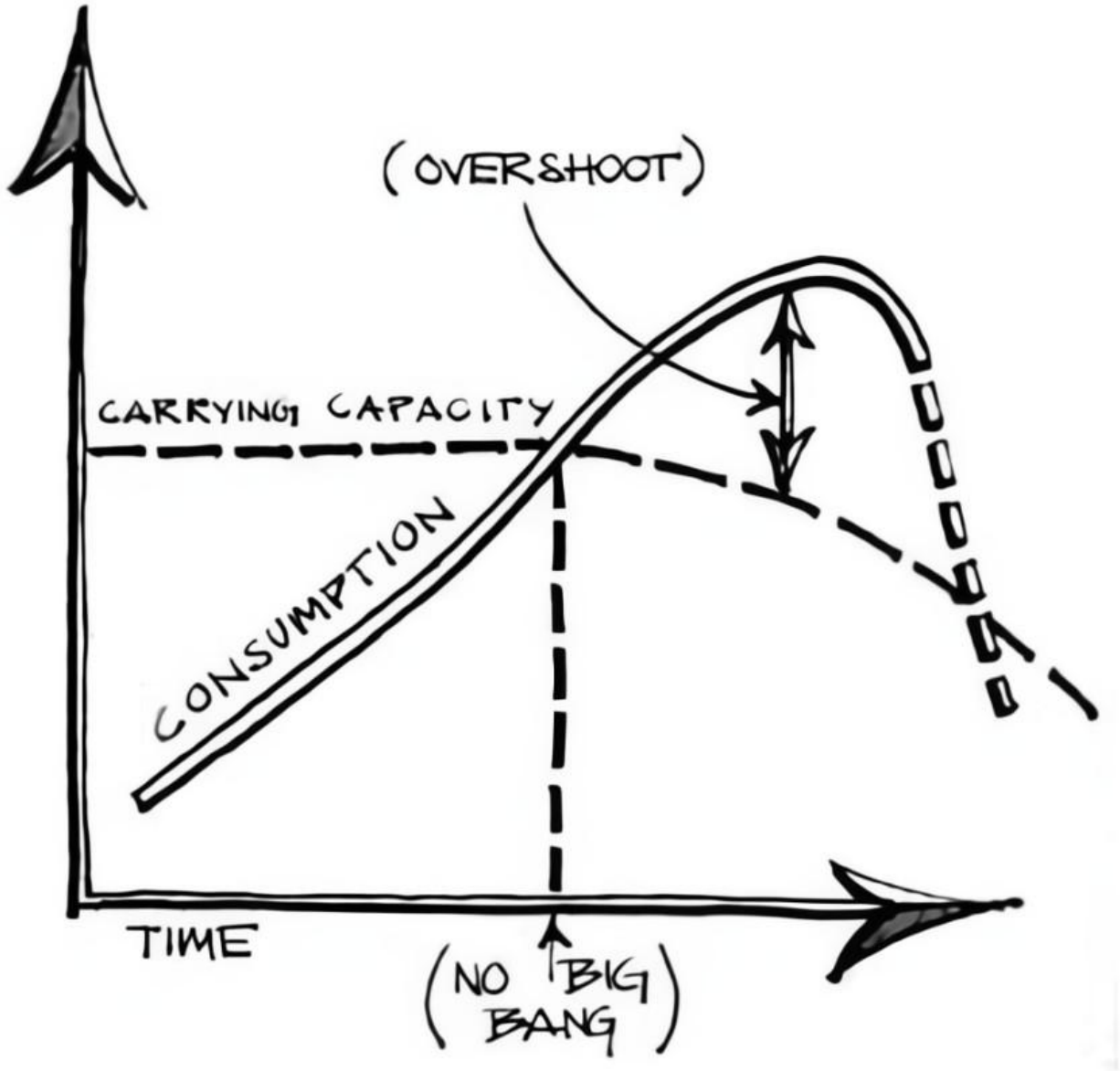
It Bears Repeating: Best Of...



Volume One

A compilation of writers focused on the predicament of ecological overshoot.

...[W]e, the human species are inexorably tightening the two jaws of the vise around our fragile civilization...there are already more human beings alive than the world's renewable resources can perpetually support. We have built complex societies that therefore depend on rapid use of exhaustible resources. Depletion of resources we don't know how to do without is reducing this finite planet's carrying capacity for our species. That is one jaw of the closing vise. The other is the accumulation of harmful substances that are unavoidably created by our life processes. There are so many of us, using so much technology, that these substances accumulate too fast for the global ecosystem to reprocess them; in fact, by overloading the natural reprocessing systems we are even breaking down their already limited capacity to set things right for us.

–William Catton, Jr., 1980. Overshoot: The Ecological Basis of Revolutionary Change.

However much we like to think of ourselves as something special in world history, in fact industrial societies are subject to the same principles that caused earlier societies to collapse. If civilization collapses again, it will be from failure to take advantage of the current reprieve, a reprieve both detrimental and essential to our anticipated future.

–Joseph Tainter, 1988. The Collapse of Complex Societies.

A delay in a feedback process is critical relative to rates of change in the stocks that the feedback loop is trying to control. Delays that are too short cause overreaction, 'chasing your tail,' oscillations amplified by the jumpiness of the response. Delays that are too long cause damped, sustained or exploding oscillations, depending on how much too long. Overlong delays in a system with a threshold, a danger point, a range past which irreversible damage can occur, cause overshoot and collapse.

–Donella H. Meadows, 2008. Thinking in Systems: A Primer.

Table of Contents

Editorial note:

The initial goal of this publication was to compile the ‘Best Of’ from a variety of authors that could be used as an ‘overview of/introduction to/update on’ the variety of issues that encompass the nexus of limits to growth, ecological overshoot, and energy.

This is not, however, a guided narrative towards a singular or overarching message; except, perhaps, that we are in a predicament of our own making with a far more chaotic future ahead of us than most imagine–and most certainly than what mainstream marketing/politics would have us believe. They are presented in alphabetical order by author last name or organisational title.

Another ‘goal’ of this document is to provide readers with exposure to some authors they may not be familiar with. Some of the contributors are more widely read and therefore known to many; others not so much, but all are active and participating in the circle of discussions on the issues. This document provides a thin cross-section of the voices warning us all of our predicament.

This collection provides a variety of authors, perspectives, foci, and rhetorical approaches from over the past handful of years to the present–one being still ‘in press’. They have all been replicated in their original form with perhaps only formatting changes so that the document is consistent in this regard. Any errors in formatting, layout, and replication of the article from the author’s’/publisher’s site are entirely the fault of the editor.

Links to author websites and the shared article are included for each chapter. Some of the articles have references/links embedded within them, while others follow a more academic publication-style with these provided at the end.

The articles are all public domain ones put out by the author and any replication in whole or part needs only an appropriate attribution to the author/publisher.

Please note that there exists a combination of both British and American English spelling for some words (e.g., organise and organize).

And, finally, a HUGE thank you to the authors/thinkers/activists whose work is included in this compilation. Their willingness to participate and provide feedback has been immeasurable, and it has been a pleasure to make contact and work with them on this project.

-Steve Bull
August 2023

Michael Dowd
Post-Doom

Foreword
(August 2023)

It's an honor to have been invited by Steve Bull to offer a brief forward and afterward to this excellent compendium of contributions by some of my favorite authors and most cherished colleagues on the subject of ecological overshoot. **Warning: this is not a volume to be read quickly or superficially!**

In each of my most important teaching videos ("Collapse in a Nutshell", "Overshoot in a Nutshell: Understanding Our Predicament", "Collapse 101: The Inevitable Fruit of Progress", "Unstoppable Collapse: How to Avoid the Worst", and "Ten Inevitables: Post Doom, No Gloom"), I mention how William Catton's seminal 1980 book, Overshoot: The Ecological Basis of Revolutionary Change, was (and remains) the single most important book I have ever read.

To illustrate why I find the concept and reality of overshoot so essential for understanding our world, our predicament, and the nature of our times (and why I so recommend this volume of essays, "It Bears Repeating…" so highly!) I have included in this Foreword and the Afterword a few key slides that I used in my recent 50-minute Canadian Association for the Club of Rome (CACOR) presentation, "The Big Picture: Beyond Hope and Fear".

I invite the reader to carefully read (rather than merely skim) the text on the following slides. I will not repeat my narration of the same here, as those who are interested can watch the presentation and follow-up Q&A for themselves.

> ***"It is axiomatic that we are in no way protected from the consequences of our actions by remaining confused about the ecological meaning of our humanness, ignorant of ecological processes, and unmindful of the ecological aspects of history. I have tried to show the real nature of humanity's predicament not because understanding its nature will enable us to escape it, but because if we do not understand it we shall continue to act and react in ways that make it worse."***
>
> -William R. Catton, Jr., Overshoot (1980)

Summary / Overview

The stability of the biosphere has been in decline for centuries and in runaway (unstoppable) collapse for decades.

This "Great Acceleration" of technology- and market-driven ecocide is an easily verifiable fact; the scientific evidence is overwhelming.

Evidence is also compelling that the vast majority of people will deny this, especially those still benefitting from the existing order, those legitimately concerned about the consequences of collapse, and those who fear that accepting reality means "giving up".

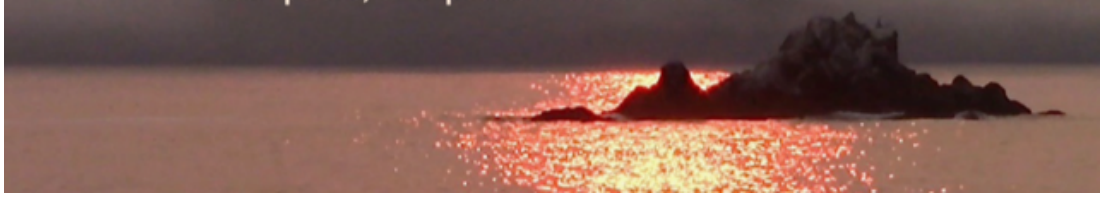
The history of 80+ previous boom & bust (*progress / regress*) societies clearly reveals how and why *Homo colossus* is commiting ecocide.

Whereas widespread hope and optimism will lead to dozens, if not hundreds, of nuclear meltdowns, *acceptance of collapse and its inevitable consequences (i.e., trusting reality)* may be the single most important thing any of us can do to live fully, fearlessly, and inspiringly in this time of global hospice — i.e., at TEOTWAWKI.

Denial

The largely unconscious habit of thought whereby we refuse to accept the reality of things that are bad or upsetting — or that challenge our world-view, our legacy, how we live, what is required of us, and/or our feelings of self-worth or superiority.

The reflexive impulse to reject or discount information that calls into question our hopes, assumptions, or expectations about the future.



