We're Saved!

A Collection Of 'Solution' Critiques, Volume 2.

March 2026

Contents

Foreword: We're Saved! Summing Up Volumes 1 & 2.

The need to believe tomorrow will be like today and yesterday is strong. Humans despise uncertainty. It creates immense anxiety; a 'pain' that needs to be avoided and replaced by 'pleasure', if at all possible. If our immediate environment can't help with this, our minds can. It is in this vein that we seek stories which enable our bodies to decrease our anxiety and the physiological symptoms that accompany it. Particularly comforting are the tales that suggest we have more agency in our existence than we actually do.

It is here that narratives about 'saving' our planet and species from the consequences of our intense use of materially-intense technologies arise. "There are no problems that can't be fixed!" is the mantra of the times. The 'bug' in our thinking, however, is that we tend to be focussed upon a 'doubling down' on the very technologies and their extractive and ecologically-destructive processes that have put us in this predicament of ecological overshoot. There are very, very few voices highlighting that enough is enough. Those that are present tend to get marginalised and shouted down for a variety of reasons; not least of which is the discomfort created by such ideas.

Across these almost two dozen "We're Saved!" Contemplations critiquing supposed 'solutions' to the dilemmas that plague our species and planet, a pattern emerges: the technological and systemic 'solutions' tend to be overhyped, fundamentally flawed, and serve, in the end, to exacerbate the issues they claim to address. Each promised salvation rests upon a structure of human psychological defence mechanisms, wrapped in language that portrays them as innovative and progressive–the opposite of what they truly are.

The commonalities that exist among the various 'solutions' include:
Narrative management via greenwashing: they are marketed through their supposed benefits while ignoring or suppressing their drawbacks, usually by way of suggesting these are temporary challenges requiring simply some engineering tweaks. The sales pitches focus almost solely on their promise of salvation while overlooking the trade-offs that arise and the physical limits impeding their possibility.

Avoidance of their additive nature to extraction and biosphere degradation: while presented as replacements for hydrocarbons, proposed technologies are actually adding to total energy consumption and material throughput. Hydrocarbon use continues to rise alongside the growth of alternatives demonstrating that the story about a 'transition' is fictional–albeit comforting.

Blindness to scale: proposals that may work within a small, local venue become resource-intensive and ecologically destructive when industrialised for global application. Niche applications do not scale up to societal levels without exacerbating the issues they are claiming to address.

Carbon tunnel vision: ignoring the broader ecological impacts of proposed fixes (e.g., biodiversity loss, waste streams, resource depletion, etc.) by hyperfocussing upon carbon emissions allows some 'management' of anxiety about climate impacts but it does zero to address the broader array of ecological destruction brought on by the mass-produced, industrial technologies typically presented as 'solutions'.

Faith in unhatched chickens: almost all technological 'solutions' that get marketed rely upon technical breakthroughs that are invariably "just around the corner" and always seem to require continual funding to be achieved. This has tended to sustain hope while avoiding responsibility for the failure to meet promises.

Perpetuation of growth: virtually every 'solution' reinforces the perpetual growth paradigm; a paradigm that is driving ecological overshoot. Business-as-usual expansion is supported without confrontation. The hard discussions about degrowth and simplification are almost invariably avoided.

Enrichment of the global elite: the 'solutions' that are laid out before humanity as public goods for the benefit of all are concentrating wealth (including massive state subsidies) and power to the top of societal socioeconomic and sociopolitical structures. Continued extraction, industrialisation, and the inequality that results are masked behind an anxiety-reducing narrative of collective salvation.

If there exists a core message in these We're Saved! Contemplations it's that no innovation–technological or systemic–can solve the pursuit of infinite growth on a finite planet. Our species is in ecological overshoot having exceeded planetary boundaries across multiple dimensions and the 'solutions' being bandied about are not neutral tools but amplifiers of the very systems that are exacerbating overshoot.

Through these essays I have tried to show that believing in such technological salvation is a collective defence mechanism: it allows the avoidance of uncomfortable truths, especially that complex industrial societies cannot be sustained indefinitely. The narratives that have been created have granted most the illusion of agency–the sense that we can 'fix' our way out–while avoiding for the most part any fundamental changes to our patterns of consumption, extraction, and growth that have led us into overshoot.

The real need is not for better or more technologies but for honest acknowledgment of the biophysical limits we face and to engage in those difficult conversations about degrowth, simplification, relocalisation, and harm reduction; conversations that are foreclosed by those who profit from status quo arrangements, but also those with the best of intentions but continue to hold that more technology is our best pathway to pursue. Until we can face the anxiety and discomfort such conversations provoke and what it means for our future to accept limits, it seems we are destined to continue chasing the salvation stories. And with them, the acceleration of the 'collapse' they promise to avoid.

Volume 1 can be found here.

"*These reactors face profound and possibly insurmountable technical, economic, and material hurdles. They have been promoted as a 'solution' within human systems that are predicated upon infinite growth and debt, but which are serving to exacerbate the fundamental predicament of ecological overshoot and its various symptom predicaments. Investing in these speculative technologies not only drains resources and results in further ecological destruction, but diverts attention from the urgent tasks of attempted 'managed' societal simplification and community resilience-building. The evidence makes clear that these reactors are not a saviour, but a symptom of humanity's general refusal to confront a far more inconvenient truth.*"

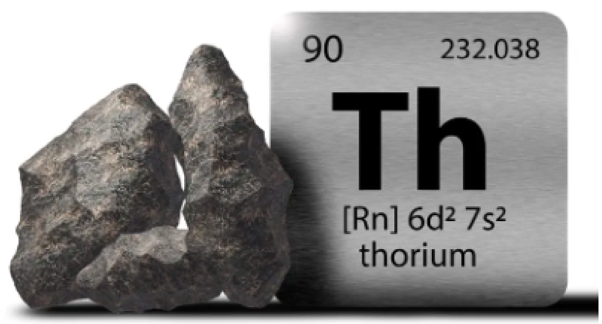
Website **Medium** **Substack**

Today's Contemplation: Collapse Cometh CCXXIV–
We're Saved! Thorium-Fuelled and Molten Salt Reactors.

There always seems to be an acceptance-pushback response (e.g., "Yeah, but…") by someone when I raise the alarm about a trumpeted energy 'solution' that is making legacy media headlines and/or the rounds on social media–then is invariably overhyped by a click-bait site seeking to generate revenue through more eyes[1]–and becomes amplified by those who trust what they're being repeatedly exposed to and have not cared to look critically into the claims being made.

And, more often than not, when I have been critical of nuclear energy, these are "but…fusion", "but…small modular reactors (SMRs)", "but…thorium", or "but…molten salt reactors". I've already expanded on a critique of nuclear fusion reactors[2] and addressed SMRs in my series on the supposed Nuclear Renaissance[3]. This Contemplation focuses upon thorium-fuelled and molten salt reactors (MSRs).

I will begin with an overview of the history and basic engineering of such reactors, followed by a focus on the significant hurdles and issues facing this latest, greatest 'solution' to creating sustainable, clean energy. Many of the impediments facing thorium and molten salt reactors are identical to those of fusion reactors but believers will be believers regardless of evidence that contradicts their enthusiasm and 'hope'.



Thorium and Molten Salt Reactors

Current Praise

Thorium-fuelled nuclear reactors receive a lot of kudos from the industry (who just happens to be profitting from any increased investments in such technology) and media (who tend to parrot uncritically the industry marketing/propaganda; which might have something to do with the infinite growth story it supports and the advertisement revenue garnered from this mythological narrative). The primary talking point for such cheerleading is that they offer a number of 'potential advantages' over current uranium-based systems. Proponents argue this energy is needed to not only power economic growth but expand sectors like Artificial Intelligence and data centres; this argument, however, operates within a perpetual growth paradigm that does not account for the biogeophysical limits that exist on a finite planet.

[1] See my series of Contemplations on this phenomenon: Part 1 Website Medium Substack; Part 2 Website Medium Substack; Part 3 Website Medium Substack.
[2] See: Website Medium Substack.
[3] See: Part 1 Website Medium Substack; Part 2 Website Medium Substack; Part 3 Website Medium Substack; Part 4 Website Medium Substack.

According to nuclear energy advocates, the benefits of thorium-fuelled reactors include: a more abundant fuel source with thorium being about 3 to 4 times more bountiful in the planet's crust than uranium; the ability to 'breed' uranium within certain reactor types, providing more fissile material than is consumed; supposedly being 'safer' than traditional reactors–Molten Salt Reactors (MSRs), for example, can have their reaction stopped relatively easily via its liquid fuel being drained–and they produce less long-lived high-level radioactive waste; and, as the U-233 produced is extremely highly radioactive, it is much more difficult to handle and proliferate illicitly.

Early Promise

While the concept of thorium-fuelled reactors (like fusion ones) is thought by many to be a relatively novel one, the reality is that research surrounding such reactors to provide safe, sustainable, and efficient carbon-free energy has been with humanity since the beginning of the atomic age–some 75+ years. (Note that the history of thorium-fuelled reactors is somewhat parallel to that of MSRs since MSRs are well-suited to using thorium as a fuel.)

In the early 1940s, nuclear chemist Glenn Seaborg discovered how to use thorium-232 (Th-232) to breed uranium-233 (U-233) via neutron bombardment in a cyclotron. Shortly afterwards, during the Manhattan Project, he realised the potential of this uranium as a fissile material and proposed that Th-232 and U-233 could be used in thermal-breeder reactors. While his research on this aspect of nuclear chemistry continued, it was largely shelved by administrators of the project in favour of a focus on plutonium, which he had also discovered.

Experimentation

After the Second World War, reactor experimentation expanded using different fuels and reactor designs. Some reactors used a thorium-uranium mix, others tried plutonium fluoride, and still others used solely uranium.

Of particular interest to thorium fuel use were the Aircraft Reactor Experiment (ARE) in the 1950s and the Molten Salt Reactor Experiment (MSRE) during the 1960s; both carried out at the Oak Ridge National Laboratory in the United States. The ARE was the first MSR to operate successfully (for 9 days), demonstrating the feasibility of the design. This led to the MSRE which used U-233 bred from thorium to show that a liquid-fuelled reactor was possible.

Additional research in both the US and Europe used thorium-based solid fuels to test its viability for reactors. Most notably, the US's Shippingport Atomic Power Station exhibited a 'breeding gain' during the 1970s whereby U-233 fissile material bred from Th-232 increased slightly during the process–in other words, more material was produced than was consumed.

Faltering Economic and Political Support

Despite the success of thorium-fuelled and molten salt reactors, the 1970s witnessed the US Atomic Energy Commission (AEC) opting to push and build out a fleet of solid, uranium-fuelled reactors. They argued that the uranium reactors were more efficient, and that thorium's breeding ratio could not support a scaled-up number of reactors. The decision was likely also influenced by the fact that the industry had already invested heavily in uranium-fuelled, light water reactors, and transitioning to a thorium fuel cycle requiring a different infrastructure would be extremely costly. This decision greatly slowed the exploration and use of thorium-based reactors. [Note: some have suggested that the uranium-breeding reactors were preferred due to the weapons grade plutonium that could be produced via them[4].]

Resurgence and Renewal

Since the 1990s there has occurred a resurgence in interest in thorium-fuelled reactors alongside research on novel reactor designs and molten salts. The enthusiasm for these thorium-fuelled, molten salt reactors has been building; in fact, molten salts were formally recommended to be the basis of Generation IV reactors in 2002. For more than twenty years now, the focus for the nuclear industry has been to get such reactors and the massive research surrounding them funded. They have flooded the media with potential benefits and

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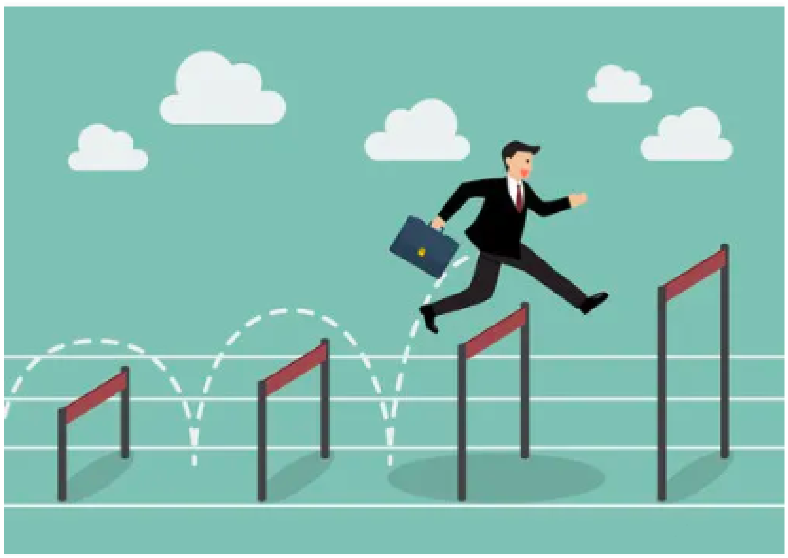
4 See here and/or here.

highlighted ‘breakthroughs’ on a regular basis in order to attract evermore investment, and “keep the dream alive”.

Academic and private research/experimentation surrounding these thorium-fuelled, molten salt reactors and new reactor designs continues. In Norway, thorium-bearing fuel rods have been tested in conventional reactors. More recently, China has claimed criticality and full operational success with an experimental MSR; and India has experimented with a Prototype Fast Breeder Reactor (PFBR) and Advanced Heavy Water Reactor (AHWR)[5]. The industry is proclaiming that pre-commercial prototypes demonstrate the need for further investment to fund advanced research (to overcome specific ‘challenges’) and eventual construction. Any. Moment. Now.

A clean, sustainable, and safe option to uranium-fuelled nuclear reactors. What’s not to like?

Well…



(stock.adobe.com)

Despite the much ballyhooed benefits outlined above, there exist a variety of not insignificant hurdles to the mass build out of thorium-fuelled nuclear reactors. These are technical and physical in nature, but also economic and political–thus the need for massive lobbying and marketing/propaganda to help build investment funding and political and social capital. But before getting into these impediments in greater detail let’s have a brief reality check on some of the more common claims by the advocates of these reactors and their fuel.

Common Claims Critique

The argument that these reactors are inherently safer is not due to the fuel source but due to some engineering changes. But even given this, without proven commercial reactors working at scale the claim is, at best, based on faith/hope that new designs and their safety protocols will work as projected.

The assertion that thorium-fuelled power generation will be more economical because there exists abundant fuel is also in question. In fact, this is considered false by many. A traditional uranium-fuelled reactor’s fuel costs are a relatively small percentage of operating budgets; most costs are due to the upfront funding of constructing the reactor (which are considerable, and almost always well beyond initial projected budgets). Using thorium fuel does not reduce costs and may actually result in higher costs given the need to create a whole new fuel cycle infrastructure from scratch.

Additionally, the idea that thorium waste is easier to manage than uranium is patently false. While thorium-based fuel has a radioactivity similar to uranium for the first 100 years of its existence, it will actually be

[5] See also: here, here, here, here, here, here, here, and/or here.

much higher after 100,000 years. This suggests such waste must be properly controlled and managed much, much longer than uranium-fuelled reactor waste–neither of which, of course, are going to be for the length of time needed if we're being honest (more on this later).

Specific Hurdles To Overcome

Complex Material Science and Engineering

Thorium is not fissile in that it cannot sustain a chain reaction and requires a 'driver' fuel that can start and maintain the reaction process. It must have fissile U-235 or plutonium present for this. This causes the fuel cycle to be more complex, and thus more costly, than traditional reactors.

Th-232 is converted to U-233 through absorption of a neutron within the reactor. And to breed new fuel 'efficiently', spent fuel must be processed to remove neutron-absorbing fission products and extract the U-233; all of which requires the development and operation of an expensive, heavily-shielded, and complex chemical processing plant that is constructed with materials that can withstand high-level radiation. Such molten salt reprocessing technology has yet to be proven at a commercial scale.

MSRs require highly corrosive fluoride or chloride salts that must be kept at extremely high temperatures (about 700°C). Because of such temperatures, a major challenge then becomes finding and creating material that can withstand high temperatures and not corrode for very long periods (i.e., decades). And, as recently as 2018, a US study of the corrosion issue concluded that this was perhaps the most problematic hurdle keeping MSRs from being viable at a commercial level. They had yet to find any material that would work.

The breeder fuel (U-233) tends to be contaminated with U-232 that contains high-level radioactive decay isotopes (e.g., thallium-208) that produce gamma radiation making fuel fabrication, reprocessing, and transportation extremely hazardous and quite difficult. As a result, heavy shielding and remote handling is required, and which further increases the costs.

Regardless of the decades-long knowledge of such reactors and research surrounding them, the technology remains relatively immature in its development–a number of the 'solutions' being proposed to address such issues remain 'theoretical' in nature. There is also a lack of commercial-scale experience having had past experiments discontinued.

Economics

Relative to established alternatives, thorium-fuelled reactors are quite expensive (not less as is often argued). They have extremely high upfront capital, research, and development costs. Significant long-term investment is required to fund: the creation of new designs; attempts to 'solve' the engineering and material issues; construction of experimental/prototype reactors; and, establish needed infrastructure for supply chains.

Entrenched uranium-fuelled reactors are extremely cheap in comparison, especially given established fuel supply chains. Until and unless the price of uranium increases substantially, the expensive and complex reprocessing of thorium is unjustifiable. Of course, the industry argues that significant investment is needed to address such issues and bring down the costs. A further argument in favour of addressing the prohibitive costs is to build thorium-fuelled Small Modular Reactors where factory fabrication of components can reduce budgets; of course, this is only after they are built out into the hundreds of such reactors[6]. So, build them and the costs will 'eventually' come down is the 'promise' by the industry–and that has always worked out according to plan; except I seem to recall a promise about electricity being 'too cheap to meter' when nuclear power generation was in its infancy and seeking support.

In addition, there exists uncertainty regarding timelines, costs, and financial risk given the absence of regulatory frameworks for thorium-fuelled and molten salt reactors. What appears to be happening in light of this, however, is a lobbying push by the industry to expedite such processes by reducing/removing regulations so as to reduce the risk for investors (thus attracting capital). Critics argue this is highly 'problematic' in that by rushing such approvals through the likelihood of overlooked issues increases substantially, placing not only the immediate environment at risk but the entire biosphere.

[6] See my Contemplation on this 'solution': Website Medium Substack.

Politics
There exist some not insignificant political considerations and hurdles to an expansion of nuclear reactors in general, with some of these specific to thorium-fuelled ones.

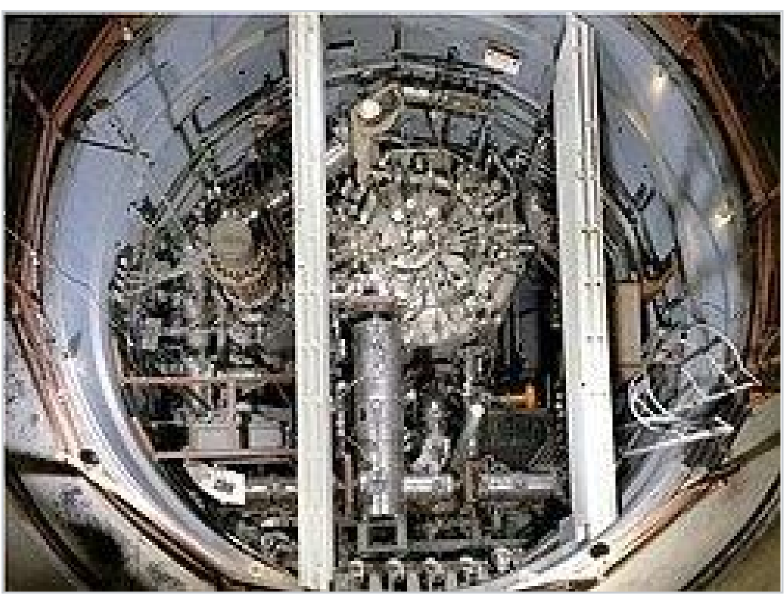
The proliferation of nuclear weaponry is one of those. While thorium is heralded as 'proliferation-resistant' (i.e., the U-233 produced from it contains high-level gamma radiation making it extremely difficult to handle safely), a determined nefarious actor could overcome this.

In addition, the sunk costs for the current global fleet of uranium-fuelled reactors and its infrastructure are enormous. It is financially prohibitive in the extreme to try and duplicate and/or replace this–and this may be especially so in a world 'drowning in debt' and already bumping up against material and mineral 'resource limits' in a number of areas. [Note: the marketing/propaganda by the industry and sociopolitical system, however, is trying desperately to underplay/ignore these impediments by spinning their buildout as economically beneficial, massive job creators, and necessary for the 'guaranteed' and 'inevitable' economic growth on the horizon.]

There also exists significant competition within the nuclear industry itself for investment funding. Next-generation uranium-fuelled reactors (especially Small Modular Reactors) and refurbishment of many reactors within the current fleet are competing for financial support. Despite what appears as self-evident limits to expansion, the nuclear industry and sociopolitical systems seem to be advocating for all iterations, including thorium-fuelled SMRs[7].

A Cautionary Tale
The MSRE carried out at the Oak Ridge National Laboratory in the 1960s is often referenced as successful by optimists as it is considered the foundational example upon which molten salt reactor hopes are placed. The operational record of this experiment, however, demonstrates ongoing and persistent issues that should, but don't, temper enthusiasm.

The MSRE experienced some 225 unplanned shutdowns over its four years of operation due to various technical failures, with only 58 of these being planned–the vast majority caught the operators completely by surprise. In addition, the reactor failed to ever reach its projected power generation, experienced ongoing component failures (e.g., blower and electrical system), pipe plugging, and fuel leaks despite safety systems meant to prevent such leakages.



Early thorium-based (MSR) nuclear reactor at Oak Ridge National Laboratory in the 1960s.

[7] See: this, this, and/or this.

Some Further 'Small' Considerations To Ponder

As-Yet-To-Hatch-Chickens

The enthusiasm displayed for thorium-fuelled reactors, especially of the molten salt breed, continues to be based quite substantially upon theoretical potential as opposed to repeated and confirmed evidence–particularly at a commercial scale. The technical hurdles for the fuel cycle (e.g., requires continuous chemical processing), reactor component longevity due to corrosive molten salts, and extremely high-level radioactive byproducts remain.

