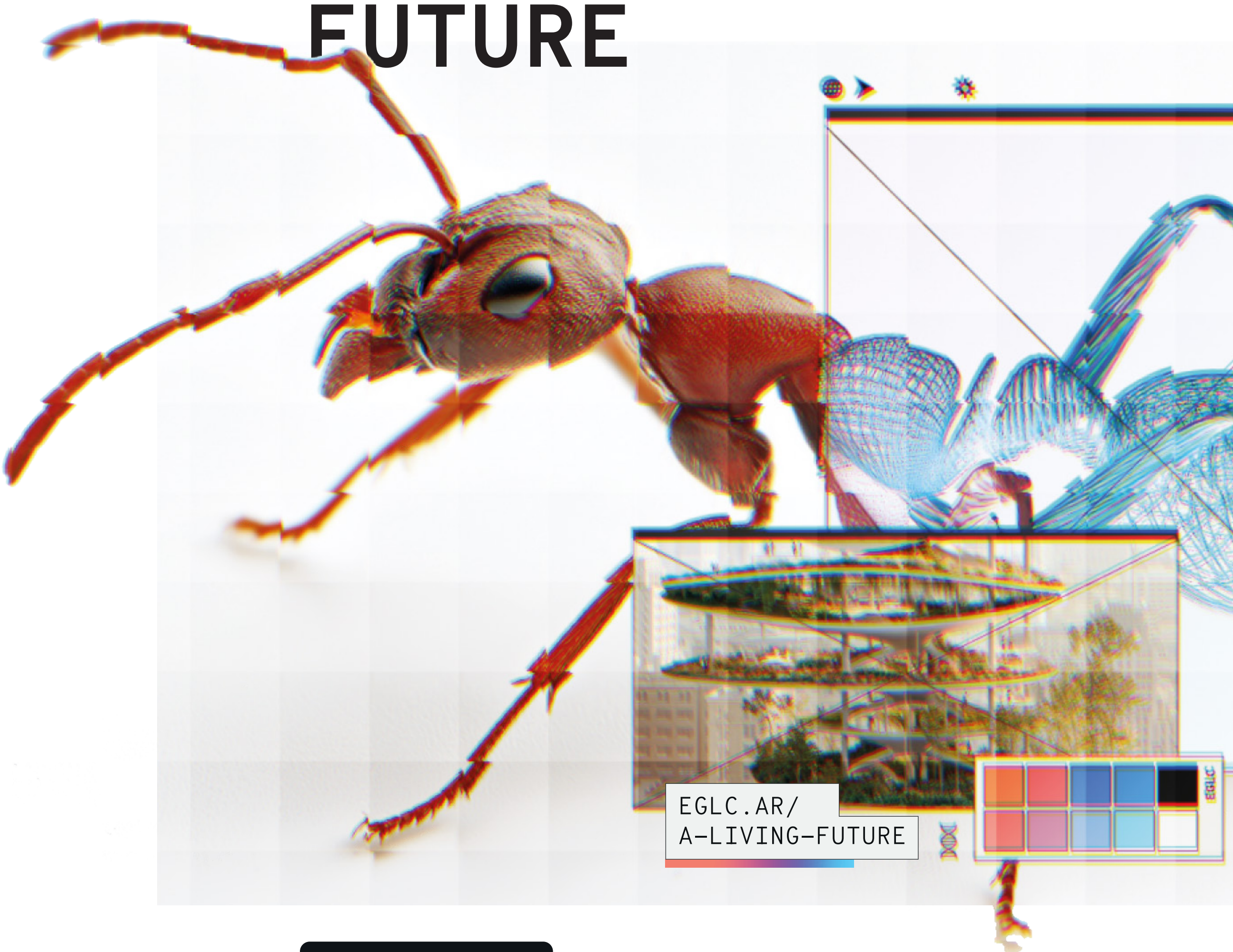
FUTURE

El Gato
y La Caja

A LIVING FUTURE



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FUTURE

A living future / Un futuro vivo

-

TXT Pablo A. González, Juama Garrido

How might we accelerate towards a biosolar civilization? Can we lead the way towards a Material Transition?

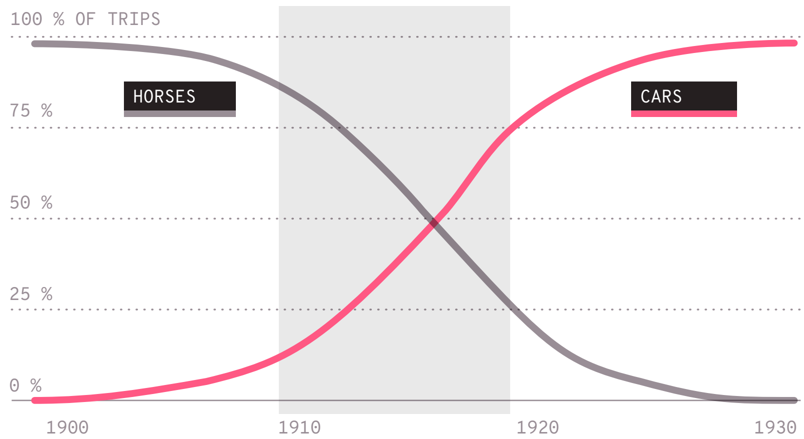
There have been many technological disruptions, but only a few have completely redefined the relationship between humanity and its own limits. Technological disruptions are, ultimately, the historical pulse of our species. And that pulse is accelerating in a very specific direction.

PART I | MANURE ON THE WHEELS

We need to understand this:
For over five thousand years, horses were the cornerstone of land mobility. However, in just a single decade, cars relegated them to the past. First came cars on the streets of the world's major cities: rubber and combustion replaced the smell of manure, and engines and horns echoed where once there were neighs and the clatter of hooves on dirt. Advertising—glorifying the machine and disparaging animal traction—turned black and metallic paint into an object of desire. More cars made more trips, and more trips demanded more infrastructure. Soon, cities needed sidewalks for pedestrians and traffic lights to organize flow, parking meters instead of water troughs. In 1910, New York's streets were dominated by carriages and stables; by 1920, the urban landscape had been completely transformed.