Collapse & ecocide are the *inevitable* fruit of civilizational "progress"

"Forests precede civilizations and deserts follow them."
~ Francois-Rene de Chateaubriand

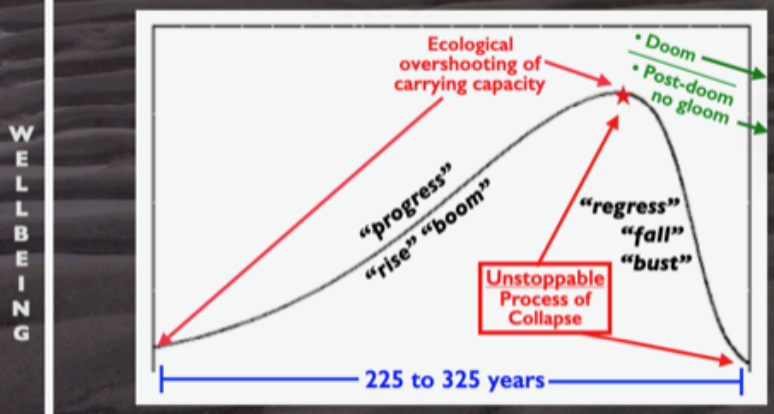
"All of our exalted technological progress, civilization for that matter, is comparable to an axe in the hand of a pathological criminal."
~ Albert Einstein

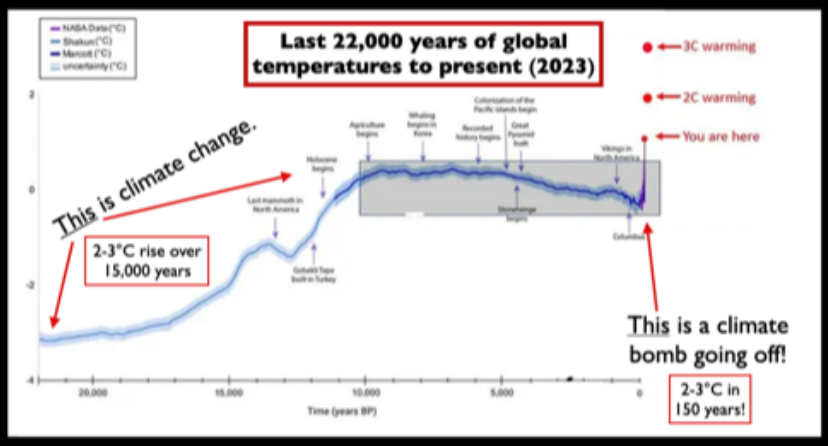
"Civilization is a hopeless race to discover remedies for the evils it produces."
~ Jean-Jacques Rousseau

"The end of the human race will be that it will eventually die of civilization."
~ Ralph Waldo Emerson

"The Earth is littered with the ruins of empires and civilizations that once believed they were eternal."
~ Camille Paglia

How *human-centered* civilizations commit suicide





climate.nasa.gov

Hope and optimism lead good people to unwittingly ensure geological-scale evil…

- There are 440 nuclear reactors worldwide…
- Requiring us to *assume* that industrial civilization has eternal life.
- We are already 25-30 years into *abrupt (runaway) climate mayhem.*

The unavoidable long-term question…

As industrial civilization continues to collapse (faster and faster), how many Chernobyl- or Fukushima-like (or worse) meltdowns due to wildfires, hurricanes, droughts, tsunamis, power-grid failures, political instability, or terrorism do you think are *possible*?…*likely*?…*inevitable?*

4 Main Drivers of Collapse, Ecocide, and Likely NTHE

1. Extractive, exploitative civilizations
2. Human-centered science & technology
3. Human-centered '*progress*' & '*development*'
4. Money-based growth economics

Ecological Overshoot of Carrying Capacity

How we define & measure *wealth, wellbeing, "progress"*

Human-centered (*anthropocentric*) measures

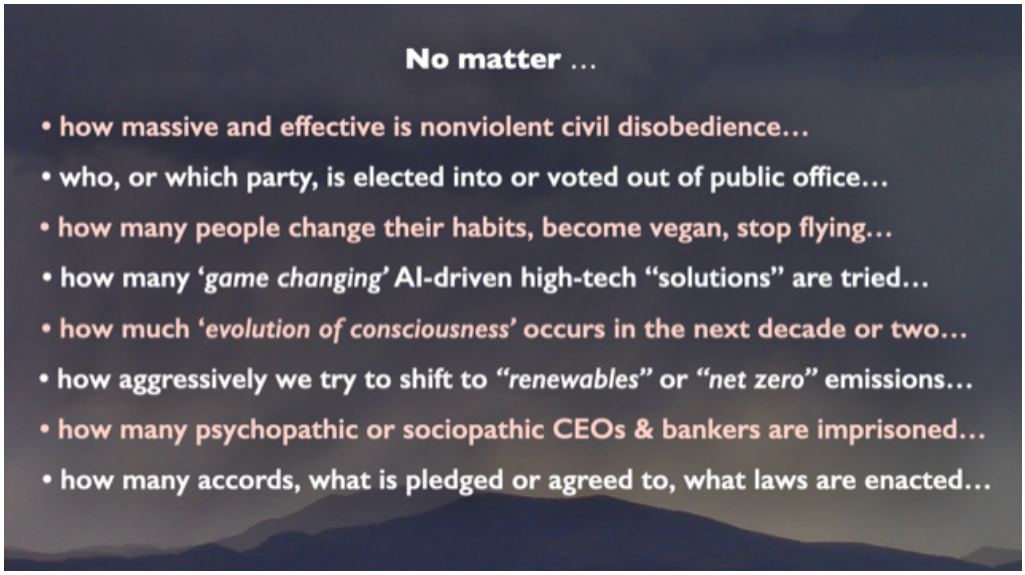
vs.

Life-centered (*ecocentric*) measures

★ extinction-level runaway mode

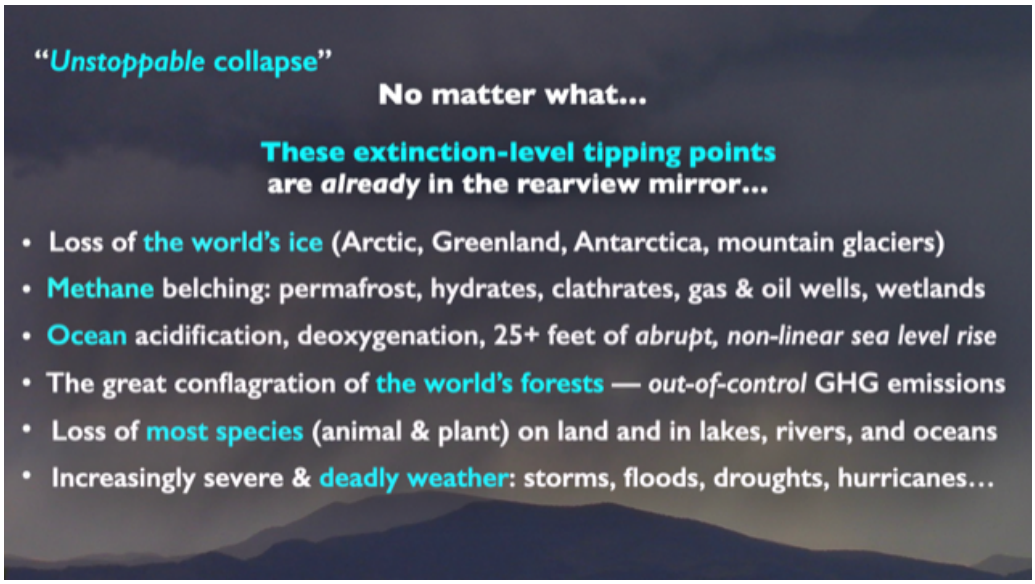
★ Climate change
★ Death of the oceans
★ Plant & animal annihilation
Topsoil poisoning and loss
Critical resource depletion
Chemical & nuclear wastes
Growing gulf btw rich & poor
Economic instability / insanity
Political polarization & conflict
Contracting of in-groups
Rise of totalitarianism, -isms

The most hopeful thing that I have discovered about an ecological understanding of history is that it gives a larger context of *certainty* upon which all the various uncertainties and unknowable things rests. So while some of the authors in this volume focus on what we can't know for sure, and what is still uncertain, the gift of overshoot I found most valuable is in pointing us to what we can know for certain — what there is no debate about and what we can be 100% confident regarding. Such a grounding of legitimate uncertainties in the context of a few absolute certainties reduces anxiety, fear, and depression if and only if we truly accept what we cannot change. The most important certainty, in my opinion, is that once ecological and societal collapse is well underway, no power in heaven or on earth can slow, stop or reverse it and a significant die-off or loss in population is guaranteed, as is the further cascading and accelerating breakdown of societal and social structures.



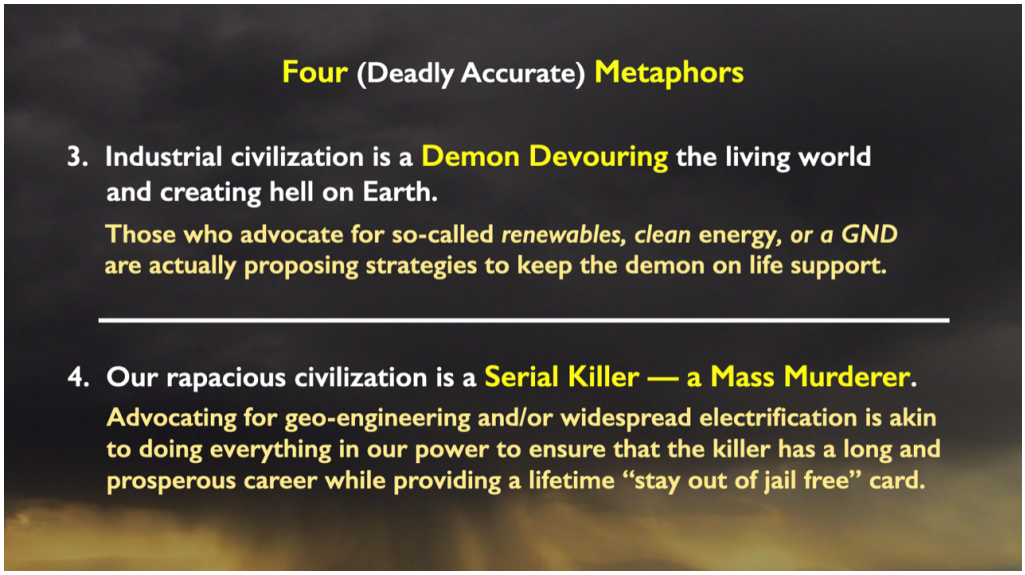
"Yet one thing is now obvious. To accept the hard path of belt- tightening and sacrifices, we must first trim back our technological optimism. We need, in short, something we lost in our haste to remake the world: a sense of limits, an awareness of the importance of earth's resources."

-Stewart L. Udall (from the Foreword to Catton's Overshoot)



"Nature is going to require reduction of human dominance over the world ecosystem. The changes this will entail are so revolutionary that we will be almost overwhelmingly tempted instead to prolong and augment our dominance at all costs. And, as we shall see, the costs will be prodigious. We are likely to do many things that will make a bad situation worse. It is hoped that the kind of enlightenment offered in this book may help curtail such tendencies."

-William R. Catton, Jr., Overshoot (1980)

