The Oil Age May Not End the Way You Imagine It Will

Who’s going to decide — governments or the oil industry?

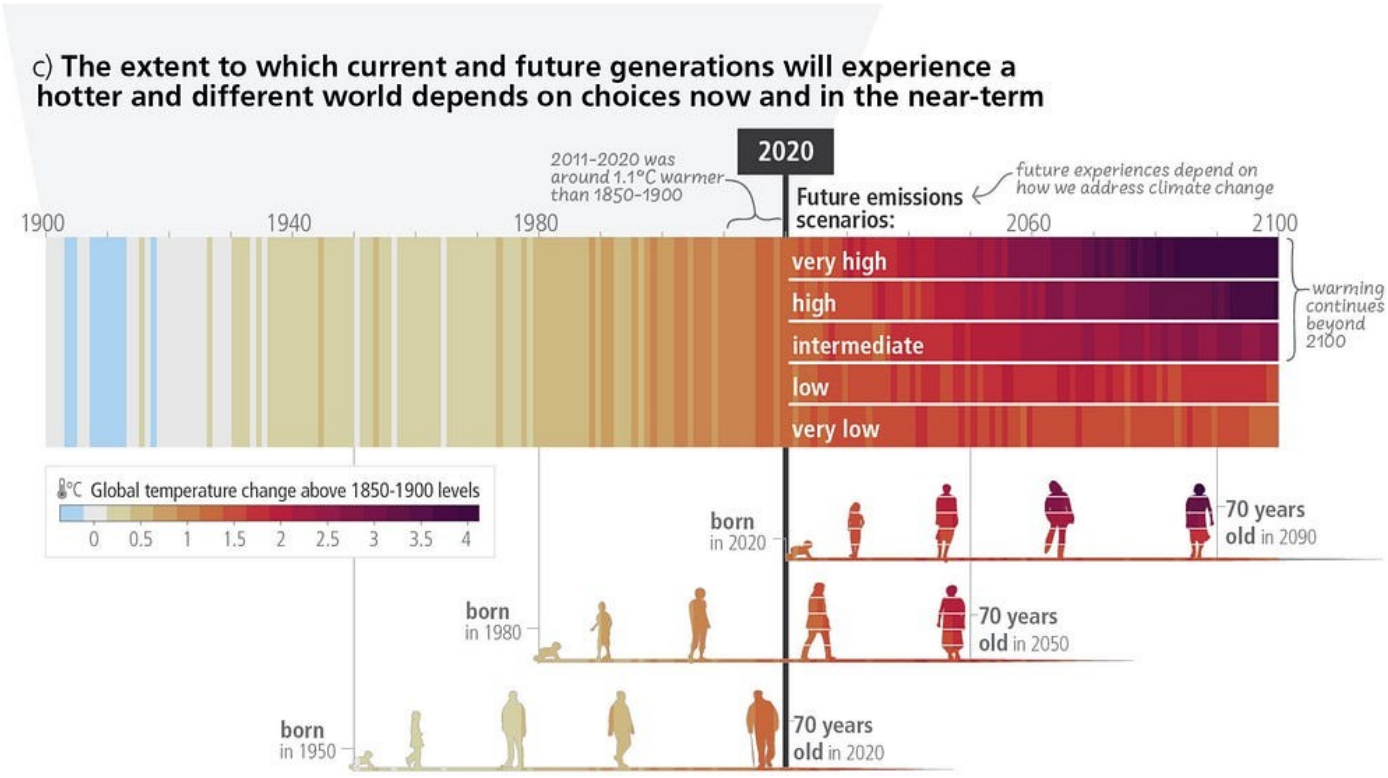
Steve Genco Sep 23, 2023

Image by Alessandra Verre on Unsplash

As an average citizen of the United States, one with no particular power over our political trajectory beyond my ability to vote and encourage others to vote, I have very little say in how our descent into a hotter, resource-depleted world will play out. This contrasts with how much I worry

about that impending descent, its impact on my children and grandchildren, and its deep implications for the future of humanity writ large.

The IPCC recently posted a graphic that emphasizes the vastly different dangers climate change poses for different generations living today. Here it is:



Source: Figure SPM.1 in the AR6 Synthesis Report by the IPCC, p. 7, 2022. For the story behind this graphic, see source.