Politics

Sociopolitically, a novel regulatory framework is required to be created given the uniqueness of the reactor designs and fuel cycles. And the push by the industry to minimise such regulations (with accidents still in most people's minds and accumulating waste piling up at nuclear plant sites) is raising substantially the concerns amongst a growing number of people.

Being 'Green'

The idea that this technology (or any nuclear-powered one) is 'green/clean' must be challenged given the long-lived radioactive isotopes in their waste streams–more on this below–to say little about the massive material and hydrocarbon inputs required for their build out to the scale being proposed by the industry and politicians.

Waste

I covered the waste dilemma of nuclear reactors in some detail in Part 3 of my Contemplation series on the Nuclear Renaissance[8]. And I would argue that this is perhaps one of the more significant blind spots for most people when it comes to the perceived safety of nuclear energy.

Just because we have been relatively successful (lucky?) in managing waste products and have mostly avoided 'accidents' for the past 75 years should in no way assure everyone that such 'success' will continue for the millennia that are required for high- and intermediate-level radioactive byproducts of these technologies. Relatively short-term control/management should not be taken as a guarantee for future control/management; especially a longer-term view of it. The Precautionary Principle has been completely abandoned it would seem when it comes to this (and virtually all) technology.

Without even considering the prospects for such 'control' in light of our ecological overshoot predicament, pre/history demonstrates that the recurring phenomenon of complex society collapse/simplification results in a loss of sociopolitical stability and technological capability–meaning the perpetual management/control of these stores of waste products is a pipe dream based on magical thinking and faith, not evidence. We will lose management/control of these byproducts at some point in our future and they will impact our biosphere; that, I would argue, is guaranteed, and perhaps much sooner than most realise. And rather than plan for that eventuality, we are doubling/tripling down on the technologies and waste byproducts in question.

Jevon's Paradox

I touch on the issue of Jevon's Paradox in my Contemplation on Fusion Reactors[9] and that any prospect of 'clean' and 'inexpensive' energy (neither of which any type of nuclear is) tends to not only be additive to humanity's energy consumption but actually increases it. Efficiencies and increases in energy are gobbled up and expand consumption; they do not help to reduce our growth tendencies at all–in fact, quite the opposite. And, this additive nature, is what nuclear offers: more energy to do ecologically-destructive things (more on this below).

What We Do With Energy

Related to Jevon's Paradox, there's also the issue of what humanity does with its energy that should be considered[10]. I would contend that the vast majority of our energy consumption is used for purposes that, in the end, make our various predicaments worse; far, far worse. And not just by a little, but by A LOT.

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[8] See: Website Medium Substack.

[9] See: Website Medium Substack.

[10] An idea that had been floating around in my mind but that solidified for me after reading an article–I can't recall which one–by Dr Tom Murphy whose work you can find here.

Be it funnelling it towards the various nations' militaries and their war machines, chasing the perpetual economic growth chalice, expanding the reach of our extractive industries, chasing complex, industrial technologies, or simply just our expansion across the planet and into all its various environments–all of these activities exacerbate our fundamental predicament of ecological overshoot and its various symptom predicaments (e.g., biodiversity loss, resource depletion, sink overloading, etc.).

Mineral/Material Needs/Limits
I've made reference to the mineral and material needs of various technologies in a number of Contemplations. Besides the issue of Peak Hydrocarbons (which is fundamental to all technologies, especially the extraction, refining, production, and transportation of everything), especially oil, there are supply chain concerns and bottlenecks already occurring for numerous critical minerals and material–particularly when one considers the scale of construction and build-out being proposed. While a portion of this has to do with the geographic location of critical minerals (nations cannot find everything they need in their own backyard) , some has to do with geopolitical competition and how this is playing out with respect to trade and dependencies on national competitors.

But there are also concerns about the physical limits of certain matter, especially those required to meet the 'electrify everything' universe that nuclear power is proposed to support (e.g., copper). On top of the rare-earth elements (e.g., europium, dysprosium, ytterbium, lanthanum, praseodymium, promethium), there are concerns regarding quantities of barite, hafnium, zirconium, chromium, nickel, niobium, and high-assay low-enriched uranium.

Economics
Economically, these reactors are no better than their uranium-fuelled cousins. And, in fact, considering the significant research and development investment and government subsidies required to try and meet the hype they're getting, they may end up being much more costly.

The other monetary consideration in all these 'solutions' that tend to get marketed and pushed is the funding/debt of it all. The interest-bearing credit-money that is created out of thin air to fund these ventures–that appear to funnel money up society's power and wealth structure–that are marketed as benefitting society is not only akin to stealing resources from the future but puts extraordinary pressure upon ensuring further expansion/growth of economies in order to produce profits to pay the debt off–a Ponzi-like structure if ever there was one.

The world is currently carrying trillions of dollars of debt-bearing loan obligations; even if one just considers the principal payments, the growth required is astronomical—and then there are the promises of pensions and social welfare.

And the manipulations by central banks (especially efforts to lower interest rates and debt monetisation) exacerbates the above significantly, and also results in massive malinvestments, a bubble economy, and price inflation that disproportionately impacts the masses—particularly those at the bottom of our wealth structures.

Concluding Thoughts
All of these aforementioned 'hurdles' keep thorium-fuelled and molten salt reactors at a basic research and development phase–regardless of periodic announcements of 'breakthroughs'–and certainly well beyond the claims of their operational build-out being imminent and economically viable. Active research is ongoing to create alloys and component coating to prevent or slow corrosion, as well as modelling tools to better understand the reactor physics which are still not completely comprehended.

These reactors face profound and possibly insurmountable technical, economic, and material hurdles. They have been promoted as a 'solution' within human systems that are predicated upon infinite growth and debt, but which are serving to exacerbate the fundamental predicament of ecological overshoot and its various symptom predicaments. Investing in these speculative technologies not only drains resources and results in further ecological destruction, but diverts attention from the urgent tasks of attempted 'managed' societal simplification and community resilience-building. The evidence makes clear that these reactors are not a saviour, but a symptom of humanity’s general refusal to confront a far more inconvenient truth.

Recent and Relevant articles:

The World’s First Thorium Molten Salt Reactor | OilPrice.com

Thorium nuclear bombs and reactors have too many challenges | Peak Everything, Overshoot, & Collapse

China’s New Thorium Ship Just Challenged U.S. Maritime Power

Thorium: the wonder fuel that wasn’t. Bulletin of the Atomic Scientists | Peak Everything, Overshoot, & Collapse

Ontario and New York Sign Agreement to Build Nuclear Energy and Grow Economies

Thorium in the news | Peak Everything, Overshoot, & Collapse

Twenty Years Into Fracking, Pennsylvania Has Yet to Reckon With Its Radioactive Waste - Inside Climate News

Bill Gates Gen IV sodium-cooled fast reactor (SFR) in Wyoming | Peak Everything, Overshoot, & Collapse

Chernobyl

The End of Reason - The Honest Sorcerer

AI/data center backlash vs. the “progress” myth

Federal Regulators Issue Order Requiring Large-Load Users Pay To Grow Grid | ZeroHedge

Big Tech Ramps Up Propaganda Blitz As AI Data Centers Become Toxic With Voters | Common Dreams

Naval Reactors For AI Data Centers | ZeroHedge

“The narrative of ‘decoupling’ a growing economy from carbon emissions is the quantitative cornerstone of a larger, flawed ‘green economy’ paradigm. This paradigm is apolitical, relying on technological fetishism and market mechanisms like carbon credits to commodify nature further, rather than confront the fundamental political conflicts over distribution, limits, and power that ecological overshoot demands we address.

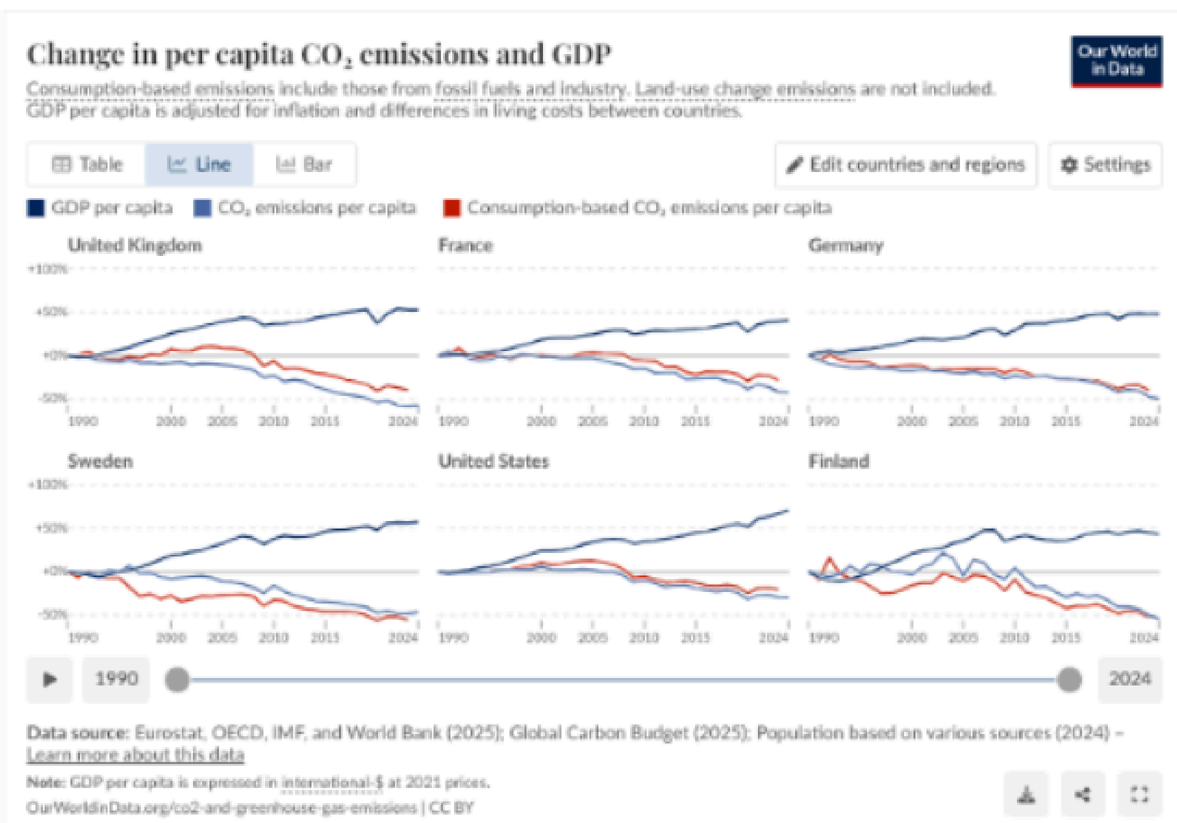
Perhaps it is little more than “a tale told by an idiot, signifying nothing” and belongs in the garbage bin of salvations that are constantly and repeatedly championed by profit-seeking interest groups and those intent on maintaining and/or expanding status quo wealth and power structures at the expense of the planet’s biosphere and all its inhabitants. It needs to be confronted and challenged like all the other similar saviours being used to justify perpetual economic growth while ignoring the negative consequences that accompany this quest.”

Website **Medium** **Substack**

Today’s Contemplation: Collapse Cometh CCXXV–
We’re Saved! Carbon Emissions Have Decoupled From Economic Growth.

In a recent article, energy analyst Art Berman critiques a report put out by The Energy & Climate Intelligence Unit (ECIU) regarding the notion of ‘decoupling’. I found this a timely article given I had already begun to think about doing another in my We’re Saved! series of Contemplations looking at the concept of ‘decoupling’ after reading an article by Matt Orsagh who writes at Degrowth is the Answer.

Before looking at Matt’s piece and raising Art’s critique, let me begin with some context for the discussion on them. After which, I am going to expand on their points with some of my own thoughts.



Decoupling

'Decoupling' is fundamentally referring to two things becoming disconnected from one another. When discussing economics and the environment, it is a buzzword for many in the 'sustainability' movement and for those concerned with anthropogenic climate change. It typically refers to greenhouse gas emissions (primarily carbon dioxide) 'decoupling' from economic growth (typically measured by Gross Domestic Product (GDP)). Simplistically, it refers to carbon emissions falling or expanding at a rate slower than the growth of the economy.

Some speak about a more complex and expansive 'decoupling' where a broader scope of environmental impacts are 'decoupled' from economic growth, not just emissions but where we witness less energy use, lower resource extraction, and reduced pollution. Similar to the simpler version, those who use it tend to aim for endless economic growth while minimising or eliminating planetary destruction. Most analyses and commentaries, however, tend to focus upon the 'simpler' connection between carbon emissions and economic growth, and not the broader ecological aspects.

'Relative' and 'Absolute'

'Decoupling' can be 'relative' in that emissions are growing but at a rate slower than the economy. In such cases, the 'decoupling' is considered weak but not broken. Planetary damage is still occurring, just at a slower pace. This is the more common form when spoken about.

When 'decoupling' is 'absolute', it refers to emissions falling while economies are growing. This is the type that many climate activists/environmentalists get excited about and set as the ultimate goal. 'Absolute decoupling' is the holy grail of those advocating 'green growth'.

How Does 'Decoupling' Occur?

'Decoupling' can take place through a variety of mechanisms. First, energy efficiency–where less energy can produce the same economic output–can bring on such 'decoupling'. A structural change in the economy can also lead to it, with an example being shifting from certain carbon-intensive industries (e.g., cement and steel production) to service- or knowledge-based ones (e.g., finance, healthcare). Switching fuels can, given enough time, also reduce emissions, such as replacing coal with natural gas or nuclear or solar photovoltaic. Finally, societal policy and regulation can reduce emissions, such as carbon taxes or cleaner technology standards.

National 'Decoupling'

Proponents of the 'decoupling' narrative point to real, documented drivers behind emissions reductions in some nations. Reports from statistical agencies attribute national declines to specific policy frameworks, the rapid build-out of 'renewable' energy capacity that is replacing more carbon-intensive forms of energy, gains in energy efficiency, and shifts towards service sectors and away from industrial-based ones.

Why Is It Important?

'Decoupling' is believed by many to be very important as it demonstrates that prosperity through economic growth can continue without harming the planet and take place within planetary boundaries. What has become known as 'green growth' is entirely within our capability, if we simply do the 'right things'.

Perpetual economic growth and associated 'progress' in balance with Nature. What's not to like?

Well…

Criticism Abounds
The idea of emissions 'decoupling' from economic growth and related concepts have come under critical scrutiny given the importance of narratives around human progress, economic growth, ecological systems impacts, biogeophysical limits, and planetary boundaries.

It is crucial to engage directly with the evidence proponents use to support their claims. A 2024 study in Scientific Reports that analysed 164 countries found that 49 had achieved some form of 'decoupling' but the rest had not. The ECIU report mentioned at the outset claimed economies representing 92% of global GDP had demonstrated 'decoupling'. It is this type of data that fuels and supports the optimism of 'green growth'. Such success, however, is geographically limited, observed predominantly in wealthy nations, and–as the following critiques will show–is often based upon accounting that hides more than it reveals. A pertinent question, then, is not if decoupling can be measured in select places but if what is occurring is sufficient, genuine, and global.

Decoupling: Don't Get Your Hopes Up
Matt Osargh's post is a critique regarding an article that appeared in the Guardian reporting on the same ECIU analysis that Art Berman critiques in his post.

The Guardian article is what I would characterise as a regurgitation of the ECIU's claims with no in-depth or critical analysis: it simply accepts and reports the findings. It highlights exactly what the ECIU report argues: economic growth has 'decoupled' from emissions across nations that represent 92% of the global economy; this trend is pronounced in 'advanced' economies and shifting in the right direction for others; and, it is the result of governmental policies and regulations, as well as a quickening energy transition.

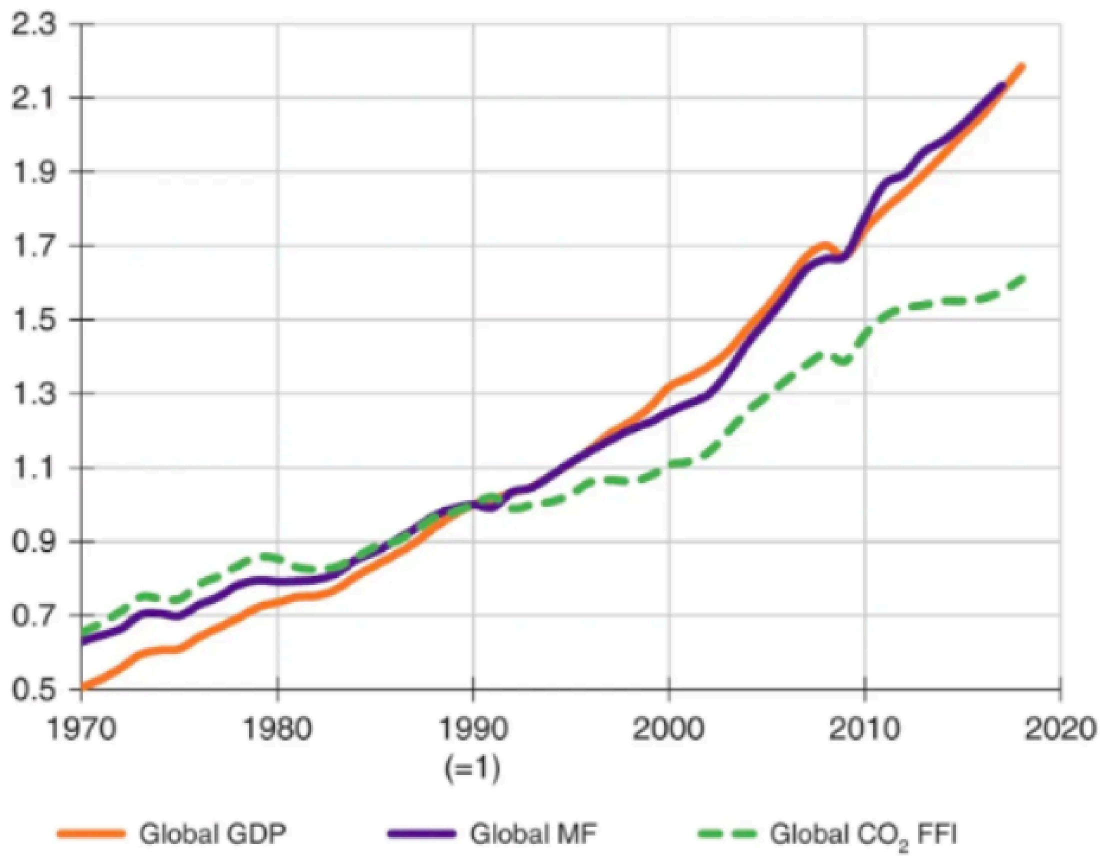
As Matt points out, the Guardian was quick to highlight the ECIU's claim that a number of high-consumption nations had achieved 'absolute decoupling' from economic growth as measured by GDP. Matt takes exception with that declaration (and especially the headline wording) arguing that **such claims are not just misleading but create dangerous and false hope as well as distracting from more fundamental societal shifts that are needed to address our climate crisis**.

He goes on to argue that while there is evidence to suggest that the link between GDP and emissions is weakening, the way the data is presented implies the issue is 'solved'; which it is not. Only half the countries in the report achieved decoupling in 'absolute' terms, while the other half showed it in 'relative' terms. More problematic, however, is that **the report only focussed upon 'consumption-based carbon emissions' and excluded major carbon emission sources such as those that occur as a result of land-use changes or deforestation**.

But even if we accept the claims of the report, Matt contends that **the scale and speed of 'decoupling' is not occurring at a rate fast or large enough to meet climate targets**. And Matt wonders if large-scale 'decoupling' is even possible. He cites a 2019 review that the European Environmental Bureau carried out and which did not find any empirical evidence of such 'decoupling'.

Matt further argues that if one looks at global material resource use (MF in the above graph; which requires significant ecological destruction, including emissions), GDP has correlated tightly with this measure for more than a century.

Matt concludes with the argument that **the 'green growth' techno-optimists claim is possible and occurring is a fantasy. Instead, the world needs to embrace degrowth since the pursuit of economic growth is "false, ridiculous and self-destructive"**. Humanity needs to prioritise well being and ecological limits as opposed to perpetual economic expansion. False hope needs to stop being offered and **the difficult truth that our economic systems need to change dramatically must be confronted**.



Source: Wiedmann et al. (2020). Scientists' warning on affluence. Nature Communications (11)

Dumb and Dumber

Art Berman's post also critiques the claims made in the ECIU report, pointing out that their assertions are not only misleading but based upon flawed accounting and does not indicate genuine physical progress towards 'decoupling'.

Art argues that the conclusion reached by the ECIU is false because it relies upon consumption-based emissions data and fails to account for advanced economies that import many goods where the emissions are 'counted' in the producing country's ledger, not the importing one. This is an accounting trick that allows importing nations to appear as if their emissions are falling when in fact they are simply shifting them to another nation.

Art maintains that there is no 'decoupling' occurring from a physical systems perspective. Emissions continue to rise globally and reductions in some nations are offset by increases in others. The past 35 years shows a strong correlation (0.82) remaining between GDP and carbon emissions with no change in this trend despite decades of policy changes and 'green' technology. Mitigation attempts (e.g., electric vehicles, 'renewable' energy) have not changed this trajectory.

