, Mama. Tim took forever."

"I'm sorry, Ms. Hernandez," the juicer said sheepishly. He had a crackly, pubescent voice. "I was working out."

"What else could you have been doing, Tim?" Carlos asked sarcastically.

Gradually Raj calmed down. He couldn't believe it—his nephew had been a pudgy little brat when he'd last seen him. Carlos was now tall and lanky, with bright eyes. And somehow he seemed to be in control of this entire crew.

"Carlos," his daughter said, shaking free of Raj's grip. "It's me, Rosa."

"Mom said you would need help getting around," Carlos said. "But you've got a leg."

"People like me aren't supposed to exist anymore. But I can walk fine."

"No, it's cool. I didn't mean anything by it—"

"What is that thing above you, a gopher?" Rosa asked.

His daughter didn't have patience for anyone who pitied her.

"It's a wombat, actually. They have them in Australia."

"They poop cubes too," Tim chimed in.

"Gross!" Rosa laughed.

"We unite our flexies with the insignia app," Tim explained. "Yesterday we were a vampire and it freaked people out." He ran his fingers through his hair, spiked with some kind of gel creme. "You want to see the bats tonight? We know a place that none of the tourists can find. Best spot in La Estrella."

"We're going to the house first," Raj intervened. "We'll all watch the bats together."

"It's not a baseball game," Rosa argued. "We don't have assigned

seats."

"When I say that we're going together—" he began, waving his finger in the air.

But Helena pulled Raj aside. "Raj, we need some time to catch up with Yeimi and Peter."

"We'll have plenty of time to catch up—"

"Not if Rosa's with us. Come on, Raj. She's been cooped up all day in the car, and she sat through the Alamo. Let her have some fun."

"Have you seen that boy? He could break her like a twig. How is it responsible to let her run around in a neighborhood like this?"

"Carlos will take good care of her," Yeimi announced to everyone. "Don't worry, or he'll answer to me, won't you Carlos?"

"Right, Mama."

"You too, Tim."

"Right, Ms. Hernandez," the juicer said.

Raj looked from Carlos to Tim and to his daughter, trying to assess the situation. No one had prepared him for this. "You'll call if you have an issue," he said, feeling outmaneuvered. "Anything."

"We'll call if the bats suck out our blood, Dad."

"You won't survive the first bite," Tim laughed.

"Hilarious. Keep your flexies on."

He watched as Rosa mingled with her cousin and the juicer, surprised at their enthusiasm for one another. At that age, he'd believed that overexcitement was uncool. But maybe that was because he was an immigrant kid trying to blend in at a Houston middle school. Rosa paced confidently away, seemingly unconcerned that her leg was about to become leaden and heavy.

"Did you see that?" Helena said to Yeimi.

"Sure did," Yeimi laughed. "Tim's such a sweetheart. Couldn't hurt a fly."

"What?" Raj asked. "What did you see?"

"Blind as the bats, Raj," Helena said.

"Sparks," Yeimi said. "I saw sparks."

"What, from the battery?"

"Blinder than the bats," Yeimi laughed.

Now he realized they were talking about love or, worse, sex, a topic he had studiously avoided with his daughter. Rumors about the denizens of La Estrella had reached Houston. The story went that the subdued lighting, energy restrictions, and quiet ambiance made people naturally throw off their clothes in the cool of the evening, swapping partners like outfits. Even though La Estrella had become a tourist destination, it remained shrouded in lusty mystery—not even searchable on satellite view. Photos and videos were geofenced so that they couldn't leave.

More people were joining the walking path now: locals going for a stroll, tourists hopping off AVs to watch the bats, commuters returning from work. Instead of the sticky billboards of Houston, the older buildings were painted with festive murals, which Yeimi explained were voted upon by the neighborhood. One depicted a half-naked woman with her bare breasts exposed, nurturing an infant with a bib that read *Independencia energética*.

Finally, they arrived at Yeimi's home, a low-slung three-bedroom ranch house that would have been considered small in Houston. Except there was no driveway and no garage. Instead, there was a fenced garden with various herbs and vegetables, and a backyard with some kind of succulent grass that shined silver. There was also a free-standing climbing wall where Yeimi explained that Carlos practiced bouldering. It didn't look like the home of a family that had struck it rich, which meant that paying back $20,000 couldn't have been easy for them.

After unloading the suitcases, the baggage porter didn't hold out its hand for a tip or announce anything. It simply turned around and wheeled back to the AV drop-off, ready to help the next passenger who had paid for a mobility package.

Yeimi's husband Peter was barbecuing synthetic pork in the backyard when they arrived, and Raj found himself drawn to the barrel smoker like a mosquito to hot blood. Yeimi and Helena lingered in the kitchen to catch up. Peter had large hands and a wide chest, with thick arms. He was some kind of fitness buff. Not a juicer, but the middle-age equivalent.

"This a real steel drum?" Raj asked.

"No, it's a Carolina smoker. Got it from a neighbor." Peter flipped a tenderloin with a sizzle. "It cooks at a low temperature so you've got to take your time with it. You get the money?"

"We got it. Thanks."

"No need to thank me. We wanted to thank you. We invested that money in this house. Couldn't have afforded it otherwise. It may not look like much but we're proud to own it. Of course, a portion went to the community association, but it's worth it."

"The way everyone talks about this place, it sounds like some kind of commune."

"Heh, it's no commune. We all chip in towards the batteries. Since we're equal partners with the grid, we get paid when we contribute more than we take. They can't just look at our usage and charge us accordingly, because we've walled that off too. If they want access to our data, they can pay for it. Otherwise, we're a black box to them. No one has to live here, though. Some people don't like having to put down their hairdryers at night when the great battery in the sky turns off. You have to be more mindful."

Peter opened a cooler and pulled out a rack of ribs. Unlike Houston,

where heat could linger until the early morning, the temperature was dropping swiftly. A prickly pear cut a long shadow on the sandstone gravel sprinkled about the yard.

"I suppose the most socialist thing," Peter added, "is that you can't sell your home for more than seven percent of what you paid for it. The excess goes back into the neighborhood. But we're planning to stay so we're not worried about it. You know the first term that comes up when you ask for La Estrella on your flexy, Raj?"

"Sex?"

"Sex? Sex, no. Not in my household anyway." He slapped Raj on the back, chuckling. "No, it's crime. Rape. Murder. Anything they can throw at us. The data lords didn't forgive us when we started keeping our information from them. It's how they try to keep people away from us. I paid you that check out of our energy credits. Learning how to convert our own data into money—that's what scares them." He turned over the ribs, the fat spitting into the grill. Raj's stomach rumbled. Somewhere along the way he'd forgotten to eat.

"There's work here for people with your skills," Peter added.

"How do you know?"

"You're an engineer, right?"

"Petrochemical. I don't have any background in electrical."

"But you clean up dirty water, right?"

"I clean up refineries—crackers and oil tanks. Brownfields. Most of it's been remediated already in Texas."

"Sounds like you worked yourself out of a job, Raj."

Raj knew he was right. He could've thrown in his lot with the typical petrochemical engineers and focused on production, which was a much more lucrative job when the price of oil was high. He had a cousin who had retired in luxury before he turned forty. But even after Raj's resolution to become Texan, back at the Alamo, he had

secreted away a piece of his Guyanese heritage. He would work in oil but he would clean it up, too, as if he could scrub his newfound identity clean of guilt. He had never expected the oil market to collapse so swiftly. No one had.

"I don't know about crackers," Peter went on, "but we could use your help here along the river. Helena told Yeimi you need the work, so I hope you don't mind me being so forward. There are going to be more neighborhoods like us. Lots of spills to clean up. La Estrella was built around an old tannery—you wouldn't believe the shit they used to cure leather. Cyanide, someone told me."

"Chromium, more likely." Raj tried to get Peter off his soapbox: "Don't you get tired of the darkness here?"

"Tired of the dark?" Peter smiled, amused. "Raj, my man, you don't get tired of it. It's how we were meant to live."

"Raj, time to get going," Helena shouted from inside the house. "Yeimi said the bats fly out in fifteen minutes."

"Regular as clockwork," Peter said.

Yeimi sent them ahead, telling them she would prep for dinner. Outside, the neighborhood had been transformed. Instead of overhead street lighting, fiber-optics tracked along the walkways in soft colors: cobalt blue, forest green, blood red. The illumination was so faint that if you looked directly at the lights they disappeared like starlight, but somehow the combined effect steered Raj and Helena in the right direction. Some homes had pathway lamps instead of the inset lighting. Hundreds of people were walking along the path, many in a jubilant mood. In the distance, Raj heard a trumpet climbing through a scale.