The subtext is obvious. Today, climate mitigation and adaptation decisions are being made (or not made) by decision makers generationally in the bottom row of this image. That's my generation. But it is those in the top row — young people born in this century — who will bear the burden of the decisions (or non-decisions) being made today.

My generation has lived through an era that future historians will no doubt consider the pinnacle of human civilization. We got here because we exploited a dense energy source that multiplied our power over the natural world thousands of times (source). That triggered unimaginable wealth, which we used to extend our dominion over the planet's resources, increasing not just our consumption but also our *rate of consumption* of the planet's resources. Along the way, we've doubled our life spans (for some of us, at least), and multiplied our numbers exponentially (doubling from 4 billion to 8 billion humans in 50 years).

Our children and grandchildren, along with their descendants, cannot expect any such progress during their lifetimes. On the contrary, they will be forced to pay the piper for our excesses and deliberate ignoring of physical realities. The lives of every young person alive today and facing the rest of the 21st Century will necessarily be shaped by what might be called the *Four Uncertainties*:

- When will fossil fuels end?
- How hot will it get, where and when?
- What climate tipping points will we breach, with what consequences?
- How much alternative energy capacity will we build, and where will we build it, before fossil fuels end?

Answers to each of these questions will become less uncertain over time. That is, questions that appear highly uncertain today will less so over time, as decisions and non-decisions accumulate, as new policies and solutions are enacted or foregone, as deadlines are met or missed, as the pace of climate catastrophes accelerates, and as second- and third-order effects of global warming arise and begin to reinforce each other. Each decision we make, each outcome we incentivize, will make some paths less likely and others more likely. Over time, the number of possible paths will dwindle until there is only one left — the one we will be living with in the year 2100.

> **In this article, I want to begin a discussion of where we need to look if we want to get a realistic understanding of the path we are on — both as a civilization and as a population.**

Recognize the difference between things humans can’t stop and things we won’t stop

The first thing we need to consider in handicapping humanity’s trajectory through the 21st Century is the difference between things we can’t stop and things we can stop, but won’t.

The most important things we can’t stop are the physical processes we have unleashed. Hotter average temperatures, for example, are “baked in” because they are a function of the CO2 (and other greenhouse gases) we have already pumped into the atmosphere. Similarly, that average level of warming will continue to increase for every ton of CO2 we continue to emit, because the human-caused heating of the planet is directly proportional to one known quantity: the concentration of CO2 in the atmosphere. When we stop emitting CO2 into the atmosphere, that concentration will stop increasing, so the heating will stop (not precisely, but close enough). Temperatures will not decrease from that point, but they will not increase either. This causal connection is a function of the physics and chemistry of the carbon cycle. So, if and when we lower our additional CO2 contributions to zero, we will halt the current ratcheting up of the planet’s temperatures. Conversely, as long as we continue releasing CO2 into the atmosphere, temperatures will continue to rise, with all the risks and dangers that entails.

Here’s another thing we can’t stop: the end of fossil fuels. Humanity will lose its magic energy elixir sometime this century. Whether it will happen in 2030, 2050, or 2070 remains in much dispute, but *that it will happen* is undeniable. So we know there is an *off-switch* built into our planet-warming trajectory. When we stop burning fossil fuels, we will stop heating up the planet.

> **The concentration of CO2 in the atmosphere when we exit the Age of Oil will be the defining factor that determines how much heat our descendants will have to endure for the next several thousand years.**

Here we enter the realm of human choice. On the one hand, we could stop burning fossil fuels tomorrow. Climate scientists tell us in no uncertain terms that each tenth of a degree of global warming we inflict on the planet will bring with it potentially catastrophic effects, including the likely triggering of irreversible tipping points that could render the planet not just hotter, but essentially uninhabitable by humans (not to mention millions of other species).

On the other hand, economists and politicians tell us if we stopped burning fossil fuels tomorrow, we would destroy the world economy, bring industrial civilization to its knees, and probably put the lives of a large fraction of the human population in jeopardy. And they're probably right. So we could do it, but we won't do it.

