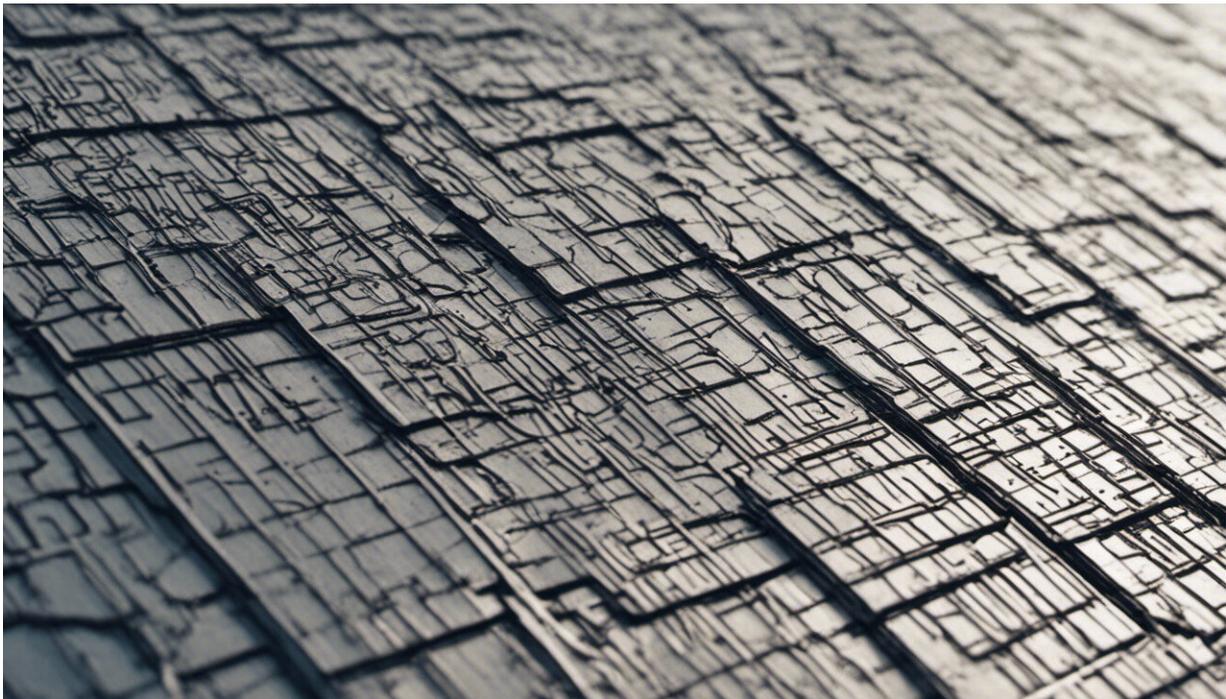


A globalized solar-powered future is economically unrealistic

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Credit: AI-generated image ([disclaimer](#))

Over the past two centuries, millions of dedicated people—revolutionaries, activists, politicians, and theorists—have been unable to curb the disastrous and increasingly globalized trajectory of economic polarization and ecological degradation. This is perhaps because we are utterly trapped in flawed ways of thinking about

technology and economy—as the current discourse on climate change shows.

Rising greenhouse gas emissions are not just generating climate change. They are giving more and more of us climate anxiety. [Doomsday scenarios](#) are capturing the headlines at an accelerating rate. Scientists from all over the world tell us that emissions in ten years must be half of what they were ten years ago, or we face apocalypse. School children like Greta Thunberg and activist movements like Extinction Rebellion are demanding that we panic. And rightly so. But what should we do to avoid disaster?

Most scientists, politicians, and business leaders tend to put their hope in technological progress. Regardless of ideology, there is a widespread expectation that new technologies will replace [fossil fuels](#) by harnessing renewable energy such as solar and wind. Many also trust that there will be technologies for removing carbon dioxide from the atmosphere and for "geoengineering" the Earth's climate. The common denominator in these visions is the faith that we can save modern civilization if we shift to new technologies. But "technology" is not a magic wand. It requires a lot of [money](#), which means claims on labor and resources from other areas. We tend to forget this crucial fact.

[I would argue](#) that the way we take conventional "all-purpose" money for granted is the main reason why we have not understood how advanced technologies are dependent on the appropriation of labor and resources from elsewhere. In making it possible to exchange almost anything—human time, gadgets, ecosystems, whatever—for anything else on the market, people are constantly looking for the best deals, which ultimately means promoting the lowest wages and the cheapest resources in the global South.

It is the logic of money that has created the utterly unsustainable and

growth-hungry global society that exists today. To get our globalized economy to respect [natural limits](#), we must set limits to what can be exchanged. Unfortunately, it seems increasingly probable that we shall have to experience something closer to disaster—such as a semi-global harvest failure—before we are prepared to seriously question how money and markets are currently designed.