Helena slipped her hand into his, something she hadn't done in years. He couldn't recall the last time they'd gone for a stroll anywhere except when they were on vacation—their neighborhood in

Houston only had one sidewalk, and it led to the convenience store. Next to that was a strip club, a symptom of Houston's utter lack of zoning.

"Yeimi told me USAA is hiring," Helena said. "They prioritize veterans."

"You want to work for a bank?"

"Who knows? I might be good at it. They pay on time, unlike my clients."

"I wish you hadn't told Yeimi about our problems. It's private. I'll get my consulting practice going again soon."

"They want to help us, Raj. They were in our situation just a few years ago and you helped them. There's nothing wrong with them returning the favor."

"It's not like we're living on the street. I grew up in Houston. I like doing things our way. This place is some kind of socialist experiment."

"No, you like doing things your way, Raj. Not our way."

"What about Rosa? It's not like we can drive her wherever we want in here. There are barely any roads."

They paused at a home with LEDs that swept over its facade like water, timed to some kind of electrozen music. He felt nothing but strident, grating notes in its atmospheric soundscape, as if the music was stripping away the lacquer of self-reliance he had so diligently painted over his life. I want to leave this place, he thought. As soon as possible.

"Have you heard from her?" Helena suddenly asked.

He pulled out his flexy. "Someone buzzed me a second ago."

They looked at the screen together. The message from his daughter read **XKJŒ□OF*(S*ESD**.

"What does that mean?" Helena asked.

"She probably sat on it."

"I'm sure she's fine," Helena said, hopefully. But he could sense the growing nervousness in her voice.

"I'll try her," he said, firing off a message.

"Good."

But Rosa didn't return his message. "Should we look for her?"

"I don't know."

And then he did something he promised his daughter he'd never do—he checked the battery of her leg remotely. **OFF**. Not low, not yellow, not green, but off.

"Her leg is off."

Helena started to protest, then kept silent.

"We're her parents," she said, as if justifying the privacy intrusion. "Tim said they were going to a place that the tourists don't know."

"I thought that juicer was joking."

"She'd call us if anything went wrong."

"But what if she couldn't call us?"

The thought of Rosa fallen down, with no means of getting up, hadn't crossed his mind since she was three years old. Everything she'd done since then suggested that the very opposite would happen—that she was resilient, that she would always find her way to them. But the whispered lighting and silhouetted strangers became menacing in Raj's head.

"Your hand is sweating," Helena said, rubbing her palm on her dress.

He should have been projecting calm. He should have been resolute. But the fiber-optic paths and the twinkling lights were making him anxious. And the pulse stick was miles away in his truck. He had nothing.

Finally they came to the canal, which was a causeway with a bridge arching over it. He'd expected a more enduring structure, like the chipped limestone bridges of the San Antonio Riverfront, maybe, with

a WPA logo emblazoned on its ribbing. This was a utilitarian bridge, free of adornment. Steel and concrete. The green-brown water flowing underneath was almost certainly laced with trihalomethanes and perchlorates. The entire trip—come to La Estrella to see the bats!—was starting to feel like a nasty marketing trick.

Where was Rosa? He began to doubt everything: the hard sell by the cousins, the batteries painted like Easter eggs, the juicer trying to blend in like a normal kid. This was a solar Wonka factory with a river flowing with garbage liquor instead of chocolate.

He heard a countdown begin in the throngs: "Twenty, nineteen, eighteen ..."

"What are they doing?" he asked.

"It's a countdown until sunset."

"Ten, nine, eight ..."

"Someone help us!" Raj shouted. "We've lost our daughter." But his voice was drowned out by the jubilant crowd.

"Three, two, one ..."

And then at the count of one, or within a few seconds of one, the first bat flitted from beneath the bridge, zig-zagging across the blue-black sky. He thought he heard the flutter of its wings. It sparked a chittering, high-pitch susurration that emanated from the heart of the bridge, as if the ugly structure had come alive. The bats spilled out from the shadows in a rush of frenetic energy. Thousands, then tens of thousands of bats corkscrewed into the dusk.

"There she is!" Helena said, grabbing Raj by the arm.

"Where?"

"There, down on the bank by the water."

Rosa was there, pointing up at the bats as they swept past. She was sitting on the gravel bank next to her cousin Carlos and what must have been his girlfriend, who was clinging to him possessively.

They were laughing. And even Tim, who must have watched the bats a hundred times, looked up with a smile, enjoying the sight.

"Rosa!" Helena shouted, waving her arms. "Rosa!"

Now Raj noticed the scent of the bats, a raw guano musk, a kind of peat-moss purity, earthy and primal.

"She can't hear us," Helena said. "Should we go down to her?"

When the last bats trickled out of the bridge, the entire riverscape lit up in a dizzying array of fiber-optics. The moon was hoisting its way above the live oaks. He looked down at his daughter's face, radiant with expectation.

She could be fine here, he realized. Somehow, in the maelstrom of parenting, he had overlooked what she had become. He could be fine. He clasped Helena's hand as the moon slipped above them. He pulled his wife into the crowd, and they began to dance.

Freetails, Freedom, and Community in a Solar-Powered Future

By Lauren Withycombe Keeler

In "The Scent of the Freetails," the year is 2050 and a shift has happened. Cities and towns, houses and apartments, temples and shrines, are all powered by the sun. The shift happened slowly and then all at once, as it so often does. At first, solar panels were for wealthier, liberal-minded individuals who wanted to contribute to a greener future and more rugged individualists who wanted to depend on themselves and the sun, rather than the government, to power their lives. Eventually utilities, responsible for bringing power to the people, could not ignore the lower cost of solar energy—and, to a lesser extent, the demands of their consumers for a cleaner grid—and they began to diversify. Solar panels began to consume empty spaces outside cities. Mountaintops sprouted wind turbines. Shuttered coal plants and industrial sites were refurbished to house batteries, which stored power for cities and towns when the sun went down and the wind ceased to blow. By 2050, an new energy system has emerged, as diverse and variable as America itself.

People have shifted too. At first, many clung to the earth. For

several hundred years man and machine had cleaved, broken, drilled, exploded earth—extracting her black insides to enliven cities and illuminate the night sky. Carbon brought livelihoods, predictability, convenience, and comforting daily routines to people across the world. Turning from fossil fuels to renewables was a gamble for some, but for others it was an outright rebuke of once honorable and honest ways of life. But in geologic time these affronts were short-lived, and by the time the energy transition was well underway, most people looked to the sun for light, and power, and liberation too. In 2050, the light of the sun shines bright on arrays, reflects off mirrors, and refracts through windows and skylights. Sunlight sustains cities like it sustains flowers and trees, feeding them in the daytime and retreating in the night, that they might rest, recover, and grow.

In "The Scent of the Freetails," the transition to a future powered by renewable energy could not be achieved by technology alone. Solar and wind are not barreled and piped, shipped and fired on demand like oil and coal. The daytime sunlight powers human life, but only so much of that sunlight can be stored in batteries for use in the evening. To use less power in the evenings, people and industries have shifted how they operate, moving high-energy-use activities to times of peak solar production, between about 10:00 a.m. and 3:00 p.m. in a place like San Antonio. As a result, people and technologies work together in different ways than they do today, and what emerges are new cultures and patterns of life, both foreign and familiar. "Freetails" explores some of those cultural shifts while highlighting how people's experiences of the renewable energy transition look very different depending on their ability to adapt to changing social, economic, and technological circumstances.

La Estrella provides a rich backdrop to explore how society and culture are shaped by technology, and vice versa. This middle-class part of San Antonio had long supported policies to reduce fossil-fuel

use. Perhaps more importantly, though, this was a community that had elected leaders and supported policies that put the health and well-being of their community above those of individuals. When the electrical grid went full-renewable, this community had experience pooling their resources to invest in their community. That experience helped them more easily agree to create a battery co-op. Peter explains to Raj that they have community-owned battery storage, where energy created from solar arrays built into homes and businesses can be stored for use by the community at night.

This, in and of itself, is not so radical, but La Estrella has further embraced this diurnal way of life. The community has decided to welcome back the darkness, becoming a Dark Sky community: committing through policy and practice to keeping nighttime light pollution to a minimum.[1] With the return of the darkness has come the sunset dance of the freetail bats, backlit by the rising stars. Residents of La Estrella use little of the community's stored energy at night, and sell the excess to other communities who wish to keep the darkness and its denizens at bay. They invest the money they make back into the community to replace roads with walking paths shaded by native cottonwoods, verdant with vegetation that cools the neighborhoods, and to expand habitats for the freetail bats, nine-banded armadillos, tiger swallowtail butterflies, and other San Antonio natives once pushed to the urban perimeter. In La Estrella, we see how people can use technology to reshape the patterns of daily life, to leverage the values held by individuals and communities, and to reflect those values in policies and practices.