> **Our world is built on nonrenewable fossil-fuel energy. When that energy source is no longer available, our world will no longer be sustainable. It will have to morph into something else. What that something else will be remains to be seen.**

There is of course a deep irony in the fact that while we continue burning fossil fuels to prop up our global economy, those fossil fuels continue to heat up the planet and produce climate damage that is equally threatening to our global economy, if not more so.

As I've argued elsewhere (source, source), that's where we are today. Damned if we do and damned if we don't. No wonder our leaders are paralyzed, trying to impose climate-friendly policies and programs around the edges of the dilemma (e.g., nibbling away at renewable electrification while 80% of the world's industrial capacity remains fossil fuel-based) but unwilling to do anything that might risk the money-making machinery (for the lucky few) embedded in our civilization's obsession with hyper-consumption, resource depletion, and unfettered economic growth (source).

Here are some other things we will not do to cut back on CO2 emissions, at least not voluntarily: eating less meat (even though we'd be healthier if we did), driving less, giving up internal combustion vehicles altogether, flying less, building smaller houses, banning marketing and advertising to curb over-consumption, accepting rationing, and (my personal favorite) undoing the extreme inequality of late-stage capitalism (source) by taxing extreme wealth more aggressively (source). This is not to say we won't eventually be *forced* to do all these things, due to failures of supply and rising costs of climate calamities, but we won't do them voluntarily. We may wish it were otherwise, but history tells a different story. We are a rapacious species and we won't stop depleting our planet's resources as long as there are resources left to deplete.

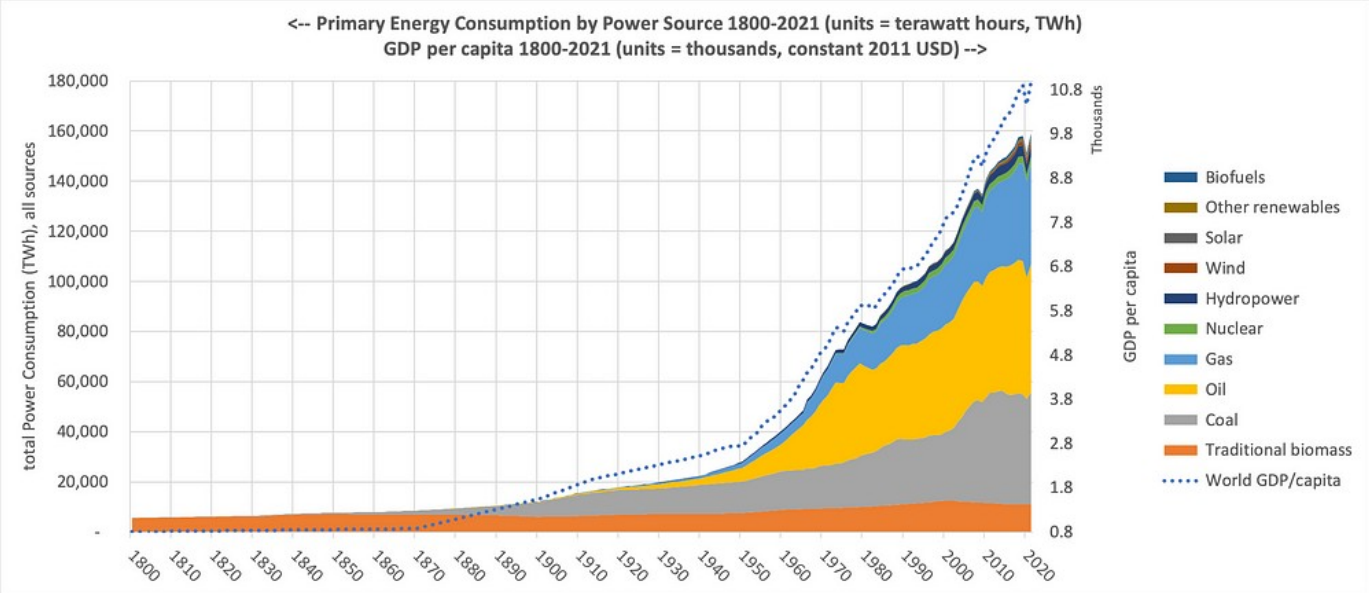
These realities are frightening and disheartening, but they are also reliable. They are either certain, based on physical laws, or they are highly likely, based on human nature and past behavior. Putting all these elements together, we arrive at a less uncertain view of our future. We can put aside the wishful thinking, the magical thinking, the denialism, and the boondoggle hustles. What remains is the only viable path, the one we cannot avoid.