THE DISRUPTION OF THE HORSE BY THE CAR

A SUFFICIENTLY SUPERIOR TECHNOLOGY DISRUPTS THE PREVIOUS ONE IN THE SHAPE OF AN S-CURVE: SLOW AT FIRST, THEN RAPIDLY ACCELERATING, UNTIL THE TRANSITION IS COMPLETE.



AN AGE STRUCTURED DEMOGRAPHIC THEORY OF TECHNOLOGICAL CHANGE. MERCURE, 2013.

With this reconfiguration came unexpected systemic effects: the disruption of the horse by the car didn't just replace the way we move through cities—it changed the very essence of cities themselves: their housing priorities, their use of space, their supply chains, the professions that were relevant, and even the desires and culture of their inhabitants.

This single event has many lessons to teach us, but there's one we must not lose sight of: **a technological disruption has the power to change the world—literally and almost instantly.**

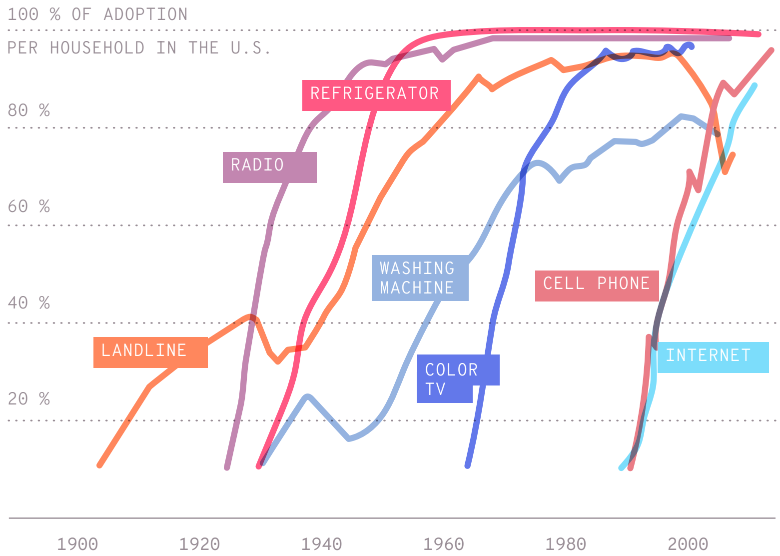
This is the first lesson we learned, and at the same time, only the beginning of what we need to understand.

No way back

The pace at which we adopt new technologies accelerated dramatically after the Industrial Revolution and the first version of capitalism. Hydrocarbons took nearly a century to reach the farthest corners of our civilization, but electrification took only a few decades—and the internet did it in a fraction of that time. Advanced artificial intelligence models like ChatGPT achieved it in a matter of weeks.

TECHNOLOGY ADOPTION CURVE

TECHNOLOGIES TEND TO FOLLOW AN ACCELERATED ADOPTION CURVE.



OUR WORLD IN DATA;
HORACE DEDIU; COMIN AND HOBIJN (2004);

Of course, this acceleration is no accident: each new technology grew by building on the foundations of its predecessors. At the same time, it offered undeniable comparative advantages—profound ones. True paradigm shifts. And if there's a second lesson we must learn quickly, it's this: **the essence of a disruption is a one-way proposal for a new world.**

Electricity didn't just replace gas lighting—it made automation of industrial and domestic processes possible. Mobile devices didn't just make communication easier—they established permanent connectivity that reshaped daily life and the global market. In every case, it meant the creation of a new world, one built upon the foundations of the old, but already bearing little resemblance to it. After each disruption, humans changed their production systems, their consumption habits, their social and communication dynamics, their ways of relating—and even how they behaved in solitude.

If the first lesson was that disruptions have the power to transform the world instantly, and the second was that this transformation has no return, then let's add one more: the outcomes of that change are, ultimately, unpredictable. We knew very quickly that the world would never be the same after the invention of the car—what took us decades to understand was exactly how it would be different.

The digitization of the world

In the same way, the last major disruption we experienced—the digitization of the world in just a few decades—taught us to be cautious with optimism, because when one world dies, it's very hard to predict the shape the next one will take.

For example, a couple of decades ago, no one would have been able to say these words: "They will promise us the dream of being our own boss, but instead, life will look more like figuring out how to coexist with digital nomads who arbitrage the cost of living by moving to commodity cities. Those cities will be tailored to the fine-tuning of the AirBnB algorithm that will gentrify them, their longtime residents will be displaced, and the new rentiers will avoid paying taxes by using cryptographic systems of decentralized currency. Meanwhile, we'll be trying to prevent hybrid wars involving hacked infrastructure and drone attacks piloted by twenty-somethings running on gummy bears and nicotine." But even if those words had been spoken, we probably wouldn't have known how to hear them.

Today, it's easier to stay alert and recognize when someone is trying to sell us the idea that everything is part of a grand plan. We know it isn't. It's the emergent outcome of a series of smaller plans, a complex web whose path no one fully understands. At some point, we figured out how to make one computer talk to another, and we decided to build the world around their conversation. This is the result — unexpected, but undeniable. And yet another piece of evidence— as if we needed more—that **a technological disruption is the first tile in a turbulent domino chain that sets off second-, third-, and fourth-order consequences: extremely hard to predict in detail, but very easy to estimate in terms of impact—just assume it will be massive**.

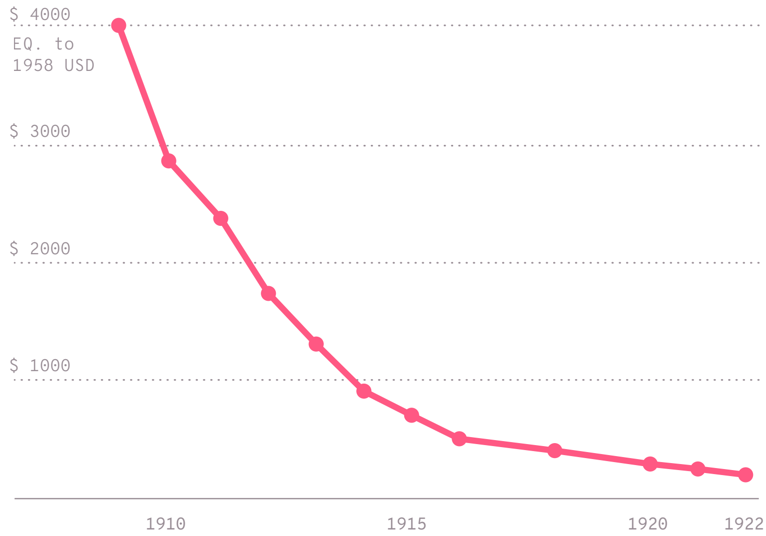
The infinite loop

Disruptions have an underlying mechanism known as a **feedback loop: a cycle of positive, accelerated reinforcement that traces a consistent pattern over time.** Increased car production lowers costs and makes this product more accessible to more people, which in turn demands more infrastructure and stimulates an entire set of surrounding industries that increasingly depend on car production continuing to grow. It can also be put this way: more cars lead to more cars.