Not everyone is comfortable with the retreat of humanity from nature's supposed master to one of its many inhabitants, and most communities in this future are not La Estrella. Raj comes from a different place, mentally and geographically. His experience in "The Scent of the Freetails" can help us understand how other individuals

and groups might cope with and adapt to a solar-powered future. As a Guyanese immigrant, he's a bootstrapper; he's witnessed firsthand the power of the individual to better their life, and he's a believer in this principle. He is fiercely protective of his nuclear family and dubious of this amorphous "community" of La Estrella residents whom he's supposed to trust with the well-being of his only child.

The highway from Houston to San Antonio is filled with shared autonomous vehicles and autonomous buses in dedicated lanes, but Raj makes the journey to La Estrella in his truck. It is not the fastest option, but he gets to be in control. His experience as an immigrant kid in Houston schools, and later raising a child with a disability, have taught him that the world is not a reliable place and that one must be prepared to take care of their own. In this future, people like Raj power their homes with solar energy and have in-home battery storage that ensures consistent access to electricity day and night; no need to negotiate with your neighbors to create a co-op, no reason to contend with the darkness when you'd prefer light. Still others might purchase their power from utilities, like today, and receive nighttime power at higher rates if they can afford it, or in lower quantities if they can't afford nighttime pricing. In Raj's experience and the depiction of a future Houston, we see that it might be possible for some people and some cities to weather a transition to renewable energy with very little change to the rhythms of daily life—but the world does change around them.

If the COVID-19 pandemic has taught us anything, it is surely that our social systems and patterns of behavior can be transformed in an instant. Individually, we are not all able to adapt to these changes in the same ways—and we are likely to value different kinds of adaptations. However, together we can share the burden of transition and use the disruption to create communities and ways of life that better reflect our values.

The energy transition is often discussed and monitored in terms of the sources of electrons on the grid or square meters of solar panels, but such quantitative metrics tell us little of what matters in daily life. An inventory of a community's values says far more about how that community will look when powered by renewable energy. If you want to live in a community like La Estrella, transformed by renewable energy, you'll make more progress on that future by getting to know your neighbors than by putting solar panels on your roof.

Unlike today, the energy system of the future will be far less uniform. Regional and even local differences in climate, geography, and culture will play a role in shaping the kind of energy that is used, when, and how much. In the short term, this transition creates uncertainty about how to ensure stable and reliable access to energy. In the longer term, however, it might be more reflective of an American way, deferential to the rights and preferences of the individual but fashioned according to the shared values and cultural practices that make the country rich in diverse, local identities.

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1 "International Dark Sky Communities," International Dark-Sky Association, https://www.darksky.org/our-work/conservation/idsp/communities. Accessed February 17, 2021.

Customized Energy Futures

By Chris Gearhart

Go anywhere in the United States, today, and most people's relationships to energy are pretty much the same. We drive cars to work and to the mall, and we power our devices by plugging them into centralized electricity grids. Will that sameness persist in the future? Or will different communities develop more customized energy solutions that fit their goals and aspirations for how they want to live?

Customization is increasingly possible because of the potential for integrating different kinds of systems together: transportation, electricity, data, buildings, and cities. As the director of the Center for Integrated Mobility Sciences at the U.S. National Renewable Energy Laboratory, I think a lot about how the integration of these technologies as part of future urban systems will affect our lives. Transportation has always been integrated into our lives and has driven the evolution of our cities. Historically, this integration has happened through relatively slow processes: the buildout of infrastructure, which takes place on the timescale of years and decades, and the delivery of fuel to filling stations, which occurs on a timeframe of days and weeks. New technology is accelerating the speed of integration and multiplying the channels of interaction. This

acceleration is driven by the introduction of electric vehicles, connectivity of travelers with the internet of things, distributed electric-vehicle charging, distributed electrical generation, and soon, the introduction of automated vehicles. As these technologies are developed and deployed together, they create new opportunities for communities to organize themselves differently than in the past.

As our team imagined a future San Antonio, we found ourselves focusing on many of the indirect consequences of an energy-generation system based on solar power. In creating this world, we looked to the past to think about how the creation of a centralized, coal-based electrical system changed communities during the early part of the last century. Large centralized power plants are not easy to turn on and off. They cannot be turned down quickly when demand for power is low, and they cannot be turned up quickly when power is needed again. In order to keep these generators running as close to steady-state as possible, demand was created to keep lights on at night. Machines were invented to electrify tasks that didn't really need to be made more convenient. The shift of transportation to automobiles, driven by the development of the internal-combustion engine, had similar impacts and drove the evolution of cities for the past century. Cities were organized around automobiles as the dominant technology and evolved based on the assumption that everyone would use them to go everywhere. With these shifts, the cycles of most people's lives changed and were locked in by monolithic systems over which they had no control.

The aspect of Deji Bryce Olukotun's story "The Scent of the Freetails" that I find most interesting is the extent to which new technologies could give communities back some control over these cycles. Much of the motivation for this future vision was an attempt to answer the question, how might a distributed, solar-based electrical system allow people to shape the rhythms of life in their community?

To do so, as the story suggests, will require strong integration across transportation, information, and distributed energy systems, as well as the rest of the urban environment. This integration makes it possible for communities to customize their relationship with both energy and mobility.

In the story, we see the community of La Estrella through the eyes of a person traveling from Houston. From this perspective, we get a glimpse of two communities that have adapted to electrification in two very different ways. La Estrella is a forward-looking urban community, while Houston is a city having trouble moving away from its past. For the residents of La Estrella, it is important that their community get closer to the natural day-night rhythm. Locally generated solar power is a perfect fit for this. For the people of the fictional future Huston, it is important to respect their legacy as a key part of the nation's oil and gas industry. Because of this legacy, there is strong preference for internal-combustion-engine vehicles.

It is interesting to imagine how other communities in this fictional future might take advantage of this flexibility to adapt energy systems to their diverse priorities. As I write this, I am currently sitting in my home, sheltering in place to avoid spreading COVID-19. In this environment, it is easy for me to imagine enclaves of people using these technologies to isolate themselves from the rest of the world. I also imagine rural communities in the Midwest where farmers in feed caps meet at the local diner for morning coffee to compare dividends from the local Solar and Wind Electrical Cooperative, and rehash old arguments about which had a better electric drive system, the F-150 or the Dodge Ram. I imagine wealthy communities full of energy-independent estates that reflect the individualistic self-made images the owners want to project. Everywhere in between, I imagine the vast majority of folks are still plugged into the traditional energy grid—but an energy grid of the future that must take advantage of the same

integrated technologies in order to adapt quickly to changing energy generation and demand.

Critical to all of these scenarios is a need for nearly ubiquitous energy storage, coupled to local energy generation from solar or wind. Communities can adapt to the average cycles of renewable-energy generation, using more power during the day when solar generation is high and less at night, for example, but there must be some source of power for those times when there is no solar or wind energy available. Energy storage provides the needed energy buffer that allows us to decouple generation of energy from demand for energy. There are several ways this energy storage could be provided. Utilities could use very large energy-storage systems to store energy within the grid. Our imagined future La Estrella elected a community-based solution that allows them to be independent from the grid. Electric vehicles will each contain large batteries that, coupled with bi-directional charging systems, could provide the needed energy storage. The cost of lithium-ion batteries has dropped dramatically in the past decade. It is projected that electric cars will soon be no more expensive than comparable internal-combustion vehicles. There has been a similar drop in the cost of photovoltaic solar cells. The simultaneous reduction in price of these two critical technologies makes the idea of customized energy communities not only possible, but perhaps inevitable.

Today, data and mobility are already tightly integrated. Essentially all new vehicles are constantly sending and receiving data. Even when the vehicle is not, most travelers carry a smartphone that is transmitting the traveler's location and preferences. From a mobility perspective, these data are currently used primarily for navigation purposes, but we can expect these uses to expand. Automation of vehicles is the aspect of integrating mobility and data that gets discussed most often. Typically, this discussion goes in one of two directions: either speculation that automated vehicles will usher in an area of increased

efficiency in the movement of people, or that future highways will be filled bumper-to-bumper with even more cars, half of them empty.

In "The Scent of the Freetails," a more nuanced version of these two futures is presented. The story recognizes that both of these futures may exist simultaneously. Just as we have communities today that are pedestrian-friendly and communities that are not, in the future we imagine some communities that adopt integrated mobility solutions in ways that push people toward travel by car, and others that enable a more flexible car-lite lifestyle. A subtle but beautiful example of this from Deji's story is the way in which the low-level lighting integrated into the walkways of La Estrella serves to also direct pedestrians to their desired destinations.