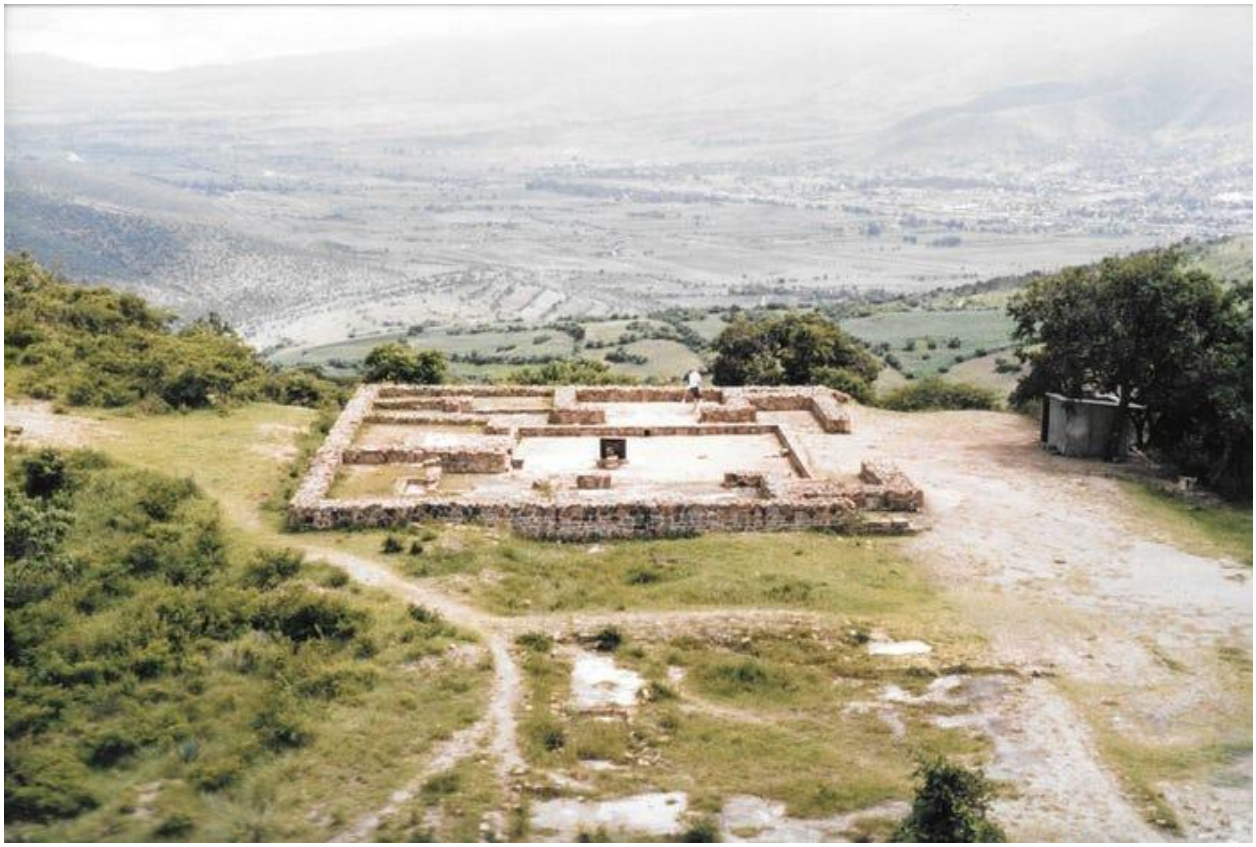


The essays (and slides) in this "It Bears Repeating…" anthology by Steve Bull, Alice Friedemann, Kevin Hester, Erik Michaels, Simon Michaux, Rob Mielcarski, Tim Morgan, William Rees, Tim Watkins, and Max Wilbert all point to the cascading causes and drivers of our ecological predicament. The essays by David Casey, Tristan Sykes and Kate Booth,and Mike Stasse point to how we might adapt and cope with what is already unfolding and unstoppable.

NOTE: In addition to these helpful resources, I also recommend reading this linked book review (excellent summary/overview) of William Catton's book, Overshoot (perhaps after Steve Bull's "That Uncertain Road" essay) as it provides a more detailed look at the phenomenon of ecological overshoot, the overarching predicament that our species faces.

Steve Bull
Today's Contemplation: Collapse Cometh

Today's Contemplation: Collapse Cometh CII
[Published February 20, 2023]



Monte Alban, Mexico. (1988) Photo by author.

That Uncertain Road, Part 1

> *"I think it's much more interesting to live not knowing than to have answers which might be wrong. I have approximate answers and possible beliefs and different degrees of uncertainty about different things, but I am not absolutely sure of anything and there are many things I don't know anything about, such as whether it means anything to ask why we're here. I don't have to know an answer. I don't feel frightened not knowing things, by being lost in a mysterious universe without any purpose, which is the way it really is as far as I can tell."*
> *— Richard P. Feynman*

> *"As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality."*
> *— Albert Einstein*

There are many words that could be used to describe the future and humanity's ability to know how it will unfold. Unknowable. Unpredictable. Uncertain. Unwritten. Undetermined. Unforeseeable.

These tool-making, story-telling apes we have termed homo sapiens just happen to abhor this aspect of existence. Uncertainty has been found to result in negative affect for most people in most situations[1]. In fact, it has been suggested that "the oldest and strongest emotion of mankind is fear, and the oldest and strongest kind of fear is fear of the unknown"[2] and that "…fear of the unknown may be a, or possibly the, fundamental fear, representing an Archimedean lever for human psychology"[3].

As Dan Gardner reminds the reader in Future Babble humans want and need control, especially of their environment/surroundings. Not having control, or at least the sense of it, can lead to stress, disease, and early death. Having some 'certainty' about what the future holds is a type of control, even if we know what happens is out of our personal control.

We have developed a host of psychological mechanisms to defend against our fear of uncertainty (e.g., illusion of control). In fact, psychologists have found an increased dependence upon magical thinking when control is lost or uncertainty increases[4]. In addition, people will cling more fiercely to their belief system in the face of counterfactual evidence in order to increase their sense of certainty. They will ignore or deny those things that increase their cognitive dissonance and the uncertainty it creates.

We also more often tend to see patterns where none exist as we search for certainty[5]. Reassurance about the future motivates people to seek it somewhere. Anywhere.

Cognitive psychologists suggest prospection, the term used to describe the generation of possible future scenarios, is a central tenet of both cognition and emotion[6]. But it is also a fundamental aspect of learning for any animal that is driven by their avoidance of pain and seeking of pleasure since being able to sense patterns of environmental changes or actions of other animals can alter their behaviour to seek a reward or avoid a punishment — perhaps the most basic one being falling prey to a potential predator.

As tool makers, we leverage this rather unique ability in attempts to help us control our environment, thus providing a sense of security against this uncertain future. And it seems we often fall back on this skill to help us believe some as-yet-to-be-hatched 'tool' will be created to help us achieve what we have yet to achieve — certainty about the future by solving our various problems, such as a lack of 'clean' energy.

As story tellers, we craft all variety of narratives to help us understand our world — the past, the present, and especially the future. Religion. Biology. Politics. Physics. Economics. History. Mathematics. Psychology. Astrology. Ecology. Chemistry. Philosophy.

Are any of the tales we tell and share accurate reflections of our world and its functioning? Can we predict the future? Can we, using all of our cognitive abilities, understandings of the world, and technologies reduce the uncertainty that lies before us?

The answer may actually be irrelevant since we all tend to believe what we believe — be it learned or conditioned, accurate or misinformed. And we use what we believe to reduce our anxiety about an uncertain

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[1] See this, this, and/or this.
[2] See this.
[3] See this.
[4] See this, this, and/or this.
[5] See this, this, this, and/or this.
[6] See this.

future.

Despite all of the above, and knowing full well that predictions about the future are just stories we tell to reduce our uncertainty, the following is one perspective on what the future *may* hold based upon two beliefs that seem certain to me, although I know they don't to everyone:
1) We exist upon a planet with finite resources;
2) Biological and historical precedents exist from which we can learn and help us map a likely future.

First, we live upon a planet with a finite amount of resources available to us. Despite the story that infinite substitutability can overcome or mitigate this reality, I firmly believe we cannot create more of our most important resources from thin air. This is especially true for life's primary resource, energy. As the First Law of Thermodynamics states: energy can neither be created nor destroyed, only converted from one form to another. This limits what is available to all species upon our planet.

Second, there exist biological and historical 'experiments' concerning ecological overshoot and complex society 'collapse' that we can use to help us understand important processes and how they are likely to unfold.

To paraphrase the saying about events rhyming with the past, there should be no assumptions that the future will unfold exactly as it has in the past. While there will no doubt be similarities because humans are animals with strong genetic predispositions that act and react in somewhat constrained ways, we are also a species with strong sociocultural influences upon our behaviour that vary in both time and place. And the contextual environment within which we are behaving is never precisely the same; particularly given the complexities that accumulate and impact us — especially technological in nature.

There is so much that has already been written and could be said about ecological overshoot and humanity's prospects as we travel further into it. It is important to my thinking here that I note that humans are a biological species similar to every other one on our planet and there exist many behavioural responses that we cannot avoid because of this. Perhaps the most fundamental biologically-based one is that of reproduction and a species tendency to reproduce to a level that can be sustained by their immediate habitat. Overshooting this sustainable carrying capacity invariably results in moving to an uninhabited and unexploited area or 'reversion to the mean' of a species' population size[7].

Humans however, as an apex predator and with their tool-making abilities, have been able to exceed significantly the natural, environmental carrying capacity allowing us to go well beyond the limits imposed by nature. Population biology demonstrates that such a situation cannot and will not go on indefinitely. And the resulting 'correction' may as a result of this be even more dramatic in nature.

As William Catton Jr. argues, our ability to employ technological tools to expand our carrying capacity has resulted in a trap that now threatens the environment and ecological systems we require for our survival. Blind to what we are doing, we have embraced and increased the speed with which we are drawing down the finite resources we rely upon. There will be, based upon other species that have overshot their environmental carrying capacity, a reversion to the mean of population size that can be 'sustained' — and it will be much, much lower than may have been reached in an uncontaminated and undamaged environment[8].

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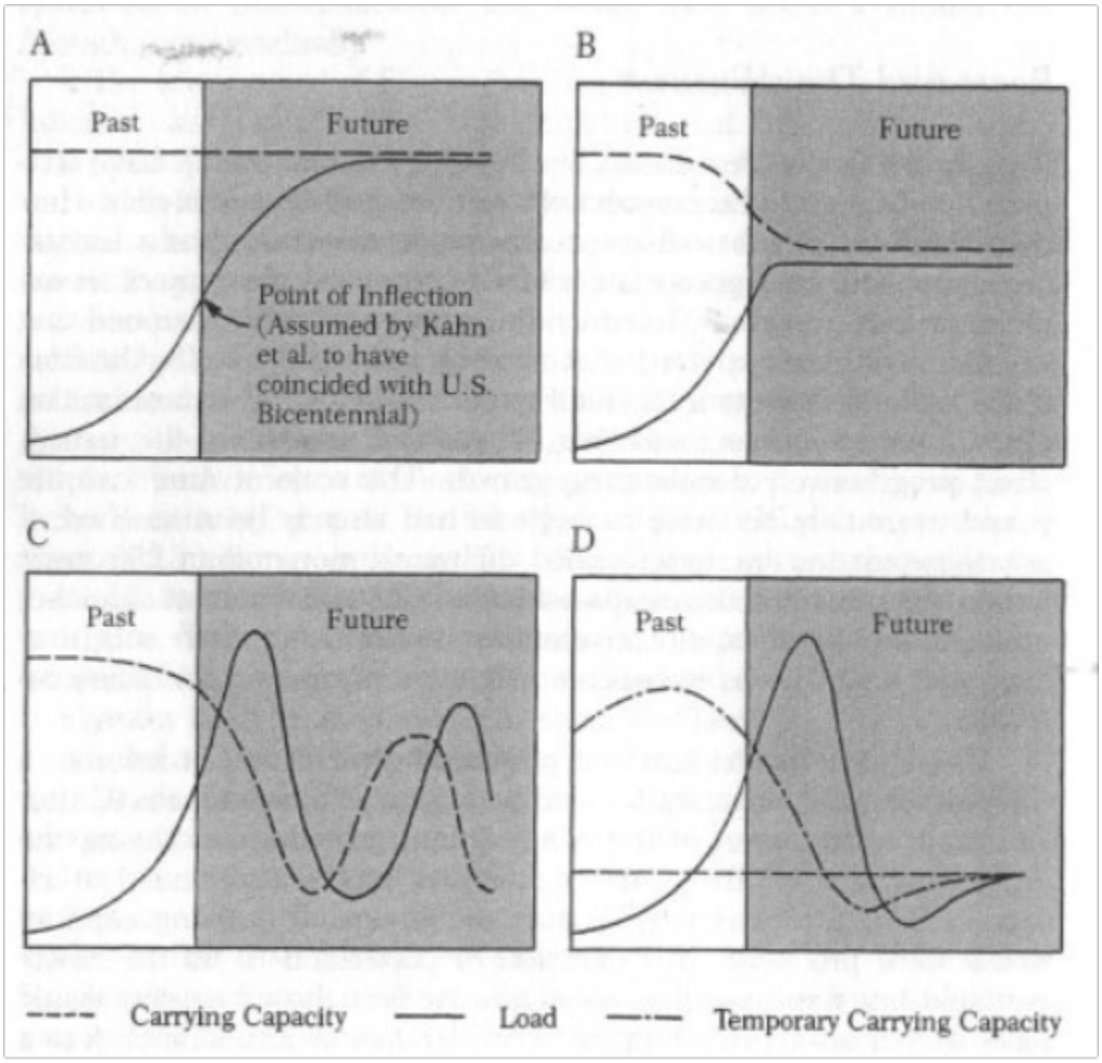
[7] See this, this, this, this, and/or this.
[8] See this.