Of course, not every superior technology is capable of triggering and accelerating that cycle. **The phenomenon only occurs if costs decrease as scale increases.** So it would be more accurate to say it wasn't the car that disrupted the horse—it was the cheap, mass-produced car, accessible to the majority.

COST CURVE FOR AUTOMOBILES

AS MANUFACTURING SCALE INCREASES, PRICES DROP (WRIGHT'S LAW). IN THE CASE OF THE MODEL T, THE COST FELL BY 85% IN A SINGLE DECADE.



HARVARD BUSINESS REVIEW: LIMITS OF THE LEARNING CURVE
BY WILLIAM J. ABERNATHY AND KENNETH WAYNE

The same thing happened with cell phones. The first ones were expensive, produced at low scale, accessible only to small elites, and came with huge per-minute usage costs. The real disruption in telephony came with large-scale cell phone production: mass manufacturing, larger and more efficient telecommunications networks, and a collapse in the price of each device—as well as the drop of cost per minute of use. These factors created a feedback loop that accelerated the adoption of the device, and it was so powerful and so fast that it unfolded within a single generation. Many of us still remember a world that ran on payphones and paper maps.

But even though nostalgia is a powerful force, that world is gone. There's no going back. Now, even in the most remote village, someone can access ChatGPT via SMS. That phase shift shows us that **the digital revolution—the one we still believe we're living through—has, in fact, already ended**. So the real question becomes: what is the disruption of the present?

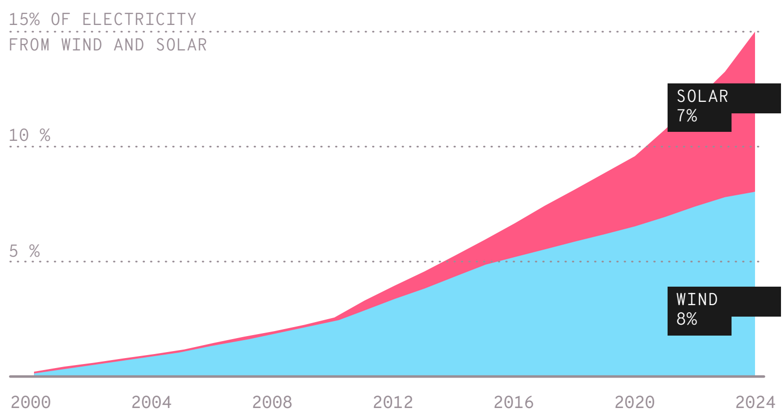
PART II | TAMING A STAR

Let's recap: it always starts with an advanced, inconvenient technology that only early adopters are willing to deal with due to its high cost and clunkiness. Even so, it gains such traction that it sparks capital's appetite to replicate itself. Demand for the technology grows, and capital shifts toward large-scale manufacturing. That scale leads to lower costs, and those lower costs mean greater access to the product.

This is how it reaches the mainstream and penetrates the thinnest and deepest capillaries of society. It happened with cars, it happened with cell phones, and it is also happening now with renewable energy.

WIND AND SOLAR

WIND AND SOLAR POWER ARE CURRENTLY EXPERIENCING EXPONENTIAL GROWTH IN DEPLOYMENT AND ARE EXPANDING FASTER THAN ANY OTHER ENERGY TECHNOLOGY IN HISTORY.

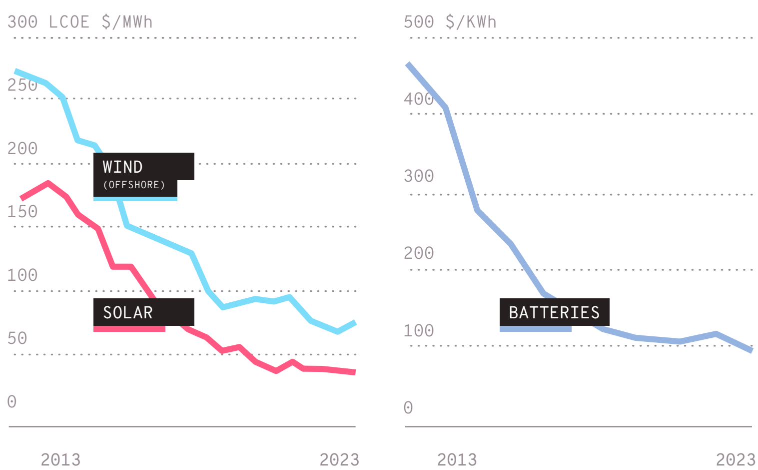


COMPILED BY EGLC, BASED ON DATA FROM OUR WORLD IN DATA, ENERGY INSTITUTE, ROCKY MOUNTAIN INSTITUTE, AND EMBER.

The energy transition we are undergoing today is driven at its core by the decline in costs of its three key technological components: wind turbines, solar panels, and batteries.

COST REDUCTION IN RENEWABLE ENERGY TECHNOLOGIES

KEY TECHNOLOGIES FOR THE ENERGY TRANSITION HAVE REDUCED THEIR COSTS BY 80% IN THE LAST 10 YEARS AND ARE NOW THE CHEAPEST FORMS OF ELECTRICITY GENERATION.