In the story, the implication is that energy choices will be coupled with data-management and data-privacy policies. In the transportation world, the concept of geofencing is often used to manage and enforce different mobility policies. Geofencing takes advantage of the fact that we can tell when vehicles with GPS units enter or leave different areas. Some areas could be designated for electric vehicles only, or as autonomous mobility districts, much as London now allows only taxis, buses, and delivery vans. In this story, both San Antonio and La Estrella have adopted ordinances that change data restrictions at their borders. Electronic advertising pushed to connected vehicles and mobile devices stops at the San Antonio border, as Raj and his family drive into town. Transmission of data out of La Estrella is also restricted, allowing the community to choose how their data is used and by whom. The implication in this story that data access can also be geofenced adds an interesting element to this concept, and suggests even more ways that communities can take advantage of systems integration to customize their own living experience.

The story also points out some of the many indirect consequences of these choices. Enabling communities to be less dependent on

automobiles will reduce the need for roads and parking lots. Less asphalt means less localized heating, which in turn means less energy needed for air conditioning. Changes in the design of housing are another interesting consequence. The description of the houses in La Estrella presents a vision of a neighborhood full of houses of many different styles, all taking advantage of energy-generation technology integrated into building materials to create unique energy-efficient homes. The current centralized energy and transportation systems encourage neighborhoods to be very uniform. Today we see car-intensive communities that, from the road, appear to be nothing more than an uninterrupted line of garage doors. In this story, we imagine a future in which a three-car garage could be considered an anachronism.

In the future as presented in "The Scent of the Freetails," we get a glimpse of how people might take advantage of new technologies to customize their energy and mobility futures to create the communities they want. The story also makes it clear that how people react to technology is at least as important as the technology itself, in terms of how technology is used. Central to successfully integrating technologies into our communities is understanding that people are crucial to the process. As a scientist and an engineer, I can tell you these technologies are not that far off. Low-cost distributed energy generation and energy storage are here. Information technology that ties everything together is here. What we need to understand, however, is how people will react to and interact with these technologies and put them to use to shape their lives and their landscapes. Stories like "The Scent of the Freetails" help us to imagine these human interactions and to project ourselves into these futures.

Intentional Innovation

By Max Gabriele

As I write, the world is going through a global crisis the likes of which I have not seen in my lifetime. Forced to withdraw from work, school, and other unavoidably social environments, people are finding solace in home-improvement projects, livestreamed yoga classes, and all those books in the "to be read" pile. But that's not all they're doing. They're forming mutual-aid groups online and amongst their closest neighbors, organizing to distribute suddenly scarce food and hygiene items to those in need. My own neighbors and I walk each other's dogs, use each other's gym equipment, gather for game nights in the evenings, and have planted vegetables in each other's yards. We have become, without prior intent, an intentional community.

As the crisis ramps up, the disappointing response of many of this nation's leaders stands in stark contrast with the ad hoc ingenuity of its citizens. I've seen bed frames converted into garden plots, classes taught on *World of Warcraft*, parents supporting each other by sharing home-schooling lessons and activities, or even teaching each other's children over videoconferencing software—reorganizing and repurposing assets to meet the demands of the day. These and other responses are innovative in every sense of the word.

Observing and experiencing this has led me to reflect on what we mean when we talk about innovation. Despite excellent scholarship

and service by dedicated members of academic institutions, NGOs, and governmental organizations that have highlighted the resourcefulness and generalizability of bottom-up and indigenous innovation, it's still common to think of innovation as a top-down process that happens when hundreds of geniuses crunch noggins in Silicon Valley, or at the MIT Media Lab. But that's just one kind of innovation, and one that is not without problems. For all its intellectual and computational horsepower, that kind of innovation risks instrumentalizing humans as users according to a market logic that prioritizes speed and scale over the essential needs of real people. Communities get divvied up by demographics instead of neighborhoods, diverse identities get averaged and aggregated into normative avatars, and society gets atomized into individual constellations of pain points and preferences.

In Deji Bryce Olukotun's story "The Scent of the Freetails," the dominant ideology of a possible future Houston reflects that of our own present society in its almost neurotic commitment to a style of defensive individualism. In contrast, the path-blazing neighborhood of La Estrella, in San Antonio, has chosen to resist individuation by thinking and acting collectively. Top-down, market-driven innovation might see a solar-powered community as disadvantaged during the unlit hours of the day and then produce all kinds of techno-wizardry to service each individual household's nighttime power demand. In contrast, bottom-up, community-driven innovation in La Estrella opted simply (but profoundly) to see the dearth of power at night as an opportunity to revel in the unique natural advantages of their local environment by instituting a "dark sky" ordinance.

A Dark Sky community, according to the International Dark-Sky Association, "is a town, city, municipality or other legally organized community that has shown exceptional dedication to the preservation of the night sky through the implementation and enforcement of

a quality outdoor lighting ordinance, dark sky education and citizen support of dark skies."[1] But the clever surprise in Olukotun's story is that, for La Estrella, "dark sky" is not only a celebration of the local, but also a strategy of communal empowerment through the geofenced occlusion of satellite surveillance. La Estrella's data sovereignty is an example of how what is, on one level, a decision about energy can also be an opportunity to extend agency to communities who might otherwise be marginalized or aggregated in other spheres of life.

Data and energy are deeply intertwined. Historically, electric companies understood that energy consumption was related to consumers' daily rhythms—sleep, work, social time, family intimacy, etc.—and simultaneously, that the predictability and consistency of consumption was instrumental to their profit margins. It is cheaper and more efficient to run power plants on fossil fuels at equilibrium, rather than lowering or raising output throughout the day based on human needs. Electric companies invested in things like amusement parks and television and promoted the institution of night shifts for workers, all in an effort to bring human behavior into conformity with the needs of the energy system. In light of this, La Estrella's decision to "black-box" their data and to match their behavior to a more natural day/night pattern—the way "we were meant to live"—is also a rejection of the system's attempt to mold them to its own rationalized logic. The fact that this is done collectively is important, because even though one consumer's usage data is of little significance, the entire community's data has real value to utilities and others. Thus, the decision to reject conformity to aggregated and abstracted averages is inherently emancipatory and democratic.

No doubt La Estrella took flak for their outside-the-box thinking. The point-of-view character Raj, coming from Houston, is wary of San Antonio and of La Estrella in particular, suggesting that the neighborhood may be unique even in the context of the surrounding

city. Difference rarely pleases everyone, so we can assume the community has weathered a storm of criticism. But the inhabitants of La Estrella stuck to their principles, resolutely maintaining that this new direction was the right choice for *their* community. That, it seems to me, is what intentional innovation ought to mean. It is the opposite of generalized, one-size-fits-all solutions and normalizations formulated and imposed from some distant perch, unresponsive to the local idiosyncrasies and personalities of the people they are supposed to apply to.

As a kind of experiment as I was preparing to write this, I did two Google image searches for "innovation hub" and "intentional community." I imagine what I saw is what anyone would intuitively expect. Innovation hub: scenes of modern architecture, audacious spans of tempered glass, pale wood, white furniture, young, enthusiastically engaged professionals working their way through a project, with no real variation even after several minutes of continuous scrolling. The results for "intentional community" were just as consistent, but with images of outdoor scenes, communal gardening, group meals, repurposed building materials, people meditating or doing yoga. Although the results conformed to my expectations, I can't help but think of this as odd. When did innovation become synonymous with technology and design, and partitioned off from vibrant spaces where people live and play? When did intentionality become associated with some kind of new age sub- or even counter-culture? This isn't just odd, it's stupid.

For all the significance that the word innovation has come to bear in our current era, it simply means to introduce something new or to find novel applications for something that already exists. So why not take "The Scent of the Freetails" as an opportunity to think about innovation differently? It's time to take seriously the idea of intentional innovation: novel technologies or applications designed

from the earliest stages to serve communities and help shape them based on their own collective visions. It's time to take seriously a notion of innovative communities, empowered to reject or adopt technologies and practices based on their capacity to further internally generated goals. This doesn't mean turning every neighborhood into a Googleplex; rather, it means doubling down on what makes each neighborhood and its residents unique. Nor does it have to be solemn or militant. It can be fun, even inspiring. In Olukotun's story, naming and decorating the community's collectively owned batteries and gathering to observe the nightly exodus of the Mexican freetail bats are two examples of how conscientious energy use, communal self-determinism, and collective celebration can overlap and strengthen one another.