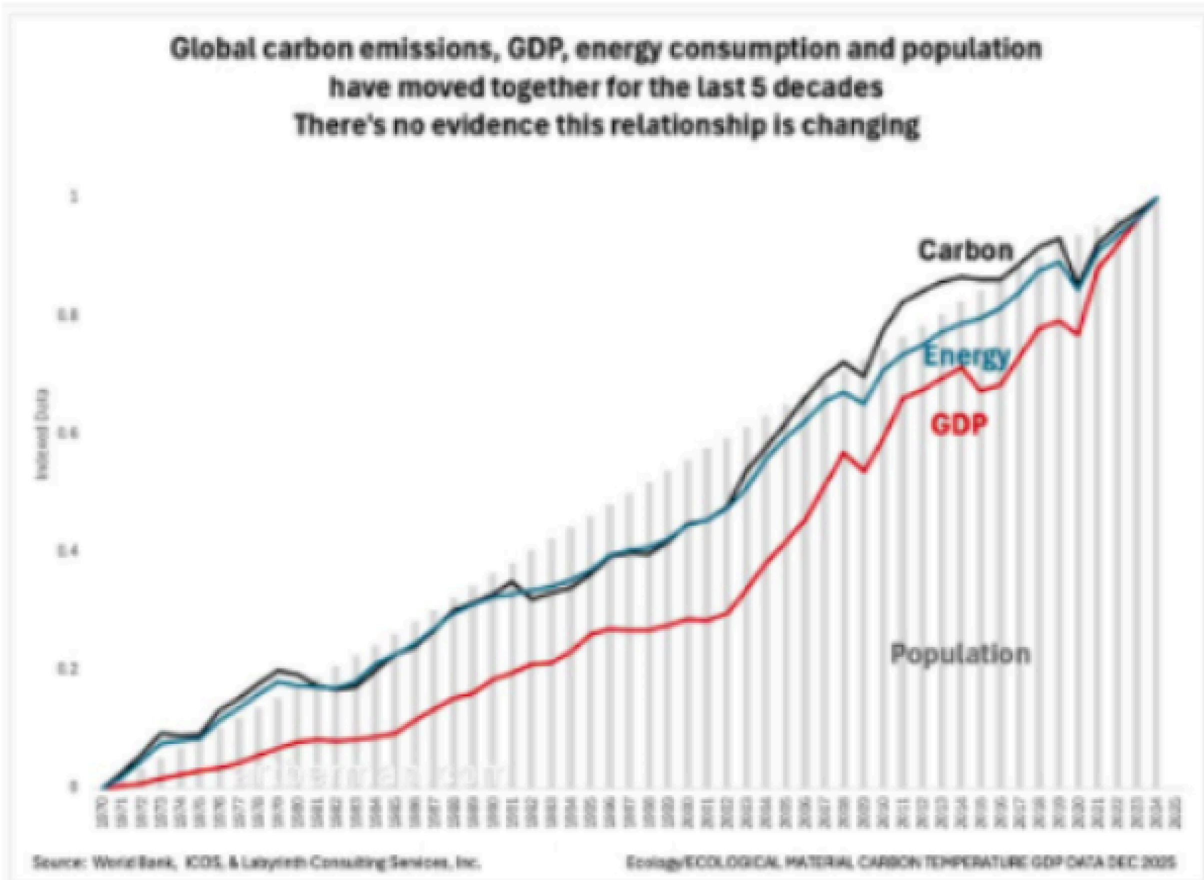


Figure 5. Global carbon emissions, GDP, energy consumption and population have moved together for the last 5 decades. There's no evidence this relationship is changing.

Art contends that the ECIU's report is motivated by institutional self-preservation and via the creation of a comforting narrative where a number of beliefs can be held simultaneously: climate change is real; perpetual economic growth can continue; and, current policies are adequate to address climate change concerns. He further argues that only the first of these three beliefs is true.

Art concludes by calling for honesty around these topics and their related issues. **The illusion of progress towards 'decoupling' via accounting tricks is "biophysically meaningless". Humanity needs to be honest regarding the hard, physical constraints that exist on a finite planet and the implications of this for our economic systems, not lying to itself with cherry-picked data.**

These two essays examine critically the claim that carbon emissions and economic growth have 'decoupled'. They share a core skepticism but differ in their arguments, evidence, and what to do in light of the issue.

Despite approaching the issue from different but complementary angles, they arrive at the same conclusion: 'decoupling' is a dangerous myth. Matt provides what can be considered an ideological and moral case for moving beyond growth, framing the issue as one of false hope and the need for systemic change. Art, on the other hand, uses the physical and data-driven evidence to show how the claim is an 'accounting trick' that conflicts with biophysical reality.

Together, they provide a powerful critique that the ‘decoupling’ narrative is physically unfounded while being politically obstructive and delaying the needed systemic and societal shifts necessary for a stable climate–let alone a broader array of ecological impacts that are ignored by those making claims about ‘decoupling’ taking place.

I wish to add a few more thoughts on the idea of ‘decoupling’ that some claim is occurring; or will at any moment, if we simply employ the correct policies and/or technologies.

Gross Domestic Product (GDP)

Many experts and institutions argue that the use of GDP as **the** metric to base ‘decoupling’ on is extremely problematic and, as we can see from the two articles presented above, creates a misleading picture.

GDP is fundamentally a measure of economic transactions that excludes both societal well-being and environmental health; the latter being core to the arguments for ‘decoupling’. This undermines its ability to be effective as an indicator of ‘sustainability’.

Ecological Blind Spots

GDP’s core flaw is that it carries with it significant ecological blind spots. It measures economic activity without any consideration if the activity is beneficial or detrimental to the planet’s ecological systems.

In fact, activities that are clearly environmentally harmful (e.g., deforestation, hydrocarbon extraction and consumption, mining, land-use changes) are considered economic gains; the negative impacts are not part of the equation. Dispersal of pollutants and toxins are not counted as a ‘cost’, but the activity to clean up environmental disasters such as chemical spills is seen as a contribution to GDP. And, resource depletion is ignored; natural resources are viewed as infinite income and not finite capital assets.

This flawed accounting impacts how growth and emissions data are interpreted. Progress towards ‘decoupling’ gets grossly overstated in a nation that has off-shored much of its carbon-intensive industries but has a rising GDP while importing industrial goods from others. Incentives can get misaligned when polluting activities contribute to the economy, creating a situation where policy shifts to help with long-term sustainability–such as pursuing degrowth–are frowned upon, if not denigrated. Finally, other forms of ecological systems degradation are masked when GDP growth is sustained by industries that might be less emissions-intensive but lead to issues that are not captured (e.g., biodiversity loss, water and/or air pollution, ocean acidification).

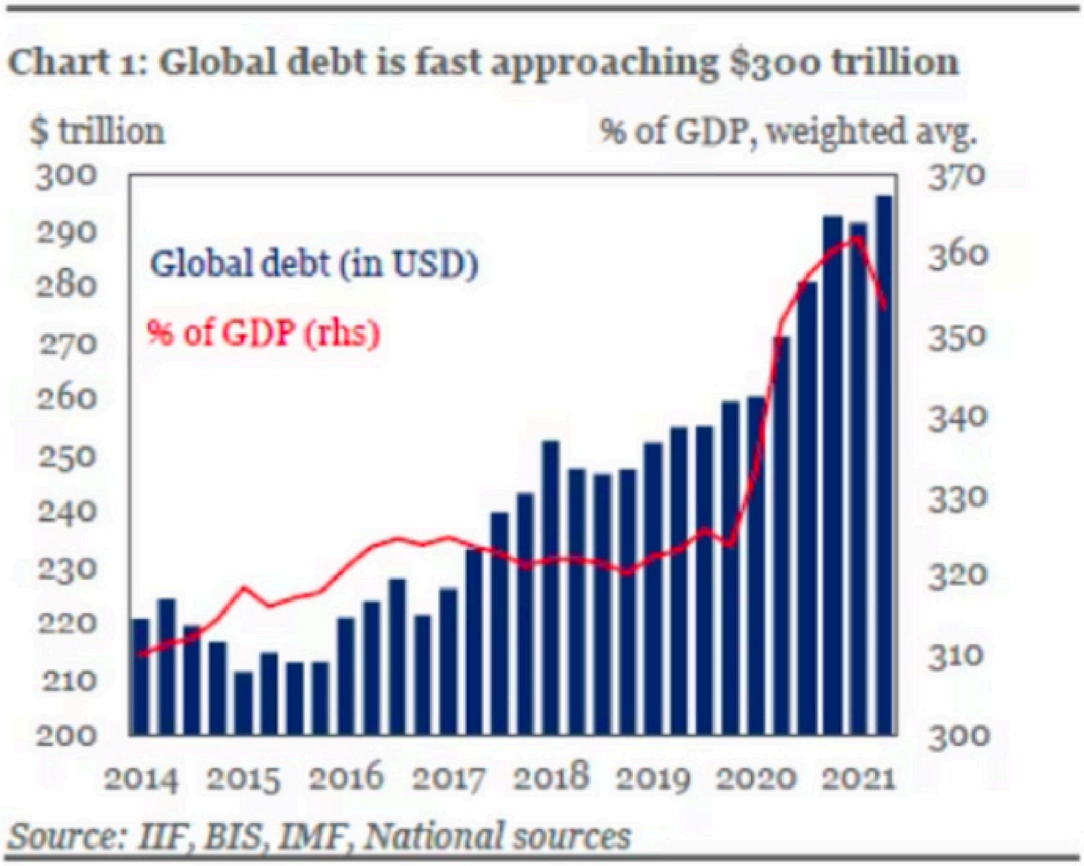
Debt and Financialisation

GDP-based ‘decoupling’ claims are further weakened and distorted due to monetary aspects of our economies.

Debt, especially when used to finance growth, creates a link between GDP, emissions, and financial expansion that challenges the very idea that ‘decoupling’ of economies can easily occur if we just ‘do the right thing’.

A recent study that modelled debt-financed growth and ‘carbon lock-in’ for four advanced economies found a strong relationship between cumulative GDP, debt accumulation, and cumulative emissions. Debt-driven growth was found to amplify emissions due to high-carbon trajectories being locked-in because of the need for sustained growth to service the debt. Credit-driven growth regimes challenge the very feasibility of ‘decoupling’. And world debt has done little but significantly grown in an exponential fashion across the planet, meaning significant exponential economic growth is required.

The study further notes a macroeconomic rebound effect where a positive feedback loop is created between credit expansion and carbon-intensive industries. Even where debt is used to expand 'clean' energy and boost GDP, higher emissions occur not just from the industrial activities associated with mass-producing the non-renewable, renewable energy-harvesting technologies but via increased consumption.

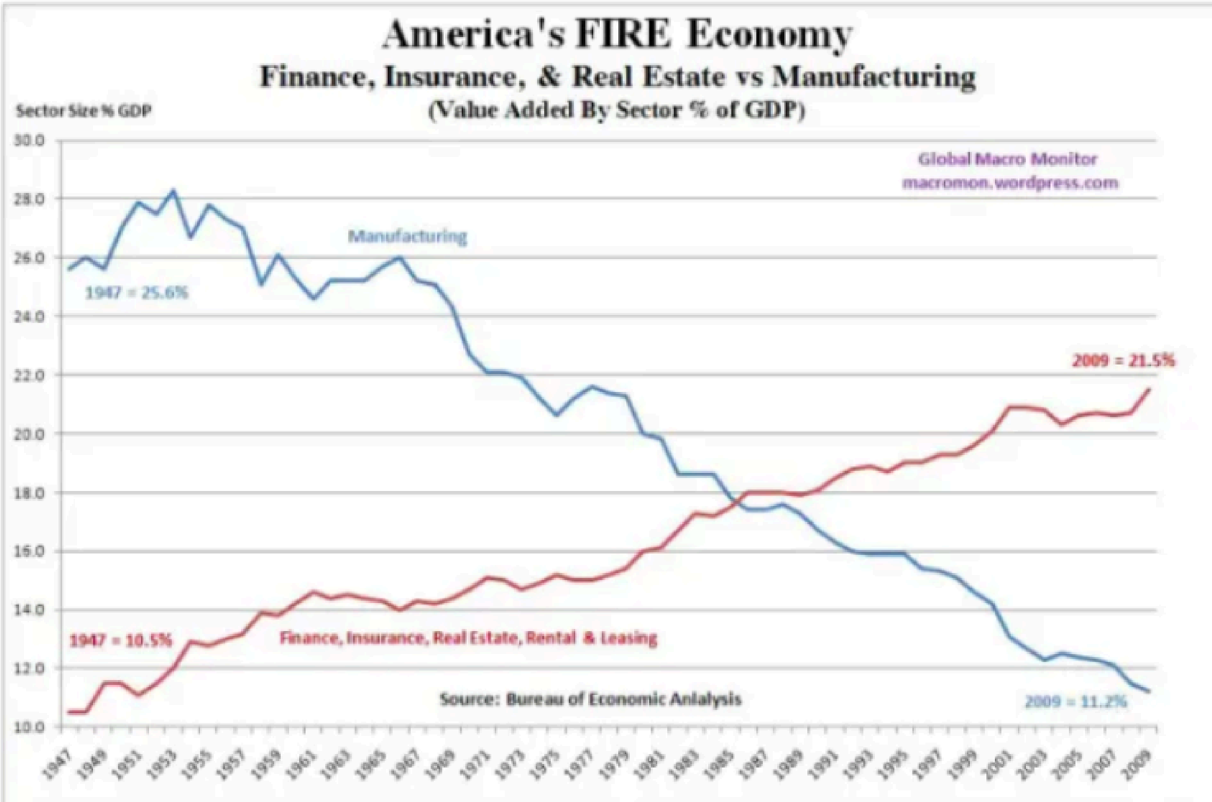


Similar to issues surrounding debt, the increasing growth of economies–as measured by GDP–via the FIRE sectors (i.e., finance, insurance, and real estate services) influences significantly the GDP-emissions link in a fashion that distorts perceived environmental improvements.

The financialisation of economies that occurs as a result of the growth of these sectors in most (all?) advanced economies has been substantial. And when combined with the off-shoring of carbon-intensive industries, 'decoupling' of a growing GDP from emissions can seem to be in a positive light.

This is not a systemic improvement, however; it is a sectoral shift. A recent study that examined this phenomenon across 172 nations from 1960-2014 found that while per capita GDP and emissions 'decoupled', it did no such thing in relation to growth from manufacturing. The absolute and negative impacts on the environment from manufacturing and their associated emissions tended to be maintained or actually grow: 'decoupling' was the result of growth in the FIRE sectors combined for some nations with the off-shoring of manufacturing.

The financial transactions that take place within the FIRE sectors contribute significantly to GDP without corresponding emissions increases. All this is doing, however, is inflating the economic aspect of the 'decoupling' ratio. It's a statistical improvement that masks the continued and oftentimes increasing environmental degradation via the industrial-based economy (especially in those nations whose manufacturing industry sector is increasing as a result of other nations decreasing theirs).



[Global Macro Monitor]

The expansion of debt and finance-based sectors greatly undermine the claim about 'decoupling' in most nations that make it. In fact, combined, these aspects reveal the limitations of the narrative completely.

Debt-driven growth actually leads to structural 'coupling' due to repayment requirements. Apparent 'decoupling' may be totally illusory (or temporary) as the perpetual growth that is needed to occur will result in future emissions, with greater and greater emissions occurring as the interest on debt compounds. Increases in the financial transactions of the FIRE sectors do result in a statistical 'decoupling' but not in the material manufacturing sector that result in the lion's share of environmental impacts.

This highlights that a rising GDP can be driven by financial mechanisms almost completely detached from or contradictory to actual environmental sustainability. This brings to mind the saying: There are lies, damned lies, and statistics.

Reification

The phenomenon of treating abstract concepts like concrete, measurable entities is known as reification. It is a concept I first became aware while in university when I read the late Stephen Jay Gould's critique of the concept of biological determinism and the notion that economic and social differences between human populations are due to inherited traits; Gould used it when discussing intelligence as viewed through intelligence quotients (see: [The Mismeasure of Man]).

Reification is a process that occurs when an abstract concept or idea is treated as though it were a concrete and physical thing. Something immaterial becomes a physical 'thing' with the appearance of natural existence.

When we ‘reify’, we lose sight of the fact that the thing we are discussing is a human-created and abstract system or idea; we begin to view it as an unchangeable thing beyond our control or influence.

This process takes place all the time. In capitalist societies, for example, we tend to view the economic system as consisting of objective and natural laws to be obeyed, and not as a historically created human system. And, as Gould argued, in psychology when we view intelligence as a measurable entity and give it a number. The common thinking about GDP is a perfect extension of this.

GDP began as an abstract and statistical tool to measure the economic activity of a nation. The calculation of it was based upon the market value of goods and services produced within a specific timeframe. It was a model of one aspect of an economy. (See: here)

Over the decades since its introduction, the concept has become reified. As we can see through some of the discussion above, it is now treated not as a descriptive measurement but as a concrete thing and goal to be pursued. We have masked the human construction involved, such as what counts as ‘productive’ and what doesn’t, and forgotten that these are subjective, arbitrary, and value-laden choices.

We have turned an abstract concept into an ‘objective and natural entity’. It is treated as a measure of progress while ignoring the ecological damage left in its wake. This allows us to turn negative impacts of our economic activities (e.g., oil spills, pollutant dispersal) into positives (i.e., GDP increase/economic growth) when we engage in activities to counter these impacts.

Why is the reification of GDP problematic? Well, there are profound effects when we view GDP as an objective and concrete gauge of national well-being rather than the narrow one of economic output that it is.

First, governments in particular but also other institutions become compelled to prioritise policies that encourage perpetual growth of GDP. They seek to encourage large-scale projects and stimulate consumption, and often at the expense of other goals–particularly environmental sustainability. Increase of this abstract metric becomes the guiding objective. And governments are not shy at all about connecting this to ‘progress’ and taking on significant debt to achieve it.

By connecting GDP to progress and the well-being of society, our current form of market capitalism becomes seen as the most natural and rational path. Alternative economic systems that might prioritise a more stable and sustainable trajectory over the endless growth we are currently chasing becomes viewed as contrary to ‘economic laws’. GDP becomes not only the arbiter of socioeconomic systems but also social arrangements.

The reification of GDP also serves to disconnect us from what matters. Society’s members view personal well-being, much like their nation’s success, via this number. Feelings of prosperity become connected to it, regardless of personal job security, health, and community resilience. Human experience becomes subordinated to this abstract measure.

‘Decoupling’ Reified

Not only has GDP become reified, but the idea of ‘decoupling’ has similarly fallen prey to this phenomenon. An extremely complex statistical relationship between an economic metric (GDP) and an emissions measurement has increasingly become viewed as a concrete thing that has been serving to direct policy goals, especially the primary one of economic growth; while its limitations are hidden, obscured, and even ignored.

Much like the economic activity metric GDP, ‘decoupling’ the drivers of emissions has become reified into a goal that could be labelled ‘green growth’ and has helped to further GDP growth as a non-negotiable policy.

While this notion of ‘decoupling’ arose first, it has become tightly associated with the descriptive framework called the Kaya Identity that attempts to analyse the relationship between a number of important variables (i.e., energy, GDP, carbon intensity, and population) so as to identify the drivers of emissions; which has aided in the reification of ‘decoupling’.

Its reification masks not just the very messy complexity behind the statistics involved, but the choices made along the way as to what gets ‘counted’ and what doesn’t. Reified ‘decoupling’ also can become a self-fulfilling prophecy where models only assume continuous GDP growth as an input regardless of biogeophysical planetary limits and constraints. As a result, the question as to whether perpetual growth is even possible on a finite planet shifts to a naturalised growth imperative asking how do we ensure continued growth.

As the discussion above demonstrates, however, there exists a gap between this reified and relatively simplistic notion of ‘decoupling’ and the complexities of the physical world. Accounting illusions, continued global positive correlation between GDP and CO_2, and research that shows most advanced-economy emissions reductions since for the past 200 years have occurred as a result of economic recessions and not ‘green growth’ are just a sampling of this.

Carbon Tunnel Vision and Resource/Energy & Ecological Blindness

I penned a three-part Contemplation series on the blind spots that exist for many when it comes to energy/resources and ecology along with the phenomenon of carbon tunnel vision (see: Part 1, Website Medium Substack; Part 2, Website Medium Substack; Part 3, Website Medium Substack), and these blind spots certainly apply to the narrative about ‘decoupling’ carbon emissions from economic growth.

In these previous essays I basically argue that the hyperfocus upon carbon emissions and climate creates a perspective that overlooks broader and more severe symptom predicaments of ecological overshoot (e.g., biodiversity loss, soil degradation, novel entity pollution). This constricted view leads to a promotion of technological ‘solutions’ (e.g., non-renewable, renewable energy-harvesting technologies, electric vehicles) that ‘may’ address carbon emissions but exacerbates several other of the very important planetary boundaries.

In addition, society tends to be blind to the energy inputs (particularly the one-time cache of cheap and dense hydrocarbons) necessary to support our many complexities (e.g., food production, complex material supply chains, mass industrial production). Instead of attributing our complexities–what some would refer to as ‘progress’–to these hydrocarbons, we have created stories to elevate the importance of our species’ ingenuity and technological prowess while also failing to recognise our dependence upon these and other significantly important finite resources.

Finally, a similar blindspot exists with respect to our life-supporting ecological systems. Systems that have been and are being degraded far beyond their natural limits. Many of the planetary sinks that would compensate for perturbations in the natural environment have become overloaded and can no longer perform their function. To say little about the impact upon the many non-human species as a result of our expansion into and destruction of their habitats.

These blindspots are the result of human psychology. We not only create narratives to confirm biases but to protect our self-esteem. We display both confirmation and self-serving bias to elevate our sense of control and ingenuity through these stories rather than acknowledge our dependency on finite resources and nature. Those at the top of societies’ wealth and power structures promote these narratives as they support status quo systems (that they profit from) and because addressing overshoot would require degrowth that threatens these structures.

In summary, this 'series' hopefully demonstrates that arguing about which industrial technology will 'save' us is quite meaningless within the perspective that we are will into ecological overshoot. Mitigation of this overshoot via a drastic reduction in scale and complexity of our societies and relocalisation of important survival mechanisms (especially food production and potable water procurement) may be humanity's only viable path. But there exist powerful narratives and cognitive biases working hard to help us deny this reality.

Application to 'Decoupling'
Applying this theme to the claim of 'decoupling' reveals that it is a dangerous and quite illusory narrative reflective of the cognitive biases just highlighted above.

It is perhaps the ultimate expression of carbon tunnel vision. It is hyperfocussed upon carbon emissions and ignores the wider predicament of ecological overshoot. The 'green growth' the 'decoupling' narrative attempts to justify would serve to accelerate planetary boundary breaches through its material and energy throughput of economic growth. It serves to treat a single symptom (not very well given the evidence to the contrary), while feeding the disease.

The 'decoupling' narrative is further founded upon energy blindness that ignores physical reality. It holds that technology and efficiency will sever a historic link between economic growth and energy use while misattributing the growth to human ingenuity rather than the subsidy provided by hydrocarbons. It ignores that the 'green' technologies it advocates are extremely energy- and resource-intensive products only available because of the hydrocarbons it is seeking to supplant. Further, it overlooks the Law of Diminishing Returns and Rebound Effects. And, it appears to be a thermodynamic fairy tale used to justify business-as-usual through its contention that infinite growth is quite possible on a planet with biogeophysical limits.