Green growth?

Take the ultimate issue we are facing: whether our modern, global, and growing economy can be powered by renewable energy. Among most champions of sustainability, such as advocates of a Green New Deal, there is an unshakeable conviction that the problem of climate change can be solved by engineers.

What generally divides ideological positions is not the faith in technology as such, but which technical solutions to choose, and whether they will require major political change. Those who remain skeptical to the promises of technology—such as advocates of radical downshifting or [degrowth](#) – tend to be marginalized from politics and the media. So far, any politician who seriously advocates degrowth is not likely to have a future in politics.

Mainstream optimism about technology is often referred to as ecomodernism. The [Ecomodernist Manifesto](#), a concise statement of this approach published in 2015, asks us to embrace technological progress, which will give us "a good, or even great, Anthropocene." It argues that the progress of technology has "decoupled" us from the natural world and should be allowed to continue to do so in order to allow the "rewilding" of nature. The growth of cities, industrial agriculture, and [nuclear power](#), it claims, illustrate such decoupling. As if these phenomena did not have [ecological footprints](#) beyond their own boundaries.

Meanwhile, calls for a Green New Deal have been voiced for more than a decade, but in February 2019 it took the form of a [resolution](#) to the American House of Representatives. Central to its vision is a large-scale shift to renewable energy sources and massive investments in new infrastructure. This would enable further growth of the economy, it is argued.

Rethinking technology

So the general consensus seems to be that the problem of climate change is just a question of replacing one energy technology with another. But a historical view reveals that the very idea of technology is [inextricably intertwined](#) with capital accumulation, unequal exchange and the idea of all-purpose money. And as such, it is not as easy to redesign as we like to think. Shifting the main energy technology is not just a matter of replacing infrastructure—it means transforming the economic world order.

In the 19th century, the industrial revolution gave us the notion that technological progress is simply human ingenuity applied to nature, and that it has nothing to do with the structure of world society. This is the mirror image of the [economists' illusion](#), that growth has nothing to do with nature and so does not need to reckon with natural limits. Rather than seeing that both technology and economy span the nature-society divide, engineering is thought of as dealing only with nature and economics as dealing only with society.

The steam engine, for instance, is simply considered an ingenious invention for harnessing the chemical energy of coal. I am not denying that this is the case, but steam technology in early industrial Britain was also contingent on capital accumulated on global markets. The steam-driven factories in Manchester would never have been built without the [triangular Atlantic trade](#) in slaves, raw cotton, and cotton textiles. Steam

technology was not just a matter of ingenious engineering applied to nature—like all complex technology, it was also crucially dependent on global relations of exchange.

This dependence of technology on global social relations is not just a matter of money. In quite a physical sense, the viability of the steam engine relied on the flows of human labor energy and other resources that had been invested in cotton fibre from South Carolina, in the US, coal from Wales and iron from Sweden. Modern technology, then, is a product of the metabolism of world society, not simply the result of uncovering "facts" of nature.

The illusion that we have suffered from since the industrial revolution is that technological change is simply a matter of engineering knowledge, regardless of the patterns of global material flows. This is particularly problematic in that it makes us blind to how such flows tend to be highly uneven.

This is not just true of the days of the British Empire. To this day, technologically advanced areas of the world are [net importers](#) of the resources that have been used as inputs in producing their technologies and other commodities, such as land, labor, materials, and energy. Technological progress and capital accumulation are two sides of the same coin. But the material asymmetries in world trade are invisible to mainstream economists, who focus exclusively on flows of money.

Ironically, this understanding of technology is not even recognized in [Marxist theory](#), although it claims to be both materialist and committed to social justice. Marxist theory and politics tend toward what opponents refer to as a Promethean faith in technological progress. Its concern with justice focuses on the emancipation of the industrial worker, rather than on the global flows of resources that are embodied in the industrial machine.

This Marxist faith in the magic of technology occasionally takes extreme forms, as in the case of the biologist David Schwartzman, who does not hesitate to predict future human [colonization of the galaxy](#) and Aaron Bastani, who anticipates [mining asteroids](#). In his remarkable book [Fully Automated Luxury Communism: A Manifesto](#), Bastani repeats a widespread claim about the cheapness of solar power that shows how deluded most of us are by the idea of technology.

Nature, he writes, "provides us with virtually free, limitless energy." This was a frequently voiced conviction already in 1964, when the chemist Farrington Daniels [proclaimed](#) that the "most plentiful and cheapest energy is ours for the taking." More than 50 years later, [the dream](#) persists.

The realities

Electricity globally represents about [19%](#) of total energy use—the other major energy drains being transports and industry. In 2017, [only 0.7%](#) of global energy use derived from solar power and 1.9% from wind, while 85% relied on fossil fuels. [As much as 90%](#) of world energy use derives from fossil sources, and this share is actually increasing. So why is the long-anticipated transition to renewable energy not materializing?