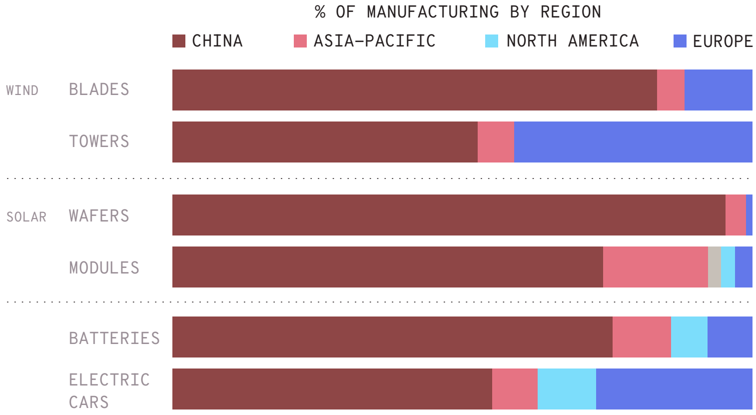


THE CLEANTECH REVOLUTION (BOND, BUTLER-SLOSS, WALTER). 2024, ROCKY MOUNTAIN INSTITUTE.

Understanding this allows us to ask a relevant question: who stands a chance of winning this race? Well, no one ran toward the energy disruption like China did. **China is the first answer to virtually every question about the past and future of the energy transition.** Who has the fastest electrification rate? China. And the most rapid deployment of solar technology? China. And wind? And batteries? And vehicles? China, China, China.

RENEWABLE TECHNOLOGY MANUFACTURING

CHINA IS THE WORLD'S LEADING MANUFACTURER OF TECHNOLOGIES FOR THE ENERGY TRANSITION.



ENERGY TECHNOLOGY PERSPECTIVES 2024, IEA.

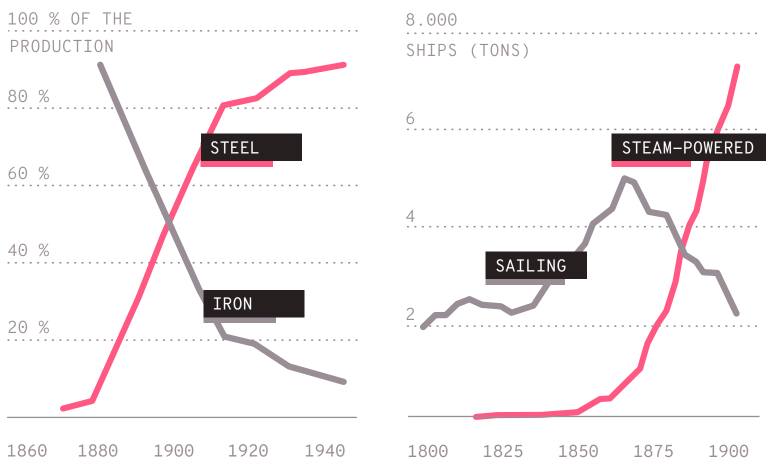
Such was China's foresight that it not only concentrated the implementation of this new technological core, but also its manufacturing: today it controls 80% of the SWB (Solar, Wind, Batteries) value chain, and also leads the electric mobility market. China saw a wave coming and made the conscious decision to ride it. Fully aware of what it was doing, it developed on the back of the feedback loop of disruption, investment, acceleration, and scale in renewable energy. It built an entire technological, industrial, and human ecosystem around that accelerated bright core—and in doing so, it tamed a star.

Winners and losers

Let's return for a moment to the best-known example. The rise of cars and their rapid expansion led to the dismantling of the horse-based transportation system. Just as there were incentives directed toward cars, using horses was also actively discouraged: stable costs skyrocketed, tying a horse on the street became increasingly difficult, and finding a replacement horseshoe became nearly impossible. By 1930, owning a horse in the city was frowned upon. Naturally, the market shrank and became specialized. Investing in racehorse breeding might still have made sense for a select few, but investing in horses at scale had become a terrible idea.

DISRUPTIONS RESEMBLE EACH OTHER

A DISRUPTION IS NOT AN EXCEPTIONAL PHENOMENON, BUT RATHER THE RULE



THE CLEANTECH REVOLUTION (BOND, BUTLER-SLOSS, WALTER). 2024, ROCKY MOUNTAIN INSTITUTE.

This pattern of one technology displacing another is not the exception—it's the rule. It happened to horses with cars, to iron with steel, to gas lighting with electricity, to coal with oil. **Every transition is both an opportunity and a threat. It does not mean the same for those who embrace it as for those who try to avoid it.** While China positions itself as the leader in the renewable energy wave, the United States shows uneven adoption across states and lacks a coherent federal strategy—despite significant initiatives like the Inflation Reduction Act (IRA) and state-level clean energy programs. This fragmentation, combined with recent rollbacks in climate policy, suggests that the U.S. risks falling behind in the energy transition race, even if it doesn't acknowledge it—or outright denies it—and takes increasingly aggressive steps to assert its position.

We must understand that the future will arrive the same way it always has. We can't change how the engine of history works; we can only try to glimpse where it's taking us. And in this case, the direction is clear: **we have already transitioned our technological core in information, and then in energy. The next transition will be the material one.**

PART III | A LIVING FUTURE

Hydrocarbons were—and still are—one of the most important discoveries and technological developments in the history of our civilization. They shaped our productive structures, our cities, and our flows of capital. They also provided us with a spectacular material foundation—petrochemistry—which allowed us to create materials like plastic (that were previously unimaginable), and opened up possibilities (also previously unimaginable) such as producing fertilizers, solvents, detergents, medicines, textiles, and paints at scale, transforming matter through the use of fossil energy.