Let's return to those *Four Uncertainties*. For this post, I want to focus on the first one: **when will fossil fuels end?** What evidence should we be looking for if we want to narrow down the uncertainty around this critical question, given that we can expect our abandonment of fossil fuels to be essentially involuntary, not voluntary?

Follow the trail of dwindling oil

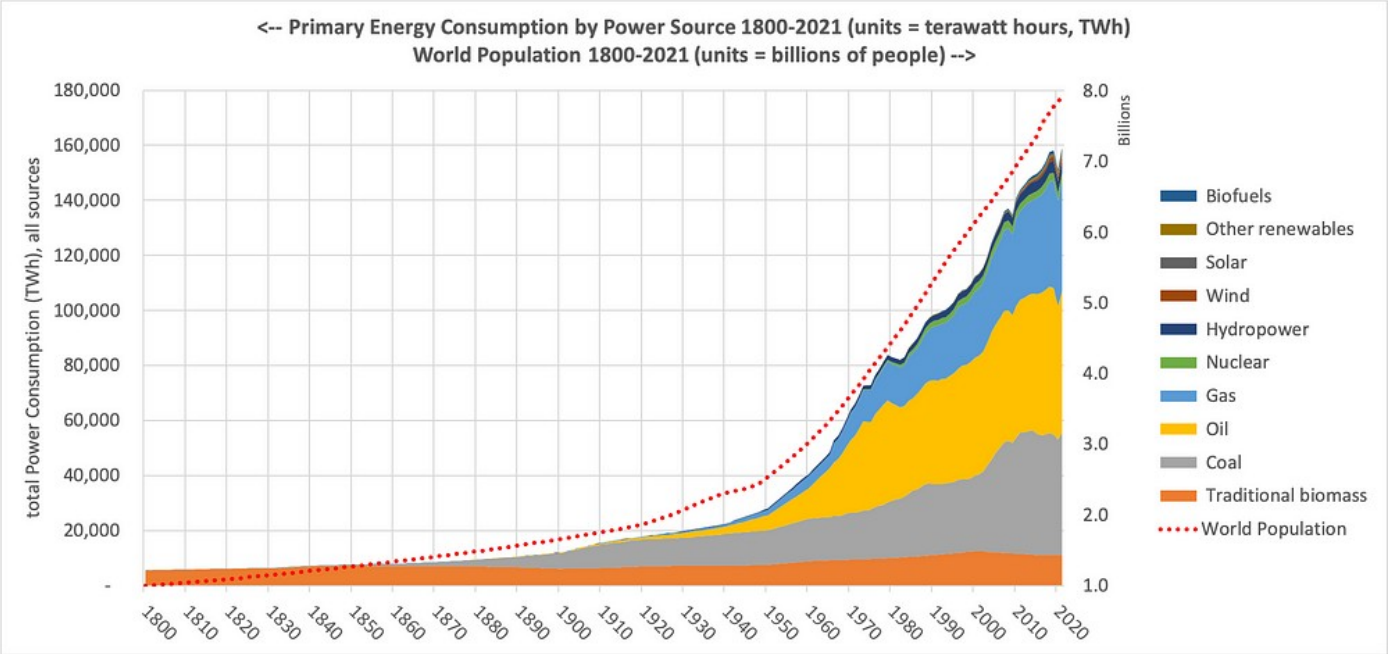
If you read about climate change here on Medium or elsewhere, you are probably familiar with the energy consumption “hockey stick” chart from *Our World in Data*. I’ve replicated it below, overlaying a second measure tracking the course of global GDP per capita over the same period (the blue dotted line).

What is clear from this chart is that energy consumption is closely tied to economic growth. It always has been and, presumably, always will be. As GDP per capita has ascended to its current peak, energy consumption has ascended right along with it. And where we see small dips in energy use, we see identical dips in economic activity as well. This is because economic growth *requires* energy growth to fuel it.