One highly contested issue is the land requirements for harnessing renewable energy. Energy experts like [David MacKay](#) and [Vaclav Smil](#) have estimated that the "power density"—the watts of energy that can be harnessed per unit of land area—of [renewable energy sources](#) is so much lower than that of fossil fuels that to replace fossil with renewable energy would require vastly greater land areas for capturing energy.

In part because of this issue, visions of large-scale solar power projects have long referred to the good use to which they could put unproductive areas like the Sahara desert. But doubts about profitability have

discouraged investments. A decade ago, for example, there was much talk about [Desertec](#), a €400 billion project that crumbled as the major investors pulled out, one by one.

Today the world's largest solar energy project is [Ouarzazate Solar Power Station](#) in Morocco. It covers about 25 square kilometres and has cost around US\$9 billion to build. It is designed to provide around a million people with electricity, which means that another 35 such projects—that is, US\$315 billion of investments—would be required merely to cater to the population of Morocco. We tend not to see that the enormous investments of capital needed for such massive infrastructural projects represent claims on resources elsewhere—they have huge footprints beyond our field of vision.

Also, we must consider whether solar is really carbon free. As Smil has shown for [wind turbines](#) and Storm van Leeuwen for [nuclear power](#), the production, installation, and maintenance of any technological infrastructure remains critically [dependent on fossil energy](#). Of course, it is easy to retort that until the transition has been made, solar panels are going to have to be produced by burning fossil fuels. But even if 100% of our electricity were renewable, it would not be able to propel global transports or cover the production of steel and cement for urban-industrial infrastructure.



Credit: Monstera Production from Pexels

And given the fact that the cheapening of solar panels in recent years to a significant extent is the result of [shifting manufacture to Asia](#), we must ask ourselves whether European and American efforts to become sustainable should really be based on the global exploitation of low-wage labor, [scarce resources](#) and [abused landscapes](#) elsewhere.

Collecting carbon

Solar power is not displacing fossil energy, only [adding to it](#). And the pace of expansion of [renewable energy](#) capacity [has stalled](#) – it was about the same in 2018 as in 2017. Meanwhile, our global combustion of fossil fuels continues to rise, as do our [carbon emissions](#). Because this trend seems unstoppable, many hope to see extensive use of technologies for capturing and [removing the carbon](#) from the emissions of power

plants and factories.

Carbon Capture and Storage (CCS) remains an [essential component](#) of the 2016 Paris Agreement on climate change. But to envisage such technologies as economically accessible at a global scale is clearly [unrealistic](#).

To collect the atoms of carbon dispersed by the global combustion of fossil fuels would be as energy-demanding and economically unfeasible as it would be to try to collect the molecules of rubber from car tires that are continuously being dispersed in the atmosphere by road friction.

The late economist Nicholas Georgescu-Roegen used this example to show that economic processes inevitably lead to entropy—that is, an increase in physical disorder and loss of productive potential. In not grasping the implications of this fact, we continue to imagine some miraculous new technology that will reverse the [Law of Entropy](#).

Economic "value" is a cultural idea. An implication of the Law of Entropy is that productive potential in nature—the force of energy or the quality of materials—is [systematically lost](#) as value is being produced. This perspective turns our economic worldview upside down. Value is measured in money, and money shapes the way we think about value. Economists are right in that value should be defined in terms of human preferences, rather than inputs of labor or resources, but the result is that the more value we produce, the more inexpensive labor, energy and other resources are required. To curb the relentless growth of value—at the expense of the biosphere and the global poor—we must create an economy that can restrain itself.

The evils of capitalism

Much of the discussion on climate change suggests that we [are on a](#)

[battlefield](#), confronting evil people who want to obstruct our path to an ecological civilization. But the concept of capitalism tends to mystify how we are all caught in a game defined by the logic of our own constructions—as if there was an abstract "system" and its morally despicable proponents to blame. Rather than see the very design of the money game as the real antagonist, our call to arms tends to be directed at the players who have had best luck with the dice.

I would instead argue that the ultimate obstruction is not a question of human morality but of our common faith in what Marx called "money fetishism." We collectively delegate responsibility for our future to a mindless human invention—what [Karl Polanyi](#) called all-purpose money, the peculiar idea that anything can be exchanged for anything else. The aggregate logic of this relatively recent idea is precisely what is usually called "capitalism." It defines the strategies of corporations, politicians, and citizens alike.

All want their money assets to grow. The logic of the global money game obviously does not provide enough incentives to invest in renewables. It generates greed, obscene and rising inequalities, violence, and environmental degradation, including climate change. But mainstream economics appears to have more faith in setting this logic free than ever. Given the way the economy is now organized, it does not see an alternative to obeying the logic of the globalized market.

