

What Would A Real Renewable Energy Transition Look Like?



Richard Heinberg

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The transition from relying overwhelmingly on fossil fuels to using alternative low-carbon energy sources could be “[unstoppable and exponential](#),” according to some experts. A boosterish attitude by many renewable energy advocates is understandable; overcoming people’s climate despair and sowing confidence could help muster the groundswell of motivation needed to end our collective fossil fuel dependency. But occasionally, a reality check is required.

In reality, [energy transitions](#) are a big deal and typically take centuries to unfold. Historically, they’ve been transformative for societies—whether we’re speaking of humanity’s taming of fire hundreds of thousands of years ago, the agricultural revolution 10,000 years ago, or our adoption of fossil fuels starting roughly 200 years ago. Given 1) the current size of the human population—there are eight times as many of us alive today compared to 1820 when the fossil fuel energy transition was underway, 2) the vast scale of the global economy, and 3) the unprecedented speed with which the transition will have to be made to avert catastrophic climate change. A rapid renewable energy transition is easily [the most ambitious enterprise](#) our species has ever undertaken.

The evidence shows that the transition is still in its earliest stages, and at the current rate, it will fail to avert a [climate catastrophe](#). This will result in the death of an unimaginable number of people or forced migration, with most ecosystems transformed beyond recognition.

We'll unpack why the transition is such an uphill slog. Then, crucially, we'll explore what a real energy transition would look like and how to make it happen.

Why This Is (So Far) Not a Real Transition

Despite trillions of dollars being spent on renewable energy infrastructure, [carbon emissions are still increasing](#), not decreasing, and the share of world energy coming from fossil fuels is only [slightly less](#) today than 20 years ago. In 2024, the world [will use](#) more oil, coal, and natural gas than it did in 2023.

While the U.S. and many European nations have seen a declining share of their electricity production coming from coal, the continuing [global growth](#) in fossil fuel usage and CO2 emissions [overshadows any cause for celebration](#).

Why is the rapid deployment of renewable energy not resulting in declining fossil fuel usage? The main culprit is economic growth, which consumes [more energy and materials](#). So far, the annual increase in the world's energy usage has exceeded the energy added each year from new solar panels and wind turbines. Fossil fuels have supplied the difference.

So, for now, we are not experiencing a real energy transition. All that humanity is doing is adding energy from renewable sources to the growing amount of energy it derives from fossil fuels. The much-touted energy transition could, if somewhat cynically, be described as just an aspirational grail.

How long would it take for humanity to fully replace fossil fuels with renewable energy sources, accounting for both the growth trajectory of solar and wind power and the continued expansion of the global economy at 3 percent per year? Economic models suggest the world could obtain most of its electricity from renewables [by 2060](#) (though many nations are not on a path to reach even this modest marker). However, electricity represents only about [20 percent of the world's final energy](#) usage; transitioning the other 80 percent of energy usage would take longer—likely many decades.

However, to avert catastrophic climate change, the global scientific community says we must achieve [net-zero carbon emissions](#) by 2050—in just 25 years. Since it seems physically impossible to get all of our energy from renewables that soon while still growing the economy at 3 percent, the Intergovernmental Panel on Climate Change ([IPCC](#)), the international agency tasked with studying climate change and its possible remedies, assumes that humanity will somehow [adopt](#)

[carbon capture and sequestration](#) technologies at scale—including technologies that have [shown to be ineffective](#)—even though there is [no existing way of paying](#) for this vast industrial build-out. This wishful thinking on the part of the IPCC is surely proof that the energy transition is not happening at sufficient speed.

The energy transition is not happening at the required pace because governments, businesses, and many advocates have set unrealistic goals of reducing emissions while still pursuing economic growth. Also, the tactical and strategic global management of the effort is insufficient. We will address these problems and provide answers concerning how we can support a true energy transition.

The Core of the Transition is Using Less Energy

At the heart of most discussions about the energy transition lie two enormous assumptions: that the transition will leave us with a global industrial economy similar to today's in terms of its scale and services, and that this future renewable energy economy will continue to grow, as the fossil-fueled economy has done in recent decades. But both of these assumptions are unrealistic. They flow from irrational expectations: we want the energy transition to be completely painless, with no sacrifice of profit or convenience. That goal is understandable since it would presumably be easier to enlist the public, governments, and businesses in an enormous new task if no extra cost is incurred (though the history of overwhelming societal effort and [sacrifice during wartime](#) might lead us to question that presumption).

But, the energy transition will undoubtedly entail costs. Aside from tens of trillions of dollars in [required](#) monetary investment, the energy transition will [require](#) energy—lots of it. It will take energy to build solar panels, wind turbines, heat pumps, electric vehicles, electric farm machinery, zero-carbon aircraft, batteries, and the rest of the vast panoply of devices that would be required to operate an electrified global industrial economy at the current scale.