Finally, the 'decoupling' story should be seen for what it is: a tale told to protect status quo power and wealth structures. It is a socially-constructed narrative designed to serve specific interests. It promises endless economic growth, creates new markets via 'green' technologies, and ensures revenue streams for the ruling elite.

Concluding Thoughts
'Decoupling' is very appealing because it reinforces our self-serving biases and desire for agency. Our species is so ingenious we can pursue infinite growth on a finite planet without sacrifice, something most wish given how deeply invested in the current economic paradigm we are. By focussing on the visible products, the ecological destruction being created behind the scenes can remain hidden–out of sight, out of mind. Blind to what is behind the curtain, most will find the narrative entirely plausible.

Unfortunately, the 'decoupling' story in supporting 'green growth' worsens our fundamental predicament of ecological overshoot. It accelerates our breaching of the various planetary boundaries and postpones actions that would help to mitigate the consequences of this overshoot. It is not a rational policy goal but a collective psychological defense mechanism created through energy blindness and carbon tunnel vision by those in power to make infinite growth on a finite planet appear entirely plausible.

The narrative of 'decoupling' a growing economy from carbon emissions is the quantitative cornerstone of a larger, flawed 'green economy' paradigm. This paradigm is apolitical, relying on technological fetishism and market mechanisms like carbon credits to commodify nature further, rather than confront the fundamental political conflicts over distribution, limits, and power that ecological overshoot demands we address.

Perhaps it is little more than “a tale told by an idiot, signifying nothing” and belongs in the garbage bin of salvations that are constantly and repeatedly championed by profit-seeking interest groups and those intent on maintaining and/or expanding status quo wealth and power structures at the expense of the planet’s biosphere and all its inhabitants. It needs to be confronted and challenged like all the other similar saviours being used to justify perpetual economic growth while ignoring the negative consequences that accompany this quest.

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"*We are not saved. A hydrogen-based energy system, like so many techno-fixes, is ultimately a story we tell ourselves to avoid the harder, more fundamental story. It is a tale of sustaining the unsustainable. The inescapable conclusion is that we are not facing an energy problem to be swapped with a new carrier, but a civilizational predicament rooted in the impossibility of infinite growth on a finite planet. The first step toward genuine mitigation of our overshoot predicament is not a new round of magical thinking, but the courage to stop—to read the physical evidence before us, and to finally turn towards the conversation we have spent a century evading.*"

Website **Medium** **Substack**

Today's Contemplation: Collapse Cometh CCXXVI–
We're Saved! Hydrogen Energy.

There exists a variety of justifications surrounding the potential of using a hydrogen-based energy system to play a much larger role in supporting human societies and their array of complexities and growth. As seems typical, the claims made by the energy industry and supporters of such an energy system don't appear to be as straightforward and certainly not as beneficial as marketed.

I will begin this Contemplation with an overview of what exactly hydrogen energy is and isn't, and then explore a variety of aspects that need to be considered with respect to any evaluation as to whether a hydrogen-based energy system is a useful path to pursue–or not.

depositphotos.com

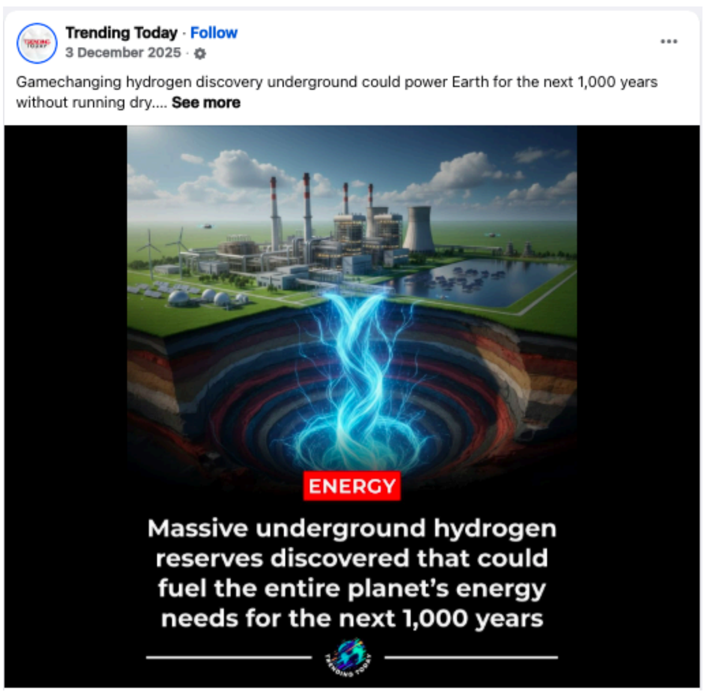
Hydrogen Energy
First, it is extremely important to clarify that **hydrogen-based energy is not a primary source of energy** such as coal. **It is a medium that can store energy produced by other sources** and then deliver it to be used. Think of hydrogen as a battery into which one can place energy and then retrieve it when needed. From a narrow end-use perspective, its only waste product is water vapour and this is why many argue its use can help to clean up and decarbonise the energy sector.

Production and Energy Input
While hydrogen is the most abundant element in the universe, it doesn't tend to occur in its molecular form on our planet. Hydrogen must first be 'produced' before any hydrogen-based energy system can begin. It's during

this production (where significant energy inputs are required to break apart chemical bonds to create H_2 molecules) that the energy it is to carry is 'transferred' to the hydrogen molecules.

The environmental impact of a hydrogen-based energy system thus depends greatly on what process is used to generate the energy-carrying hydrogen, and the industry has colour-coded the various types that it produces. But, as we will discover below, the environmental impacts don't stop and start with how hydrogen is produced and the energy it carries is input. The story is much more complex–as are all stories that involve energy production and use.

'Green hydrogen' is considered the 'gold standard' because it is viewed as completely carbon-free. Its production is via 'carbon-free renewables' such as solar photovoltaic panels and wind turbines. Blue hydrogen, the next step down in the 'clean hydrogen' narrative, is produced from natural gas by a process called steam methane reforming; its carbon emissions are minimised via carbon capture and storage (CCS). Gray hydrogen (that makes up approximately 95% of today's supply) is also made from natural gas but is very carbon intensive as there is not any CCS involved. There also exists turquoise (via methane pyrolysis), pink (via electrolysis using nuclear power), and other types of hydrogen 'energy' based on emerging methods of hydrogen production.



Typical click-bait site post

Storage and Transportation
One of the first challenges to overcome after hydrogen's production is its storage and transportation. Hydrogen is light with a low energy density by volume and very difficult to store and move.

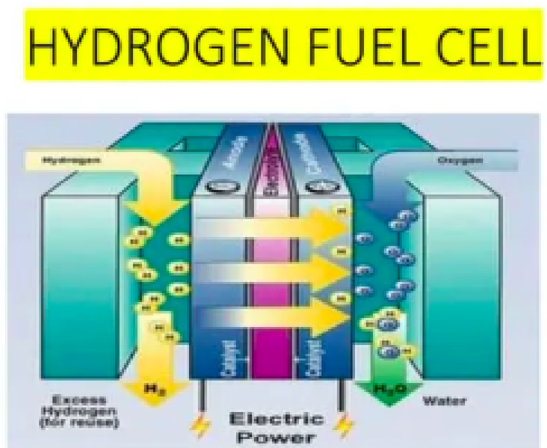
There exist three methods of storage, all of which are very energy-intensive: compression of hydrogen gas into high-pressure tanks; liquefaction at extremely low temperatures (-253°C); or, binding with appropriate chemicals or other materials to serve as a hydrogen carrier. Pros and cons accompany each of these approaches.

Transportation methods depend upon the distance and quantity of hydrogen to be moved. Most of today's hydrogen is transported via pipelines or tube trailers in its gaseous form over short distances. Longer distances tend to use specialised tankers for its liquid form, or specialised ship containers for chemically-bound hydrogen.

Energy Conversion
Once stored and transported to its destination, hydrogen must be converted back to a usable energy form. The primary method for this is a hydrogen-fuel cell where it is mixed with oxygen to produce heat, water, and electricity to power vehicles, industries, and buildings. Hydrogen can also be burned directly in turbines for electricity generation or within engines to power heavy machinery or ships.

In applications where batteries aren't ideal (i.e., limited space and/or weight concerns) hydrogen seems particularly well-suited, especially heavy transport. It can also be used as a fuel where high heat is required, such as 'green' steel production, or as a chemical feedstock for fertiliser.

As a carrier of energy, hydrogen is marketed as a great means of storing excess energy produced from 'carbon-free renewables'. It is then available at a later time in order to help stabilise the electricity grid. And while its direct burning can serve as a fuel for heating, it is actually more efficient to burn hydrogen gas to produce electricity for heating.



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Benefits
Hydrogen energy advocates highlight its many advantages: produces only water vapour at its point of use; is versatile in being useful for power generation, heating, and as an industrial feedstock; with its high energy density by weight, it is better than batteries for weight-sensitive applications such as heavy transportation vehicles; can store energy for very long periods of time unlike batteries; and, when produced 'cleanly', reduces dependency upon hydrocarbons and can serve to help 'decarbonise' society.

What's not to love?

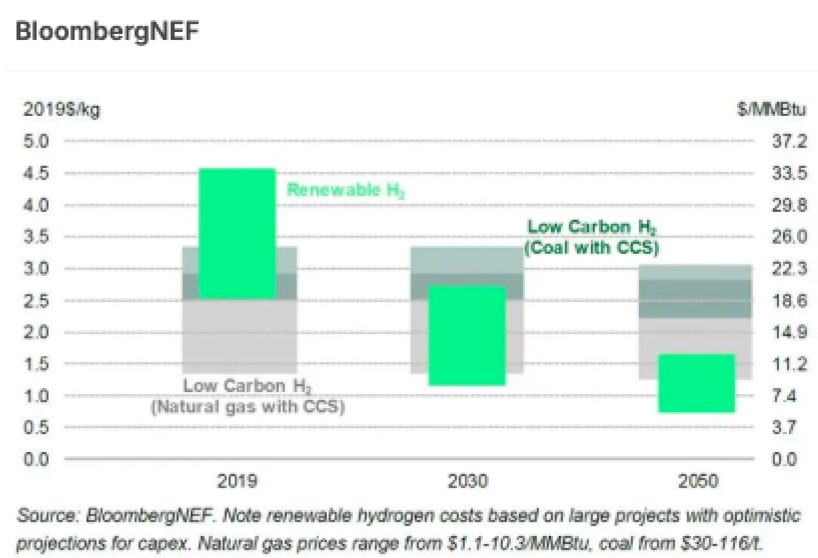
Well…

Hurdles and Difficulties
The challenges and disadvantages of exploiting hydrogen as an energy carrier are not insignificant, but rarely if ever raised by those who are marketing it or have come to believe it is the next energy 'saviour'. These difficulties run the gamut from economic to energetic to safety. And then, of course, there exist significant finite material and mineral needs.

Economics
From an economic perspective, a hydrogen-based energy system is prohibitively expensive. The bulk of this is caused by the need for a massive new infrastructure to be created if it is to be used beyond small-scale, experimental, and/or prototype applications.

First, the production of hydrogen is significantly expensive, especially when one considers the 'green' ideal (i.e., via 'renewables') that receives the greatest headlines but constitutes a miniscule portion of the current market (less than 3%). The far less expensive (and much 'dirtier') 'gray' option dominates, negating the supposed 'clean and carbon-free' argument. Add on top of this the concerns about how resources could become a limiting factor since the 'green' option requires massive 'renewable-energy' inputs and significant amounts of water, placing a strain on local environments. Then there's the hugely expensive electrolysers required for the production of 'green' hydrogen.

Additionally, materially-adequate production, transportation, storage, distribution, and fuelling infrastructure must be constructed from scratch. This requires significant funding, especially given all the materials are specialised for leak prevention and metal embrittlement reduction. Storage, for example, requires specialised high-pressure compression tanks or energy-intensive liquefaction facilities. When transported, very specialised vehicles or pipelines are a must. And then there are the supply bottlenecks and limits as rare minerals are required for the production of these specialised materials.



blogs.worldbank.org

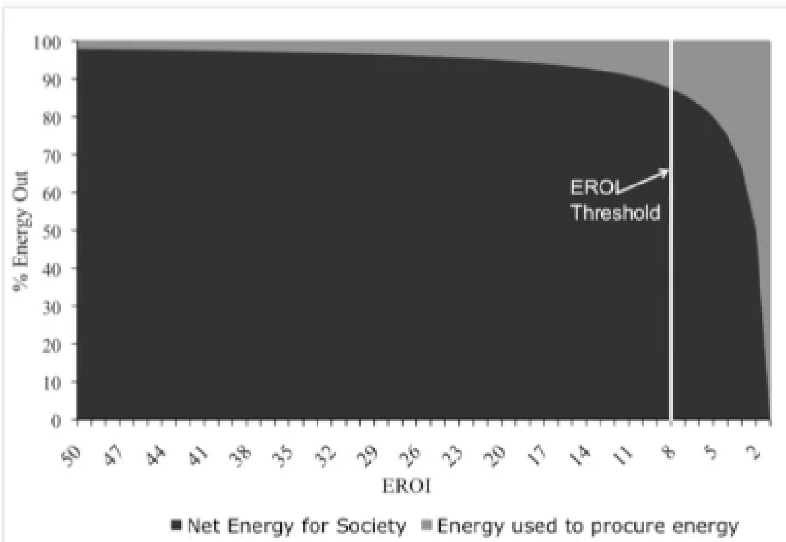
When one tallies up the balance sheet from all the processes and necessary infrastructure to support it, **it makes little to no economic sense**. Without significant government subsidies (primarily via debt expansion), there is no economic argument to support it. Given the huge upfront investment costs, the lack of actual demand, and the uncertainty surrounding the ability to meet material requirements, **it should be viewed not as an investment risk but as an investment sink**.

Energetics
The energy-return-on-energy-invested (EROEI) is not great for hydrogen. In fact, from a thermodynamic point of view, it's abysmal. Depending upon the type considered and the processes involved, **it actually consumes as much or more energy than it produces because of the energy losses along its life cycle**. Some analysts actually argue that the losses are so great that such a system makes absolutely no sense.

A study examining hydrogen EROEI along several avenues found that 'green' hydrogen via electrolysis had an estimated EROEI of ~0.51; (235 megajoules (MJ) of energy required to produce a single kilogram of hydrogen, and only produced 120 MJ of usable energy). The study also found that the EROEI is even worse when producing hydrogen from hydrocarbons (the predominant form, making up 95% of current use), estimated at ~0.126 (66.75 MJ of energy inputs using diesel returned only 8.4 MJ of hydrogen fuel). These are net energy losses: **more energy is being put into the process than is gained by carrying it out**.

These numbers are low because of energy losses during: production (e.g., electrolysis is about 70-80% efficient, meaning a 20-30% loss of energy from the start); compression and storage (e.g., high pressurisation or cooling for liquefaction lead to another 10-15% loss); reconversion to electricity via a fuel cell (an additional 40-60% loss); and, then there are the embodied energy costs of the infrastructure.

Combined, these energy losses are why some studies conclude that **a hydrogen-energy system is a consumer of energy, not a producer of it** (see this). If it has any value at all, it may be as a storage medium or specialised fuel for niche applications and where energy loss is considered acceptable. The concern that **such a system diverts energy output to fuel its own cycle rather than providing net energy for society** is quite valid given the above evidence.



theoildrum.com

And then there are the concerns raised by some that an EROEI of more than 14 is required to maintain our societies' many complexities (see this) and 3 just to survive at a minimal level (see this). The EROEI for hydrogen just won't cut it; not even close.

Safety

Hydrogen exhibits unique chemical and physical properties that raise a number of safety concerns. These need to be 'managed' via adequate engineering, design, and strict safety protocols.

Hydrogen is exceedingly flammable and ignites easily with very low energy. Even in air, concentrations can be as low as 4% for it to become flammable. It is difficult to contain given its molecule is the smallest of any element, so it can leak through the tiniest of gaps that would otherwise contain other gases. Hydrogen is both invisible and buoyant, with its flame being close to undetectable visually in daylight and capable of accumulating in poorly ventilated spaces. Materials exposed to hydrogen can become embrittled and prone to cracking–a critical issue for any pipelines or storage tanks.

Storage

If a gas storage tank is compromised in any way (e.g., embrittlement), the high-pressure gas (5000-10,000+ psi) can result in catastrophic tank failure. Any leaks of the highly flammable gas could lead to a jet fire. Storing as a liquid (-253°C) requires constant monitoring as any vapourisation can result in an overpressure explosion. Severe cryogenic burn risk is also possible.

Transportation and Pipelines

While it has been proposed, the use of natural gas pipelines to transport hydrogen is exceptionally risky. Hydrogen accelerates embrittlement and metal fatigue increasing the chance of failure and leaks, especially since it is the smallest gaseous element. If blended with natural gas, additional risks emerge such as the potential for separation and altered combustion properties for users.

As energy analyst Alice Friedemann writes here: “No container can contain hydrogen for long. Use it or lose it. Hydrogen is the Houdini of elements, the smallest of them all, and will boil off and escape no matter how many gaskets and valves there are on a container and at every pipeline junction.” She argues that it is little more than irrational optimism to believe that the storage and transportation of hydrogen can be performed economically or safely at scale.

Fuel Cells and Refuelling

Multiple hazards become concentrated at refuelling stations or where fuel cells are used. Refuelling stations require high-pressure storage facilities and fuelling connectors where leaks are possible. Leaks can result in a vapour cloud that can explode. The fact that hydrogen flames are invisible pose a further risk, especially for workers and/or first responders when accidents do occur. (For a dramatic Hollywood version of what might occur where fuel cells are present, watch the 2008 James Bond movie Quantum of Solace; and see this.)

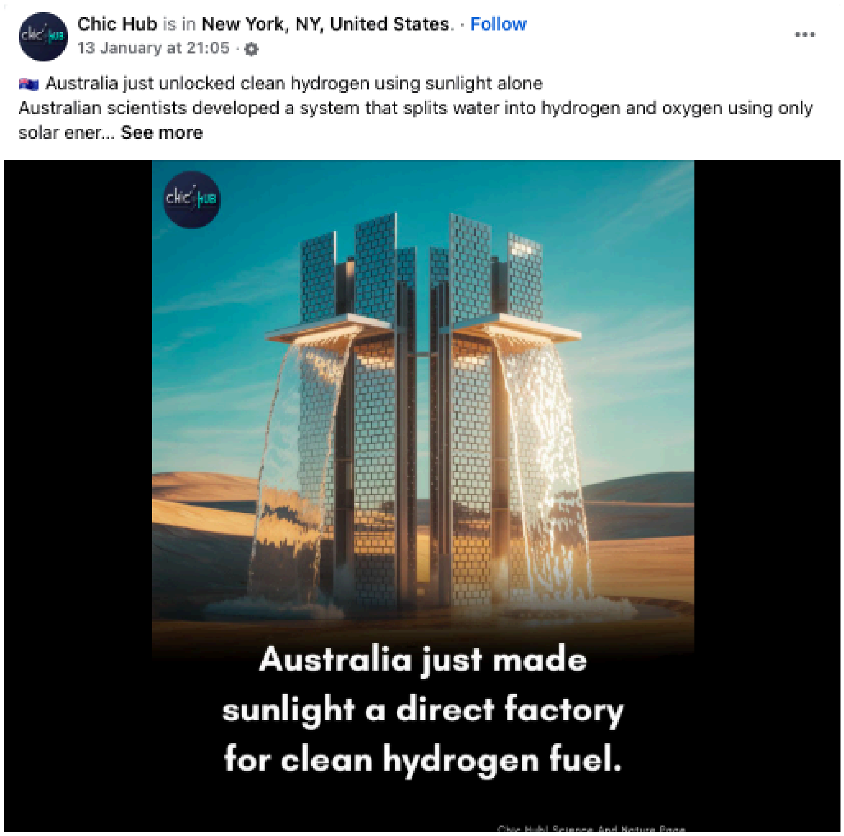
Prevention and mitigation of risks require strict protocols and unique material engineering. Ignition sources need to be eliminated and not simply minimised. Leak detection systems must be robust. Embrittlement-resistant materials have to be used. Extensive ventilation (especially at high points) is necessary. Ultraviolet and infrared flame detectors should be installed. Extensive training and standards must be in place as well as very specific emergency procedures.

Infrastructure

As mentioned above, a massive new infrastructure is required for producing, storing, transporting, and dispensing of hydrogen. And this is on top of the massive infrastructure required to produce the hydrogen and generate the energy to ‘store’ in it, such as solar photovoltaic, wind turbines, or natural gas. In effect, this doubles (or more) any infrastructure expenses and material/mineral needs.

Hydrogen does absolutely nothing with respect to replacing other energy systems and their infrastructure. Hydrogen actually compounds energy-system infrastructure and complexity. An energy-generation system (i.e., natural gas turning turbines, solar photovoltaic panels) with all its infrastructure is first required. To this is added an entirely new hydrogen infrastructure of production facilities, storage systems, transportation systems, distribution facilities, and fuelling stations.

The primary reason hydrogen-based energy has been pursued for niche applications only is because direct electrification is less expensive, more efficient, and not as materially-/minerally-intensive (leaving aside for the moment the storage option of batteries).



Another click-bait site post

Infrastructure Needs of 'Green' Hydrogen

The ultimate 'ideal' and the one typically sold to the public and advocated for is the use of 'green' hydrogen. As described earlier, it is based on the use of 'renewables' for hydrogen production and energy input. Its ultimate appeal is through the carbon-tunnel vision perspective where 'renewables' are 'clean' and 'carbon free'. Recent estimates point to this type of hydrogen energy making up only about 1-3% of the current hydrogen market.

Perhaps one of the primary reasons for such low uptake of this version of hydrogen energy is the massive infrastructure needs. There are four distinct layers required.

The first is the 'renewable' energy infrastructure itself. The wind farms. The fields of solar photovoltaic panels. The grid connections from all these non-renewable, renewable energy-harvesting technologies. To produce 'green hydrogen' at scale, massive renewable capacity dedicated exclusively for the task is required.