Further, Catton observes that "[o]vershoot will occur, if it hasn't already. We may come to feel guilty about stealing from the future, but we will continue to do it. Overshoot will further aggravate the reduction of carrying capacity. Crash must follow. The greater the overshoot, the greater the crash." (p. 253)

The following graph from Catton's text provides four possible growth scenarios, with Panel D being the most likely for humanity. As he explains "'carrying capacity' has been represented by two different curves. A major fraction of the recent, apparently high carrying capacity for human high-energy living must be attributed to temporary resources — i.e., non-renewable fossil acreage, the earth's savings deposits. In Panel D, it is optimistically assumed that the component of carrying capacity based on renewable resources has remained stable so far. But it is recognized that serious overshoot, induced by temporarily high composite carrying capacity, will at least temporarily undermine even the sustainable component." (p. 253)



That's overshoot in a nutshell: an epic crash in population as our fundamental resources can no longer support our numbers. The writing seems on the wall that human population numbers are likely to fall precipitously from their current and relatively high numbers.

How that unfolds is yet to be determined, but it seems the most likely scenario some time down the road as the resources, especially energy, become more scarce to support our inflated numbers…

In Part 2, I will elaborate on what I believe our pre/historical precedents suggest about what we might expect down that uncertain road…

Bio

Steve Bull is a retired educator who spent the entire decade of the 1980s chasing four degrees, studying biology/physiology, psychology, anthropology/archaeology, and education–attaining a Masters in archaeology but pursuing a career in education. He fell down the rabbit's hole of Peak Oil and related predicaments after watching the documentary Collapse featuring the late Michael Ruppert. In an attempt to reduce the resulting cognitive dissonance, he ventured into fictional writing penning a novel trilogy centred around societal collapse to share his learnings with family and friends. Since that time he has pursued non-fictional writing on the topics discussed in this compilation. Also, see this and this.

David Casey
Articulating the Future

Preparing
[Published June 12, 2016)

My last post gave a bird's eye view of what the future will look like. How can we prepare for such a future? Preparing to face the end of industrial civilization is not an easy task mentally, physically, or spiritually.

The question is what positive program could be proposed to prepare for the coming scarcities. The answer is that the individual and local programs have to be worked out by those who recognize its importance. In this post my speculations about what should go into such a program might be used as a guide.

> *"We need now to start focusing specifically on the issue of resilience. If we go through this period of decline without foreknowledge, without preparation, I fear that it will strip away many of our fundamental values, that we will be left afterwards with a system that is very very unpleasant. If we can build resilience into the system at different levels and then go through this period of decline knowing that at the end of it we will have the capacity to engineer the system in a new way, sustainably, then I think we can sustain our commitment to democracy, equity, and so forth. And that's the challenge for us. "*
> *–Dennis Meadows, March 9, 2012, lecture at the Smithsonian entitled: Perspectives on the Limits of Growth: It is too late for sustainable development.*

Meadows was talking about the system, the economy, the government, the "big picture" response. But look at it from an individual's perspective. You and I and our family and our friends and our neighbors need to start focusing on resilience. If we go through this period of decline without foreknowledge and without preparing for it, we will be left in a very unpleasant situation. If we build resilience into our lives now, then after the decline we will have the capacity to rebuild a better way of life. This is partially what I meant in my last post when I said that the sooner people and societies prepare for a post-peak-oil life, the more they will be able to influence the direction of their opportunities. If you are caught off guard by what will happen then you will be poorly positioned to influence the course of your life, to put it mildly. You will at best get lucky, and at worse be a complete victim of circumstance.

When this subject was brought up recently, a friend of mine told me that what a lot of people wonder about regarding 'collapse' situations is how much time they will have to get that last tank of gas, one last run to the store, or how they will get money out of their bank account. This, and these kinds of situations, are regularly talked about in prepper-porn (fiction books that deal with usually outlandish survival situations) and prepper forums online.

My response is that it completely depends on what services are being blocked/denied and how resilient you and your community are. In almost all circumstances (except for Black Swan events) you will have more time than you might think. But if you are even slightly resilient then you don't need to worry about making one last run to the store or the bank or the gas station. This is Prep 101. You should not be panicked about needing cash or running to the store. Such measures would only help you for about a week or two anyhow. And if that's all you're prepared for, then you'll probably be dead within a month of anything significant occurring.

This may sound harsh, but what I am saying is that if something so significant happens that you're panicked and going to the gas station, the bank, and the grocery store to get you prepared for it at the literal last minute then you're probably not pre-prepared, and you'll at best be able to get about 1-2 weeks of minimally prepared in that last minute. This only works in very short-term situations. Far better to get actually prepared rather than some minimal preparedness that revolves completely around short-term foodstuffs in your garage - and to do so far in advance, rather than rushing around in a panic to get some very small measure of comfort.

The point is that we are facing the end of industrial civilization. The duration is forever. This is not akin to preparing for some small event, like having packed bags ready to go because a wildfire is bearing down on your home, or having a few days worth of food to survive a short-term grid down scenario. What we are facing is not going to be short term, and it's not going to affect one small area. It will affect literally everything, in progressively compounding ways. Eventually, within your area (wherever that may be), grocery stores won't exist, no one will be driving a car anywhere, hospitals won't be open, firefighters and police won't come to your aid. Etcetera.

This is something that can take a while for one's mind to wrap around. Preparing to survive a few extra weeks longer than others (by having some storage of food and water, etc) just increases your odds that you will die quite soon after seeing most other people die. If that's all you're prepared for, then it might be better to just accept your death and go when most other people go. And I mean that very sincerely. There are a few people I know who have so many limitations that they don't see a way out for themselves in the coming hard times and they have moved to a mental/spiritual place of gracious acceptance that embraces the time they have left. If you really want to survive you have to accurately and soberly face the reality that we're facing the end of industrial civilization itself, and prepare well beyond just storing some food in your basement or garage.

Preparation

There will always be a continuum of "best practices" that give you a higher-to-lower probability of survival. The realistic absolute best would probably be some intentional community of highly skilled people (150 or less, as science tells us that's about the limit to how many contacts one person can really keep track of and making lasting connections with) on a great amount of land (adjoining a national/state park or BLM land on 3 sides maybe) and having the ability to grow enough food for all of those people year-round, as well as provide your own top-notch security. In such a situation (with a lot more expanding of ideas), you'd probably have the best chance of surviving pretty much anything besides all-out nuclear holocaust. On the other end of the spectrum is someone who lives a normal life and has a few extra things they think could be useful in an emergency situation in the garage or the closet, but who hasn't thought or planned beyond that and has no contingency plans. That person and their loved ones are probably not going to survive any kind of serious event except through sheer luck.

Another thing to remember is that you can survive anywhere if you are prepared - if you have the time and resources required. You can survive in the city, you can survive in the rural areas, you can survive in Alaska or the Arctic or the blazing heat of the desert, etc. You don't need to go off-grid in some remote rural area to survive. In fact, if you do that and you don't have a community you will inevitably run out of supplies or run into a medical problem you can't handle or get picked off by someone looking to take your stuff. You can't

provide 24/7 security and farm the land at the same time. Individualists will inevitably be picked off eventually or die alone.

Categories

I see preparation as having categories. And I see these categories in the same way as education.

1.) The first is **High-School-level preparation**. This is where you're aware of the threats in a vague way but you're not doing much about it. Maybe it would be better to say you're aware of impending disaster, rather than that you're aware of the threats. Threats are specific, and to know the threats you really have to do a threat assessment, in the style of military intelligence.[9] (I will talk about this more in a footnote at the end of the post.) This type of person completely relies on others to take care of them in an emergency situation.

2.) The second category is **College-Level-Preparation**. This is where most "preppers" are at - on some level between freshmen and seniors. They might have quite a bit of food - some even work up to a year's worth or so - stored away, they have water storage as well, and they have guns and ammo and have taken training classes on how to use them and they go to the range and shoot at targets a few times a year. They are most likely frequent attendees of prepper conventions and take classes there on everything from canning food to HAM radio usage and tons of other things that might suit their interests. They almost certainly at some point become a part of at least one if not more prepper groups but only meet up with these people probably on average a couple times a year at best. They may or may not have their own smaller tribe of friends and family, though it is usually more of a rag-tag bunch than a cohesive group with a single vision. The majority of people in this category, like most college students, are more into the "cool" factor than serious preparedness efforts. Survival knives, the newest HAM radio setup, or their pantry full of hand-canned food items are the common topics of conversation. The "seniors" of this group may have moved on to more serious preparation, such as physical fitness, post-oil mobility, intelligence analysis, force multipliers, counter-intelligence, and studying fourth-generational warfare.

3.) The third category is **Graduate-Level-Preparation**. This is where you're actually, in my mind, preparing and not doing preparation as a side-hobby that merely makes you feel better emotionally. At this level you're actually serious. You have soberly faced what the future holds and are mentally prepared for the hard, sometimes morally grey, decisions you will inevitably have to face. You have prepared yourself as best you can spiritually for the trying times to come. You are consistently working on your health, always addressing your physical limitations, finding alternative ways of doing things where your body limits you, and becoming as accustomed as you can to a world that does not have medications readily available. You have, or are actively preparing to build, a tribe of family and/or friends who are all on the same general page and are actively working with you to achieve your goals. You have done threat assessments for your AO (Area of

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[9] Intelligence collection, threat assessments, and analysis are literally the foundation for everything else. They reduce uncertainty about the future and tell us what to prepare for and how to prepare for it. The best civilian trainer (and really the only one I know of doing this level of work) is Sam Culper at Forward Observer. He has an e-course you can take: here. (Subscription required.) He also gets booked for public and private classes all around the country and frequently has a booth at preparedness conventions. He also just recently wrote a book called SHTF Intelligence which is an excellent resource and can be found here in both print and e-book form.

Operations) (which is basically where you live: your neighborhood, your town, and the towns adjoining yours. In a city it would be your house, your block, your neighborhood, etc), moving ever-outwards as far as you/your group are willing to defend or respond to in an emergency. At this point, if you are physically able, you have taken or are currently taking serious training classes with firearms at least up to and including SUT (Small-Unit Tactics) as well as advanced medical training (not just a first aid course) from a legitimate civilian trainer.[10] If you have a cohesive group, you have almost certainly done this in concert with some if not most of them, and you have taught the rest of your tribe what you've learned as best as they can learn and execute it, according to their abilities. If you do not yet have a cohesive group you are actively, physically, networking (being a part of a Facebook group doesn't count). You of course have done, and continue to do, all the things that were relevant under College-Level-Preparation.

Conclusion:

This is obviously not, and is not meant to be, a how-to guide or an instruction manual. If you want a step-by-step preparation guide, this isn't it. Facing our dire future can be overwhelming, but at some point we must accept it and act. The usual "first step" on the preparedness ladder rung is to store some extra food and water. But bear in mind that survival is primarily not about stuff - not about cool gear you can buy. A reliance on stuff will lull you into a false sense of complacency and get you killed. I would much rather your first step be to get healthy. And I mean as healthy as you can, given your own physical, mental, and natural limits. What is "healthy" for a person with an autoimmune disorder might be very different than for a person with an amputated leg, as it will for a person with autism or a person suffering from PTSD. Health will look decidedly different for a 65 year old retiree than for a 20 year old college student. Out of the people I've met who are into survivalist shows or that I've seen at prepper conventions or that I talk to on the internet about this topic, it is absolutely ludicrous how many of these people simply buy cool stuff that helps ease their cognitive dissonance while they are ridiculously out of shape and have health issues that they are ignoring. If you are healthy, both in body and in mind, you will be able to make yourself useful in any given collapse scenario. If you do not have food, you will be able to trade your skills and your time for someone else's. Plus, there are numerous circumstances when you won't be able to get to your 'stuff' that you've so patiently acquired and spent all that money on. Inevitably, having the right tools for the job is far more desirable and efficient, but health, knowledge, and skillsets are much more important in a collapse scenario than stored 'stuff' that you have come to rely on and can't do without.