But within all that progress lays a snake's egg, an original sin: hydrocarbons constitute a stock—massive reserves of long carbon-based molecules hidden deep within the Earth, but once released into the atmosphere, they stay there. A constant reminder that we cannot make matter disappear—we can only move it from one place to another. **Hydrocarbons leapt from the ground into the sky, and in the process, they enabled us to build a world. An incredible world, yes, but one mortgaged at an enormous cost.**

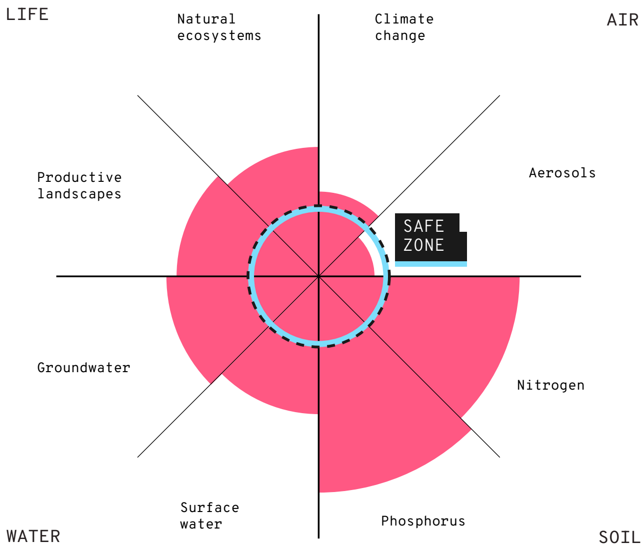
The most obvious symptom of that cost is the rise in global temperature and its cascading effects: the destabilization of ice sheets, the disruption of ocean current cycles, the collapse of ecosystems, and the increasing violence of climate events. **Because at the heart of nature lie the same feedback loops we see in human activity.** The accelerated change mechanisms that make more cars generate more cars are the same ones that make melting Arctic ice generate more melting Arctic ice. It's no coincidence—these are the mechanisms of the physical world laid bare: and if it feels like staring into a hole at the edge of infinite possibilities, that's exactly what it is.

The material transition

The energy transition represents a major step toward answering what kind of civilization we're building with the resources of that fossil mortgage. With part of those resources, we imagined, developed, scaled, and implemented wind turbines, solar panels, and batteries that increasingly resemble a flow rather than a stock. We manufacture them with fewer materials, recycle them more, and are getting better at making them better. For all the difficulty it involved—and still involves—**disrupting the energy side of hydrocarbons was relatively simple: we learned how to move and store electrons very effectively with just a handful of key technological components.**

LOOKING AT EMISSIONS IS
NECESSARY BUT NOT ENOUGH

OVERCOMING THE ECOLOGICAL AND CLIMATE CRISIS MEANS REGENERATING OUR BIOGEOPHYSICAL BALANCES UNTIL WE RETURN TO THE SAFE ZONE.



STOCKHOLM RESILIENCE CENTER.

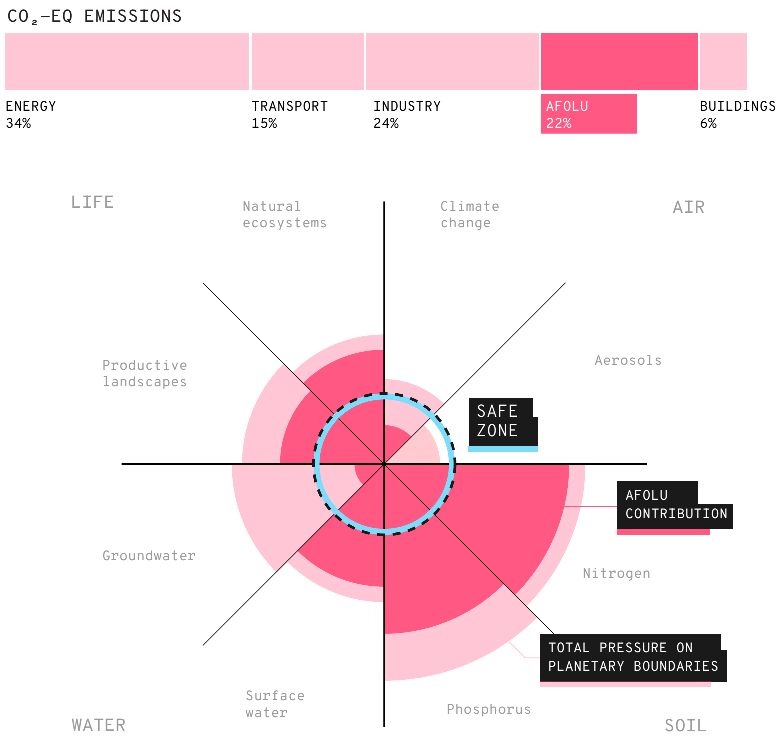
The material transition will be way harder. Not only because it requires diversity and complexity at scale, but because we need to review our diagnosis of how our current production system exerts pressure on Earth as a system.

Thinking in material terms involves two major productive domains: the production of food and the management of the land where we grow it (AFOLU, from Agriculture, Forestry and Other Land Use), and the materials we use to build our objects and environments, along with the ways we transform those materials. **That entire complex matrix that gives us fertilizer, corn, leather, cement, and hamburgers is about to change radically**. We can no longer afford the cost of maintaining it. It will change because **the pressure on key planetary systems has reached a limit. Keeping it as it is means choosing collapse.**

Perhaps what remains to be pointed out—what remains to be seen (what China saw in the energy transition)—is that the material transition, beyond being necessary, can also be a proposal for a better world.

HOW WE MEASURE CHANGES THE WEIGHT OF EACH SECTOR

AFOLU ACCOUNTS FOR LESS THAN 25% OF DIRECT EMISSIONS, BUT FROM A PLANETARY BOUNDARIES PERSPECTIVE, ITS IMPACT IS THE MOST SIGNIFICANT.



IPCC 2022, STOCKHOLM RESILIENCE CENTER.

1. JOHAN ROCKSTRÖM HIMSELF, CREATOR OF THE PLANETARY BOUNDARIES FRAMEWORK, NARROWS THE FIELD OF VIABLE SOLUTIONS TO THOSE THAT, IN ADDITION TO BIOGEOPHYSICAL COMPATIBILITY, POSSESS TWO ESSENTIAL CHARACTERISTICS: SPEED AND SCALE.

The material transition we need is not just one that addresses atmospheric emissions—**it's one in which we build a material matrix that is compatible with the balance of the biosphere across all planetary boundaries.** Our current material system, based on petrochemistry, accounts for 50% of CO_2 emissions, but it exerts an even greater pressure on planetary boundaries, with AFOLU playing a central role. This shouldn't come as a surprise. It's enough to grasp the territorial impact of growing food the way we currently do: extensive, reliant on petrochemical fertilizers, and involving animals.