Then there are the gigawatt-scale electrolyser facilities that must be constructed with access to large amounts of water and massive amounts of electricity (from the 'renewables' above). The hydrogen storage and transportation infrastructure is then required. Dedicated hydrogen pipelines or the retrofit of existing natural gas ones. Liquefaction facilities for cooling hydrogen to 253°C and specialised cryogenic tanker trucks. And if binding with other matter to transport, chemical plants for this process and specialised containers and tanker ships, as well as appropriate import and export terminals.

The final layer is the one necessary for end-use distribution and fuelling. It consists of stations with high-pressure compressors for transportation vehicles and specialised pipeline connections for industry.

If the above sounds just a bit materially- and minerally-intensive, it is. Massively so. Each of these layers add costs in terms of resources and administration. There are not only the needs of the non-renewable, renewable energy-harvesting technologies (i.e., solar photovoltaic panels, wind turbines), but the hydrogen production, storage, and distribution technologies.

While requiring massive amounts of material not currently constrained (e.g., steel, nickel, aluminum), some types of electrolysers, for example, do demand minerals that are quite expensive (e.g., platinum, palladium), that face critical bottlenecks (e.g., iridium), or are rare-earth elements (e.g., yttrium, lanthanum). Hydrogen fuel cells also require platinum-based catalysts.

Beyond the critical minerals needed, massive amounts of more conventional materials are required for storage and transportation. This includes construction of liquefaction plants, specialised steel pipelines, and high-strength carbon fibre composites for high-pressure tanks.

From an economic perspective, a hydrogen-based energy system only works if less expensive energy systems are not available. This is why **hydrogen energy systems have only found use in very niche applications** such as where long-term, seasonal energy storage is needed (e.g., storing excess energy from solar photovoltaic panels during the summer and then using it in the winter for heating), or for fuelling heavy-duty transport where batteries are impractical due to their size, weight, and charging times.

More importantly, each of the above infrastructure layers result in energy losses. As the previous section on *Energetics* highlights:
“Combined, these energy losses are why some studies conclude that **a hydrogen-energy system is a consumer of energy, not a producer of it**… that **such a system diverts energy output to fuel its own cycle rather than providing net energy for society** is quite valid given the above evidence.”

Those who advocate for a hydrogen-based energy system buildout counter all the above ‘hurdles’ with what has become a kind of standard rallying mantra for emerging energy technologies: innovation, a circular economy that recycles everything, supply chain diversification, and strategic deployment will ‘solve’ these ‘temporary’ difficulties.

Additional Thoughts

Carbon Capture and Storage

I won’t say much here about carbon capture and storage (CCS) since it is fodder for a future We’re Saved! Contemplation. It is the supposed cornerstone of ‘blue hydrogen’ but for all intents and purposes this is another in the growing list of false technological solutions being bandied about by the energy industry. Rather than being helpful, it is yet another resource sinkhole whose benefits are shouted from the hilltops but in actuality has–in spite of billions of dollars already being poured into it–delivered no significant success to date. (See this, this, this, and/or this)

Hydrogen as a ‘Clean’ Fuel

Obviously, none of the above is ‘clean’. The various infrastructures that would be needed to support a hydrogen-based energy system require massive extraction of material and minerals as well as refining and industrial production. As much as the end-use may indeed only produce water vapour, there are significant ecologically-destructive processes required before hydrogen is ever dispensed to a consumer.

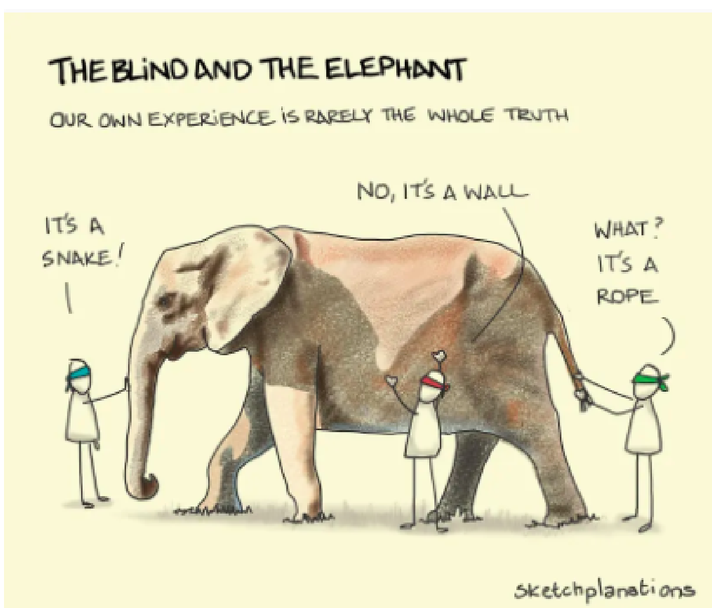
And even for the ‘green hydrogen’ ideal, the ‘carbon-free energy’ derived from ‘renewables’ is in addition to that already built-out for other purposes. An entirely new and massive infrastructure of solar and wind farms dedicated exclusively to hydrogen production is required.

linkedin.com

The term ‘clean’ is derived almost exclusively through a narrow keyhole perspective that can only see the end user and the water vapour created, but is blind to all that comes before. The exceedingly complex and massive hydrocarbon-fuelled: extraction and refinement of various materials and minerals, and industrial production of the components for all the infrastructure. To say little about the land use changes and water requirements. The ecological destruction that occurs in the wake of all of this is lost behind the curtain that the marketers and supporters erect in their fervor to sell a dramatically oversimplified narrative of ‘clean and sustainable energy’.

Blind Spots

Similar to virtually every technological ‘solution’ put before humanity to address our ecological degradation and resource depletion predicaments, a hydrogen-based energy system is ‘blind’ to a variety of impediments, limits, and negative consequences The carbon-tunnel vision mentioned above, for example, and its narrow perspective that ignores all the other planetary boundaries leads to a faulty interpretation of the broader impacts of a hydrogen-based energy system. Resource depletion and the biogeophysical limits of what is and what is not possible also gets hidden from view.



sketchplanations.com

These blind spots mislead. They allow one to believe a hydrogen-based energy system is ‘clean’ and ‘sustainable’. But when one removes the blinders and takes in the larger picture and its complexities, one should be able to see the forest for the trees. [I say ‘should’ because it seems to me that many, many people fight against the disturbing realities and prefer the comforting illusions that get perpetually put before us.]

Funding

Industry lobbies governments for funding since private equity inputs are few and far between given that it has to this point been an investment sink with little to no profit revenue to show for it. This is certainly one of the motivations for those in the energy industry to employ widespread public relations campaigns and invest money in mass marketing of the ‘benefits’ of ‘solutions’ such as a hydrogen-based energy system.

I would argue that given the evidence it is not inappropriate to ask whether this is just another ‘profiteering racket’, like so many of the energy ‘solutions’ bandied about. It is sold to the public as a ‘green solution’ to our energy and environmental predicaments; government takes on massive debt to fund it, helping to market it and spin their approach as responsible problem-solving–that aids in the legitimisation of their rule; monies get funnelled to the industry (with a lot of quid pro quo for politicians that support it); the extractive and exploitive industries–along with corporate colonisation of mineral-rich nations–continue or expand; and, little to no progress towards the ‘green utopia’ occurs except for in the stories told. But some folks are making a hell of a lot of money from these ventures.

The Less-Bad Option

Often supporters of these technological ‘fixes’ argue that we must simply choose the ‘best’ option given the circumstances—the less environmentally-damaging one. The lesser of two evils.

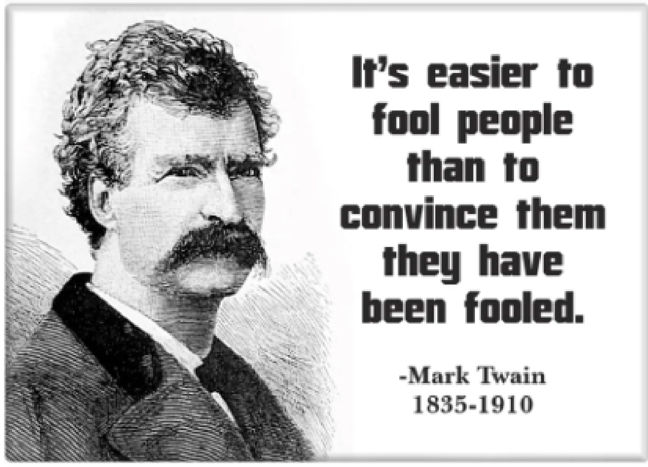
This, unfortunately, is a form of narrative control that closes off all other options. It constrains the choice to two ecologically-destructive industrial pathways—hydrogen-based or hydrocarbon-based—while leaving the foundational premise of perpetual growth unquestioned. The illusion of meaningful choice remains, steering capital, innovation, and public conversation squarely toward sustaining the growth machine. We are thus left debating which resource-hungry, complex ‘solution’ to pursue, while the more radical questioning of our need for ever-more complex systems is silenced.

The analogy is apt: we are arguing over which pump is best for bailing out a sinking ship, while the options of repairing the hull, lightening the load, or changing course are deemed unmentionable, outside acceptable discourse. To shift focus from chasing the perpetual growth chalice toward cultivating resilience within ecological limits is verboten. Rather than pursue demand reduction through sufficiency, localization, and community resiliency, we elevate the fantasy of endless supply substitution. The notion of halting—or, heaven forbid, degrowing and simplifying—our socio-technical complexities remains marginalized. This is not because it is infeasible, but because it fundamentally challenges status quo power structures and forces a confrontation with deep-seated fears of material sacrifice and a future that looks nothing like the mass-marketed vision of an accelerating, prosperous present.

In the end, the ‘less-bad’ option is a safe harbour for those fearing to confront the deeper, more difficult question: are these proposed technological ‘solutions’ actually solving our predicaments, or are they, in fact, exacerbating them?

Scale, Scale, Scale!

What can appear as a ‘solution’ to a perceived ‘problem’ on the surface can very quickly dissipate once the scale required to address the ‘problem’ is taken into consideration and attempted. Extremely small-scale applications and uses of specific technologies can be ‘helpful’, but once they are attempted at a larger scale the systems are overwhelmed.



I harken back to my initial We’re Saved! Contemplation on the use of hemp and bamboo where a limited and regional use of naturally-occurring biomass may address material needs in a relatively ecologically-balanced manner. But once such a ‘solution’ is necessarily industrialised to scale it up to meet significantly growing demand, the ‘balance’ is lost. The ‘solution’ has now added to the predicament of overshoot and its various symptom predicaments.

Scale is perhaps everything. So while the use of hydrogen as an energy carrier might address specific issues in specific settings, the scale of what is being proposed by many regarding its use on a ramped-up basis would–as most ‘solutions’ do–exacerbate our ecological overshoot predicament by drawing down finite resources, overwhelming compensatory sinks, contributing to further biodiversity loss, etc..

Is it All About Sustaining the Growth Monster?

Every one of the energy ‘solutions’ that get proposed appear to be an attempt to sustain/grow humanity’s social complexities, be it the economy, material consumption, governing institutions, etc.. Completely lost in the ether is not only the ecological destruction that occurs in the wake of these ‘solutions’, but the very existential threat that infinite growth on a finite planet carries with it. The anti-thesis of growth is degrowth, and few apart from some rather marginalised voices are supportive of a degrowth philosophy.

It’s not that I personally believe a pursuit of degrowth can ‘save’ large and exceedingly complex human societies at this point in our evolutionary journey, but we can’t even seem to have a serious conversation about trying to stop the digging of the ever-deeper hole we have dug ourselves into. There is a relatively large and powerful contingent of our species that is pushing for perpetual expansion. More people. More resources. More extraction. More. More. More. And these people tend to steer the narratives for society.

Forget about reversing our growth in such an environment. It would be a major coup to get the-powers-that-be to admit we have encountered (actually, overshot) limits and we need to turn our attention towards actions to mitigate the ‘challenges’ ahead. Instead, we have our ‘leaders’ doubling- and tripling-down on policies and practices that are exacerbating our dilemmas. And most humans, being what they are, tend to defer to these ‘authority’ figures. They accept with little questioning the diktats and narratives put before them.

And there are others, very well-meaning others, who are well aware of the limits and the issues-at-hand but have adopted a type of technological fetishism where the complex, material-based and energy-intensive tools we have developed can indeed aid our quest for a sustainable society at scale.

Concluding Thoughts

In the final analysis, the promise of hydrogen energy is more than a technical proposal—it is a mirror. It reflects our deepest dilemmas: our desire for a seamless, painless transition; our unshakeable faith in technological silver bullets; and, our collective inability to conceive of a future not predicated on perpetual *more*. The math of EROEI is a physical verdict, declaring such a system a net energy consumer. Its staggering infrastructure demands are a material reality that bumps harshly against planetary limts. The 'clean' label is a comforting narrative that dissolves under the weight of ecologically-destructive extraction and industrial complexity.

Thus, the hydrogen debate transcends engineering to become a profound diagnostic of our thinking. To champion it as a systemic 'solution' is to remain imprisoned within carbon-tunnel vision and growth dogma, attempting to solve a crisis of limits with tools that themselves voraciously consume the very resources and energy they are meant to save. It is the belief that we can innovate our way out of biophysical reality, blind to the fact that each new layer of complexity–especially via our complex industrial technologies–deepens our overshoot.

We are not saved. A hydrogen-based energy system, like so many techno-fixes, is ultimately a story we tell ourselves to avoid the harder, more fundamental story. It is a tale of sustaining the unsustainable. The inescapable conclusion is that we are not facing an energy problem to be swapped with a new carrier, but a civilizational predicament rooted in the impossibility of infinite growth on a finite planet. The first step toward genuine mitigation of our overshoot predicament is not a new round of magical thinking, but the courage to stop—to read the physical evidence before us, and to finally turn towards the conversation we have spent a century evading.

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[Can Hydrogen Fuel Power the Planet?]
[Hydrogen Is the Future—or a Complete Mirage]

“*Wave energy advocates present an attractive vision of dense, predictable, and constant ‘renewable’ power generation that’s ‘clean and sustainable’. Upon closer examination, however, such a promise is another in a rather long line of technologies that cannot possibly meet the hype. From corrosion and survivability to prohibitive costs and habitat disruption, there are serious material, economic, and environmental challenges to any near-term viability and possible scalability.*”

Website **Medium** **Substack**

Today’s Contemplation: Collapse Cometh CCXXVII–
We’re Saved! Wave Energy.

A relatively recent article and some social media click-bait site posts have me exploring the potential of wave energy-harvesting technologies. But as with every such technological promise examined in the last dozen or so Contemplations, a close scrutiny of wave energy shows that it does not live up to the hype its marketers and supporters make. The challenges for this technology are not just technical and economic, but systemic in nature and help to demonstrate the flaws in the commonly held belief that humanity can innovate its way out of ecological overshoot.

ecowavepower.com

What is Wave Energy?
This technology attempts to harvest energy from the movement of ocean waves in order to generate power for use by humans. As wind transfers its energy to the surface of oceans through friction, kinetic and potential energy is created from the water’s motion and its being lifted against gravity. Specialised technologies (wave energy converters, WEC) capture this energy and convert it to electricity for human use. Obviously, this technology is rather restricted to specific areas of the world with its prime location being the west coast of continents between 30° and 60° latitude where the strongest winds occur and create the most powerful waves.

There exist a variety of WECs: floating buoys that move up and down with the swelling of waves to drive an internal generator or hydraulic pump–known as point absorbers; reservoirs with walls located at sea level that get filled by wave action and then drain to turn a low-head turbine–known as overtopping devices; flaps or panels affixed to the seabed in shallow waters that get moved back-and-forth with the water action driving a generator–called oscillating wave surge converters; and a number of others.

The energy harvested from the world’s ocean waves is potentially enormous. The International Panel on Climate Change estimates that globally some 29,500 terawatt hours of energy could be provided to humanity (see this). Despite this potential, the harvesting of wave energy is still in its infancy with most projects in their prototype and testing phase.

The benefits of this type of potentially ‘clean and sustainable’ energy production are seductive. The power density is high, much denser than that provided by wind turbines or solar photovoltaic panels. Wave activity is predictable with activity being forecast relatively accurately days in advance aiding in grid management. And, the energy source can be provided almost constantly, day and night all year long.

Advocates highlight these benefits and argue it is one of the most promising future contributors to a ‘clean’ energy mix, especially for remote coastal and island communities who currently depend upon expensive diesel generators. It can also provide relatively consistent power generation to supplement more intermittent ‘renewables’.

High power density. Constant and predictable energy generation. And ‘clean and sustainable energy’. What’s not to love?

Well…

There are a number of fundamental factors that challenge this technology before we even discuss the broader implications of chasing another technology to add to humanity’s seemingly insatiable energy consumption.

Costs
Current estimates of costs for wave energy generation are quite high relative to other technologies. The material challenges, complex manufacturing, and structural expenses all push up prices. Those marketing it argue that economies of scale will bring these costs down once the technological components are more widely produced.

Direct Environmental Impacts
The direct impacts on marine wildlife of this technology are quite concerning to some. They include: underwater noise; collisions and entanglement; electromagnetic fields; habitat change and loss; water quality impacts; and, altered hydrodynamics and sediment transport. The long-term consequences are not yet known but are in the process of being studied at current test sites.

Technical and Material Hurdles
The harsh marine environment presents a number of intractable issues: corrosion from saltwater; biofouling from organisms like barnacles; and extreme mechanical forces from storms.

These factors lead to metal fatigue, increasing drag, and monumental survivability challenges. Finding durable materials that can withstand these conditions at a reasonable cost is extremely difficult. Research continues on how best to address these issues but for the moment using high-strength steel coated with a specialised thermochemical layer provides some protection from corrosion and reduces organism attachment.

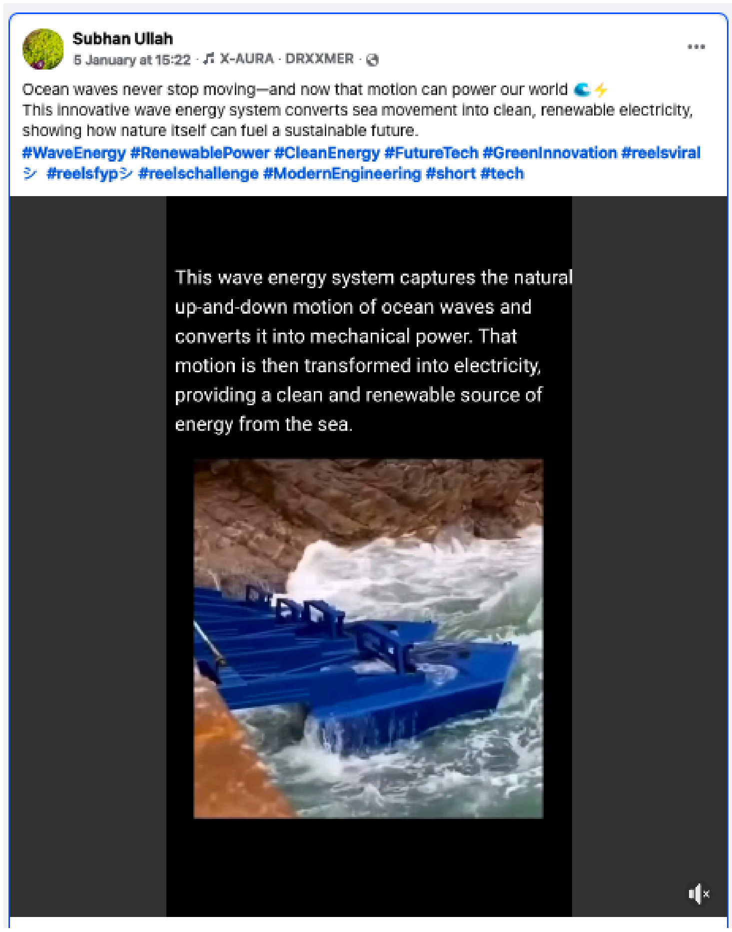
Withstanding significant storm waves is a must but very challenging to guarantee, especially at a reasonable cost. Concrete and/or steel structures offer protection for some designs. This particular ‘solution’ can increase costs dramatically, perhaps by 25-50%, and its negative environmental impacts are significant.

Research into novel materials with which to construct WECs and ensure suitable energy conversion continues. These include: rubber-like material that generates power when stretched–dielectric elastomers; Polyvinylidene Fluoride combined with graphene that will generate electricity when flexed by waves–piezoelectric composites; and, devices that generate power via friction between polymers–triboelectric nanogenerators. These are all rather expensive and require significant chemical and material-refinement industrial processes for their production.

Commercial Viability
The monetary and resource costs for this technology are substantial, and one of the main reasons they are not commercially widespread. Massive steel and concrete structures upon which to attach many WECs are required for several types. Sea transportation and deployment is exorbitantly cost prohibitive. Advocates argue that they can be made far more reasonable in cost with economies of scale and continued research. Note the common refrain of many energy-technology cheerleaders: “We need more funding for research and once a

massive build out is carried out, this latest 'saviour' will be cost competitive"–in other words, pay us now and you'll reap the benefits some time down the road.

Even if all the above cost and engineering hurdles were to be overcome, the foundational flaws that plague proposed 'clean' technologies remain.



Typical click-bait site post regarding wave energy.
Clean, Sustainable. Powering Our World.