But what of the Googleplex? What of the Media Labs and the Motherships and the innovation hubs as we know them now? What role would they have in this intentional paradigm? Rather than outline a proposal for some new kind of institution or mechanism of exchange, I think the first and most essential step that could be taken in these places, as they exist today, is to cultivate a new ethic of innovation—an ethic that emerges from a patient and persistent effort to place the values, concerns, and desires of communities ahead or above technical or economic optimization. This vision is inspired by ideas sketched out by Isabelle Stengers in her "Cosmopolitical Proposal," where she promotes a kind of collective thinking that happens in the presence of those that will be victim to or affected by the product of that thinking.[2] Crucially, Stengers insists that those community concerns must be prioritized and addressed, even when the substance of them sharply diverges from or even denies the legitimacy of the innovators' own expert opinions and goals. The power of the "cosmos" in cosmopolitical is to embed innovators and innovation in a complex ecology of interactions and responsibilities. It cancels out

the artificial distance between the sites where innovation is produced and where it is put into action, and affirms that its products must be answerable to real human needs, not vice versa.

How might this be accomplished in practice? How might the community be made present in the halls or on the screens where innovation occurs? Isn't it true that engineers already attempt something like this in their use of avatars—fictional characters based on aggregated surveys, statistics, and stories—to stand in for the user? And don't cutting-edge labs like the Media Lab and Google's Moonshot Factory employ groups dedicated to bombarding product-development teams with every imaginable criticism in an effort to foresee unintended consequences, mishaps, or dissatisfaction? They do, but I want to suggest that there are two fundamental differences between what those groups do and what I am suggesting. In both instances (and others like them) the decision to innovate *has already been made* by the designers and engineers *before* the avatars are conjured and the bombardments begin. At the same time, the avatars are merely stand-ins for users; they are rarely the users themselves. My vision of intentional innovation, inspired by Stengers's cosmopolitical proposal, would be something much more (maybe wholly) passive: rather than thinking up products for other people, intentional innovation would be at rest until *called upon* by the community to use its remarkable knowledge and technical expertise.

Innovation's next product, in effect, must be an ethics that emerges from a new aesthetic approach to its work—one that allows itself to be constrained by the community in which and for which that work is done, just as an artist is constrained by the medium she chooses to work with. "Politics is an art," writes Stengers, "and an art has no ground to demand compliance from what it deals with. It has to create the manners that will enable it to become able to deal with what it has to deal with." I think we should think about innovation as

an art in the same sense. We could talk (maybe in future iterations of *The Weight of Light*[3] and *Cities of Light*) about what the characteristics of such a manner might be—respect, deference, patience, a virtue of service—but if we really want to take up this idea, then talking isn't where to begin. It is and always will be practice that leads to great art. That is to say, there is no reason not to start, right away, polishing the manner from which a theory of cosmopolitical, or intentional, innovation can emerge.

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1 "International Dark Sky Communities," International Dark-Sky Association, https://www.darksky.org/our-work/conservation/idsp/communities. Accessed February 17, 2021.

2 Isabelle Stengers, "The Cosmopolitical Proposal," in Bruno Latour and Peter Weibel, eds., *Making Things Public: Atmospheres of Democracy*, MIT Press, 2005: 994-1003.

3 Joey Eschrich and Clark A. Miller, eds. *The Weight of Light: A Collection of Solar Futures*, Center for Science and the Imagination, 2019.

Democracy and Justice in Solar-Powered Cities: The Power of Customized and Inclusive Futures

By Clark A. Miller, Andrew Dana Hudson, Max Gabriele, and Patricia Romero-Lankao

The central insight of this book is that the future of cities is tightly bound up with the future of energy. This relationship is two-way, and it has been true throughout human history. Energy systems coevolve with cities, each shaping the other.[1]

The role of energy as a driver of urban transformation is particularly salient at this moment in history. The fundamental reshaping of global energy systems to address climate change will have deep implications for the future city. Although, to date, solar and wind energy and electric vehicles account for no more than a percent or two of urban energy production and use, renewable energy technologies are already reshaping urban imaginaries, infrastructures, environments, politics, and lives.[2]

The future is not fixed, however. The solar-powered cities of tomorrow might yet take many forms.[3] Choices abound with regard to the

design and deployment of diverse energy technologies, including solar panels, smart homes and smart grids, automated and electric vehicles, ubiquitous data-sharing, hydrogen, and the capture, recycling, and storage of carbon, etc. These choices, and those who have the power to shape them, will profoundly influence future urban cultures and geographies and the organization of social, political, and economic life.

To conclude the book, we reflect on how urban energy choices intersect with the future of social justice. This spring and summer, COVID-19 and the escalating crisis of police killings of Black Americans laid bare the deep inequalities in today's cities. In the process, they served as a stark reminder that the future of social justice is fundamentally at stake in the future of cities.

The stories, essays, and artwork in this book highlight that choices about energy are also choices about how to organize the city and how to distribute services, benefits, and risks among its inhabitants. Urban inequalities stem as much from choices about urban infrastructure as they do from other social, economic, and political structures present in the city.[4] At every turn, our authors direct readers' attention to energy systems that reinscribe and reinforce lopsided distributions of power, wealth, living conditions, economic opportunities, and access to nutrition, health, and security.

If, tomorrow, we want different cities—if we want cities that catalyze and create justice among all of their inhabitants, that distribute life's opportunities and pitfalls fairly, that are in more just relationships with their rural neighbors and the inhabitants of places bound up in the far-flung supply chains that provide the material foundations of urban life—we need to make different choices about the design of urban energy futures.

This, then, is the second central insight lurking in the pages of this book: when we build the solar cities of the future, we can choose

to leverage energy innovation to make cities more just. Or we can choose to let injustice and inequality persist, rooted in designs of energy infrastructure that advance the prosperity and thriving of some, but leave others behind. It's not really a choice, is it?

Energy is Part of the Problem

Energy innovation has long been heralded as a force for democracy and justice. As documented by Timothy Mitchell in his book *Carbon Democracy*, carbon-based systems of energy production and consumption fundamentally shaped the political contours of democratic societies, their distributions of power and wealth, and their collective dreams and imaginaries.[5] Coal and oil provided the resources to create industrial economies in Western societies and underwrite arguments about the ability of democracy to secure economic growth, material abundance, well-paying jobs, and technological progress. The automobile became a symbol of personal freedom, exemplified by James Dean on his motorcycle, ready to ride off to wherever he chose. David E. Lilienthal, chairman of the Tennessee Valley Authority, an early federal power project, wrote in 1943 in *TVA: Democracy on the March* that electricity promised to bring economic development and prosperity to the country's poorest regions.[6]

Many of the characters in the stories in this book reflect the fact that this dream is still very much alive. Avery Luther Black, in Paolo Bacigalupi's "Efficiency," has built a neighborhood electric co-op on the South Side of Chicago, on the promise that locally owned, locally sourced energy will help free his community from the ravages of poverty. For Tanama, in S.B. Divya's "Things that Bend, But Don't Break," energy innovation means the possibility of forging a good life in Puerto Rico, rather than having to go off-island in the hopes of securing a better future. For Raj, in Deji Bryce Olukotun's "The Scent of the Freetails," it means the hope that perhaps his family has finally

found a place in La Estrella where his daughter can be free, and so he can be freed of the crushing responsibility of trying to protect her. Even Kismet, in Andrew Dana Hudson's "Solarshades," senses by the end of the story that it might be possible, with a lot of work, to leverage solar energy to create a better life for the people in his downtrodden part of Clackamas County, Oregon.

However, these characters' struggles to find empowerment in solar-powered futures remind us that reality is more complex. As much as any industry, the energy sector (coal, oil, automobiles, electricity, lighting, radio and television, air conditioning, heating, home appliances, etc.) created the modern city.[7] Despite its promise to serve to uplift the downtrodden and foster a more just and equal society, the growth of the energized city, and the systems that power it, has just as often served as an instrument for advancing the interests of the powerful. Key social, economic, and political debates of the past 150 years have been fought over the alignment of the relentlessly expanding energy sector—and its ability to power economic vitality and national security—with the ideals of democratic societies, e.g., in such areas as labor rights, the concentration of wealth and economic power, public versus private ownership of critical infrastructures, the use of military power to secure resource supplies, relationships between cities and their rural neighbors, and adjusting the design of human enterprise to the limits of the Anthropocene and planetary sustainability.[8]

The intersections between energy and inequality are not blind to racial, economic, political, geographic, or social inequalities and insecurities. Fuel and electricity systems in the U.S. continue to leave many communities behind. Data on energy costs, for example, reveals uneven and disproportionate burdens on communities of color, low-income and rural communities, indigenous communities, people with disabilities, and others with less social, economic,

and political power. According to *Lifting the High Energy Burden in America's Largest Cities*,[9] low-income households in the U.S. pay, on average, 7.2% of their income for electricity and fuel to power and heat their homes, versus 2.3% for the rest of the country, equivalent to a 5% regressive tax on poor communities. If gasoline expenses were included, that number would be even higher. In Memphis, the bottom quintile of low-income families pay as much as 26% of their income on energy, compared to 8% for their richest neighbors. According to data from the Department of Energy, the energy burden exceeds 50% in some Census tracts in Puerto Rico.[10]