Excel chart created by me. Data from Our World in Data.

A similar relationship holds between energy consumption and population growth. Below is the energy consumption graph again, this time juxtaposed against the rise in world population over the same timeframe. In this case, energy consumption doesn’t cause babies (a different process is involved), but the more people you add to a population, the more energy you need to support them. The opposite logic also applies: the less energy you have available, the fewer people you can support.



Excel chart created by me. Data from [Our World in Data](#).

Charts like these are often called *hockey stick* charts, because they resemble a hockey stick lying on its handle, blade up.

A generic hockey stick (source). Going up.

However, "hockey stick" may be a misnomer for what we are seeing in these charts, given the finite nature of fossil fuels. These hockey-sticks will not continue their upward trajectory forever. Eventually, the available energy sources will no longer keep up with the exponential growth in people and consumption. If history is any indication, the resulting energy-economy gap will radically disrupt economic activity and, at a minimum, dampen population growth (source).

This is the reality we face over the next several decades. So we might want to consider calling these things "roller coaster" charts rather than "hockey stick" charts, because hockey sticks are really only capturing the front half the picture … *and what goes up must come down*.

A generic roller coaster (source). Going down.

Not only do we know that fossil fuels will decline to zero as an energy source, we also know *how* that will happen. What we don't know is precisely *when* that point of no return will be reached, but we can be pretty confident it will happen well before the end of the century. In other words:

> **Fossil fuels will soon be unavailable to power our civilization "Soon" means within the lifetime of people alive today.**

We know we will not literally run out of oil

What we will do is run out of *energetically profitable* oil. What does that mean? It means that when the energy input required to produce a barrel of oil exceeds the energy output that can be derived from burning that barrel of oil, oil stops being an energetically profitable energy source. At that point, no one has any incentive to produce more oil, so no more oil is produced. The same logic applies to natural gas and coal. They will eventually become energetically unprofitable as well. And that's when our energy descent (aka transition) will really begin.

The tale of oil's energetic trajectory is measured by a metric called *Energy Return on Energy Invested* (EROI or ERoEI). Considerable effort has gone into estimating the EROI of various energy sources, from oil and gas to solar and wind (source). The task is a complex one, because there are many different weights of oil, extracted from many different environments, processed into many different downstream products, each with different energy densities and optimal applications.

Simon Michaux has produced a useful graphic that shows how all these factors interact to produce an overall decline in fossil fuel EROI in this century. With each step down from the top of this

pyramid, the quality of oil (its energy density and sulfur content) declines and its cost of extraction increases. Production of “conventional” oil (at the top of the pyramid) has been declining since around 2005 (source). Our current supply is coming largely from remaining Middle Eastern oil fields (also in decline, but often obscured by government statistics) and lower quality “unconventional” sources, such as fracked oil in the US, oil from tar sands in Canada, and biofuels (e.g. ethanol from corn), also largely from the US.