The best advice and perspective that I've heard about the coming future is this

> *"Live with death in mind. Love what is, not what should be. Identify what you love, and pursue it. Pursue excellence in your life. Do what is right, without attachment to the outcome."*
> *–Guy McPherson*

Bio

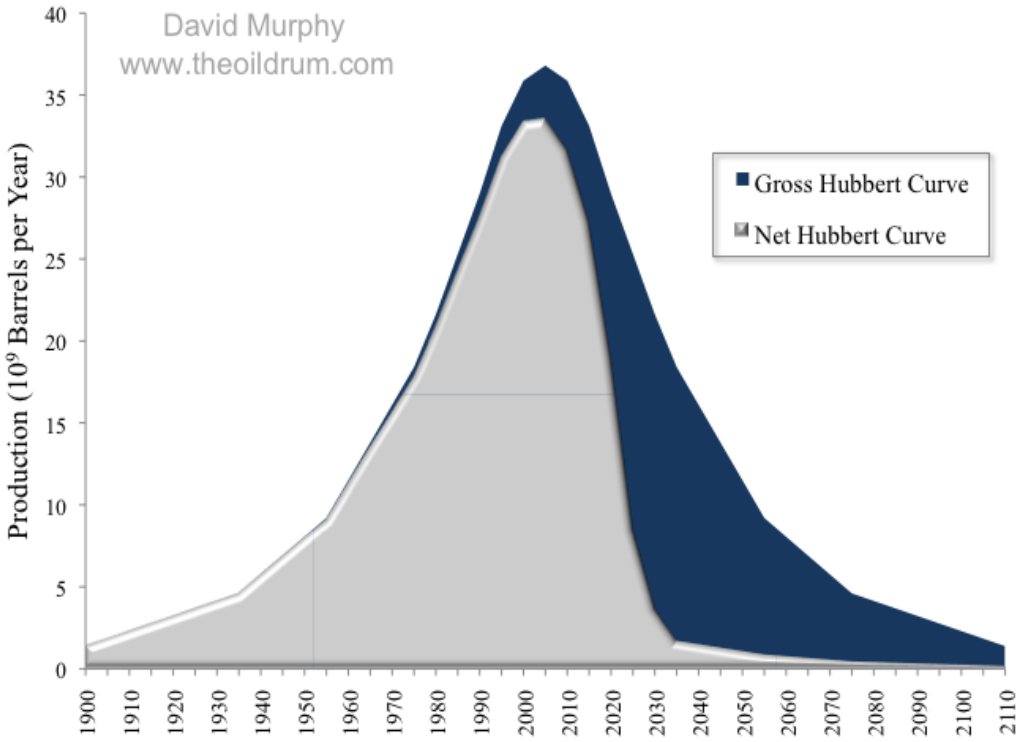
[10] The best civilian trainers on tactical training and grid-down medical training that I know of are John Mosby and Max Velocity. Both are ex-SOF (Special Operation Forces) guys with many years experience and know what they're doing.

Alice Friedemann

Peak Everything, Overshoot, and Collapse

Net Energy Cliff Will Lead to Collapse of Civilization

[Published December 11, 2019]



The remaining oil is poor quality, and the energy to get this often remote oil so great that more and more energy (blue) goes into oil production itself, leaving far less — the grey area — available to fuel the rest of civilization. Source: 22 June 2009. David Murphy. The Net Hubbert Curve: What Does It Mean? Theoildrum.

This is the scariest chart I've ever seen. It shows civilization is likely to crash within the next 20-30 years. I thought oil depletion curve would be symmetric (blue), but this chart reveals it's more likely to be a cliff (gray) when you factor in Energy Returned on Energy Invested (EROEI).

The gray represents the actual (net) energy after you subtract out the much higher amount of energy (blue) needed to get and process the remaining nasty, distant, low-quality, and difficult to get at oil. We've already gotten the high-quality, easy oil.

Before peaking in 2006, the world production of conventional petroleum grew exponentially at 6.6% per year between 1880 and 1970. Although Hubbert drew symmetric rising and falling production curves, the declining side may be steeper than a bell curve, because the heroic measures we're taking now to keep production high (i.e. infill drilling, horizontal wells, enhanced oil recovery methods, etc.), may arrest decline for a while, but once decline begins, it will be more precipitous (Patzek 2007).

Clearly you can't "grow" the economy without increasing supplies of energy. You can print all the money or create all the credit you want, but try stuffing those down your gas tank and see how far you go. Our financial system depends on endless growth to pay back debt, so when it crashes, there's less credit

available to finance new exploration and drilling, which guarantees an oil crisis further down the line.

Besides financial limits, there are political limits, such as wars over remaining resources.

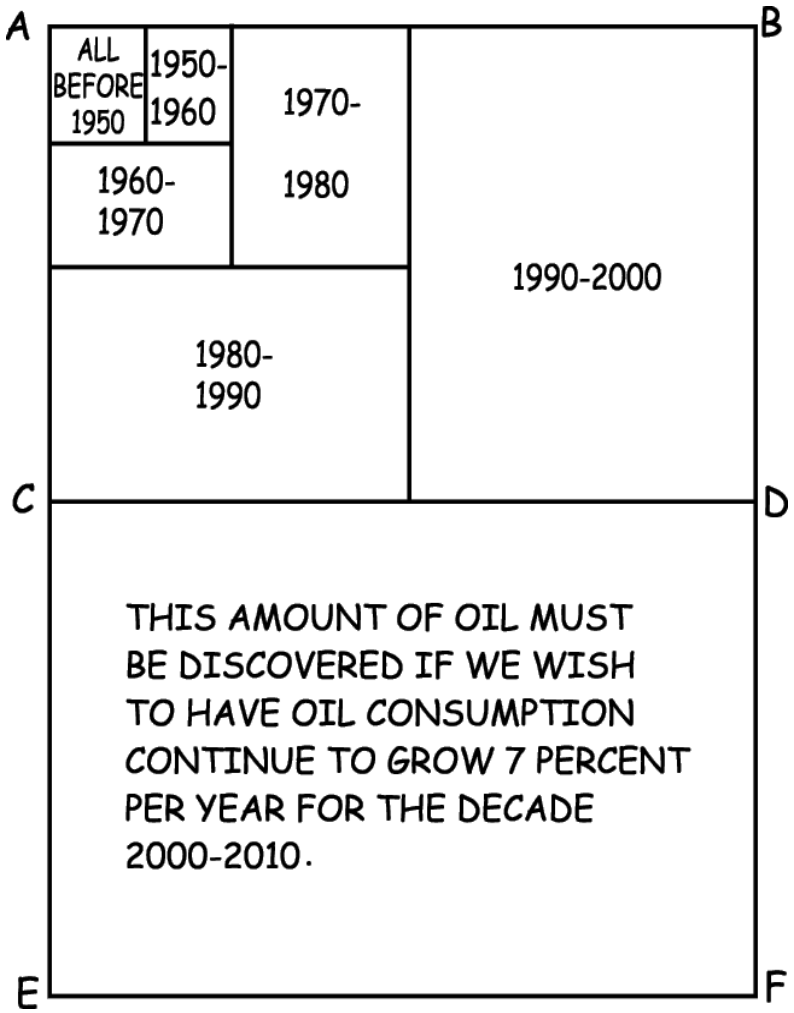
For a little while you can fix broken infrastructure and still plant, harvest, and distribute food, maintain and operate drinking water and sewage treatment plants, pump water from running-dry aquifers like the Ogallala which grows 1/4 of our food, but at some point it will be hard to provide energy to all food and infrastructure.

The entire world is competing for the steep grey area of oil that's left, most of which is in the Middle East.

Hubbert thought nuclear energy would fill in for fossil fuels

Gail Tverberg at ourfiniteworld writes "Hubbert only made his forecast of a symmetric downslope in the context of another energy source fully replacing oil or fossil fuels, even before the start of the decline. For example, looking at his 1956 paper, Nuclear Energy and the Fossil Fuels, we see nuclear taking over before the fossil fuel decline".

The Power of Exponential Growth: Every 10 years we have burned more oil than all previous decades.



Another way of looking at this is what systems ecologists call Energy Returned on Energy Invested (EROEI). In the USA in 1930 an "investment" of the energy in 1 barrel of oil produced another 100 barrels of oil, or an EROEI of 100:1. That left 99 other barrels to use to build roads, bridges, factories, homes, libraries, schools, hospitals, movie theaters, railroads, cars, buses, trucks, computers, toys, refrigerators – any object you can think of, and 500,000 products use petroleum as a feedstock (see point #6). By 1970 EROEI was down to 30:1 and in 2000 it was 11:1 in the United States.

Charles A. S. Hall, who has studied EROEI for most of his career and published in Science and other top peer-reviewed journals, believes that society needs an EROEI of at least 12 or 13:1 to maintain our current level of civilization.

Because we got the easy oil first, we have used up 73% of the net energy that will ever be available, since the remaining half of the reserves require so much energy to extract.

Some other reasons why the cliff may even be steeper

It's not our oil

Nearly all of the good, high quality, cheap sweet oil is in the Middle East. Most of the remaining oil will need vast amounts of fresh water to get it out, but there is very limited fresh water in these countries. The refineries and other extraction infrastructure are easy targets to damage or destroy by terrorists or in wars as well.

Export Land Model

Oil producing countries are using more and more of their own (declining) oil as population and industry grows within their own nation, and they too need to use more and more energy to get at their difficult oil. This results in a similar chart to the net energy cliff — suddenly there will hardly be any oil to buy on the world markets. See Jeffrey Brown's article "The Export Capacity Index" (one of his statistics is that at the current rate of increasing imports of oil in India and China, these 2 countries alone would be importing 100% of available oil within 18 years).

Technology

As we improve our technology to get at the remaining oil, we make the cliff on the other side even steeper as we get oil **now** that *would* have been available to future generations.

Investments won't be made because the payback times will lengthen

Since what remains is increasingly difficult and expensive to find, develop and extract, investment payback periods lengthen, eventually to impossibly long periods, or to periods that approach the useful life of the capital investment (effectively the same limit in the financial dimension as is an EROEI of 1). Which means it doesn't matter how much might theoretically be underground, the only thing that matters is how much is actually going to be economically feasible to recover, and that is going to be considerably less than 100% of what might be theoretically and technically possible to recover.

Energy is becoming impossibly expensive, as you can see in these photos of *The Tallest structure ever moved by Mankind*, a Norwegian natural gas offshore platform.

Exponential growth of population

This makes whatever oil we have left last even less long.

Less oil obtained than could have been

Projects maximize a return on investment over a return of every last drop of possible oil. Making money is so important that a lot of offshore Gulf oil that could have been obtained if extracted more slowly remains in the ground to wastefully get it out as fast as possible to make a profit because that's how our financial system operates: short-term gratification. But hey! That's less carbon dioxide and global warming, so in a totally unintended orgy of insatiable greed the "there are no limits to growth" billionaires have ironically helped save the planet.

Flow Rate: An 8% or higher decline rate is likely

Many energy company CEO's and other experts the average rate of decline world-wide will reach 8% or higher. If the 8% decline starts at 30 billion barrels in 2015, we'd have only half as much oil in 8 years. That's too fast for civilization to cope with.

- 2016 = 27.6
- 2017 = 25.4
- 2018 = 23.4
- 2019 = 21.5
- 2020 = 19.8
- 2021 = 18.2
- 2022 = 16.7
- 2023 = 15.4 (half of what we had 8 years ago!)
- 2024 = 14

The decline rate could be less than 8% for a while, or more than 8% if an economic crash prevents the funding of future projects, wars interfere with oil production, the technology to drill for arctic oil isn't figured out within a few years (we can't do it yet safely), and so on.

Oil Chokepoints

There are several critical areas of the world where the flow of oil could be stopped by war or terrorism.

Wars, cyber-attacks, nuclear war, social chaos

By 2024, if not sooner, the unequal distribution of the remaining oil, starvation generated riots and pillaging, and collapsing economies have triggered war(s), massive migrations, and social chaos.