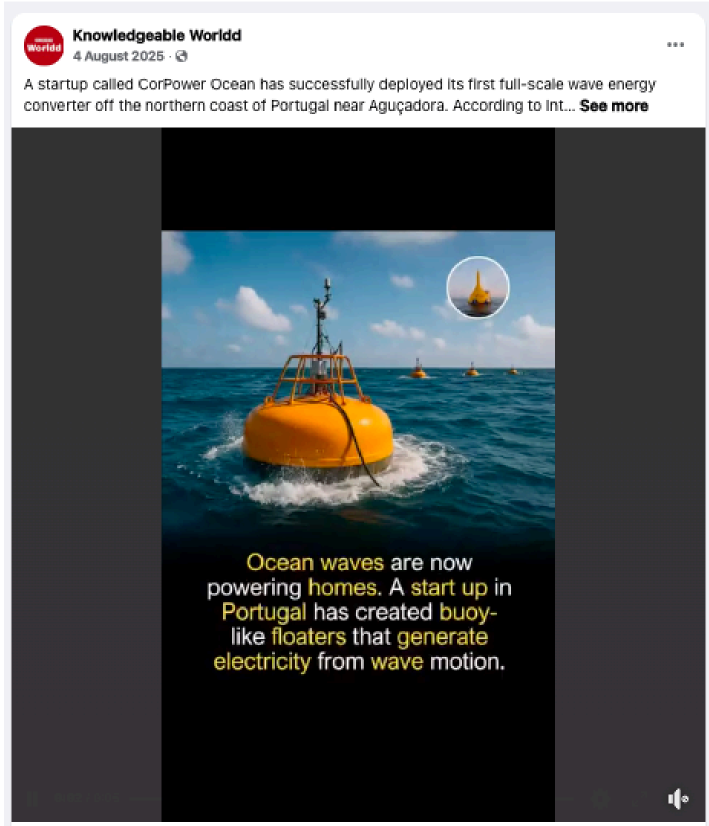
Common Energy Technology Issues of Concern

Claims of Being 'Clean and Sustainable'

Once deployed and functioning, the claims regarding generation of 'clean and sustainable' energy are easy to make (as long as you can ignore the immediate environmental impacts). But prior to such deployment there are a host of industrial processes employed and resources required, especially hydrocarbons and various materials/minerals. Yes, the impacts are 'mostly' upfront, but they are there and quite substantial nonetheless.

And the ever-present narrow focus upon carbon emissions–due to carbon tunnel vision that seems to permeate all discussions and interpretations of 'clean energy'–is problematic in its overlooking of ecological systems destruction beyond the narrow perspective this focus causes. Any mass-produced, industrial technology entails a destructive lifecycle: from extraction and refinement of materials, to manufacture and distribution, and finally to reclamation or disposal.

Even if lifecycle analyses of a technology demonstrates less carbon intensity than another, this does nothing to address the other ecological systems damage being carried out nor the issue about continuing to chase growth and complexities via complex industrial-based energy technologies. 'Greening' a supply chain or reducing the 'footprint' of such technologies serves more to create comforting narratives and rationalisations than addressing the fundamental predicament of ecological overshoot our species' growth and activity has created.



Another click-bait site post.
Powering our homes.

Replacement Theory
As with every other energy source, the power generation being created by WECs is adding to humanity's energy consumption; it is not replacing the hydrocarbons that its proponents argue it is.

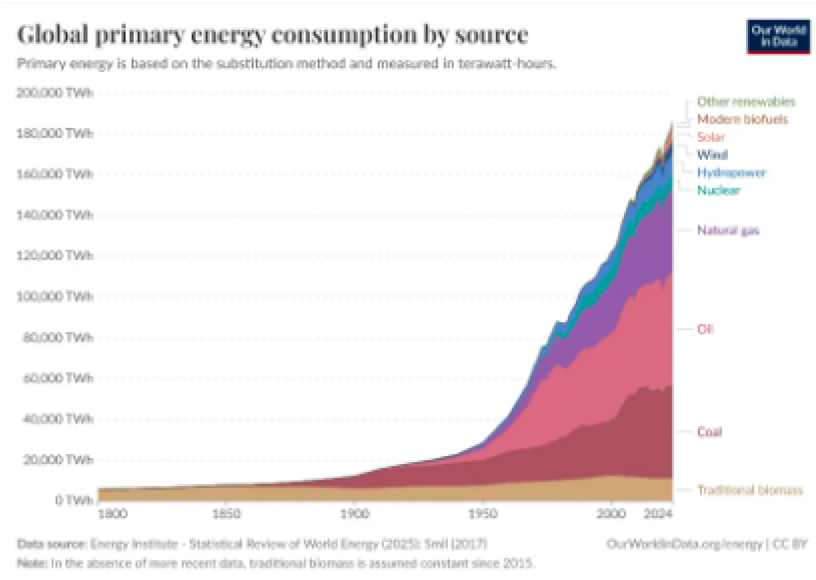
But even beyond this rather simplistic narrative about non-renewable, renewable energy-harvesting technologies replacing hydrocarbons, is the evidence that they are part and parcel of the problem. Every step in their supply chains and manufacturing requires hydrocarbon inputs. And this is especially so for WECs and their chemical coatings, concrete and steel structures, plastic and steel components, etc.. These are hydrocarbon-dependent technologies and are helping to draw down ever more quickly this finite material.

In addition (no pun intended here), these new energy technologies are fuelling the larger fire of humanity's resource consumption. Hydrocarbon extraction continues to increase year-over-year, as does the energy use by our species. There appears to be no replacement taking place.

Technological Chickens Yet to Hatch
There are two fundamental issues that get glossed over during discussions about 'renewables' that get to the heart of notions regarding human society's 'sustainability'.

First, there exists 'embodied hydrocarbons' a plenty. All extraction and refining of material and minerals are only possible because of hydrocarbons. And virtually all large-scale industrial manufacturing is powered by and made from products reliant on hydrocarbons. And this is a finite energy source that has hit significant diminishing returns.

Second, the rebound effect and consumption growth that accompanies energy efficiencies or new energy sources. Known as Jevon's Paradox, this phenomenon sees energy generation such as that from WECs added to the global total rather than displacing old sources; and helping to keep alive the comforting narratives that the perpetual growth chalice is within reach. Coal, for example, did not replace biomass as a heat source; the planet is seeing increasing amounts of biomass used for a variety of purposes. Oil did not replace coal as an energy source; we are seeing increasing amounts of coal mined every year. ‘Renewables’ are not replacing oil for energy generation; they are adding to our overall energy consumption.



ourworldindata.org

More to the point, much of the argument for the technologies marketed as being ‘cleaner, sustainable, and capable of replacing hydrocarbons’ is based almost invariably upon as-yet-to-hatch technological chickens. If only more research funds are steered into them and/or funds are made available to build them out extensively, then the utopian dreams of ecomodernists and cornucopians will come to fruition. Any. Moment. Now. Just have faith. And placing human survival on technological breakthroughs that are always just over the horizon is a form of collective delusion.

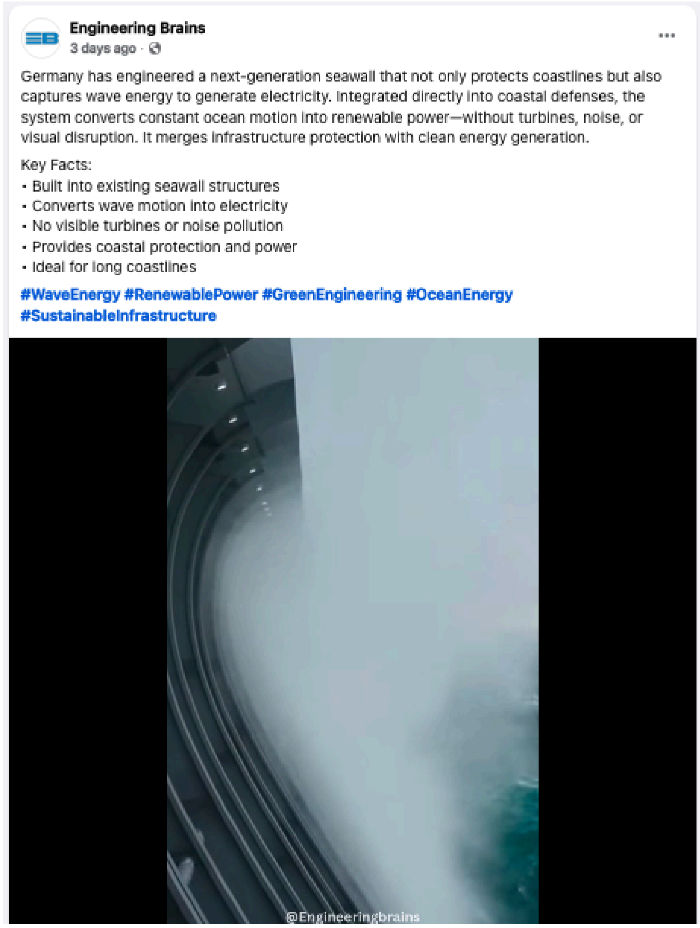
Conclusion

Wave energy advocates present an attractive vision of dense, predictable, and constant ‘renewable’ power generation that’s ‘clean and sustainable’. Upon closer examination, however, such a promise is another in a rather long line of technologies that cannot possibly meet the hype. From corrosion and survivability to prohibitive costs and habitat disruption, there are serious material, economic, and environmental challenges to any near-term viability and possible scalability.

Perhaps more importantly this technology, like other ‘clean and sustainable’ ones, is constrained by two major systemic issues. First, it is an energy source being added to humanity’s seeming insatiable energy consumption and not a replacement for ‘dirtier’ energy sources as most such technologies are marketed as being. It is almost totally dependent upon hydrocarbon-intensive supply chains and production and thereby can never be a ‘replacement’.

Second, similar to all other ‘renewable’ technologies being hyped globally it helps to perpetuate a dangerous illusion that humanity can innovate its way clear of the consequences of ecological overshoot while maintaining perpetual economic and energy-demand growth. Wave energy is yet another distraction helping to create a comforting narrative about human progress while drawing down finite resources, destabilising ecological systems, and overloading planetary sinks.

The evidence appears to be clear: no technology can ‘save’ a global civilisation determined to pursue infinite growth on a finite planet. We’re telling ourselves comforting stories by believing in the tales of technological salvation and exacerbating our predicaments by acting upon them.



Another click-bait site post.
Constant. Renewable. Clean. Sustainable. Green.

Afterword

A bit of research revealed that the site of the original article that spurred this Contemplation described itself as an “*internet destination for those who care about our planet and environment and want to make a difference…[and] for people who care about the Earth and have an interest in nature, the environment, and science. It’s for those who care about our planet and want to make a difference.*”

The site had many, many articles on technological ‘solutions’ to our various predicaments but few on sociocultural shifts to address or mitigate our plight. For example, I found close to a dozen on wave energy and only a single one on degrowth; I found countless numbers on ‘clean energy’ technologies (from the best investment ventures to support research and where to mine the best lithium, to hydrogen- and fusion-based energy and how the renewable energy transition will boost the economy), and only four on permaculture. Pushing an ecomodernist/cornucopian ‘technology will save us’ narrative. Not very caring about the planet, environment, or Nature in my opinion.

We’re telling ourselves comforting stories–precisely the kind promoted by ‘caring’ planetary sites–by believing in tales of technological salvation, thereby exacerbating the very predicaments we seek to solve.

Recent and relevant articles:
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Scientific Mysticism
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We're Racing Down the Highway to a Mad Max World - ZNetwork
The Sustainability Conference Where Everyone was Given Truth Serum
Regenerating Earth Through Collapse | by Joe Brewer | Jan, 2026 | Medium
Energy, population, and production - by Jeff McFadden

“The promises made by ‘green’ steel’s advocates collapse under the weight of the evidence. It is not only not ‘green’–given the hydrocarbon-intensive infrastructure required–but it is also a non-solution, impossible to scale up for even a fraction of global demand. Thus, the celebration of ‘coal-free’ steel stands as a classic example of techno-optimist overreach.”

[Website](#) [Medium](#) [Substack](#)

Today’s Contemplation: Collapse Cometh CCXXVIII–
We’re Saved! Steel Production Without Coal.

Techno-optimist’s claims are relentless. One that has come across one of my social media feeds a few times is the tale that Sweden is now producing steel without the use of coal, a process that “could reshape the industry forever”.

And, yes, the declaration that Sweden has made steel ‘without coal’ is, on the surface, true. A pilot project has been successful in producing a relatively small amount of steel using hydrogen-based energy from ‘renewable’ sources and delivered it for industrial use to Volvo Cars (see: [this](#) and [this](#)). The claimed benefits of this production methodology are plentiful according to both the marketers and supporters of this process who are, not surprisingly, primarily those who profit from this narrative. Let’s pull back the curtain a bit and explore this ‘world-changing’ technology and its myriad of beneficial attributes.

Typical click-bait site post regarding making steel without coal.

RMI, a ‘clean energy’ advocacy organisation, argues that because steel making with the use of coal is a major carbon emitter (estimated at 7-9% of global emissions), it’s of utmost importance to implement decarbonising strategies and processes for steel making on a global scale (see: this). The strategy to do this put forward by RMI is that steel production can be ‘decarbonised’ through the use of hydrogen-based, ‘carbon-free' energy, with the energised hydrogen being produced via ‘renewable energy’ technologies, particularly hydroelectric- and wind-based power generation.

The benefits highlighted by RMI include those in both the environmental and economic arenas. The main benefit focussed upon is a reduction of carbon emissions to near zero, with the only byproduct being water vapour.

According to RMI the economic benefits for Sweden of pursuing this technology are massive. **Although there would be significant upfront costs**, the argument goes that increasing market demand and a **willingness to pay a premium for ‘green’ steel ensures future profitability**. And the implementation of carbon-pricing regulations will make traditional steel production more expensive, helping to make ‘green’ production more attractive since it avoids such carbon penalties. Having low-cost hydro and wind generation further benefits Sweden, making the production of ‘green’ hydrogen possible and profitable.

On a longer-term basis, Sweden benefits economically through the **massive economic growth** such a transition stimulates and the billions of dollars in investment likely to flow to the leaders in this new and unique industry.

At least two wonderful selling points: ‘Clean, sustainable, and carbon-free’ steel production, along with massive economic growth.

What’s not to love?

Well…

When it comes to such bold claims, it’s wise to scratch a little at the surface to get a glimpse of the reality upon which such assertions are made. A closer examination reveals a narrative built upon a very narrow definition of ‘green’, thermodynamic ignorance, and a gross failure to confront the limits of scale and growth.

Green Steel’s Clean and Carbon-Free Energy Production

As for RMI’s claims above regarding the decarbonisation of steel production via hydrogen-based energy, this is a patently false claim–as I argue in my Contemplation on hydrogen-based energy systems (see: Website Medium Substack). Simply stated, hydrogen-based energy requires massive hydrocarbon inputs. From its ‘renewable-energy’ infrastructure to the hydrogen-production facilities, extremely significant hydrocarbon-based industrial processes are required to procure ‘carbon-free’ energy.

When one only focuses upon the end-user byproduct of water vapour for the generation of hydrogen-based energy systems, then it is entirely possible to claim that this energy is ‘clean’. But this is disingenuous since it ignores so much of what goes on to create this energy, to say little about the fact that the byproduct (water vapour) is the most significant greenhouse gas serving to amplify the greenhouse effect (see: this, this, and this). To only include the end-use aspects in forming a declaration of ‘cleanliness’ is misleading in the extreme in that it ignores all the ecologically-destructive processes and industries necessary to produce the energy.

The energy source ‘green’ steel uses is not ‘carbon free’. Given that this tends to be the guiding light for what technologies are considered ‘clean’ or not, it is also thus not ‘clean’. So, right from the get go the contention that ‘green’ steel is ‘clean’ is patently false. The error of these assertions, however, go much deeper as I will demonstrate.

Hydrogen-Based Energy’s Other Drawbacks

As I highlight in my Contemplation on hydrogen-based energy systems, this energy system results in a net energy loss. In other words, more energy is required to produce the energised hydrogen than it delivers for use. So, any ‘green’ steel production is operating at an energy loss. And while this may be fine for small-scale test runs whose chief goal is to demonstrate the feasibility of the technical process, attempts to scale this up would result in massive energy losses. This is neither economically nor thermodynamically sustainable.

‘Green hydrogen’ also requires a dedicated and massive infrastructure. Energy production in the form of ‘renewables’. Storage. Transportation. Distribution. All of these aspects need to be newly constructed, managed, and maintained.

There are also significant safety and technical hurdles to confront. From the highly flammable and difficult-to-contain properties to the material embrittlement concerns. In addition, specialised, complex, and very expensive engineering and safety protocols are required.

Finally, there is the argument that the production and use of hydrogen-based energy systems add to our fundamental issue of exacerbating the negative consequences of pursuing business-as-usual economic growth. Rather than pursuing demand reduction, degrowth, and resilience-building within ecological limits, techno-fixes like ‘green’ steel production using ‘green hydrogen’ attempts to sustain the unsustainable.

Even if these thermodynamic and safety hurdles were disregarded, the project of scaling ‘green’ steel up to meet global demand faces insurmountable practical barriers.

Other Relevant Hurdles

While Sweden’s pilot proves technical feasibility, there exist some rather significant hurdles for ‘green’ steel to ever reach commercial success.

Scale

The implementation and scaling up of such an industry faces complex and relatively time-consuming and slow permitting that will delay any massive build out. It has been estimated that just for Sweden, full-scale production could increase electricity demand by 50% or more leading to a bottleneck in any attempt to secure ‘green’ energy sources (see this). This energy demand would also likely lead to tension over access to current energy, and perhaps lead to significant price increases for all users.

It is estimated that ‘decarbonising’ all iron production through the ‘green’ steel technology being discussed would require 2,700 TWh of ‘renewable’ electricity per year. This is equivalent to the total annual electricity demand of the entire European Union (see: this). To put this energy need in perspective, the planet uses about 1.8 billion tonnes of steel per year (while production has tripled over the past fifty years, the last 4 have held steady). As for ‘green’ steel produced by Sweden, it currently produces no ‘green’ steel but is hoping that before 2030 to produce about 2.5 million tonnes per year–just slightly less than 0.14% of the global total.

Economics

‘Green’ steel production currently costs about 20-30% more than that produced via traditional, coal-based technologies. According to economic projections, ‘green’ steel only becomes competitive where and when carbon-pricing regulations are present. There are also significant upfront costs that must be secured via investments in the billions of dollars, and this is already impacting construction plans significantly. And although the marketers and advocates suggest customers will pay a premium for ‘green’ steel, there are no guarantees of this. ‘Build it and they will come’ is not a sound economic plan, but one that is often offered by those pushing such technologies–with projected costs almost always exceeding estimates and benefits rarely, if ever, meeting expectations.

Technical and Operational
There are some projects that are being rushed in an attempt to achieve full-scale production (see this), but given the lack of experience this increases the risk of making errors. This is particularly so because the technology is relatively new with unforeseen challenges and complexities. Success also depends very much on a parallel build out of ‘green’ hydrogen infrastructure, including ‘renewable’ energy and grid capacity.

Sweden’s rushed commercial facilities have already run into construction delays and ever-rising costs. They are hoping to begin steel production within the next two years, but there are no guarantees.

Conclusion
The promises made by ‘green’ steel’s advocates collapse under the weight of the evidence. It is not only not ‘green’–given the hydrocarbon-intensive infrastructure required–but it is also a non-solution, impossible to scale up for even a fraction of global demand. Thus, the celebration of ‘coal-free’ steel stands as a classic example of techno-optimist overreach.

While the pilot project proves technical feasibility, the surrounding hype serves as a dangerous distraction from the necessary discussions about growth-oriented overconsumption. Such techno-fixes ultimately strive to sustain the unsustainable.

In light of the non-green lifecycle, the negative energy balance, and its fantastical scaling requirements, ‘green’ steel reveals itself not as a path to sustainability, but as a proposal to swap one set of resource-intensive inputs for another. True sustainability will not be found in such substitutions–if it can be found at all–but in questioning the growth-oriented consumption they are designed to perpetuate.

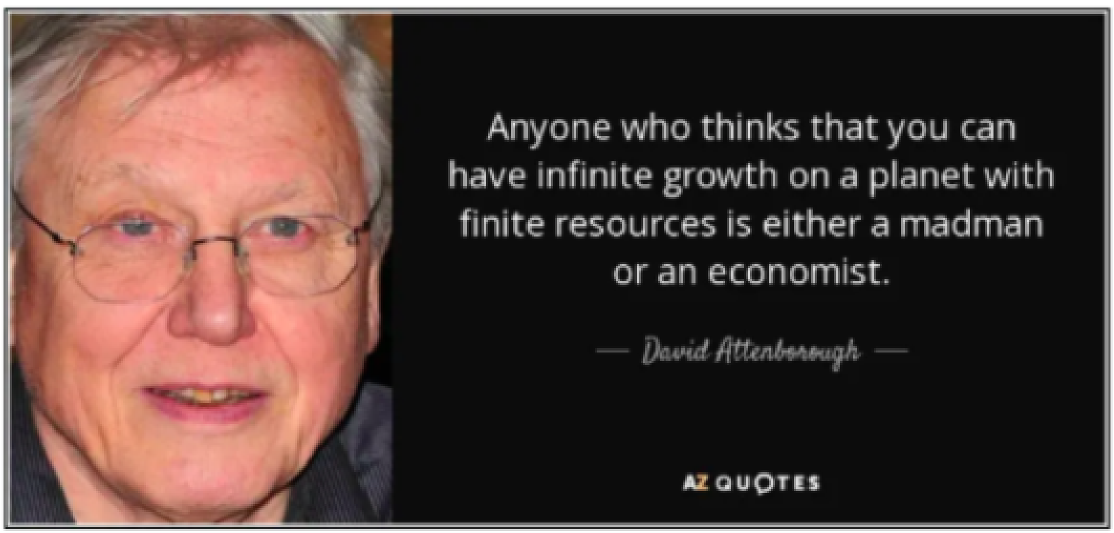
"A society pursuing perpetual growth will turn even the most 'green' technology into a tool for further extraction and overshoot. As a result, the question of any evaluation of 'solutions' needs to shift from "Does this work?" towards "Work for what? To sustain what? And for whom?" And it doesn't matter if the growth is intentionally-driven by social structures and institutions or natural, biological imperatives. Growth that disregards biophysical reality and limits is impossible to pursue for long on a finite planet. What is not sustainable cannot be sustained. This is as true for a society pursuing expansion or one attempting to maintain societal complexities in the face of diminishing returns."

Website **Medium** **Substack**

Today's Contemplation: Collapse Cometh CCXXIX– We're Saved! Pulling It Together…So Far.

After my previous We're Saved! Contemplation (see: Website Medium Substack)–another in my series that has attempted to pull the curtain aside on excessively-hyped 'solutions' to our various predicaments–I couldn't help but notice that there are a number of commonalities in the critiques for the technologies and systems that I have reviewed so far.

In this relatively short synopsis I tie these together and create a series of questions for myself (and others) to use going forward when assessing proposed 'solutions' to our various predicaments.