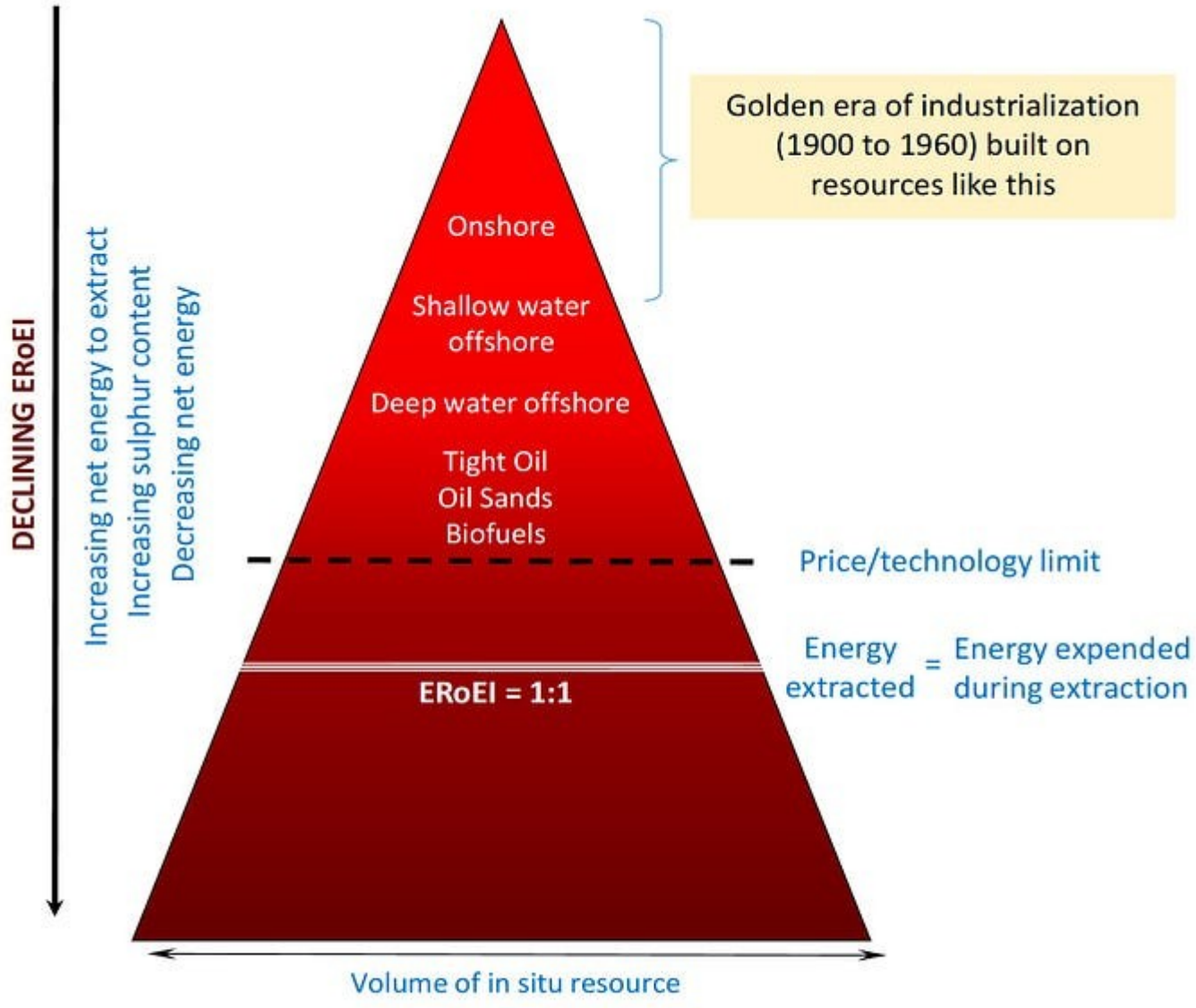


Figure 186. The pyramid of oil and gas resource volume versus resource quality

Graphic by Simon Michaux in source, p. 174.

The graphic shows two thresholds. The first, the black dotted line, represents the point at which oil becomes *financially unprofitable*. This occurs when the cost of producing a barrel of oil becomes so expensive that no one can afford to buy it, even without adding a margin for profit. If the price of oil were simply a function of its cost, this threshold would have been hit years ago. But the reality is that fossil fuels today are massively and artificially *underpriced* compared to their real cost, because the fossil fuel industry is subsidized by governments to keep the price of oil and its derivatives affordable. According to a recent analysis by the *International Monetary Fund (IMF)*, direct and indirect governmental subsidies to fossil fuel companies totaled over *seven trillion US dollars* in

2022 alone (source). So prices are artificially “adjusted” to stay within a zone that both consumers and producers can afford. Michaux has produced another graphic that illustrates this nicely.