Shale oil and natural gas can not prevent the cliff. Martin Payne explains: "shale oil plays give us a temporary reprieve from what Bob Hirsch called the severe consequences of not taking enough action proactively with respect to peak oil. **Without unconventional oil, what we wind up with is essentially Hubbert's cliff** instead of a Hubbert's rounded peak". But this won't last: **"**Conventional oil–which was found in huge quantities, in giant fields in the 40's and 50's – well those giant fields had huge reserves *and*

high porosities and permeabilities – meaning they would flow at very high rates for decades. This is in contrast to a relative few shale oil plays which have very low porosity and perm and which must be hydraulically fractured to flow. Conventional oil is just a different animal than unconventional oil; some unconventional oil wells have high initial rates of production, but all of these wells have high decline rates. Hubbert anticipated a lot of incremental efforts by the industry to make the right-hand or decline side of his curve a more gradual curve rather than a sharp drop (Andrews)

If any of these wars involve nuclear bombs, then at least a billion people will die.

The unrest has certainly curtailed the ability of oil companies to drill.

Even farmers may stop growing crops once city residents and roaming militias harvest whatever is grown (i.e. Africa as described in Parenti's "Tropic of Chaos: Climate change and the new geography of violence).

Cyberattacks from China, Russia, and elsewhere have brought the electric grid down in the USA to prevent US military forces for trying to grab the remaining Saudi and Iraqi oil –the armed forces will be too busy trying to maintain order in the USA to venture abroad — nor could they go even if they wanted to, because Chinese and Russian drone attacks will have destroyed all of the United State oil refineries, and we have retaliated against them, so they won't be able to refine oil either). We've also cyberattacked their electric grids. Most major cities have no sewage treatment or clean water. Nuclear power plants are melting down.

There's no substitute for oil

Coal — why it can't easily substitute for oil

"Peak is dead" and the future of oil supply:

Steve Andrews (ASPO): You mention in your paper that natural gas liquids can't fully substitute for crude oil because they contain about a third less energy per unit volume and only one-third of that volume can be blended into transportation fuel. In terms of the dominant use of crude oil—in the transportation sector—how significant is the ongoing increase in NGLs vs. the plateau in crude oil?

Richard G. Miller: The role of NGLs is a bit curious. You can run a car on it if you want, but it's not a drop-in substitute for liquid oil. You can convert vehicle engines in fleets to run on liquefied gas; it's probably better thought of as a fleet fuel. But it's not a substitute for oil for my car. By and large, raising NGL production is not a substitution to making up a loss of liquid crude.

The only way I can see this being prevented or the end of oil delayed a few years, is if a government has already developed effective bio-weapons and doesn't care if their own population suffers as well.

I feel crazy to have just written this very dire paragraph with just a few of the potential consequences, but the "shark-fin" curve made me do it!

Even though I've been reading and writing about peak everything since 2001, and the rise and fall of civilizations for 40 years, it is hard for me to believe a crash could happen so fast. It is hard to believe there could ever be a time that isn't just like now. That there could ever be a time when I can't hop into my car and drive 10,000 miles.

I can *imagine* the future all too well, but it is so hard to *believe* it.

Believe it.

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Bio

Kevin Hester

Hacking at the Tree of Life: Dying Forests, Oceans, Societies Unmasked

Militarism's Role in the Sixth and Possibly Last 'Great' Extinction

[Published November 26, 2018]

"**U.S. Military World's Largest Polluter** – Hundreds Of Bases Gravely Contaminated
Producing more hazardous waste than the five largest U.S. chemical companies combined, the U.S. Department of Defense has left its toxic legacy throughout the world in the form of depleted uranium, oil, jet fuel, pesticides, defoliants like Agent Orange and lead, among other pollutants."

"One of the most recent testaments to the U.S. military's horrendous environmental record is Iraq."

"U.S. military action there has resulted in the desertification of 90 percent of Iraqi territory, crippling the country's agricultural industry and forcing it to import more than 80 percent of its food. The U.S.' use of depleted uranium in Iraq during the Gulf War also caused a massive environmental burden for Iraqis. In addition, the U.S. military's policy of using open-air burn pits to dispose of waste from the 2003 invasion has caused a surge in cancer among U.S. servicemen and Iraqi civilians alike."

"The 20,000 tons of "stressors" mentioned in the EIS do not account for the additional 4.7 to 14 tons of "metals with potential toxicity" that the Navy plans to release annually, from now on, into inland waters along the Puget Sound in Washington state."

"In response to concerns about these plans, a Navy spokeswoman said that heavy metals and even depleted uranium are no more dangerous than any other metal, a statement that represents a clear rejection of scientific fact. It seems that the very U.S. military operations meant to "keep Americans safe" come at a higher cost than most people realize – a cost that will be felt for generations to come both within the United States and abroad." This story is continued at U.S. Military World's Largest Polluter

"Internal documents obtained by the *Japan Times* offer evidence that the contamination of local drinking water sources near a massive U.S. airbase in Japan is the result of years of repeated mishaps and "lax safety standards" by U.S. military forces."

“The reports, obtained under the Freedom of Information Act, “expose a spate of accidents at the [Kadena Air Base in Okinawa] during the past 15 years that have involved at least 21,000 liters of fire extinguishing agents—some of them toxic.”

“The reporting cites several such instances, including a three-day period in 2001 when 17,000 liters of fire extinguishing agents were released and “attributed by base officials to mechanical and electronic malfunctions.”

“It also cites an incident in 2015 when “a drunk U.S. Marine activated a firefighting system. It filled a hangar with more than 1,500 liters of JET-X 2.75 percent—a foam classified by the U.S. government as hazardous. It contains chemicals known to cause cancer, and neurological and reproductive disorders.” That foam made its way to local waterways, but the base did not notify Japanese authorities.”

“The U.S. Pacific Air Forces issued a statement in January that—despite the detection of toxic substance in the drinking water sources— the water was safe because it is adequately treated before consumer use.” New Docs Link Polluted Drinking Water Supply to Massive US Military Base

“Official Iraqi government statistics show that, prior to the outbreak of the First Gulf War in 1991, the rate of cancer cases in Iraq was 40 out of 100,000 people. By 1995, it had increased to 800 out of 100,000 people, and, by 2005, it had doubled to at least 1,600 out of 100,000 people. Current estimates show the increasing trend continuing.”

A forty fold increase in just 14 years in just the human species. This ecological and genetic destruction will also be cascading through the non-human species as well.

Two US-led wars in Iraq have left behind hundreds of tonnes of depleted uranium munitions and other toxic wastes. by Dahr Jamail

A constant disconnect I have witnessed in 40 years of activism is the failure to link ecological activism and anti-war activism. Every war is a war on the biosphere and all its inhabitants. It’s not particularly complex, it’s the Military Industrial Complex:

WAIHOPAI SPYBASE PROTEST Aotearoa New Zealand

January 25-27, 2019

“In light of the disastrous Trump Presidency – why is New Zealand still an active and willing part of the US Empire? The US intelligence and nuclear war machine controls the **NZ Government Communications Security Bureau.** The **GCSB** is now legally allowed to systematically spy on New Zealanders; as well as routinely spying on any number of other countries, on behalf of the **US National Security Agency (NSA)**. And the NSA spies on everyone. More pressure must be put on the Government to end the anti-democratic and destructive activities of this NZ spy agency.” Anti-Bases Campaign

On the December 2018 episode of Nature Bats Last, myself and Professor Guy McPherson will interview Roger Hallam from the Extinction Rebellion movement where I intend to address this disconnect. The show will be uploaded to the archive with the previous 121 shows which are embedded at the following link; Nature Bats Last on The Progressive Radio Network.

“The WFP has warned that Yemen is on the brink of a full-blown famine, with 18 million of its 29 million population food insecure, 8.4 million severely so.”

The war on Yemen is being conducted by the monsters in the House of Saud who recently murdered and dismembered Jamal Kassahoggi, a former journalist with the Washington Post.”A campaign to remove Saudi Arabia from the UN Human Rights Council has been launched by a group of British lawyers, who argue the desert kingdom’s membership of the body is “contradictory and ironic”.Saudi Arabia should be dropped from UN Human Rights Council, say British lawyers

Soon the living will envy the dead, the time we have left is infinitely less than most realise or are prepared to accept.

“At the edge of extinction, only love remains”.

I’ll leave the last word to the late great Bob Marley who I had the honour of seeing play in Aotearoa N.Z. in 1979. Almost no one listened to the message Bob, sorry.

Bio

Just Collapse

Tristan Sykes and Dr. Kate Booth

Talk Collapse for a Just Collapse

[See this, this, and this]

Collapse: 'the fall of a socio-ecological system characterized by the loss of complexity, structure and order'

Justice: 'fairness and equity within socio-ecological systems and interactions'

The Limits to Growth, released some 50 years ago, forecast global collapse around 2030, and its findings were recently validated by researchers at MIT. Despite this fact, talking about collapse has been a taboo topic – with pioneers ignored, ridiculed, and slandered. Launched by #JustCollapse in late 2021, the current #TalkCollapse campaign is normalising conversations about collapse as everyone has the right to know. Momentum is now building.

Talking openly about collapse is clearly a crucial matter of justice - the more acceptable and easier it is to talk about collapse, the greater the sense of solidarity and shared purpose. These are essential for both, meeting the challenges ahead, and building a collapse-conscious citizenry who can act for a #JustCollapse.

The Talk Collapse campaign is underpinned by our theory of change.

Riding the Zeitgeist

"What I say today everybody will say tomorrow, though they will not remember who put it into their heads. Indeed they will be right for I never remember who puts things into my head: it is the Zeitgeist" George Bernard Shaw

The word 'zeitgeist', originating with philosopher Hegel, is the descriptor for the spirit of a time. In 2019, a zeitgeist coalesced around the urgent need for climate action, and climate change became an acceptable and predominant point of conversation. There were many influencing factors – Greta Thunberg, Extinction Rebellion, international convention upon international convention, science upon science – but no singular reason for why, in 2019, just about everyone started talking climate. Unconsciously and subconsciously, this zeitgeist had taken shape through liminal osmosis.

This same zeitgeist now propels big business and governments into 'climate action'. With support from large sections of the climate-environment movement, techno-fixes that boost GDP and aim to maintain business as usual, are being rolled out under the guise of a 'renewables' transition. This 'spirit of our times' is a fraught fusion of progress and climate action, failing to recognise that one is the cause for the other.

Zeitgeists, by nature, are ethereal, multifarious, and ill-disciplined creatures, not easily tamed, nor dominated. The current 'climate action' zeitgeist, and its fractured nature, is not a fait accompli, but a malleable phenomenon prone to influence and change. As 'progress' cannot be sustained and 'green hyper-growth' will only destroy the Earth faster than business as usual, the spirit of our times is amenable to shifting – to becoming one less fanciful, and more closely matching reality.

Current zeitgeists now defining the beginning of the 21st century are in hot contention, not least because the era of progress has ended, and the #GreatDescent, well and truly begun. Having thoroughly explored and exploited all opportunities to maintain infinite growth on a finite planet, writing this in August 2022, we now bear witness to 50+ years of ecological overshoot – devastated ecosystems, mass extinction, and an irreparably transformed climate.

As a result, 'collapse' is becoming a central emerging aspect of 21st zeitgeist formation and, subliminally, is beginning to seep into every nook and cranny of western culture and society. For it is collapse, not progress, that is defining the spirit of our times and 'riding' this emerging zeitgeist a most powerful means of effecting change.

Zeitgeist change is a departure from the theory of change developed by Prof. Chenoweth and colleagues which has informed recent strategies of some climate activism and activist groups. Chenoweth's theory is based on analysis of 20th century political movements which effected change through non-violent action and weight of numbers – mass mobilisation triggered by the dedication and sacrifice of a few. By employing tactics that were successful in the 20th century, this theory pushes against, rather than works with, 21st century zeitgeists, and is thus prone to failure.