Commonalities
First, there is a good deal of not only overhype but greenwashing and narrative management by marketers and other techno-optimists regarding what these technologies are capable of achieving. Almost all are presented to society through a 'sales-pitch' lens that focuses exclusively upon supposed benefits while ignoring or suppressing hurdles and drawbacks. As a result, an oversimplified and comforting tale is put out to the public–one that immediately appeals to most people's desire for painless 'solutions' to the problems and predicaments we find humanity facing.

Although the technologies reviewed are typically presented as a replacement for destructive systems (e.g., hydrogen-based power in place of hydrocarbon-based power for energy systems), they are tending to be additive to our extractive and ecologically-destructive industrial processes. As we are increasing our overall energy demand and material throughput via these supposed less-destructive technologies, the 'transition' story we are being sold is actually one of expansion and not replacement. The marketing and amplification of the supposed benefits of these technologies has led to the creation of a transition 'myth'. A myth that has taken on a life of its own and been increasingly accepted as reality–including by some very well-intentioned individuals and groups.

Third, while there may be local benefits derived from small-scale or organic applications for some technologies, once any attempt is made to scale the system up to industrial levels for global use the social and ecological costs explode. Be it massive resource inputs, logistical systems, waste production, and/or environmental impacts, the 'solution' almost always turns into a new and larger 'problem'; and one that exacerbates the very issues attempting to be addressed in the first place. These scaling issues are rarely if ever raised by the marketers and advocates of these technologies who, instead, focus on the small-scale benefits and imply that if performed on a global level the benefits will still manifest themselves.

Fourth, the evidence used by marketers and advocates to support the hyped benefits tends to focus upon a single metric (almost always carbon emissions) and ignores full lifecycle and broader impacts. Such tunnel vision leads to blindness regarding embodied energy and carbon (often for the infrastructure required), the wider ecological and social costs, and resource depletion.

Success based upon as-yet-to-hatch technological chickens is also a common theme. Hypothetical future 'breakthroughs' are required for many of the more complex technologies in order to live up to the promises made by marketers and supporters–and the highlighting of such potential is often accompanied by a request for further funding to support research. This faith in techno-salvation that lies just over the horizon distracts from actions that could be taken today that might help to mitigate the consequences of our predicaments, such as slowing or even reversing significantly our overconsumption and the ever-present pursuit of growth.

Everything reviewed so far has served to reinforce growth and elite interests. The technologies being sold as 'solutions' are not neutral tools to help all members of society. They are tools that help: legitimise the perpetual growth paradigm; create or expand revenue streams for the elite; and, sustain sociopolitical control by suppressing social anxieties around the biophysical limits to growth, thus avoiding discussions on reining in growth, simplification, and a decentralisation of power.

Seventh, all the technologies bump up against biophysical reality, including: diminishing or lower returns for new sources of energy; net energy issues once full lifecycle costs for the system and its associated subsystems are factored in, with many having very low or even negative energy returns; and, entropy and its unstoppable consequences, with the additional energy they provide actually accelerating the process and its impacts.

Finally, there is Jevons Paradox where increasing efficiency or new energy sources almost always leads to increased consumption. Achieving the Holy Grail of cheap and abundant energy would not in the end solve overshoot, but exacerbate it by loosening the constraints on our consumption and the extraction necessary to feed it.

An Evaluative 'Questionnaire'

In assessing any technology, system, or proposed 'solution', I offer the following questions to ask in order to get a glimpse behind the curtains that over-hyping marketers and over-enthusiastic supporters are consistently hanging.

Narrative

Does the proposal discuss the major drawbacks such as environmental and/or social costs, or only its benefits? Is there irrefutable evidence that the 'solution' will replace the destructive technology/system it is proposing to, or is it merely adding to total human throughput? Are the benefits of small-scale applications being honestly applied to a global, industrial scale, or are they being disingenuously applied?

Biogeophysical Reality

Does the analysis of the inputs of the ‘solution’ and any required supplementary technologies and/or systems include all lifecycle stages, in particular: raw material extraction; manufacturing; transportation; operation; maintenance; byproduct disposal; decommissioning; reclamation; end-life disposal and waste management; and, associated infrastructure needs?

What is the net energy return over the entire lifecycle, and is it greater than 10-14:1 (societal maintenance) or 3:1 (basic survival)? What finite materials/minerals are required, and are these readily available or have they already encountered supply chain bottlenecks, diminishing returns, or severe depletion?

What are the ecological blind spots? Is it being assessed through carbon tunnel vision or is it taking in a broader consideration of the various planetary boundaries?

Can the waste it is generating be safely managed in perpetuity, or are there long-term liabilities being created? Is the planetary sink that might help to mitigate any waste already overloaded or close to it?

[Potsdam Institute for Climate Impact Research]

Viability

Can the ‘solution’ survive without massive government subsidies, externalised costs, or loan guarantees? Does it require a new, massively complex, and resource-intensive infrastructure to bring it to fruition? Is it dependent upon ‘breakthrough’ technology that has yet to exist or is only in the prototype stage?

Social Aspects

Does the ‘solution’ challenge the infinite economic growth paradigm or enable its continuation? Who is promoting it and who profits from it? Will it help to further concentrate wealth/power or help to distribute it? Does it challenge or reinforce status quo wealth and power structures?

Does it promote relocalisation and community resilience, or does it require globalised, centralised, and fragile supply chains? Does it shut down discussion of more fundamental changes (e.g., degrowth, simplification), or is it presented as the only alternative within the current system of continued growth?

Conclusion

If there is a unifying theme so far in these We're Saved! Contemplations, it's that no technological or systemic innovation can solve the predicaments created by the pursuit of infinite growth on a finite planet. The technologies and systems reviewed so far are not 'saviours'; they are tools that amplify the intent of the systems that have deployed them: continuing economic growth and material throughput.

A society pursuing perpetual growth will turn even the most 'green' technology into a tool for further extraction and overshoot. As a result, the question of any evaluation of 'solutions' needs to shift from "Does this work?" towards "Work for what? To sustain what? And for whom?" And it doesn't matter if the growth is intentionally-driven by social structures and institutions or natural, biological imperatives. Growth that disregards biophysical reality and limits is impossible to pursue for long on a finite planet. What is not sustainable cannot be sustained. This is as true for a society pursuing expansion or one attempting to maintain societal complexities in the face of diminishing returns.

"*Ecomodernism's high-tech, low-impact future is compelling on the surface. Under the questionnaire's lens, however, it emerges as a flawed, largely faith-based philosophy.*

It hinges on speculative technologies, absolute decoupling, and global scalability—none of which current evidence supports. Its lifecycle analyses are incomplete; its energy-return calculations, selective. The proposed buildout would be resource-intensive, ecologically destructive, and dependent on precisely the hydrocarbon economy Ecomodernists claim to leave behind. Planetary boundaries already breached, material supply chains under strain, and long-lived waste streams without management pathways are treated as engineering problems, not fundamental constraints."

Website **Medium** **Substack**

Today's Contemplation: Collapse Cometh CCXXX–
We're Saved! Ecomodernism.

Using the 'questionnaire' for evaluating supposed 'solutions' to humanity's various predicaments that I proposed in my previous We're Saved! Contemplation (see: Website Medium Substack), I thought it might be appropriate to assess the environmental philosophy that tends to lead the way in pushing 'technological problem-solving': Ecomodernism.

Let's delve into what Ecomodernism is before deconstructing its approach through my questions. And I will do this for the most part via a very brief summary of *An Ecomodernist Manifesto* published in 2015 by a number of scholars.

Keep in mind that as with any philosophy there exists a spectrum of views on it, from both inside and outside of the Ecomodernist 'school of thought'. Also, it's important to note that some prominent Ecomodernists–such as Michael Shellenberger and Ted Nordhaus–have engaged directly with some of the critiques I will discuss below. This essay, however, addresses the philosophy's dominant tendencies and core assumptions as presented in the Manifesto and advocated for by the movement. Where engagement has occurred, it tends to be selective and reinforcing of the fundamental commitment to perpetual growth and technological salvation.

An Ecomodernist Manifesto

This publication begins with the assertion "that the Earth is a human planet…remade by human hands…and has entered a new geological epoch, the Anthropocene, the Age of Humans." The Manifesto then states that

“As scholars, scientists, campaigners, and citizens, we write with the conviction that knowledge and technology, applied with wisdom, might allow for a good, or even great, Anthropocene. A good Anthropocene demands that humans use their growing social, economic, and technological powers to make life better for people, stabilize the climate, and protect the natural world.” (p. 6)

While recognising that humans need to reduce their impact upon the natural world, they reject the idea that this must be done by harmonising with Nature in order to avoid collapse. Arguing that natural systems cannot be protected so long as humans depend upon them for sustenance and well-being, they suggest that it is only through the intensification of human activities (via socioeconomic and technological processes) that human development can continue to ‘decouple’ from the impacts it has had on the environment to this point in time.

This ‘decoupling’ appears to be the core tenet of Ecomodernism as painted in the Manifesto. Through innovative technology and well-managed socioeconomic systems, the approach aims to intensify those human activities that societies depend upon (e.g., settlement, agriculture, energy), thereby using less land and freeing up areas for Nature to recover from past abuses. This intensification can be accomplished by way of embracing certain aspects of modernity (e.g., urban centres, industrial agriculture, nuclear power, industrialisation, etc.) and liberating technology from current restraints imposed by modern environmentalism.

These shifts will result in a ‘good’ or ‘great’ Anthropocene where human prosperity and a healthy biosphere flourishes. Ecomodernism tends to reject the rather romantic version of environmentalism where humans need to live in harmony with Nature at a small scale. Such a ‘harmonious’ arrangement is viewed as impractical, counterproductive, and imposes a wretched lifestyle.

In essence, Ecomodernism is–according to its advocates–a pro-growth, pro-technology, and pro-human form of environmentalism. It argues that to save Nature, humanity must not just embrace modernity and its technologies but accelerate it–as opposed to vilifying and avoiding it as other environmental movements do.

A ‘great’ Anthropocene where humans can continue to pursue infinite growth on a finite planet while creating utopia for humanity and improving the biosphere’s health.

What’s not to love?

Well…

While praised by some for its optimism, the approach is criticised by others for its: unfailing faith in human ingenuity and technology to right the cascade of wrongs that have occurred in the wake of human expansion; failing to consider the scale of what it proposes (i.e., a global expansion of modernity and its technologies); ‘cherry-picking’ data to support its arguments; and, avoiding the power and equity issues such an approach would exacerbate.

I will now go through the ‘evaluative questionnaire’ I proposed in my last Contemplation and apply it to Ecomodernism as best I can.

Narrative
Does the proposal discuss the major drawbacks such as environmental and/or social costs, or only its benefits? Is there irrefutable evidence that the ‘solution’ will replace the destructive technology/system it is proposing to, or is it merely adding to total human throughput? Are the benefits of small-scale applications being honestly applied to a global, industrial scale, or are they being disingenuously applied?

Drawbacks
Ecomodernism acknowledges challenges to its approach but downplays the structural issues, such as inequality and power dynamics. It frames many issues as primarily problems with a mismanagement of technologies and resources. Correct the managerial components with progressive approaches and these drawbacks are 'solved'; they are not considered fundamental flaws.

Its acknowledgement of such 'problems' is rather selective, however. For example, high carbon emissions and widespread land misuse are recognised as issues but can be 'fixed' by way of low-carbon technologies and agricultural intensification. The issues of corporate power concentration and traditional community disruption tend to be minimised or sidestepped.

Traditional environmental approaches and their focus upon biophysical limits and reduced consumption is characterised as oppositional to human flourishing by Ecomodernists. In fact, some go further and label this 'miserabilism' and suggest it stands in stark contrast to their human-centric and optimistic philosophy. By framing alternatives as inherently opposed to the 'progress', technological innovation, and advancement suggested by their philosophy, a straw man is created. This oversimplified and misleading characterisation of alternative environmental movements allows Ecomodernists to overhype the benefits of their approach and minimise the drawbacks or avoid them altogether.

Replacement or Addition
Ecomodernism relies significantly on the concept of 'decoupling' whereby improvements in human welfare via technologies and improved systems are separated from any environmental impacts. Advocates promise that technological innovations will permit economic growth and throughput to continue in an environmentally-beneficial manner, while replacing the ecologically-destructive technologies and systems currently in place.

The evidence for such decoupling, be it relative or absolute, is extremely weak however (as I describe in more detail on the subject in a previous Contemplation: Website Medium Substack). Most significantly, the case for current decoupling appears to be primarily a case of statistical chicanery whereby most nations demonstrating decoupling have been able to do so via off-shoring of industries, financialisation of economies, and the importation of carbon- and materially-intensive goods. It would appear that the foundation of their decoupling argument is based upon selective and narrow definitions and evidence, as well as future 'breakthrough' technologies.

In addition, Jevons Paradox shows that efficiency gains and additional energy tends to result in more consumption and an increase in total throughput, not a decrease. This is not a replacement of destructive systems as argued by Ecomodernists, but a 'greenwashing' of expanded systems and technologies that are adding to human throughput and energy use.

Scale
Ecomodernism tends to impose a Western-biased developmental model that assumes modernisation is a desirable and universal goal. It dismisses alternative knowledge systems and values, especially as they pertain to the concentration of power that occurs with the development and buildout of complex technologies. Within their model is the assumption that scalability is both possible and desirable. Build and intensify it, and the benefits will come.

Human development is presented as an inevitable path towards an industrialised and high-tech global society, while small-scale low-tech systems are viewed as inefficient and backwards. Ecomodernism rarely if ever questions the ownership of these scaled technologies, leading critics to suggest its approach reinforces existing power and wealth structures while marginalising local and indigenous knowledge. It is a rather disingenuous approach to the scaling issue.

Summary
The Ecomodernist narrative is fundamentally one of faith in the idea that human ingenuity correctly directed can and will overcome biogeophysical constraints in a manner that allows material throughput to continue without pause while protecting the biosphere. Standing in contrast are the counter-narratives of ecological justice and degrowth that tend to be about sufficiency and equity in the face of real limits and entrenched power structures. The conflict between these two opposing philosophies tends to be in how 'progress' is defined, with Ecomodernism doing so within a perpetual growth paradigm and opposing views pointing out that it is such a paradigm that is the root cause of our predicaments.

Biogeophysical Reality
Is any analysis of the lifecycle of the 'solution' and any required supplementary technologies and/or systems including all stages? Raw material extraction? Manufacturing? Transportation? Operation? Maintenance? Byproduct disposal? Decommissioning? Reclamation? End-life disposal and waste management? What is the net energy return over the entire lifecycle, and is it greater than 10-14:1 (societal maintenance) or 3:1 (basic survival)? What finite materials/minerals are required, and are these readily available or have they already encountered supply chain bottlenecks or severe depletion? What are the ecological blind spots? Is it being assessed through carbon tunnel vision or is it taking in a broader consideration of the various planetary boundaries? Can the waste it is generating be safely managed in perpetuity, or are there long-term liabilities being created?

Lifecycle
Ecomodernists tend to make the common error of engaging almost exclusively in partial lifecycle analyses to support their arguments. They focus upon the end-use environmental impacts of many technologies (e.g., nuclear power generation, electric vehicles, 'renewables') and downplay or externalise the immense ecologically-destructive upstream (e.g., mining, refining, production) and downstream (e.g., decommissioning, reclamation, disposal) aspects, claiming the technologies are 'clean' as a result.

The 'clean' image provided by narrow lifecycle analyses is due to this snapshot of the operational phase of technologies that hides the environmental impacts of all the chemical- and hydrocarbon-based industrial processes that created the technology or are required for their decommissioning or disposal. These important lifecycle aspects of production and end-life are treated as externalities or engineering 'problems' when they are acknowledged, and not constraining fundamentals.

Net Energy Return
The incomplete lifecycle data used by Ecomodernists to support their arguments also leads to a misuse of net energy return calculations. For example, the energy return of intermittent wind and solar power generation is considered relatively high when backup storage infrastructure is absent in the numbers. The net energy such systems can deliver to society is much lower, however, once these backup systems are included–to say little about the environmental impacts of this additional infrastructure (a consideration that I find many advocates of such power generation tend to avoid or rationalise away).

Achieving an energy-return-on-investment (EROI) of at least 10:1 is imperiled significantly by the fully-electrified, high-tech complex global society advocated by Ecomodernists. Energy analyst Vaclav Smil has suggested that hydrocarbons have provided a huge subsidy to societal energy needs and made modernity possible by way of significant surplus energy (see: here). Any transition to much lower EROI energy sources (with their additional but necessary infrastructure energy/resource costs) jeopardises the surplus energy needed to maintain let alone grow societal complexities.

The paradox of what Ecomodernists are calling for is clear: the proposed low-impact, technological future requires a very significant up-front use of energy and resources where diminishing returns are already biting hard, as well as massive ecological systems impacts in a world where most planetary boundaries have already been broached.

Material/Mineral Limits
The Ecomodernist vision is highly dependent upon finite materials/minerals that are already facing geo/political, economic, ecological, and depletion challenges. The International Energy Agency (IEA) has estimated that a ‘renewable’ energy transition could lead to massive increases in demand for a number of key materials: lithium by 4200%; graphite by 2500%, and cobalt by 1900% (see: here).

Ecomodernists argue that this is entirely feasible with continuing technological innovation and improved efficiency of material/mineral use as well as recycling. According to others, however, this unprecedented scaling is impossible (see: here and here). To scale their technologies up to the global level they are proposing would not only exacerbate supply chain bottlenecks and shortages, but wreak tremendous havoc upon the planet’s biosphere.

Ecological Blind Spots
Ecomodernism is fraught with ecological blind spots, primarily due to its carbon tunnel vision that minimises/avoids the impacts upon various other planetary boundaries (e.g., biodiversity loss, freshwater use, novel entities/pollution) of what it proposes. Critics have been quick to point out that much of what is occurring in the field of ‘carbon-free’ technologies has been a shifting of destruction to both other localities and ecological systems.

Ecomodernists assume that potential crises will be avoided through unproven or unscalable ‘clean’ technologies. For example, the massive buildout of nuclear power generation being called for ignores the dilemmas of fuel finiteness and its radioactive waste accumulation (see my Contemplation on this: Website Medium Substack); and the call for agricultural intensification overlooks the dependency that industrial agriculture has upon synthetic (and hydrocarbon-based) fertilisers, herbicides, and pesticides that–among other negative impacts–result in disruptions to the planet’s nitrogen and phosphorus cycles and leading to the creation of dead zones.

Waste Management
A number of long-term liabilities are created via the Ecomodernist approach, yet they are mostly ignored or rationalised away. As mentioned above, nuclear power generation is the go-to energy source in the Manifesto with its waste requiring perpetual management. In addition, novel waste streams have been created with the production and use of ‘renewables’.

Ecomodernists don’t address these particular aspects directly but argue that a ‘circular economy’ with high recycling rates will ensure ecological devastation is avoided. What they fail to acknowledge is that recycling infrastructure lags significantly behind the extraction and consumption rates of the planet and that circular economies are an aspiration, not a reality–to say little about the energy required for recycling, the products that cannot be or require extensive chemical inputs to be recycled, and/or the additional toxic waste streams created via efforts to recycle many products.

The 'solutions' proposed by Ecomodernism to any waste management issues are entirely 'hoped-for/faith-based' with no proven scalable infrastructure support, lack of economic viability, and certainly do not reflect current realities.

Summary
The high-tech, low-impact future Ecomodernism envisions encounters a central tension with biophysical reality: a massive materially- and energy-intensive buildout that conflicts with current reality and a concern with already overloaded planetary boundaries. Ecomodernists foresee a dematerialised world by way of a hyper-materialised world. It's a material dream in a material world where lab-proven technologies (and a lot of unproven ones) are impractical from an ecological and finite limits perspective once scaled up.

Viability
Can the 'solution' survive without massive government subsidies, externalised costs, or loan guarantees? Does it require a new, massively complex, and resource-intensive infrastructure to bring it to fruition? Is it dependent upon 'breakthrough' technology that has yet to exist?

Subsidies and Externalities
Massive government subsidies, private sector investment and loans, and the externalisation of ecological 'costs' are required to achieve the dreams of Ecomodernists. State support is a must for any projects to get off the ground and be attempted. They are not viable any other way, with their economic competitiveness being based almost entirely upon political choices and regulations.

Infrastructure Needs
The technologies to bring Ecomodernism to fruition require extensive, complex, and resource-intensive new infrastructures. The electrical grid must be completely rebuilt and massively expanded. Global supply chains and their extraction and refinement facilities need to be significantly expanded, along with their infrastructure needs. Hydrogen-based energy is a prime example of this need for huge infrastructure construction (see my Contemplation focussed on this 'solution': Website Medium Substack).

Reliance on Breakthroughs
There exists significant reliance upon 'breakthrough' technologies within the Ecomodernist philosophy. This is especially true for 4th-generation nuclear power generation (see my Contemplation on Thorium-based and molten salt reactors: Website Medium Substack), green hydrogen energy (see my Contemplation on this, mentioned above), and carbon capture (target for a future We're Saved! Contemplation perhaps).

Summary
The dependencies discussed directly above are interconnected in terms of the viability issue for Ecomodernism. A 'clean' grid based upon 'renewables', for example, depends greatly on technological innovations in multi-day energy storage. Without such a 'breakthrough', the power generation and current-reality battery storage infrastructure must be massively overbuilt to account for intermittent generation. This prospect is even more expensive and resource-/energy-intensive than the already overstretched Ecomodernist vision. The financial costs for this are externalised by advocates to the State and/or future generations, which in turn means the economics of this approach relies greatly on political stability–domestically and geopolitically. Such fragility stands in contrast to the robust, market-driven transition Ecomodernists speak about.

Here lies perhaps one of the more significant contradictions in the Ecomodernist philosophy: the deregulated and innovation-driven market that advocates propose is fundamentally important to the approach would actually be one of the most coordinated and state-run enterprises in human history given its reliance on state-directed subsidies and regulations. While arguing against the choosing of marketplace ‘winners’, it depends entirely upon such a choice for perhaps decades until its favoured technologies can ‘compete’ in an open and free market.

The technological viability of Ecomodernity is as fragile and uncertain as its political and economic viability given it assumes massive upfront capital mobilisation as well as global cooperation and policy stability for the long-term–a hope-filled faith with no historical precedent.