And this isn't a moral argument—it's a thermodynamic one: it simply won't work if producing a hamburger requires vast tracts of land that displace biodiversity, land that is actively fertilized with NPK (which depends on petroleum to synthesize), using excessive amounts of water to grow crops and feedlot animals—which we only use a part of, but raise whole and over years. So **the problem with the system isn't that it's morally wrong—the problem is that it's technologically obsolete: fundamentally incompatible with the biosphere due to its linearity and its dependence on finite stocks[1].**

The good news is that by defining the problem this way, the space for a solution becomes much clearer: **we need a set of technologies based on flows (not stocks), capable of providing material complexity at scale** without exceeding planetary boundaries. Technologies that can supply us with food, materials, and the industrial matrix transformations needed to create things as diverse as functional equivalents to plastic and cement. And we need to do it for a population of 10 billion people, within the next 20 years.

Well then, let's do it.

Disrupting cows

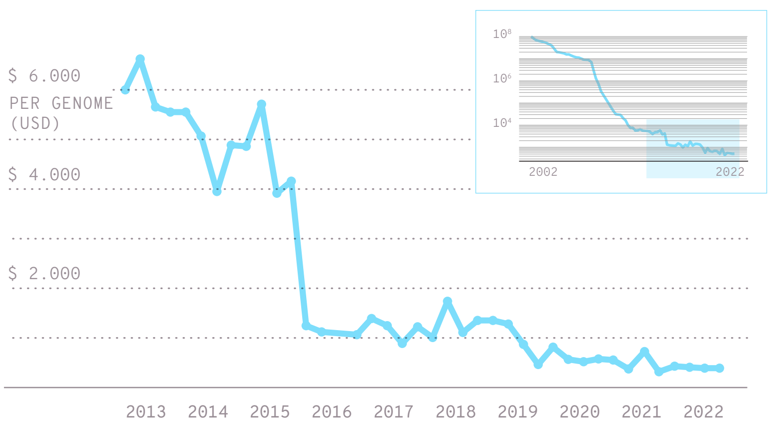
The first cell-cultured hamburger was created by Mark Post at Maastricht University in the Netherlands. Post took over two years to produce a patty made of synthetic muscle and fat—grown without a cow—that cost more than USD 300,000. The venture was funded by Google co-founder Sergei Brin and tasted by food critics with mixed reviews: some criticized its lack of flavor and juiciness, while others claimed the experience was indistinguishable from eating a conventionally produced burger.

Post's burger is like a 1990s cell phone: expensive, clunky, unviable. And it's facing the same skepticism those phones once did—critics of the time insisted the idea could never scale.

What barrier must be broken to scale Post's burger? Lower its cost? Improve its flavor? Ramp up production? Well, all of those processes are already underway.

READING AND WRITING LIFE IS GETTING CHEAPER

KEY TECHNOLOGIES FOR READING GENOMES AND CULTIVATING ORGANISMS AT SCALE FOLLOW AGGRESSIVE LEARNING CURVES.



CUSTOM VISUALIZATION BY EGLC.
DATA FROM THE NATIONAL GENOME RESEARCH INSTITUTE, ILLUMINA.

The price of meat

Over the past 20 years, life sciences and technologies have undergone a rapid transformation toward engineering. Understanding, managing, and creating things using living organisms has shifted from an artisanal process that took years to an engineering process that now takes months, weeks—sometimes even days. Minutes or seconds, too, thanks to increasingly precise digital representations. **It's impossible to miss: we are living in a present shaped by bio disruption—a kind of revenge of the horse by other means.**

At the core of this disruption, we find the usual ingredients: a set of technologies that improved, became cheaper, matured, and began to scale. Sequencing a complete human genome for the first time took 13 years to accomplish. It made front-page news in 2003 and cost around 3 billion dollars. Today, startups offer that service for USD 600.

But it's not just about reading—it's about editing. **The modern set of gene-editing technologies (CRISPR-Cas9) is now celebrating 20 years since its foundational discovery**. In those two decades, **it has radically transformed our ability to cut, copy, and paste with precision inside entire genomes,** to imagine metabolic pathways, and to grant or remove functions from cells of all kinds and origins.

READING AND WRITING LIFE IS GETTING CHEAPER

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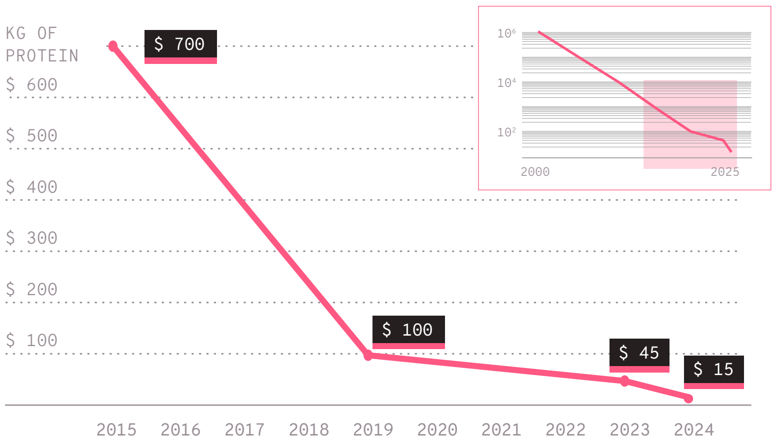


CUSTOM VISUALIZATION BY EGLC.
DATA FROM RETHINKX, MDPI, GFI, MCKINSEY.

We have also developed a new generation of bio-based productive infrastructure: next-generation fermenters. Once, we put sugary grape juice and microorganisms into vats and waited for nature to turn water into wine. Today, we manipulate mammalian cells with delicacy and precision, cultivating them in increasingly sophisticated bioreactors to produce monoclonal antibodies that target previously untreatable diseases. We create industrial enzymes at scale that now enable processes—once energy-intensive—to occur efficiently, and **we are beginning to cross the cost threshold needed to envision a fully bio-based material matrix.** Gene-editing tools like CRISPR are in clinical phases, rapidly advancing toward effective treatments for previously untreatable conditions, such as sickle cell anemia.[1] The insulin used today by hundreds of millions of people worldwide is already a biofabricated product, and **the entire pharmaceutical industry now leads the large-scale adoption of these bio-manufacturing technologies.**

As the cost per kilowatt of solar-generated electricity dropped and became cheaper than other sources, we began to implement it in all kinds of places. The creation of matter through biological means is following the same path: we first crossed the competitiveness threshold in pharmaceuticals (because molecules are extremely expensive and we only need small amounts), then in cosmetics and industrial enzymes (where higher volumes of less costly products are needed), and now we're approaching the point of competing in materials and food. When will we cross those critical thresholds? It's not yet clear. But that's the direction we're headed.