As Chenoweth and colleagues identify, this century has seen a solidification of non- democratic intent including increased surveillance and prohibitive protest laws. Chenoweth and colleagues acknowledge, this is not the same context within which successful political activities took place in the 20th century and thus poses significant additional challenges for those pursuing mass mobilisation through non-violent action, as also, does collapse – an eventuality that derails those positive narratives of a 'happy ending' that had previously motivated citizens.

In order to effect change, that effort must be located in, and relevant to the spirit of its time. It's about working with the zeitgeist to shift the zeitgeist. Our situation properly understood is not a simple problem to be solved, but a complex predicament to be responded to. This proper understanding provides the appropriate context and basis for action in face of collapse. What then is appropriate action and how can it be effected? Most importantly, what is to be achieved when things, inevitably, will not end well?

As 21st century zeitgeists form and are increasingly infused with collapse, we are 'riding this zeitgeist' by adding notions of Insurgent Planning and socio-ecological justice into the mix. The #TalkCollapse campaign is key here. Working with the reality of collapse, not against – this campaign does not seek to push against the inevitability of collapse nor against planetary limits as the 'renewables' transition does. Instead, #TalkCollapse works to make use of the ideal of justice to re-envision what can yet be achieved in a collapsing world.

Now, with more and more people talking collapse, we are collectively changing the shape, character, and direction of the spirit of our times. Doing so ensures a basis upon which we will achieve as much socio-ecological justice as possible within the complex realities and horrors that collapse entails – working together for a Just Collapse.

A Just Collapse

The inherently unjust nature of this unprecedented global socio-ecological collapse demands we take action. Collapse is a process not a switch, and we can still mitigate inequity and the unfolding horror that is coming for us all, by acting now to ease our inevitable descent.

Three points are key to understanding how we can act meaningfully within collapse.

1) Collapse is now! It is already underway. Global industrial civilisation is in extreme overshoot, having burnt through the riches of the Earth, it is now trying to run on empty as various global systems break down including climate, ecosystems, energy, economics, and agriculture.

2) Collapse is complex. Although the process of collapse is becoming more and more self-evident – globally, regionally, and locally – the precise 'when' and 'how' is hard to predict due to the complex nature and interaction of the various social, ecological, and climatic systems.

3) Collapse is diverse. Recognising that whilst many drivers for collapse are global in scale, collapse manifests differently in different places. Due to climatic, ecological, cultural, and economic diversity, how collapse happens in a town in north Africa is, and will, differ from a city in North America. As collapse disrupts and destroys global systems, communications, and supply chains, the unique qualities of different places and peoples will be magnified. For those who are used to being 'global citizens' or at least, globally connected, we are heading into a time when the local scale will become the defining feature of all our lives.

As collapse becomes increasingly self-evident, more people want to know what they can do and how they can take action. Clear-eyed realists who have absorbed and accepted these three points recognise that any meaningful action must operate within the reality of inevitable and irreversible global collapse. Fantasy, wishful-thinking and denial only delay much needed action, making our predicament far, far worse. As Martin Luther King observed, justice delayed is justice denied.

Achieving justice in the context of decline and descent is a grim reality for those already bearing the brunt of collapse and a growing concern for those who still hold some capacity to plan and act ahead of severe impacts.

A complex idea, understandings of justice differ between institutions, places, and cultures. In western cultures, broadly speaking, three types are defined in terms of human interactions. Normally these ideas of justice ignore the interactions and interdependencies between people and the environment.

This flawed, unreal, and violent separation between society and ecology is part of the reason we are in collapse, so redefining justice as socio-ecological, rather than purely human, is a priority and an initial act of justice in and of itself. Socio-ecological justice also means that justice, like collapse, is diverse. It varies depending on who, and where it is enacted.

The three types of socio-ecological justice are:
Distributive justice – the fair and equitable distribution of something within socio- ecological systems, for example, the just distribution of water between human settlements and ecosystems.

Corrective justice – a fair and equitable response to someone or something that has been wronged, for example, holding fossil fuel companies and governments to account for unmitigated climate change.

Procedural justice – fair and equitable socio-ecological decision-making, for example, hearing the voices of the poor and marginalised, and accounting for the rights of other species, when making decisions on land use.

Justice has been understood as an important element of civilisational advancement and cohesion. In collapse, we are learning to use justice in a different way. There is no ‘win’ – justice will always be relative and partial. Collapse is still collapse, and we do what we can, where we can, as a means of easing the descent. A #JustCollapse is about achieving outcomes based on decline rather than progress but is still a means of holding together what remains, as best we can.

After 50 years of overshoot, no amount of human agency can turn collapse around, and we can only do what we can do. In understanding that although death will surely come for us all, today is not that day, and there is plenty yet to fight for on the way down. #TalkCollapse is where we start.

Bio
Dr. Kate Booth is co-founder of Just Collapse. She is an experienced activist, and an Associate Professor at the University of Tasmania.

Tristan Sykes is co-founder of Just Collapse. He has previously founded and coordinated several eco-social activist groups.

Erik Michaels

Problems, Predicaments, and Technology

Bargaining to Maintain Civilization

[Published December 12, 2022]

So many people today are busy looking for solutions to the predicaments we face, not truly comprehending that there aren't any (solutions). Predicaments only have outcomes, not solutions. As long as we are preoccupied and distracted by focusing on solutions, we are ignoring the much more simple way of dealing with this properly by living with less, which is going to happen whether we like it or not. Rather than obsess on solutions, we should be spending our time focusing on ***how*** to reduce technology use and abandon civilization and learning how to live with a similar ecological footprint as our ancestors. This is because this will become necessary in the not-too-distant future. Learning how to live more resiliently and to reject technology use is going to become increasingly required and those who depend too heavily on technology will be left in the dust as the energy to power said technology becomes increasingly constrained and supply chains break down; making finding replacement equipment, repair parts, and accessories more and more difficult as time moves forward. By learning how to do things differently now rather than procrastinating or hoping for something that simply cannot be, we are putting our efforts into being able to live once the future arrives, much faster than predicted or expected. On the other hand, those who are too dependent upon technology to do all of this for them will likely perish once conditions unravel within the next several years.

Happy Winter/Summer Solstice!!

As anyone reading my articles often already knows, ecological overshoot is the master predicament causing

many different symptom predicaments. I constantly see many people blaming emissions or greed or capitalism or governments or oil companies or fossil fuels (and on and on...) for causing climate change (or their favorite symptom predicament). Playing the blame game gets us nowhere though, and unfortunately, it is also far more complicated than that. Reducing emissions is a great idea (NOT a solution as noted below in the new paper from James Hansen), but it cannot be accomplished without reducing ecological overshoot because ecological overshoot is precisely what is CAUSING emissions. Ecological overshoot is caused by technology use, which means that it is being caused by ***our behavior***. In order to reduce emissions, there is no other choice than to reduce technology use. This requires changing our behaviors. Most emissions historically have been produced by Western Society, so Western Society must change the most in how we behave. ***This is not optional.*** If we don't change our behavior, nature will solve the predicament for us by removing habitat that we require in order to continue surviving. This is the outcome for that scenario - extinction. Of course, inherent here is that infamous "***we***" which brings the good ole' lack of agency into the mix. More on our lack of agency can also be found here.

Now, this is the background to what I am writing about. While my articles here have just been recently introduced to society at large, I've actually been conversing about this and writing about it far longer in several different groups, many of which I'm no longer a member of. Why am I no longer a member in these groups one may ask. Because those groups feature and promote a mental defect known as wetiko, and they refuse to accept the truth that ecological overshoot and its symptom predicaments are not problems with solutions. In other words, they suffer from the illusion of control. Most of them are busy promoting technofixes which will never solve anything (there are no technofixes - technology use is what has CAUSED ecological overshoot, so it ***can not*** and ***will not*** solve ["fix"] anything) - or they are constantly trying to get folks to purchase EVs, solar panels, wind turbines, or other technological devices which only further exacerbate the situation and continue the same ongoing destruction that brought us to this point in time to begin with. Climate change cannot be "separated" from ecological overshoot because overshoot is what is causing it. So, eating different kinds of foods or avoiding meat, taking shorter showers, driving and/or flying less, buying different kinds of things ("organic" or "green" or "sustainable" or "clean" products) and other types of gimmicks won't generally help to reduce overshoot, which, when reduced, will concomitantly reduce emissions and climate change, pollution loading, and energy and resource decline, among other symptom predicaments of overshoot. This is because we lack agency to make ***everybody*** follow these same behaviors, and as such, universal cooperation is not possible. In order to accomplish reducing overshoot, EVERYBODY must reduce technology use. It doesn't really help for folks to recommend using devices which use less energy or resources unless everybody else is ***also*** using those same devices, and this is nothing more than a stopgap measure because at some point, the energy to power those devices will also be depleted, making them obsolete and useless. We cannot use technology if we don't have habitat, which technology use is destroying. We are not above nature; we are a part of it.

This is a ***huge*** issue because ***anything*** which serves to continue industrial civilization simply delays the coming changes necessary and steepens the Seneca Cliff we are jumping off of. It matters not one bit how the electricity we use is generated nor how much electricity can be generated because electricity generation in and of itself is unsustainable. Continuing to use it only furthers the destruction as industrial civilization collapses. Very few people I have spoken with realize this; nor are they willing to give it (electricity) up. Recently, talk about fusion has cranked back up, but this is something which has historically always been two or three decades into the future since the 1950s. The claims that they had a net energy gain are also false, quote:

> "***If gain meant producing more output energy than input electricity, however, NIF fell far short. Its lasers are inefficient, requiring hundreds of megajoules of electricity to produce the 2 MJ of laser light and 3 MJ of fusion energy. Moreover, a power plant based on NIF would need to raise the***

repetition rate from one shot per day to about 10 per second. One million capsules a day would need to be made, filled, positioned, blasted, and cleared away—a huge engineering challenge."

Here's a video explaining why there was no net energy gain despite the hype. Even if commercial fusion was an actual possibility (which would be yet another two or three decades into the future), none of this would help the predicament of ecological overshoot - it would only worsen the predicament because energy use facilitated by technology is precisely what is CAUSING overshoot. The hype that fusion is "clean" energy and requires no fossil fuels is patently false.

I have written about practically all of this before (as can be seen by the large number of links I have inserted into this article which are mostly previous articles of mine) - the impossibility of us to be able to wiggle our way out of who and what we are as a species. But I am in the process of including yet more external material here in this blog within the pages section (see Table of Contents) in order to be able to link to this material that is so key to the predicaments focused on here. Hopefully this will provide readers with the ability to point others to these pages and articles so that they, too, can understand and fully comprehend where we are and what the outcome will be. As long as we attempt to continue the system of civilization (which is unsustainable - meaning that it cannot be sustained), we are planning to fail and guaranteeing our extinction. Before I continue, here is an excellent and through description of precisely what civilization is. I must caution readers that the concepts disclosed are not comfortable thoughts to sit with. Very little in this blog IS comforting. It's very similar to the peeling of an onion, where there is constantly yet another layer to uncover, the whole while causing discomfort and bringing tears to one's eyes.

As I bring all of this to an early conclusion (yes, there's still more), the whole reason behind this post (in the paragraph below) and the necessity to point all of this out again is the constant stream of bargaining I see going on around me. Greta Thunberg is now supporting nuclear power in an effort to stop coal usage, but there seems to be a huge disconnect between the idealism represented there and the reality on the ground with regard to coal usage worldwide, not just for electrical power but also for industrial manufacturing and production. Germany is only one country and their emissions aren't even in the top five by country! (As of the date of this article, the top five are: China, United States, India, Russia, and Japan.)

The reason for this post is the fear expressed by climate scientists in Australia, although I'm certain that this extends far beyond Australia. As mentioned above, even the scientists are mostly bargaining - attempting to reduce emissions without tackling ecological overshoot. Reducing emissions REQUIRES reducing ecological overshoot, period. I find it odd that more scientists aren't calling for this. I see only a handful of people worldwide calling to reduce it. The broad majority continue harping on about CO2 emissions while said emissions continue skyrocketing. This really stymies me since the conclusions I routinely harp on about myself appear so clearly once a person understands these concepts. While I understand that there is no way out of the upcoming train wreck unfolding, surely we could reduce the harm by reducing technology use. Very few people are calling for such a program, however. Our future is decay, regardless of how or what we do. I know that this sounds bleak, but all of my research indicates that we are rapidly running out of cans to kick down the road and indeed running out of road as well.