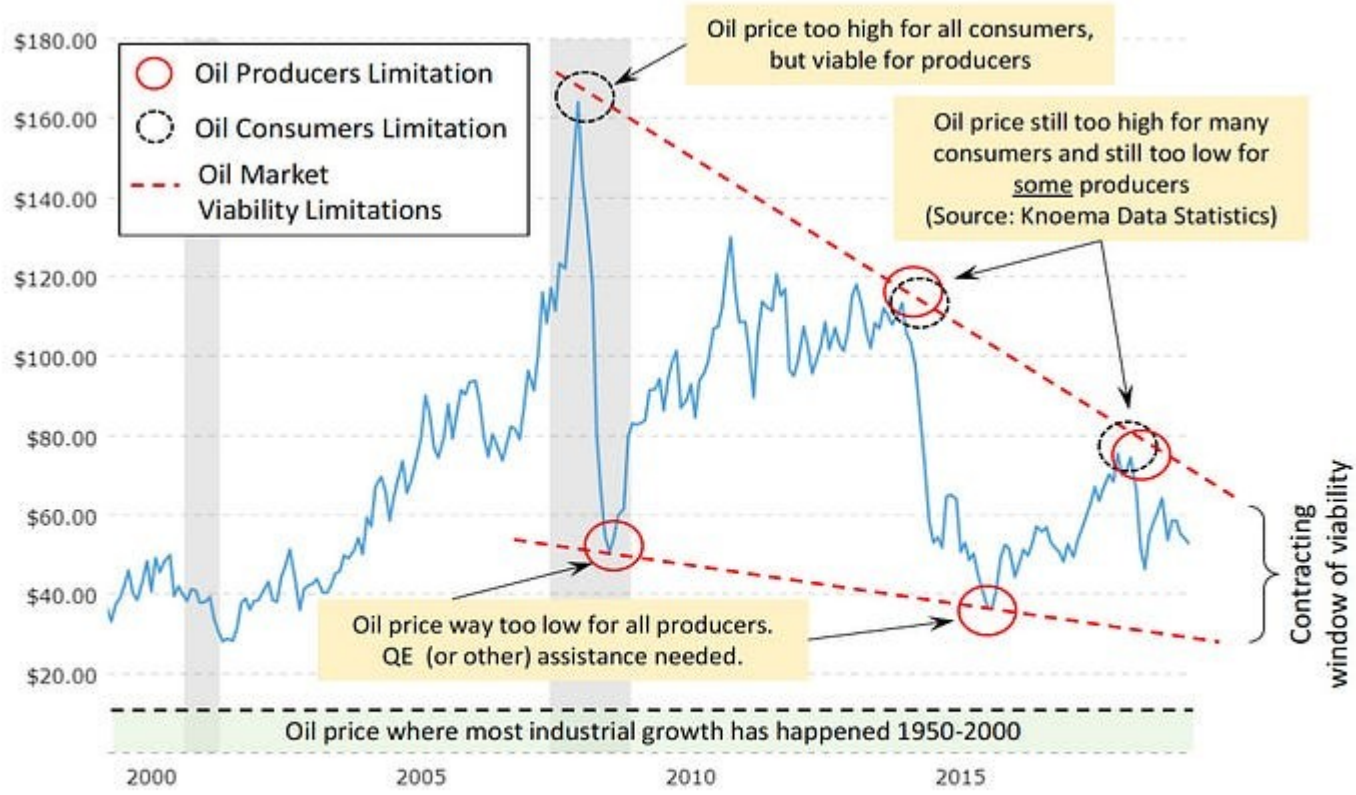


Figure 258. West Texas Intermediate (WTI or NYMEX) crude oil prices per barrel October 1999 to October 2019, Inflation adjusted (Source: MacroTrends) (Copyright: https://www.macrotrends.net/terms)

Graphic by Simon Michaux in source, p. 258.

In essence, governments are paying fossil fuel companies to continue ratcheting up global warming to a level that could plausibly result in human extinction (source). But that’s not how governments see it. In their view, they are keeping the global economic engine running because, just like the internal combustion engine in your 2010 Ford pickup, if that engine isn’t provided with fuel, it will stop running. Both outcomes are happening simultaneously, because **currently political leaders fear the end of capitalist accumulation (aka economic growth) more than they fear global warming**. This is *the* major obstacle to any well-meaning plan for voluntary degrowth as a viable response to climate change and resource depletion (source).

It is also a dangerous and short-sighted perspective. This is represented by the second threshold in the Michaux graphic, the point at which the EROI of oil declines to 1:1. When this happens, oil becomes energetically unprofitable — it simply takes more energy to produce than can be extracted from it. The whole oil and gas industry, to the extent it hasn’t transformed into a post-carbon energy industry, becomes an energy *sink* instead of an energy *source*. Its economic rationale vanishes and its products disappear.

What about “green growth”?