1. TREATMENTS DEVELOPED BY VERTEX PHARMACEUTICALS AND CRISPR THERAPEUTICS ARE ALREADY IN ADVANCED STAGES OF REGULATORY APPROVAL IN THE UNITED STATES AND EUROPE.

BIO IS NOT THE FUTURE — IT'S THE PRESENT

THERE ARE ALREADY TANGIBLE, BIO-BASED PRODUCTS ON THE MARKET: FROM MYCELIUM SNEAKERS TO PET FOOD GROWN IN BIOREACTORS.

MEATLY, ADIDAS.

Cellular agriculture hasn't been just a promise for some time now: in Singapore, you can already eat chicken grown in bioreactors. There are functional egg substitutes—both as ingredients for boxed cake mixes and in cartons, ready to pour into a pan and scramble. In the United States, there are companies with FDA approval for commercializing cultivated meat. In the United Kingdom, pet food grown in fermenters is being sold. It may seem like an innocent sign, but it's a piece of a long, branching domino effect: a fermented pet food means a slaughterhouse no longer sells animal scraps to a pet food company, which reduces its revenue, which in turn raises the price of meat for consumers. Consequence after consequence, in a complex yet predictable chain. And that's not the only one: the first real, commercial offerings of cow-free dairy proteins have appeared—sometimes in cereal bars for athletes, sometimes directly on store shelves. There's even collagen for cosmetics now available, produced without animals.

In the world of biomaterials, companies that have created leather from fungal mycelium are already partnering with major brands like Adidas and Stella McCartney. That may also seem like an innocent signal, but low-cost mushroom leather affects the agricultural sector—it no longer sells animal leather to the fashion industry, which again reduces its income and ultimately raises the price of meat for consumers.

The bio cost curve is tempting even to the most capitalist-minded—not out of ecological, aesthetic, or moral conviction, but out of convenience. These advances are part of a concrete present. And a better future is starting to become imaginable—almost inevitable—not because of the problems created by the current system, but because of the possibilities unlocked by the next one. Bio maximalism doesn't have to choose between love and fear.

The gardeners of the new world

We used to talk about "post-fossil energy" back when we didn't really know what that "post" was made of. As the future became clearer, we stopped saying "post" and started speaking directly about solar, wind, and batteries. **The *post-petrochemical* material future is also beginning to come into focus and today we can see that this clarity is inspired by nature. It's alive. It's bio.**

The revelation has the force of those things that were always there but are rediscovered in a moment of need—like finding money forgotten in a pair of jeans. We've already built airplanes with materials inspired by honeycombs made by bees and wasps; the Velcro on our clothes mimics the burr plant; and professional swimsuits have been designed based on the hydrodynamics of shark skin. We've also made buildings that manage heat with the elegance of pinecones, and bullet trains that cut through air like birds. In short: **we've always used nature as a teacher, foundation, model, and aspiration**. The difference is that we spent the first few thousand years fermenting wine and cheese—then suddenly, we learned to ferment and grow medicine, cosmetics, plastic, milk, meat. We now know how to make breathing bricks from fungi. Steaks that require 90% less water and energy. We've taken a step further.

By harnessing the vast information contained in biodiversity, we are capable of imagining, designing, and building the productive structures we need: naturally efficient, elegant, integrated with their environment. Systems that flow with nature instead of against it. And we can still ask for more, because within this transition toward nature-based systems lies the opportunity for accelerated regeneration—the kind we need to ease the burden of the fossil mortgage while rapidly creating more living world, more climate stability, better crop yields, more high-quality protein accessible to more people, and new bio-based therapies that make possible what was once impossible—and that, as they scale, will become extremely affordable.

And all of this material revolution will require infrastructure: bioreactors, a culture medium to feed them, metabolic pathway professionals to create the bioware that lives in those reactors, enzyme designers, digital models of personalized monoclonal antibodies, large-scale agro-food landscape designers—a whole new kind of workforce. The children of pioneers. The gardeners of the new world.

Growing, breeding, and healing in Latin America

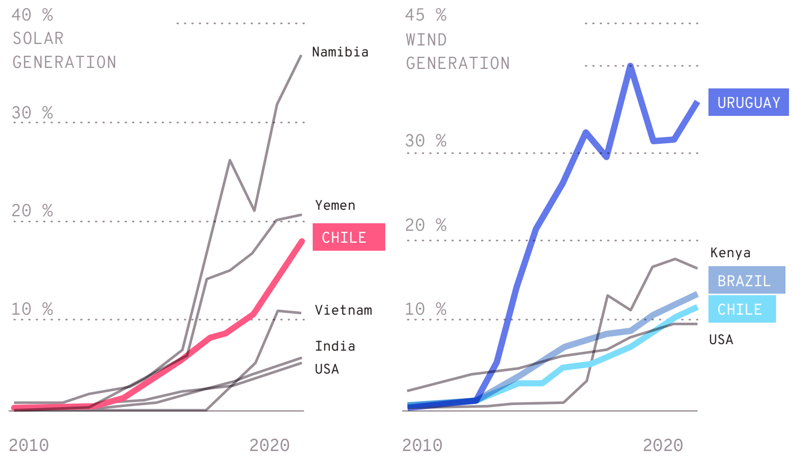
Just as in the digital and energy transitions there were those who rushed toward them and those who tried to avoid them (always unsuccessfully), **living through a material transition offers us the chance to leap forward**. China was not the only player that chose to run toward disruption. Many countries in the Global South skipped the oil & gas phase altogether and adopted solar energy directly—surpassing global powers in energy infrastructure as a result. This shouldn't be surprising: entire populations in Africa skipped landlines and went straight to cell phones, and never used credit cards because they jumped directly to digital finance.

All of this is built upon a historical foundation of decades of investment in accessible university education for large segments of the population, and a world-class scientific and technological development apparatus that places the life sciences at its core. It also includes an agrobioindustrial sector that has, at least at times, been a leader in developing and scaling those technoscientific innovation processes.