In the early stages of the transition, most of that energy for building new low-carbon infrastructure will have to come from fossil fuels, since those fuels still supply more than 80 percent of world energy, and using only renewable energy to build transition-related machinery would take far too long. So, the transition itself, especially if undertaken quickly, will entail a large pulse of carbon emissions.

Several teams of scientists have been seeking to estimate the size of that pulse; according to a study published in the journal *Nature* in November 2022, transition-related emissions will be substantial, ranging from 70 to 395 billion metric tons of CO₂ “with a cross-scenario average of 195 GtCO₂”—the equivalent of [more than five years’](#) worth of global carbon CO₂ emissions at current rates. The only ways to minimize these transition-related emissions would be, first, to aim to build a substantially smaller global energy system than the one we are trying to replace, and second, to significantly reduce energy usage for non-transition-related purposes—including transportation and manufacturing, cornerstones of our current economy.

In addition to energy, the transition will require materials. While our current fossil fuel energy regime extracts billions of tons of coal, oil, and gas, plus much smaller amounts of iron, bauxite, and other ores for making drills, pipelines, pumps, and other related equipment, the construction of renewable energy infrastructure at commensurate scale would require [far larger quantities of non-fuel raw materials](#)—including copper, iron, aluminum, lithium, iridium, gallium, sand, and rare earth elements.

While [some estimates](#) suggest that global reserves of these elements are sufficient for the initial build-out of renewable energy infrastructure at scale, there are still two big challenges. First, obtaining these materials will require greatly expanding extractive industries along with their supply chains. These industries are inherently polluting and inevitably degrade the land. For example, [more than 125 tons of rock and soil](#) must be displaced to produce one ton of copper ore. The rock-to-metal ratio is [even worse for some other ores](#). According to the [World Economic Forum](#), “As the push for clean energy technologies continues, demand for certain critical minerals is forecasted to rise by up to 500 percent.”

Mining operations often take place on Indigenous peoples’ lands, and the tailings from those operations pollute rivers and streams. [Nonhuman species and communities in the Global South](#) are already traumatized by land degradation and toxification; greatly expanding resource extraction—including [deep-sea mining](#)—would only multiply the wounds.

The second material challenge is that renewable energy infrastructure must be replaced periodically—[every 20 to 30 years](#). Even if Earth’s minerals are sufficient

for the first full-scale build-out of panels, turbines, and batteries, will limited mineral abundance permit continual replacements?

Transition advocates say that we can avoid depleting the planet's ores by recycling minerals and metals after constructing the first iteration of solar and wind technology. However, recycling is never complete, with some materials degraded in the process. One analysis, published in the *Emergent Scientist* in 2022, suggests recycling would only [buy a couple of centuries worth of time](#) before depletion would lead to the end of replaceable renewable energy machines—and that's assuming a widespread, coordinated implementation of recycling on an unprecedented scale. Again, the only real long-term solution is to aim for a much smaller global energy system.

A societal transition from fossil fuel dependency to reliance on low-carbon energy sources will be impossible without substantially reducing overall energy usage and maintaining this lower rate of energy usage indefinitely. This transition isn't just about building lots of solar panels, wind turbines, and batteries. It is about organizing society differently so that it uses much less energy *and* gets the energy it uses from sources that are sustainable over the long run.

How We Could Achieve This in Seven Concurrent Steps

We need to act now to turn the tide on the climate crisis. By taking these seven steps, we can ensure that we end the cycle of destruction and move toward a more sustainable way of living:

Cap global fossil fuel extraction through international treaties and annually lower the cap

We will not be able to reduce carbon emissions until we reduce fossil fuel usage—it's just that simple. Rather than trying to achieve this by expanding on the existing renewable energy sources (which haven't resulted in lower emissions), it makes far more sense to limit fossil fuel extraction. In 2007, I wrote up the basics of a treaty in my book, [The Oil Depletion Protocol](#), explaining how nations could cooperate to reduce their dependence on oil and move toward a global rationing system.

Manage energy demand fairly

Reducing fossil fuel extraction presents a problem. Where will we get the energy required for transition purposes? Realistically, it can only be obtained by

repurposing the energy we use. That means most people, especially in highly industrialized countries, would have to use significantly less energy directly and indirectly (in terms of energy embedded in products and services provided by society, like road building). Social means of managing energy demand will be required to accomplish this with minimum societal stress.

The fairest and most direct way to manage energy demand is via [quota rationing](#). Tradable Energy Quotas ([TEQs](#)) is a system [designed](#) by British economist David Fleming; it rewards energy savers and gently punishes energy guzzlers while ensuring everyone gets the energy they need. Every adult would be given an equal free entitlement to TEQ units each week. If you use less than your entitlement of units, you can sell your surplus. If you need more, you can buy them. All trading takes place at a single national price, which will rise and fall in line with demand.