Social Aspects
Does the ‘solution’ challenge the infinite economic growth paradigm or enable its continuation? Who is promoting it and who profits from it? Will it help to further concentrate wealth/power or help to distribute it? Does it challenge or reinforce status quo wealth and power structures? Does it promote relocalisation and community resilience, or does it require globalised, centralised, and fragile supply chains? Does it shut down discussion of more fundamental changes (e.g., degrowth), or is it presented as the only alternative within the current system?

Growth Paradigm
Ecomodernism supports and enables continued pursuit of the perpetual growth chalice. In fact, it explicitly argues in favour of continuing and intensifying growth suggesting that such growth can and will–via technology and human ingenuity–be decoupled from ecological systems impacts. With this approach it defends the growth imperative that status quo power and wealth structures depend upon, rather than challenge it.

Promotion and Profit
The Ecomodernist philosophy is very much supported and promoted by sectors, investors, technocratic think-tanks, and systems that stand to ‘profit’ from it. Big tech. Venture capitalists. Big energy. The State. Large-scale deployment of capital-intensive, centralized technologies will make certain industries and sectors massive profits/funding and provide governing institutions with increased control/power.

Wealth and Power Concentration
The system being advocated for by Ecomodernists is very expensive, centralised, and expert-dependent. It is concentrating wealth and power in the hands of the State, multinational corporations, and technical elites. There has been no redistribution of benefits or control to date, and history suggests none will ever occur.

Rather than discuss inequalities, Ecomodernism frames poverty as primarily a lack of modernisation that can be ‘solved’ through intensified growth. This growth can be directed in a way that liberates humanity and meets everyone’s needs. This ignores history and how modernisation has led to poverty by way of dispossession, land appropriation, and the creation of a complex array of dependencies. Critics also point out that the entire enterprise is one of global value transfers where resource extraction from peripheral nations benefits the few in the core nations that control everything.

Relocalisation or Centralised Globalisation
Ecomodernism requires centrally-controlled but globalised supply chains, which is the opposite of relocalisation. Some infrastructure systems may help to raise community resilience depending upon one’s perspective (e.g., rooftop solar), but for the most part the systems being proposed are dependent on centralised globalist systems. Large-scale but land-sparing intensive agriculture, for example, depends upon complex and long global supply chains for the industrial inputs needed (e.g., machinery, fertilisers). This contrasts quite starkly with other movements that emphasise community control and resilient local communities.

Discussions
In framing alternatives as radically unrealistic and anti-human approaches that would create a most miserable existence for our species, and itself as an optimistic and pragmatic philosophy that leads to continued prosperity for all and a healthy biosphere, Ecomodernism presents itself as the best and only option to pursue. Such a simplistic characterisation of alternative pathways to mitigating our polycrisis assists Ecomodernists in positioning different approaches as dangerous and radical, and thus not worthy of any further discussion or consideration.

This is, of course, the straw man logical fallacy where competing narratives are distorted to make them easier to refute and serves to elevate one's own story. Rather than address the minutia of degrowth, for example, it oversimplifies it thereby making Ecomodernism more convincing and avoiding critical engagement with the fundamental issues. Ecomodernists argue from the perspective that theirs is the only worthwhile path to pursue as it alone can repair the biosphere and establish well-being and prosperity for all of humanity.

Summary
The Ecomodernist's approach has significant implications for human societies given it is not a socially-neutral, technology-oriented project but one that reinforces centralised control and uncritically celebrates modernisation and its array of complex energy- and resource-intensive technologies. By insisting that its high-tech global world is the only reasonable path to pursue, it denigrates and marginalises far less consumptive and ecologically-destructive alternatives.

Conclusion
Ecomodernism's high-tech, low-impact future is compelling on the surface. Under the questionnaire's lens, however, it emerges as a flawed, largely faith-based philosophy.

It hinges on speculative technologies, absolute decoupling, and global scalability—none of which current evidence supports. Its lifecycle analyses are incomplete; its energy-return calculations, selective. The proposed buildout would be resource-intensive, ecologically destructive, and dependent on precisely the hydrocarbon economy Ecomodernists claim to leave behind. Planetary boundaries already breached, material supply chains under strain, and long-lived waste streams without management pathways are treated as engineering problems, not fundamental constraints.

The social implications are equally stark. Ecomodernism reinforces centralised power, globalised supply chains, and the very growth paradigm that has driven ecological overshoot. It requires state-directed subsidies and long-term political stability while presenting itself as a market-driven, deregulatory project. It frames alternative pathways—degrowth, sufficiency, relocalisation—as miserabilist or anti-human, a straw man that forecloses genuine debate. Its 'great Anthropocene' is not a break from the status quo but its acceleration.

Ultimately, Ecomodernism functions not as a solution to our predicaments but as a narrative tool: one that manages societal anxiety, legitimises perpetual growth, and sustains the power and wealth structures from which it emerges and which it serves.

Recent and relevant articles of interest:
Ecomodernism: Modernity Without Ecology.
#319: The end of growth | Surplus Energy Economics
'Nearly Indestructible' Fuel: Nano Nuclear CEO Talks 'Laser Enrichment' On Shawn Ryan Show | ZeroHedge
Reprise: Volcano-Powered Data Centers
U.S. Push for Greenland's Minerals Faces Harsh Arctic Realities - Yale E360
The New Master of the World: Power to the Technocrats. Unrestrained Use of Technology - Global Research

Ronald Wright - Seeing the Future in the Ruins of the Past
The Green Belt Was a Firewall, Not a Garden
The Dirty Work of Clean Energy with Robert Friedland - YouTube
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New Jersey governor orders state to accelerate solar, storage and virtual power plants | Utility Dive
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Why Complex Societies Collapse | Joseph Tainter
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I'm Sorry to Burst Your Bubble: You Are Being Fooled About AI, and You Will Soon Feel Really Stupid
Shell Names the Risks and Discounts Them to Zero | Art Berman
SASOL, the Nazis, and the Thermodynamics of Defeat

"Renewables can be said to swap one fuel dependence for another. Although, this is even oversimplified since in our current reality, and for the foreseeable future, renewables depend entirely upon hydrocarbons and the military-industrial complex for their existence–they are a 'parasite' on the hydrocarbon economy and cannot be built, deployed, maintained, or decommissioned without the hydrocarbons they purport to replace and the military-industrial complex they suggest can be avoided. This is not a transition but a complex symbiosis."

Website **Medium** **Substack**

Today's Contemplation: Collapse Cometh CCXXXII– We're Saved! 'Renewables' and Energy Security.

We all interpret the world through our specific schemas and broader worldview. I have been reflecting on this phenomenon with regard to 'renewables' given an article I read and a meme making the rounds on social media in the shadow of the eruption of violence and chaos in the Middle East brought about by the U.S.-Israeli attack on Iran.

It's been argued that people often make any facts they are presented with fit into their beliefs rather than forming or adjusting beliefs based upon these same facts. This psychological tendency serves to activate the reward centres of our brains, reduce any anxiety created via cognitive dissonance, and reinforce our personal and social identity. This phenomenon has also led to such statements as that offered by author Robert A. Heinlein: *"Man is not a rational animal; he is a rationalizing animal."*

When someone holds a belief, facts are 'modified' to fit into them. Instead of acknowledging the complexity and inconvenience of competing 'facts' and adjusting one's mindset, we focus on things that support our preconceived notions and interpret the world so as to align with our beliefs. We are all guilty of this since the process is rooted deeply in how humans make sense of their world and the need to avoid the physiological discomfort that accompanies contradictory information.

The article in question argues that the true market price of hydrocarbons is hidden due to massive subsidies, especially those dedicated towards protecting global oil supplies. Given that 'renewable' energy is essentially ‘free’ and unaffected by geopolitical events, the author argues that a transition away from hydrocarbons and towards ‘renewables’ will be more than simply an economic shift but also the best path to energy security.

The meme (shown above) suggests that hydrocarbon-based energy is stuck in the Strait of Hormuz while locally-situated, renewables-based energy is not and implies the same line of thinking as the article: ‘renewables’ can avoid the perils of geopolitical brinkmanship and supply chain disruptions that are being witnessed so obviously with the closure of the Strait of Hormuz and the uncertainty and consequences of disrupting about 20% of the global oil flow.

‘Free’ energy that provides energy security, and avoids geopolitical quagmires.

What’s not to love?

Well…

This ‘renewables solution’ to geopolitical turmoil appears extremely compelling on the surface but if we run its implications/argument through the lens of the evaluative questionnaire for ‘solutions’ I proposed in a previous Contemplation (Website   Medium   Substack), it dissolves into a significantly more complex and problematic picture.

getyarn.io

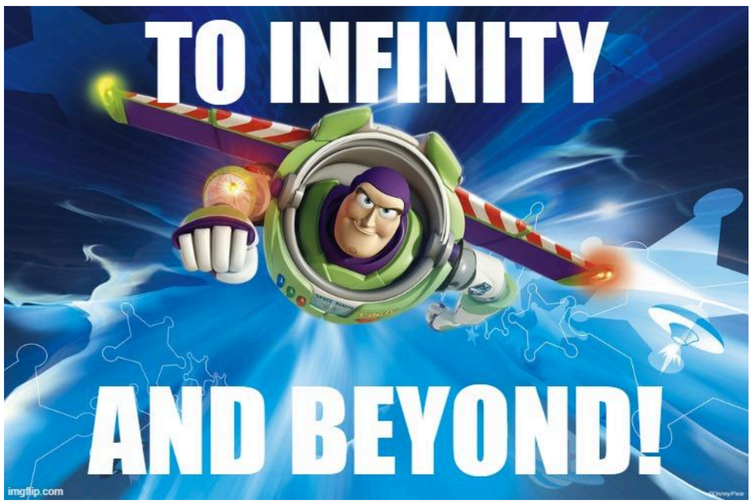
In fact, when I’ve pointed out these inconsistencies in response on social media, I have earned the label 'hardcore doomer.' But pushing back on ideas isn't the same as trying to take away someone's hope. It's about honesty regarding where we're at and what we're up against—a necessary precursor to acceptance and, perhaps, harm reduction. Because acting on comforting but incomplete solutions does not merely fail to solve our problems; it actively exacerbates our predicament, committing ever more resources and energy to pathways that cannot deliver what they promise.

Narrative
Does the proposal discuss the major drawbacks such as environmental and/or social costs, or only its benefits? Is there irrefutable evidence that the ‘solution’ will replace the destructive technology/system it is proposing to, or is it merely adding to total human throughput? Are the benefits of small-scale applications being honestly applied to a global, industrial scale, or are they being disingenuously applied?

Comparing the ‘fuel’ of renewables to hydrocarbon logistics would appear to be a classic straw man fallacy through an exceptionally uneven playing field created by omitting/ignoring the drawbacks of the mass-produced, industrial technologies required to harness the ‘free’ energy that renewables provide. Mining operations. Complex, global supply chains. End-of-life waste management/reclamation. Not only are these ecologically-destructive processes left out of the equation, but so too is the geopolitical pressure that they also experience.

While some proponents recognise these aspects, they tend to argue that they are simply challenges that need to be managed better than they currently are. In other words, these are not fatal flaws to the ‘solution’ of a renewables-based society but inconvenient hiccups on the path to utopia. I would argue, however, that this perspective is not only inaccurate but existentially problematic given that the scale that is being proposed leads to a ‘cure’ that is worse than the ‘disease’. The attempt to ‘electrify everything’, especially via renewables, would be ecologically devastating, pushing already broached planetary boundaries far, far beyond human lifetime recoverable levels–if ‘recovery’ is possible at all.

Historically, the energy derived from any new energy source tends to be additive to a society’s use and does not replace established ones. In our global, industrialised world this can be seen in the fact that today’s world uses more coal than it did in the 1800s despite the presence of oil, natural gas, nuclear, hydroelectric, and ‘renewables’; or that despite decades of exponentially-increasing production of ‘renewables’ we are witnessing ever-increasing amounts of hydrocarbon extraction and use. There is no ‘transition’ taking place. What we are experiencing is a compounding of energy consumption and associated material throughput.



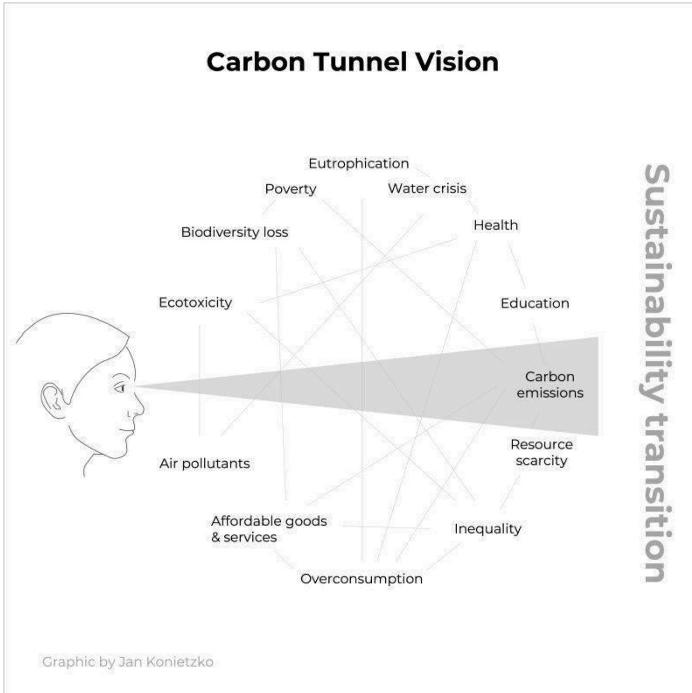
And while the benefits of any small-scale applications are being applied, it is being done disingenuously. Arguably, local resilience can be illustrated with the use of solar photovoltaic panels on a rural cabin. But a societal-scale grid powered by vast arrays of panels manufactured in centrally-located factories, shipped via diesel-fuelled transportation, occupying land cleared by hydrocarbon-based equipment, and feeding into energy-storage facilities whose components and manufacture also rely on massive hydrocarbon inputs and complex globalised industry, transportation, and supply chains (protected by the military complex) is not the same–not even close.

Biogeophysical Reality
Does the analysis of the inputs of the ‘solution’ and any required supplementary technologies and/or systems include all lifecycle stages, in particular: raw material extraction; manufacturing; transportation; operation; maintenance; byproduct disposal; decommissioning; reclamation; end-life disposal and waste management; and, associated infrastructure needs?

What is the net energy return over the entire lifecycle, and is it greater than 10-14:1 (societal maintenance) or 3:1 (basic survival)? What finite materials/minerals are required, and are these readily available or have they already encountered supply chain bottlenecks, diminishing returns, or severe depletion?

What are the ecological blind spots? Is it being assessed through carbon tunnel vision or is it taking in a broader consideration of the various planetary boundaries?
Can the waste it is generating be safely managed in perpetuity, or are there long-term liabilities being created? Is the planetary sink that might help to mitigate any waste already overloaded or close to it?

The article’s analysis exhibits carbon tunnel vision, focusing primarily on operational emissions while omitting the full lifecycle impacts of the hardware involved–especially those outside the narrow carbon focus. And while suggesting that the funds for the military to protect shipping lanes are a subsidy to hydrocarbons, it overlooks that these shipping lanes are also required to ship all the lithium for batteries, the bauxite for the aluminum frames of panels, and the finished panels themselves. The renewables system is not independent of the security apparatus criticised as supportive of hydrocarbons but part and parcel of it.



Another significant blind spot concerns the energy-return-on-investment (EROI) differences where high-quality hydrocarbons have provided those in the 30-100:1 range (and supported the development of modernity) but renewables are estimated to provide 5-12:1 in typical lifecycle analyses. When battery storage facilities are accounted for, the EROI falls below the 10-14:1 level estimated to be capable of supporting modernity and dangerously close to the 3:1 ratio of mere survival.

Perhaps most importantly, the ‘solution’ also ignores the impact of geopolitical uncertainty upon the material inputs for renewables. Lithium. Cobalt. Nickel. Copper. Rare-earths. These minerals are not located across the planet in equitable concentrations for all to use at their leisure to produce technologies. The supply chain dependencies and associated geopolitics on these finite materials are not accounted for in the analysis. In fact, they are only applied to hydrocarbons.

Also overlooked by those leveraging the current Middle Eastern conflict–what some are referring to as a Third Gulf War–to rationalise the buildout of renewables is the significant diminishing returns being experienced by many of the finite minerals that are required to build these products. Copper, the most vital to the electrification of everything, is witnessing significant ore grade decline resulting in evermore energy use and waste production to extract increasingly less metal–yet, electric vehicles require about four times more copper than a conventional internal combustion engine vehicle resulting in a massive compounding of demand pressure.

Beyond this compounding effect, there is also the scale of what advocates propose, with some arguing that the required materials do not exist in sufficient quantities on our planet. The numbers show this quite clearly: it has been estimated that to electrify the global fleet of transportation vehicles somewhere in the order of 55% more copper mines than current projected expansion would be required. This alone would mean 115% more copper would need to be mined over the next 30 years than has been accomplished in all of human history to date. And this is just for the copper required for electric vehicles; that required for the massive expansion of the supportive infrastructure is on top of this.

And all of this is only for the energy infrastructure itself. Every device, machine, and system that this ‘electrified’ society would run–from heat pumps and industrial machinery to data centres and consumer electronics–carries its own material supply chain dependencies, each reliant on the same shipping lanes, the same geopolitical stability, and the same hydrocarbon-powered extraction and manufacturing that the ‘renewables solution’ claims to transcend. The problem is not merely swapped; it is multiplied across every domain of modern life.

With a focus solely upon carbon emissions, the ecological blind spots of this ‘solution’ are massive. Mining is profoundly destructive to biosphere integrity. Industrial-scale buildout of renewables requires significant land use, resulting in ecological systems disruption and often competition with food production. The production of renewables involves various toxic chemicals with their lifecycle ‘management’ often ignored.

Then there is the ‘management’ of the waste produced. Despite arguments by advocates that these complex technologies are fully recyclable, such ‘circularity’ is still in its infancy and cannot currently fully recycle components–not even close. Almost all solar photovoltaic panels and wind turbine blades with such hazardous material as cadmium and lead currently end up in landfills.

Viability
Can the ‘solution’ survive without massive government subsidies, externalised costs, or loan guarantees? Does it require a new, massively complex, and resource-intensive infrastructure to bring it to fruition? Is it dependent upon ‘breakthrough’ technology that has yet to exist or is only in the prototype stage?

Modern industrial production is heavily subsidised. Not just the extraction and consumption of hydrocarbons, but all of it including that of renewables. From mining to manufacturing to distribution and installation. Everything is subsidised. The cost of cleaning up mining operations or ‘recycling’ material is omitted. The subsidies for hydrocarbons are highlighted by advocates, but the analysis does not account for the role that hydrocarbons play in renewables production.

There exists a stark gap between promises made and reality. The embodied energy for manufacturing solar panels, for example, may be recouped in 1-3 years as is often highlighted by advocates, but research indicates that only a single case of retired residential systems ever ‘paid back’ the economic cost prior to decommissioning, with most recovering less than 60% of their initial investment. Then there exist the distribution, maintenance, and reclamation/disposal ‘costs’; to say nothing about the original energy security argument and the military support required to ensure supply chains.

Also left out of the equation are the massive and resource-intensive infrastructure needs of renewables. Transmission systems. Energy storage. Redundancies. There exist massive energy and material costs to making this ‘free and secure’ energy bonanza come to fruition.

And while the solar and wind technologies themselves do not depend upon any technical ‘breakthroughs’, the energy storage technologies certainly do. Current storage technologies are incapable of meeting societal-level demands. Research supports this assertion: it has been estimated that batteries require a storage efficiency of at least 2 and perhaps up to 20 times greater than that which is currently available in order for such storage to be energetically preferable to hydrocarbons.

Social Aspects
Does the ‘solution’ challenge the infinite economic growth paradigm or enable its continuation? Who is promoting it and who profits from it? Will it help to further concentrate wealth/power or help to distribute it? Does it challenge or reinforce status quo wealth and power structures?
Does it promote relocalisation and community resilience, or does it require globalised, centralised, and fragile supply chains? Does it shut down discussion of more fundamental changes (e.g., degrowth, simplification), or is it presented as the only alternative within the current system of continued growth?

The renewables ‘solution’ enables the continuation of the infinite growth paradigm. In fact, its core appeal is just this: a continuation of business-as-usual growth and consumption with nary a hiccup in the transitional process. It is a ‘fix’ via technology that helps to avoid the more distressful conversations and choices that are sorely needed.

The ‘solution’ is promoted by a coalition of major corporate actors across the energy, technology, and finance sectors. This promotion aligns with observable outcomes: the infrastructure being built centralises power within existing industrial giants such as Siemens, General Electric, and Chinese state-affiliated manufacturers.

Renewables do not promote localisation as is often argued. They very much depend upon globalised and fragile supply chains. In fact, the manufacturing of solar photovoltaic panels is perhaps one of the most globalised projects on the planet, dependent entirely upon the very shipping lanes and geopolitical stability the ‘solution’ claims to transcend.

As for shutting down discussion on the fundamental changes to society that are desperately needed, this ‘solution’ is right on target. It offers a narrative that allows for the continuation of status quo consumption and growth, especially of material throughput which must increase massively to build out these ‘free-energy’ technologies.

Additional memes posted since I began writing this Contemplation.
The one on the right was accompanied with the lead: War is Fossil. Peace is Renewable.

Conclusion

The ‘solution’ offered in the article and implied in the meme(s) is seductive but disingenuous and a dangerous, incomplete picture of reality. They identify the vulnerability of dependence upon oil and its flow through one geopolitically uncertain chokepoint. However, they ignore the same serious vulnerabilities in their own resolution to energy insecurity.

Renewables can be said to swap one fuel dependence for another. Although, this is even oversimplified since in our current reality, and for the foreseeable future, renewables depend entirely upon hydrocarbons and the military-industrial complex for their existence–they are a ‘parasite’ on the hydrocarbon economy and cannot be built, deployed, maintained, or decommissioned without the hydrocarbons they purport to replace and the military-industrial complex they suggest can be avoided. This is not a transition but a complex symbiosis.

As presented, the ‘solution’ also fails to consider the core reality of ecological overshoot and the massive material throughputs that have exacerbated it. This ‘solution’ simply rebrands these within a ‘clean’ and ‘free’ narrative. Advocates are, in effect, fitting reality into their belief system–a tendency the opening of this Contemplation identified as deeply human, but one that becomes dangerous when it shapes the material future of a planet in overshoot.