Higher energy costs contribute to keeping low-income communities in poverty. Utilities participate in the federal LIHEAP program that helps low-income households pay their energy bills, and many have policies to prevent people from losing energy services when that might pose a danger. These programs do not solve the problem, however; they only mitigate it, and often only temporarily.[11] Every month, energy bills sap resources from poor communities that might be spent on food or medical care, undermining nutrition and health and limiting investments in education or economic opportunities that could help people escape poverty. These trade-offs exacerbate worries about being able to pay energy bills and impose added mental-health burdens. Low-income families and businesses often have less efficient and lower-quality energy infrastructures, further raising their energy costs, because they can't afford to invest in higher-efficiency equipment. This challenge is exemplified in Puerto Rico, where the electricity grid routinely fails: some communities went without power for 11 or more months after Hurricane Maria, and many died.[12] The concentration of burdens on low-income communities and communities of color creates and reinforces an energy-poverty nexus: feedback loops between energy, economic, food, health, environmental, and other forms of insecurity that reinforce and compound one another over time, exacerbating disproportionate harms.[13]

Making Energy More Diverse

Social justice demands broadening the purpose of a clean-energy transition to go beyond creating carbon-neutral futures. We can build cities powered by solar energy. To what ends do we propose to build them, however? Will we leverage solar innovation to end the energy-poverty nexus? Will we use solar energy not only to solve climate change but also to empower and energize the lives of Black, Hispanic/Latinx, Asian, and Native Americans, people with disabilities, the unhoused, the working class, and the poor in tomorrow's great cities of light? Unless cities and the energy sector confront head-on the fact that the energy systems of the past and present have made cities more unequal, tomorrow's energy systems may continue to undermine economic security and perpetuate energy injustices.

This book offers an important contribution to addressing these challenges, grounded in the idea of making energy systems more diverse and heterogeneous. Our participants came into the project recognizing that fixing urban energy inequalities requires understanding and reversing the systematic forms of institutionalized racism and injustice that persist in the organization of energy systems. Those sensibilities were honed, this spring, as COVID-19 ravaged communities of color, George Floyd was killed, and American society rose up once again to declare that Black Lives Matter.

Against the backdrop of these events, it became even more clear to all of us as we labored over the stories, art, and essays collected in this book that it is no longer sufficient for energy systems to act as if everyone and every community is alike and, as a result, to undermine the ability of disadvantaged communities to leverage energy to create unique and tailored forms of security and well-being. Rather, we must learn to see differences in the energy experiences of diverse communities and to design energy systems in ways that acknowledge and accommodate those differences.

Chris Gearhart captures this idea compellingly in his vision for the *customization of energy futures* as a pathway to energy justice. The goal of customization, as Gearhart explains, is to align energy systems to the contexts and needs of the communities they serve. Today, such customization occurs only at the margins, among the world's richest and poorest. Yet, as Madeline Gilleran and Max Gabriele write in their essays, in the future, it may be possible to intentionally and creatively design customized energy solutions that are more inclusive, and that tailor energy services to local opportunities, needs, resources, and contexts.

At the heart of customization, as Clark A. Miller highlights in his essay on decolonizing energy systems, is the idea that energy systems need to become more generative of thriving futures for low-income, marginalized, and vulnerable communities. The idea of generativity aims at untangling the energy-poverty nexus by enhancing the ways that energy systems create value for communities, and reducing the ways that they degrade or extract value from them. Generativity requires rethinking energy ownership and sovereignty, as Robert Ferry and Elizabeth Monoian suggest in their essays about the political economies of energized art in Puerto Rico and Chicago, to ensure that the benefits of energy flow into and not out of marginalized communities, especially if we are to redress and compensate for historical injustices. If this reversal of the energy-poverty nexus can be accomplished, as Joshua Sperling and Alāna Wilson offer in their respective reflections on how Puerto Rico and Chicago might each have arrived at the futures described in stories by S.B. Divya and Paolo Bacigalupi, generative energy customization offers a pathway to healthy, thriving communities, grounded in more diversified and more resilient economies.

Customization of energy will not be easy, especially given the diversity of communities for which it may be required. It is essential,

however, to fostering more just and democratic futures for the cities of tomorrow. It will come, Lauren Withycombe Keeler suggests in her essay, from putting a renewed focus on community values in developing future energy systems. It will come from encouraging communities to learn from one another and to follow the lead of other communities, such as the people of the mountains of Puerto Rico who, as Yíamar Rivera-Matos describes in her essay, are inventing their own solar-powered futures. And it will come, as Patricia Romero-Lankao suggests in her essay, from developing new tools and models for creating more diverse and inclusive dialogue about energy futures, such as quiet mobilization, that allow for deep conversations with communities who may not be reachable via traditional channels of communication and engagement.

Using such methods, it might be possible to make customized energy futures available to all, leveraging the interpretive flexibility of innovative solar and digital energy technologies, facilitated by supportive energy policies and institutions, and guided by local imagination, ownership, and governance. Such customization would allow solar-powered cities to truly rethink and rework the knotty relationships between energy, democracy, and justice bequeathed to us by the energy systems of the past and present. In such a way, the redesign of future energy solutions might make it possible to create more just and democratic energy futures and, through them, more just future cities.

What will it take to accomplish such a vision? What would such systems look like—and what kinds of politics, negotiations, and accommodations would be required to go from here to there? Who would drive such a transformation, who would oppose it, and why?

Seeing People and Energy Differently

To create more diverse and customized energy futures will require,

first and foremost, learning to see difference with greater depth, nuance, and sensitivity, exploring and surfacing what makes life distinct from place to place and community to community, and how that distinctiveness intersects with energy. This runs counter to the usual tendencies of the norms, routines, practices, knowledges, and policies of the energy sector, which are generally disciplined to see people in undifferentiated ways.

In *Seeing Like a State*, James C. Scott describes the tendency of modern institutions to create knowledge about society and the environment in ways that flatten differences among people and ecosystems, rather than draw out their diversity.[14] The forms of knowledge developed by these institutions oversimplify the rich complexity that they observe—typifying, abstracting, and categorizing natural and social realities. Moreover, as Scott argues, those lenses feed back into the organization of programs and policies built upon that knowledge such that, ultimately, people and landscapes are themselves standardized into predictable forms and patterns.

Scott calls this logic *legibility*: the capacity to create ways of both measuring and organizing society, the economy, and natural resources so that administrative organs can systematically see, make sense of, and regulate them. A classic example of legibility can be found in the vast rectangular patterns of agricultural farms and roads in the American Midwest and West. These patterns are laid out according to one-mile-square grid lines established by the federal government in the late nineteenth century. Those grids subsequently became the basis for land ownership and planning, only disrupted by landscape features such as rivers and hills that don't quite fit. And that, of course, was Scott's second point: much of life doesn't actually fit terribly well into the sight lines of modern institutions. The knowledge categories they use are "too coarse, too static, and too stylized *to do justice* to the world they purport to describe."

Energy is not so different from agriculture. Although not as visually obvious, the power of the federal government granted by the U.S. Constitution to regulate interstate commerce has, in fact, led electricity grids, oil and gas pipelines, the metering and sale of gasoline, and other facets of energy systems and markets to become highly standardized. Cars all have the same-sized feed intake for their gas tanks and run on the same formulation of gasoline. Electricity plugs are the same everywhere in the United States, enabling us to plug our phones in at home, at work, at the hotel, or wherever. And, in their standardization, as Angel L. Echevarria observes in his essay, energy systems also see people as identical and interchangeable. Regardless of who they are or where they live, city dwellers generally have little choice in how they encounter and inhabit energy systems: we are, first and foremost, consumers of energy, customers of energy businesses, and residents of broadly homogenized energy landscapes. We purchase energy—fuel, electricity, and natural gas. We plug devices into outlets, fill our cars with gas, flip light switches, and little else. Few of us own either energy resources or energy-generation equipment. Generally, we have little say, except perhaps indirectly through voting for candidates for various offices, over how energy is governed or provided in our city. Unless we choose to protest or attend a regulatory hearing, we do not have much influence over where energy facilities are sited, what kinds of energy services we receive, the costs we pay, or the criteria used to make those decisions.