Disruptions are bad news for champions—and the best thing a challenger can hear. Even more so **when the challenger is a country or a region under all the right pressures to disrupt itself**. For example, one threatened by the climate crisis, that needs to develop economically by building its own techno-industrial base compatible

STEPPING AHEAD

A DISRUPTIVE CONTEXT OPENS UP THE POSSIBILITY FOR LATECOMERS TO LEAPFROG AND ACCELERATE THE ADOPTION OF CUTTING-EDGE TECHNOLOGIES.



CLEANTECH REVOLUTION (BOND, BUTLER-SLOSS, WALTER) JUNE 2024, ROCKY MOUNTAIN INSTITUTE.

with the future, and that has a particularly large and well-qualified professional body in the life sciences, technologies, and engineering—along with vast tracts of agricultural land that could evolve toward regenerative, bio-based systems.

A challenger that, moreover, already has incubators, accelerators, investment funds, and—most importantly—hundreds of companies of all sizes that already possess many of the technologies and products mentioned earlier. There's no need to look beyond the horizon: there are plenty of examples of Argentine or Latin American startups working on next-generation bioreactors, computational simulation of biological processes, plant-based culture media, large-scale agroecological landscape design, regeneration-based carbon financial products, bioplastics, bioremediation, biodiversity quantification, biological inoculants for agriculture, and more.

We are a people who sow, grow, cultivate, raise, and heal. It's embedded in our education, our existing economic, institutional, and industrial infrastructure—and in our identity.

EPILOGUE – THE MACHINESQUE AND THE LIVING

As Alejandro Galliano writes in *La máquina ingobernable*, *"AI is User-Centered Design unleashed—it absorbs and amplifies all the traits of the web that feeds it: biases, fake news, hate speech, and piracy."* If this is true—if user-centered design embodies all those flaws—then we must ask: what design perspective is best suited for managing systems that are compatible with life, and therefore with planetary boundaries, working in favor of the biosphere's flows? What happens when our productive matrix stops exploiting life and begins actively cultivating it? What happens when technology is not only compatible with life—but is life itself?

Life-Centered Design shifts perspectives at an ontological level. It means a design that no longer places humans at its center, but rather the relationship—the connection between humans and all living things. Most immediately, we face the reality that living systems possess a complexity and emergent nature that defies mechanical logic. A gear is predictable within its tolerances: we design it, it fits, it turns, and it repeats its cycle with precision. A living organism, on the other hand, cannot be designed with that same degree of certainty. When we attempt to *program* living systems, we are running an open-air experiment whose outcomes can exceed our initial hypotheses. This emergent complexity presents a challenge: **it is not enough to simply transfer the logic of industrial manufacturing to biology. Biological and ecological engineering—unlike traditional mechanics—operate within scenarios of uncertainty**: any modification to living systems can trigger unpredictable effects. Thus, the manipulation and design of life-based systems resemble a perpetual experiment, with no guarantees of total control.

Therefore, **the true techno-productive leap will not be mass production through biological methods, but rather a new understanding of growth and productive development—now guided**—and the possibility of accelerated environmental regeneration.

If culture is the way we domesticate ourselves as a species, then we must ask: what kind of culture will emerge when our technology is no longer based on dominating life, but rather on cultivating it? How will our habits, economies, and values change in a civilization based on living systems? One in which we don't assemble structures—we grow them. Where we don't extract fuels—we capture the energy that flows from the Sun.

In this new paradigm, technology doesn't extract—it cultivates. It doesn't deplete—it accelerates. It doesn't reduce—it multiplies. It doesn't exploit—it regenerates. And within that logic, there is far more to gain than in the final exhaustion of a civilization built on stocks. The impact of this transition—already underway—will be defined by **the tension between the machinesque and the living.** By who serves whom.

Some fear that the material production revolution based on life sciences, techniques, and technologies will become just another way for the technocapitalist machine to subsume all life—to datify it, commodify it, buy it, sell it, protect it, and defend it through IP. But the story could be dramatically different if the mechanical is, at the same time, colonized by the living. By its needs and rhythms—but above all, by which design primitives rise to dominance. **The next version of capitalism, at the very least, will no longer be able to exist apart from natural cycles.**[1]

Even so, we can lean into that same idea and ask a different question: what happens when technocapital acceleration, productive development, and national growth are interwoven with the regeneration of the biosphere? What if the true peak acceleration in creating complexity isn't about achieving the fastest possible speed, but the most sustainable speed—a regenerative accelerationism that accepts and understands a single limit: that of living systems.

We have felt the quickening pulse of disruptions that shape our history, and today we sense the critical pressure of an Earth system demanding fundamental change. At this civilizational crossroads, the tools to read, write, and design life—now supercharged by advances in artificial intelligence—are not mere instruments; they are the lever with which we define the arc of the future. **From this very moment, right now, unfolds a vast cone of possibilities: an exponential fabric of potential destinies** where brutal efficiency that depletes the planet coexists with the promise of regenerative symbiosis; where archipelagos of biotechnological privilege might float over oceans of neglect; and where distributed autonomy contends with eco-surveillance control.

Claiming a role in shaping this new world is not about choosing a predefined path, but about planting some of the initial conditions for complex systems whose effects will multiply in cascading waves. Every technological decision, every ethical framework, every economic and productive policy we adopt today—but also those we fail to adopt, or worse, those imposed by interests opposed to our own—will be a foundational act with systemic resonance.

The crucial question, then, is not what future will come, but what future we choose to cultivate—embracing the radical responsibility of being, perhaps for the first time, the conscious gardeners of the next planetary era.

1. ACCELERATIONISM, AS CONCEIVED BY NICK LAND—AS THE CREATION OF COMPLEXITY IN ANALOGY WITH LIVING SYSTEMS—IS COMPELLING, BUT IT HAS A KEY WEAKNESS: IT IS ARTICULATED AS IF DETACHED FROM THE MATERIAL FOUNDATIONS OF THE WORLD, IN A WAY THAT—EVEN WHEN ATTEMPTING TO BUILD BRIDGES WITH THERMODYNAMICS—ULTIMATELY TURNS ITS BACK ON ITS LIMITS.

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