Manage the public's material expectations

Persuading people to accept using less energy will be hard if everyone still wants to use more. Therefore, it will be necessary to manage the public's expectations. This may sound technocratic and scary, but society has already been managing the public's expectations for more than a century via advertising—which constantly delivers messages encouraging everyone to consume as much as possible. Now, we need different messages to set different expectations.

What's our objective in life? Is it to have as much stuff as possible or to be happy and secure? Our current economic system assumes the former, and we have instituted an economic goal (constant growth) and an indicator (gross domestic product, or GDP) to help us achieve that goal. But more people using more products and energy leads to increased rates of depletion, pollution, and degradation, thereby imperiling the survival of humanity and the rest of the biosphere. In addition, the goal of happiness and security is more in line with [cultural traditions](#) and human [psychology](#).

If happiness and security are to be our goals, we should adopt indicators that help us achieve them. Instead of GDP, which measures the amount of money changing hands in a country annually, we should measure societal success by monitoring human well-being. The tiny nation of Bhutan has been doing this for decades with its gross national happiness ([GNH](#)) indicator, which it has offered as a model for the rest of the world.

Aim for population decline

If the population is constantly growing while available energy is capped, that means ever less energy will be available per capita. Even if societies ditch GDP and adopt GNH, the prospect of continually declining energy availability will present adaptive challenges. How can energy scarcity impacts be minimized? The obvious solution is to welcome population decline and plan accordingly.

The global population will start to decline [sometime during this century](#). Fertility rates are [falling](#) worldwide, and China, Japan, Germany, and many other nations are already seeing population shrinkage. Rather than viewing this as a problem, we should see it as an opportunity. With fewer people, energy decline will be less of a burden per capita.

There are also side benefits: a smaller population puts less pressure on wild nature and often [raises wages](#). We should stop pushing a pronatalist agenda; ensure that women have the educational opportunities, social standing, security, and access to birth control to make their own childbearing choices; incentivize small families, and [aim for the long-term goal](#) of ensuring a stable global population closer to the number of people who were alive at the start of the fossil fuel revolution (voluntary population shrinkage, however, will only help us to a small extent in reaching immediate emissions reduction targets).

Target technological research and development to the transition

Today, the main test of any new technology is its profitability. However, the transition will require new technologies to meet a different set of criteria, including low-energy operation and minimization of exotic and toxic materials. Fortunately, a [subculture](#) of [engineers](#) is already developing low-energy and intermediate technologies that could help run a right-sized [circular economy](#).

Institute technological triage

Many existing technologies don't meet these new criteria. So, during the transition, we will be letting go of familiar but ultimately destructive and unsustainable machines.

Some machines will be easier to live without than others. For instance, [gasoline-powered leaf blowers](#) will be easy to say goodbye to. [Commercial aircraft](#) will be harder. Artificial intelligence is an [energy guzzler](#) we managed to live without until very recently and might be something we use only sparingly in the future.

Weapons industries offer plenty of examples of [machines we could live without](#). For guidance along these lines, consult the [literature](#) of technology criticism.

Help nature absorb excess carbon

The IPCC is right: if we are to avert catastrophic climate change, we must capture carbon from the air and sequester it for a long time. But not with machines. Nature already removes and stores enormous amounts of carbon; we just need to [help it do more](#) (rather than reducing its carbon-capturing capabilities, which is what humanity is doing now). Reform agriculture to [build soil](#) rather than destroy it. [Restore ecosystems](#), including grasslands, wetlands, forests, and coral reefs.

Implementing these seven steps will change everything. The result will be a world that's less crowded, where nature is recovering rather than retreating, and where people are healthier (because they're not soaked in pollution) and happier.

Granted, this seven-step program appears politically unachievable today, but that's largely because humanity hasn't yet fully faced the failure of our current path of prioritizing immediate profits and comfort above long-term survival—and the consequences of that failure. Given better knowledge of where we're currently headed and the alternatives, what is politically impossible today could quickly become inevitable.

Social philosopher Roman Krznaric [writes](#) that profound social transformations are often tied to wars, natural disasters, or revolutions. But crisis alone is not positively transformative. There must also be ideas for different ways to organize society, and social movements energized by those ideas must also exist. We have a [crisis](#) and (as we have just seen) some good ideas for how to do things differently. Now we need a movement.

Building a movement takes [political and social organizing](#) skills, time, and hard work. Even if you don't have the skills for organizing, you can help the cause by learning about what a real energy transition requires and educating people you know about it, advocating for [degrowth](#) or related policies, and [reducing your own energy and materials consumption](#).

Even with a new social movement advocating for a real energy transition, there is no guarantee that civilization will emerge from this century of unraveling in a recognizable form. But we all need to understand this is a fight for survival in which cooperation and sacrifices are required, just as in war. Until we feel that

level of shared urgency, there will be no real energy transition and little prospect for a desirable human future.

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