The convenience of standardization comes with a trade-off, as environmental historian Samuel P. Hays observes in *Conservation and the Gospel of Efficiency*, his history of Teddy Roosevelt's agricultural, mining, land use, water, forest, energy, and other resource policies in the early twentieth century.[15] Standardization comes at the expense of a wide diversity of localized arrangements and solutions that are often better attuned to the contexts and needs of diverse communities. For

Roosevelt, of course, that was the goal. In the early twentieth century, local government was, in many ways, corrupt, inefficient, and not conducive to achieving "the greatest good for the greatest number of people." The result was inclusion through standardization: everyone became part of the system, but in ways that neither acknowledged nor tolerated local diversity and variety.

This tension between standardization and diversity is, today, at the center of the debate over the future of energy. Energy is at a crossroads.[16] The great systems of carbon-based fuels and grid-based electricity must change to reduce the rapidly increasing threat of climate disruption. That opens up the question of what will replace them in powering the great cities of the future. Some proposals, of course, call for even more imposing great systems: Masayoshi Son, for example, the CEO of Softbank, one of Asia's largest investment firms, proposes an Asian Super Grid to take electricity from Saudi Arabia to Seoul.[17] Others propose to continue burning fossil fuels while fashioning vast global waste-disposal infrastructures to capture gigatons of carbon dioxide and pump it through new pipeline networks into deep underground storage reservoirs for long-term storage.[18]

On the other hand, there is today a vast outpouring of energy democracy across the globe: a growing insistence across many communities that the voices and ideas that guide energy decision-making into the future must become more diverse and inclusive.[19] All over the world, local communities are demanding new ways of doing business that provide energy in arrangements attuned to local needs, contexts, and sensibilities. On the Navajo Nation, for example, the closure of the Navajo Generating Station—one of the world's largest coal-fired power plants and its associated mine, which provides one of the Navajo Nation's largest sources of jobs and revenues—has generated an intense interest in writing a new energy future driven by Navajo values and interests, rather than those of stockholders and

stakeholders hundreds or thousands of miles away. In the mountains of Puerto Rico, communities that went without power for months after Hurricane Maria are now searching for solar solutions that will give them more resilience and security than the state seems capable of providing. In Nepal, rural smallholders are building innovative local solar and charcoal solutions that provide energy, sequester carbon, and simultaneously create stronger community livelihoods, enhance agricultural productivity, and supply carbon-neutral energy services. And there are thousands and perhaps millions more examples.

Ideas of energy democracy are grounded in the diversity of sustainable energy resources—sun, wind, water, waves, tides, geothermal hot springs, and many more—whose distribution across the planet varies markedly from place to place and, crucially, lends itself less to the planet-encompassing economies of scale characteristic of the fossil-fuel industry. They are also grounded in the recognition that key energy technologies of the future, including the humble photovoltaic panel, are powerfully diversifiable: able to be deployed in a vast array of sizes, patterns, locations, and socioeconomic arrangements with little to no impact on the basic economics of its energy production.[20] Solar-energy markets today thrive on scales that range across more than nine orders of magnitude, from a few watts powering a solar lantern to gigawatt-scale utility power plants. Nor is solar diversity limited to the size of photovoltaic systems or their technical configuration. Their integration into social, economic, and political arrangements is also highly flexible. Solar systems, for example, have an enormous diversity of owners: individuals and households, including those in the world's poorest communities; electric utilities; many other kinds of companies; nonprofits; governments; and more.

Stories from the Future

The question at hand is whether the energy sector is capable of

adjusting to and incorporating this diversity into an alternative vision of the energy future. This question sits at the heart of the four stories presented in this volume. Each focuses, in a unique setting, on one or more communities that have set their sights on a customized energy future: a community-based, solar-powered city of tomorrow. Each also presents an electric utility—whether directly or indirectly—that is at best ambivalent about the community and its vision. The resulting conflicts, which play out in radically different ways in each of the differently imagined cities of the future, provide glimpses into the challenges of energy democracy for the future of global energy systems—and to the different ways that the tensions described by Scott in *Seeing Like a State* are likely to play out between centralization/legibility and decentralization/diversity.

The four stories play out against a backdrop in which electricity is increasingly the backbone of sustainable energy planning. Green electrons are steadily replacing black fuels as the sustainable energy source of choice. The future is thus, as told here, a fight over the future of electricity, between those who favor models that extend current forms of electric utilities and those who reject incorporation, control, coordination, and efficiency in favor of local values and viability and of local services created through grassroots innovation and investment of people, work, money, and time. Will electric utilities, regulators, and citizens choose to continue to pursue highly centralized energy futures—or will they open up future electrical systems to greater diversity and inclusion? Can innovation and accommodation be negotiated on terms that create greater energy diversity and sovereignty, without losing the benefits that come from connecting people across regions, countries, even the globe, in collective entanglements of sharing, encountering, trading, cross-fertilizing, learning, and enabling?

Perhaps the most unsettling story in the book is "Solarshades," by Andrew Dana Hudson. In Hudson's Portland-of-the-future, Kismet

lives next to an informal settlement of migrants and homeless people—"people who move around," to borrow Scott's phrase—many of whom have their own informal solar-energy infrastructure. The informal, illegible nature of this population and their infrastructure causes frustration in the Portland suburbs that boils over into animosity and violence. Punishment for illegible populations often takes the form of neglect, on the part of both the state and other state-like organizations, such as utilities, oscillating between benign and malign—as in this case, where the settlements are left to the predations of their slightly more well-off neighbors, including Kismet and his brother.

Kismet's perspective on the settlement changes when he gets his hands on a census worker's pair of augmented reality-equipped glasses. The holographic display in the glasses shows him the utility's data on his community's energy economy. He literally gets to *see like the state*. What he sees makes him realize that, despite the utility's state-like knowledge, it still doesn't see perfectly, and the blind spots are the cause of pain in his life and the lives of others.

Coming to understand the discrepancies between how the utility sees his community and how his community actually lives inspires Kismet to work to reconcile the informal energy system with the grid—including amnesty for those who might be punished for being improperly legible to the state, and a dispensation for local practices that allow marginalized peoples to survive. The hope is that we can improve large systems by empowering community organizers to be the bridge between vernacular local practices and state systems. In the end, the story is cautiously optimistic about the possibilities of this strategy, but worries that those with personal experience with community frictions are not always in the best position to do the long, ongoing work of reconciling them.

In Paolo Bacigalupi's Chicago-based story "Efficiency," state-like

knowledge is personified in an electric utility's talking, snarking artificial intelligence LUCY. Lucy's desire for efficiency in energy systems (as well as further ulterior motives) brings her into conflict with Avery, the founder of a community mini-grid called HoodElectric. Lucy wants to incorporate HoodElectric's territory into her system so she can maximize the particular metrics she's programmed to see and care about.

What Lucy refuses at first to understand is the history of exploitation, mistreatment, and betrayal that made HoodElectric want to cut themselves off from the utility in the first place. Grudges, community trauma, local needs and contexts, bottom-up perspectives—these aren't metrics she optimizes for. They aren't legible to her algorithms. But they are part of how any community works, makes decisions, and experiences the systems the state puts in place—realities with which any effort to construct customized energy futures for marginalized and vulnerable populations, local governments, and neighborhoods will need to reckon.

What would it mean for Scott's thesis if the state was manifest in a form that could literally see and speak, and even have its own goals and incentives? AI is advancing at a pace that rivals renewable energy, and is rapidly becoming part of the energy future. Yet it is also already fraught with concerns about bias and inequality. "Efficiency" suggests that a successful energy transition must integrate these technologies with the local ways of knowing and being that stitch communities and systems together. Yet these local ways are rarely legible in any easy-to-construct sense. Making them visible, and engaging with them productively, is a crucial part of the negotiations to come between utilities and the diverse communities they serve.

In "The Scent of the Freetails," Deji Bryce Olukotun's imagined La Estrella suburb of San Antonio has reached a collective decision to pool energy and data resources, to occlude satellite surveillance

and utility supervision, and to relax their way of life to a natural rhythm instead of one dictated by the constant thrum of 24/7/365 economy, culture, and administration. Their energy independence, data sovereignty, and Dark Sky ordinance—a collective commitment to turn lights off at night and reclaim the night sky as a community resource—are assertions of democratic freedom and self-determination. Like HoodElectric, they make a choice to become illegible: a liberatory act that rejects the ways of knowing, being, and governing established by the state or the energy system in favor of more customized alternatives.

Yet, La Estrella is still embedded in those broader systems: they are Americans, their roads connect to interstate highways, their information systems connect to planetary data networks, and their electricity system connects to the larger grid. Olukotun's story of La Estrella thus raises hard questions about what it will take to enable customization to flourish. What new kinds of institutions and new ways of knowing, administratively, will be required to accommodate difference?