To repeat: the end of oil is coming, it is inevitable, and currently we are ignoring, denying, or minimizing it. As an alternative, many of us are pretending we can survive climate change with a neat hat trick called “green growth”, a strategy that in essence claims we can have our cake and eat it too (source). The pretense is that we can continue to run a growing civilization that will look just like the current one, except it will be powered by renewable energy sources and storage solutions, rather than oil and its derivatives.

The problem with green growth, in a nutshell, is that it does not take into account two additional challenges that go way beyond replacing fossil fuels. The first is resource depletion, particularly depletion of the ingredients and materials needed to build all those renewable energy devices, from construction materials like steel and concrete to exotic and not-so-exotic minerals like lithium, nickel, cobalt, manganese and graphite. To date, there is much controversy as to whether enough of these materials are available to support a full energy transition (source, source), as well as whether the environmental costs of extracting these minerals will be so high as to cancel out their environmental benefits (source).

The second challenge with green-growth strategies is their failure to take seriously the likely disruptive impacts of ongoing global warming. While national governments are presumably presiding over an energy transition that will be, by all accounts, the largest and most complex project ever undertaken by humanity, they will also be buffeted by more and more severe impacts of climate change: extreme heat, drought, flooding, wildfires, melting polar ice, disrupted ocean currents, atmospheric rivers, polar vortexes, coral reef destruction, biodiversity loss, food and fresh water shortages, disease, famine (source).

While the richest nations in the world may be able to address these two sets of challenges simultaneously, at least for a time, it is unlikely that the great majority of nations, especially those in Global South, will be able to do so. Just compare how rich countries like Germany and the United States have responded to unprecedented flooding in their territories in recent years versus how poor countries like Pakistan and Libya have been able to respond to devastating floods in their countries. (for context: source)

Who’s doing the choosing, anyway?

When we talk about the end of oil, we tend to assume we will *choose* how to phase out fossil fuels in an orderly manner. We tend to assume our political leaders will tell the oil and gas industry when and where fossil fuels may be burned in the coming decades, and when and how GHG emissions must be brought down to zero.

If, on the other hand, we are mistaken in this assumption, and in fact it is the oil and gas industry that will *tell our political leaders* when the industry will stop or slow down the burning of fossil fuels, then we’re in a different situation. Oil and gas giants have been telling us what they plan to do for quite a while now, and it looks like they have no plans to just fade away. For example,

- The industry has coopted the UN COP process so successfully (source) that Saudi Arabia was able to remove any mention of phasing out fossil fuels from the 2022 IPCC report (source).

- As reported in the *New York Times* in April 2023, hundreds of new oil and gas extraction projects have been approved in the last year, and dozens more are expected to be approved (source).
- Exxon has announced plans to double its shale oil production in the US over the next five years (source).
- Based on projections by *Rystad Energy*, the 20 largest oil and gas companies are expected to invest $932 billion in developing new oil and gas fields over the next 9 years. By the end of 2040 the figure grows to a staggering $1.5 trillion (source).
- Shell announced earlier this year that cutting the world's oil and gas production would be "dangerous and irresponsible" (source).
- Both Shell and BP have reneged on prior plans to cut oil and gas production, now claiming that such moves would dampen profits (source).
- Fossil fuel subsidies remain astronomical and governments are showing little enthusiasm for eliminating or even reducing them (source).

Given the industry's resistance to an orderly phase-out of fossil fuels, combined with public officials' reluctance to endanger economic growth or risk a financial crisis on their watch, it is a pretty safe bet that we will not end fossil fuel production voluntarily, but will stall and dissemble until it becomes either financially or energetically unprofitable for the industry to continue.

We could do this differently, but we won't. If you want to know when fossil fuels will end, my advice is not to listen to government officials or the IPCC. Instead, follow the trajectory of oil, gas, and coal production. Watch the adoption rate for alternative energy solutions, like carbon-free shipping fuel, aviation fuel, or steel production furnaces (source). Look out for the emergence of fossil fuel supply shortages, price spikes, and rationing. Fossil fuels will only end when they can no longer be profitably produced. At that point, whatever alternative energy infrastructure we have in place will provide our only access to energy for the foreseeable future.

Plan your life accordingly (source).