The only way to change the game is to redesign its most basic rules. To attribute climate change to an abstract system called capitalism—but without challenging the idea of all-purpose money—is to deny our own agency. The "system" is perpetuated every time we buy our groceries, regardless of whether we are radical activists or climate change deniers. It is difficult to identify culprits if we are all players in the same game. In agreeing to the rules, we have limited our potential collective agency. We have become the tools and servants of our own creation—all-

purpose money.

Despite good intentions, it is not clear what Thunberg, Extinction Rebellion and the rest of the climate movement are demanding should be done. Like most of us, they want to stop the emissions of greenhouse gases, but seem to believe that such an energy transition is compatible with money, globalized markets, and modern civilization.



Credit: Monstera Production from Pexels

Is our goal to overthrow "the capitalist mode of production"? If so, how do we go about doing that? Should we blame the politicians for not confronting capitalism and the inertia of all-purpose money? Or—which should follow automatically—should we blame the voters? Should we blame ourselves for not electing politicians that are sincere enough to

advocate reducing our mobility and levels of consumption?

Many believe that with the right technologies we would not have to reduce our mobility or energy consumption—and that the global economy could still grow. But to me that is an illusion. It suggests that we have not yet grasped what "technology" is. Electric cars and many other "green" devices may seem reassuring but are often revealed to be insidious strategies for displacing work and environmental loads beyond our horizon—to unhealthy, low-wage labor in mines in [Congo](#) and [Inner Mongolia](#). They look sustainable and fair to their affluent users but perpetuate a myopic worldview that goes back to the invention of the steam engine. I have called this delusion [machine fetishism](#).

Redesigning the global money game

So the first thing we should redesign are the economic ideas that brought fossil-fueled technology into existence and continue to perpetuate it.

"Capitalism" ultimately refers to the artifact or idea of all-purpose money, which most of us take for granted as being something about which we do not have a choice. But we do, and this must be recognized.

Since the 19th century, all-purpose money has obscured the unequal resource flows of colonialism by making them seem reciprocal: money has served as a veil that mystifies exploitation by representing it as fair exchange. Economists today reproduce this 19th-century mystification, using a vocabulary that has proven useless in challenging global problems of justice and sustainability. The policies designed to protect the environment and promote global justice have not curbed the insidious logic of all-purpose money—which is to increase environmental degradation as well as [economic inequalities](#).

In order to see that all-purpose money is indeed the fundamental problem, we need to see that there are [alternative ways](#) of designing

money and markets. Like the rules in a board game, they are human constructions and can, in principle, be redesigned. In order to accomplish economic "degrowth" and curb the treadmill of capital accumulation, we must transform the systemic logic of money itself.

National authorities might establish a [complementary currency](#), alongside regular money, that is distributed as a universal basic income but that can only be used to buy goods and services that are produced within a given radius from the point of purchase. This is not "local money" in the sense of [LETS](#) or the [Bristol Pound](#) – which in effect do nothing to impede the expansion of the global market—but a genuine spanner in the wheel of globalization. With local money you can buy goods produced on the other side of the planet, as long as you buy it in a local store. What I am suggesting is special money that can only be used to buy goods produced locally.

This would help decrease demand for global transports—a major source of [greenhouse gas emissions](#)—while increasing local diversity and resilience and encouraging community integration. It would no longer make low wages and lax environmental legislation competitive advantages in world trade, as is currently the case.

Immunizing local communities and ecosystems from the logic of globalized capital flows may be the only feasible way of creating a truly "post-capitalist" society that respects planetary boundaries and does not generate deepening global injustices.

Re-localizing the bulk of the economy in this way does not mean that communities won't need electricity, for example, to run hospitals, computers and households. But it would dismantle most of the global, fossil-fueled infrastructure for transporting people, groceries and other commodities around the planet.

This means decoupling human subsistence from fossil energy and re-embedding humans in their landscapes and communities. In completely changing market structures of demand, such a shift would not require anyone—corporations, politicians, or citizens—to choose between fossil and solar energy, as two comparable options with different profit margins.

To return to the example of Morocco, solar power will obviously have an important role to play in generating indispensable electricity, but to imagine that it will be able to provide anything near current levels of per capita energy use in the global North is wholly unrealistic. A transition to solar energy should not simply be about replacing fossil fuels, but about reorganizing the global economy.

Solar power will no doubt be a vital component of humanity's future, but not as long as we allow the logic of the world market to make it profitable to transport essential goods halfway around the world. The current blind faith in technology will not save us. For the planet to stand any chance, the global economy must be redesigned. The problem is more fundamental than capitalism or the emphasis on growth: it is money itself, and how money is related to technology.

Climate change and the other horrors of the Anthropocene don't just tell us to stop using fossil fuels—they tell us that globalization itself is unsustainable.

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