Scott writes compellingly about the challenges that diversity and customization create for modern institutions, like electric utilities, that are organized through central administration. He describes, for example, the rise of a "willful disdain for local competence" that accompanies efforts to consolidate power and maximize efficiency, resulting in the "radical de-skilling" of local communities. Such disdain is unsurprising, given the inherent oversimplification in many facets of legibility, but it also leads to an unhealthy bias toward the center over the periphery: an asymmetric, preferential exchange that appropriates both material and intellectual resources, to the detriment of local diversity. Modern institutions end up governing not the diverse communities within their jurisdictions, but rather the flattened renderings of those communities presented by their simplified

knowledge systems. To catalyze and nurture customized futures like those embraced by La Estrella will thus require, instead, critical new administrative possibilities: a different attitude about difference; new ways of knowing that garner information through open and honest exchange with communities; and new forms of accommodation and exchange at the boundaries that enable the legibility and navigation of diversity more fluidly and authentically.

The challenge of diversity is central, too, to S.B. Divya's "Things That Bend, But Don't Break." The story is set in Puerto Rico, where the future remains clouded by the enduring legacy of Hurricane Maria's 11-month electricity outage and the persistent injustices of neocolonial rule under the thumb of the United States. Tanama, the story's central character, is looking to free herself and her people from those histories, while struggling with the realities of life as a young adult from the periphery. She has two choices: she can accept a scholarship to Columbia University and become one of the world's elite, a member of the Puerto Rican diaspora, able to support her homeland via success in the corridors of power and wealth; or she can join her friends in building the future of Puerto Rico, indigenously, from the grassroots, in the community of La Granja.

La Granja seeks its future hived off from the larger energy systems that run the nation of Puerto Rico, favoring local autonomy, design, value, and choice. To do so, however, they need space outside—and so they settle on empty, abandoned land outside the city of San Juan. Under U.S. law, however, the land belongs to a distant landlord, thousands of miles away, who has not visited the site in decades. The landlord, like the state, can see La Granja only as illegal theft, squatting on her property, a monetizable asset; she doesn't appreciate the ingenuity, labor, and love that have gone into making it a sustainable community, that her land is a space where people have created a thriving home.

Unlike the community at La Estrella, who resolutely refuse to be

translated, the folks at La Granja are only able to preserve their way of life by adapting to the landlord's values—that is, by translating their desires into a more legible frame of meaning. They ultimately make their home into a productive and profitable enterprise, and thus figure out how to pay the rent, by selling the innovative new form of electric battery the community has invented from jackfruit grown in orchards on the land. It is notable that Yuisa, Tanama's girlfriend and La Granja's de facto leader, is more than a little reluctant to make this concession. While the landlord's change of heart and decision to finally return to visit the island can be seen as encouraging shifts of focus from the center back toward the periphery, from the state to the local, they are at best taken with a grain of salt. The landlord still controls La Granja's destiny. Should a future storm like Hurricanes Georges or Maria devastate Puerto Rico once again, or the jackfruit battery market not pan out, they will be in the uncomfortable position, once again, of having to appeal to the goodwill of a distant arbiter for the right to live their lives (and produce and use energy) as they please.

In choosing centralization, electric utilities in the early twentieth century created our great illuminated cities: lighted streets, shopping malls, amusement parks, nightclubs, Christmas displays, and more in cities like Chicago, New York, London, and Paris. Yet, in Deji Bryce Olukotun's imagined San Antonio and S.B. Divya's imagined San Juan, people are looking to go dark: not just to reopen the night sky to natural wildness and human curiosity, but also to scale back the 24/7/365 madness that has consumed human life over the past century. These conflicts are the energy system's version of deleting your social-media account or forming smaller, more controlled online conversations with partners of your own choosing, focused on subjects that matter to you. Or of wanting the government to recognize and confirm the rights of your community—grounded in your own unique values and

relationships—to live freely and be treated equally under the law, without the persistent threat of state-sanctioned or state-sponsored violence, death, or eradication. Will the electric utilities of tomorrow choose continued or even further centralization of energy systems, enforced by overarching AI algorithms that optimize efficiency at the expense of difference, or will they find ways to accommodate or even catalyze and nurture a more diverse energy future?

Inclusive and Sustainable Cities

Progress is a powerful word and a powerful idea. In the Age of Enlightenment in Europe and North America, progress generally took on one of two distinct meanings. On the one hand, progress denoted the project of social and political justice: the search for and achievement of freedom, equality, and human rights for all; the liberation of the individual and the community from discrimination, violence, insecurity, and the oppression of the state and other powerful forces of social and political control. On the other hand, progress meant steady improvement in wealth and well-being, measured through the aggregate metrics of populations: better health, higher levels of education, greater prosperity, a higher income, freedom from hunger and malnutrition. In both models, progress was rooted in the search for ways to make daily life less nasty, less brutish, and less short—yet, in each, that search took very different forms.

The historian of technology Leo Marx has written that, early in the Age of Enlightenment, the idea of progress in technology was linked in people's minds to the project of social and political justice.[21] What made technology progressive, under this perspective, was its contribution to advancing freedom, rights, equality, and, above all, liberation from fear and injustice. Today, that connection has been lost. It is hard, for example, to find even remnants of a link between technology and social justice in images that circulated in the media in

recent months of the police forces of a democratic society, dressed in high-tech riot gear, brutalizing unarmed protesters—or of elderly and poor Black Americans dying in disproportionate numbers of COVID-19, with limited access to the high-tech healthcare available to the wealthy.

As Marx observes, for the past century and a half or so—not coincidentally the rough length of existence of the great energy systems of concern to us in this book—the opposite has in fact been true: technological innovation has become linked solely to material welfare, and then only for those individuals and communities able to afford access to its benefits. Silicon Valley promises to change the world. Yet, today, their apps and devices—emblematic of new technologies more generally—are designed largely for the rich and privileged and, even for them, produce a world less free, pervaded by greater surveillance, subjected to and to some degree subjugated by the grand technological systems that encircle the globe providing energy, food, water, communication, mobility, manufacturing, shelter, security, and more. Commitments to social and political justice remain central to the democratic ideal but divorced from technology, focusing instead on the transformation of human ideas—for example, the elimination of racist attitudes and institutions, such as police reform or the transformation of capitalism into more generative forms.

The stories in this book remind us that technology remains central to the possibility of justice and injustice in today's cities. They reflect an effort to return to the earlier ideal of technology as an instrument of political liberation: to refocus energy innovation on ensuring an equitable and thriving future for everyone. To root out inequality and injustice, we know we need to change our beliefs, attitudes, and social structures. What these stories emphasize is that transforming the technologies and infrastructures that make up our societies is equally critical to the project of liberation. Justice requires reimagining the

relationships between energy systems and cities, and the communities that inhabit both, in more diverse, equitable, and inclusive forms.

Solar energy is often portrayed as a tool for energy justice and democracy.[22] The creation of more inclusive and just urban energy futures rests, however, our authors suggest, not so much in solar energy per se, but in the ability to leverage innovation in solar and other energy technologies to achieve a broader suite of energy-sector reforms: customization, creativity, intentionality, ownership, decolonization, and generativity. Communities are different from one another. They have different ideas, needs, values, resources, and opportunities. It's not an accident that programs and systems built around the idea of "the greatest good for the greatest number of people" have been designed around the needs, opportunities, values, and resources of the majority, and have tended to leave behind and even subjugate historically marginalized communities. Redressing injustice and inequality will require energy leaders to become more attuned and attendant to the diversity and difference of these communities in the design of technological futures, and to more ambitiously engage the marginalized and the oppressed in the work of tuning energy systems to foster social, economic, and political justice.

The development of energy has never simply been about energy. It has always been about the kinds of future societies we want to energize. To decarbonize global energy systems in the next few decades, the International Energy Agency estimates something like $70 trillion will be required.[23] That money can create the carbon-neutral energy systems we need to combat climate change, but it can also do much more. Spent wisely, humanity can leverage investments in solar-powered cities to create inclusive futures for everyone.

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About the Contributors

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A collection of science fiction stories, essays, and art exploring how the transition to solar energy will transform cities and catalyze revolutions in politics, governance, and culture. Cities of Light explores how each city's geographic and social features, along with the arc of its local history, create unique challenges and opportunities as we work collectively to design more equitable energy futures.

The collection features stories by award-winning science fiction authors Paolo Bacigalupi, S.B. Divya, Andrew Dana Hudson, and Deji Bryce Olukotun, working with visual artists and experts from Arizona State University and the U.S. National Renewable Energy Laboratory in fields ranging from engineering and data science to sociology, public policy, and architecture.

Cities of Light explores the solar futures of four U.S. cities: Chicago, Illinois; Portland, Oregon; San Juan, Puerto Rico; and San Antonio, Texas.