Despite recent optimistic claims by some climate scientists, the news just really isn't all that great. This quote extracted from the abstract of this paper by James Hansen and 14 other scientists tells the story: "***Eventual global warming due to today's GHG forcing alone -- after slow feedbacks operate -- is about 10°C.***"

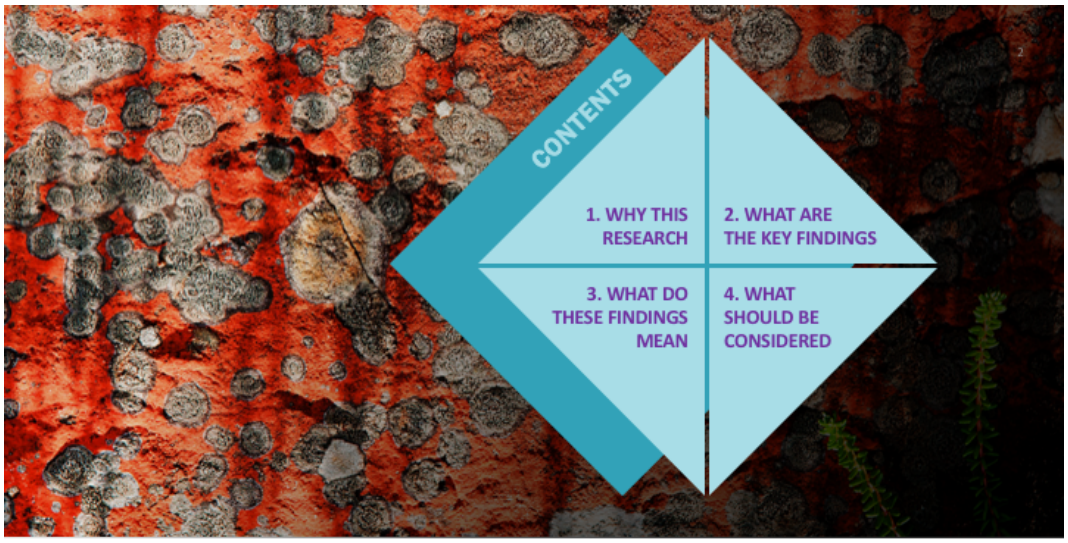
Simon Michaux has quite a few different articles out regarding the issue of "mineral blindness" in conjunction with energy and resource decline. I've written about him in the past and this article continues much of what his research indicates - that growth is over and that we need to look at the predicament of ecological overshoot in a whole new way. He also has a new video with Nate Hagens about the "Arcadians," one of the types of groups of folks he claims society is organized into. The one thing both Simon and Nate understand is that "green energy" will not reduce ecological overshoot or stop climate change. They are attempting to have the same discussion many others are also beginning to finally have - to develop a way forward from here.

My concern, as noted above, is that most all means of addressing the real issue - the predicament of ecological overshoot - is to address and/or solve symptom predicaments instead which doesn't/don't address the real issue(s). Overshoot is unsustainable. Civilization and technology use cause overshoot. I linked this paper quite some time ago and it is still relevant today. When will society begin the difficult transition to dismantling civilization and technology use? The longer the bargaining continues, the more severe the outcome will be as nature takes more and more of both away from us.

Bio

Simon Michaux

Challenges and Bottlenecks for the Green Transition
[In press]



It was possible that at some point in the near future, the European captains of industry would turn to the European geological surveys and ask:

WHY WAS THIS WORK DONE?

There was no credible feasibility plan for fundamental industrial reform that recognized the current physical industrial requirements to phase out fossil fuels – anywhere in the world

There was a clear lack of hard numbers in all publicly available strategic planning for the future

There was very little discussion about current industrial and economic dependency on fossil fuels energy

There was no discussion or visible situation awareness of the quantity or type of minerals to phase out fossil fuels

The whole commodity sector was considered to be a market phenomenon, not a series of finite non-renewable natural resources, that had engineering bottlenecks in extraction

Assumptions were being made regarding the mining, smelting & recycling industrial capabilities to deliver the required volumes of metals, that were not appropriate

"why did you not tell us of the mineral supply shortfall?"

GTK

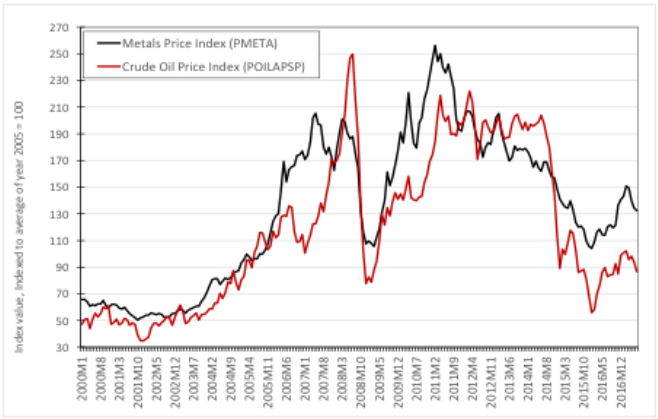
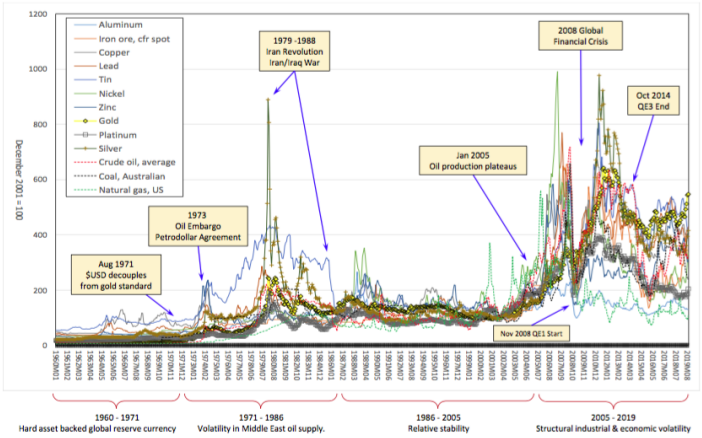


Figure 45. Correlation between global metal price and crude oil

(Source: IMF Primary Commodity Price System, http://www.imf.org/external/np/res/commod/External_Data.xls)

The industry changed in 2005

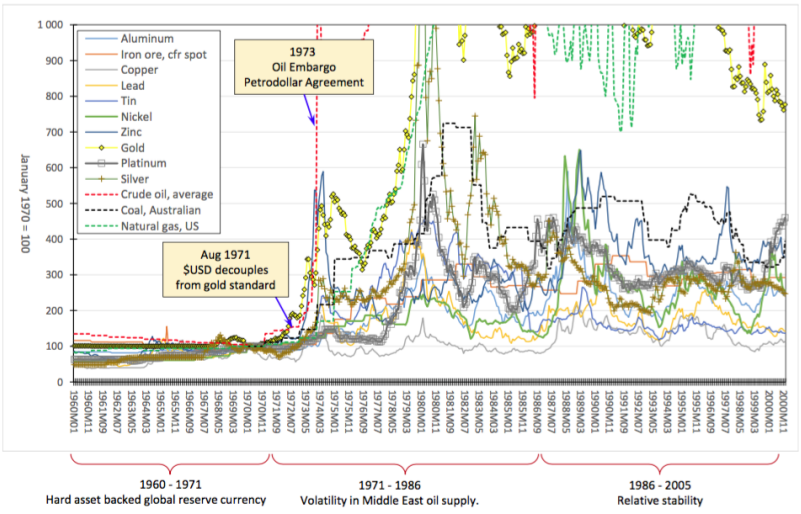


A case can be made that this blow out was a chain reaction started in the oil industry

A major economic correction (GFC 2008) did not resolve the problems

The change started something like 17 years in our past

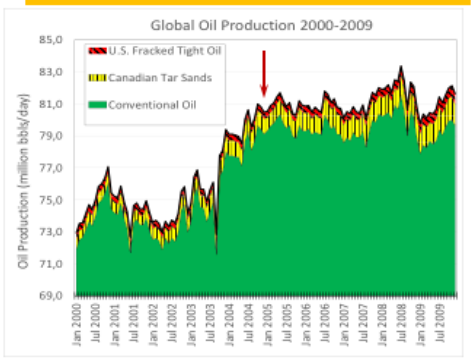
02.11.2022



30.6.2023

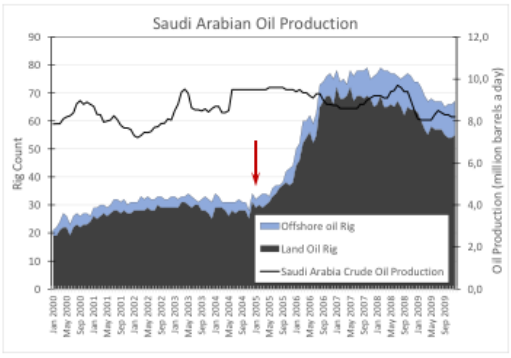
What happened in 2005?

Oil supply was not able to expand and plateaued, yet demand continued to increase after a short pause



(Source: EIA monthly oil production statistics 2019, Canadian Association of Petroleum Producers 2019, Shale Profile 2019)

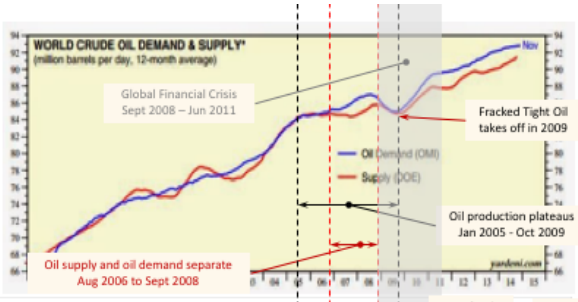
The global industry 'Swing' producer, Saudi Arabia was not able to increase supply

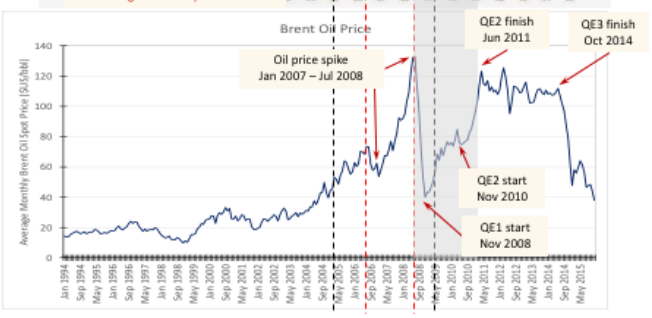


(Source. Baker Hughes Rig Count data, EIA monthly production data)

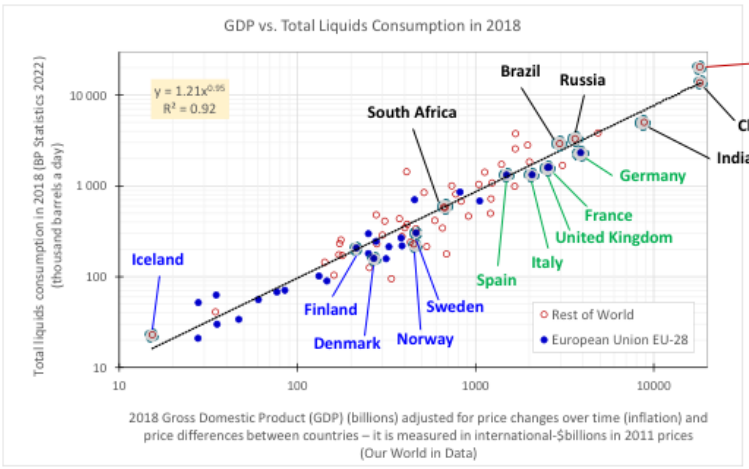
146% increase in rig count in exchange for -4.2% decrease in oil production

09.03.2020





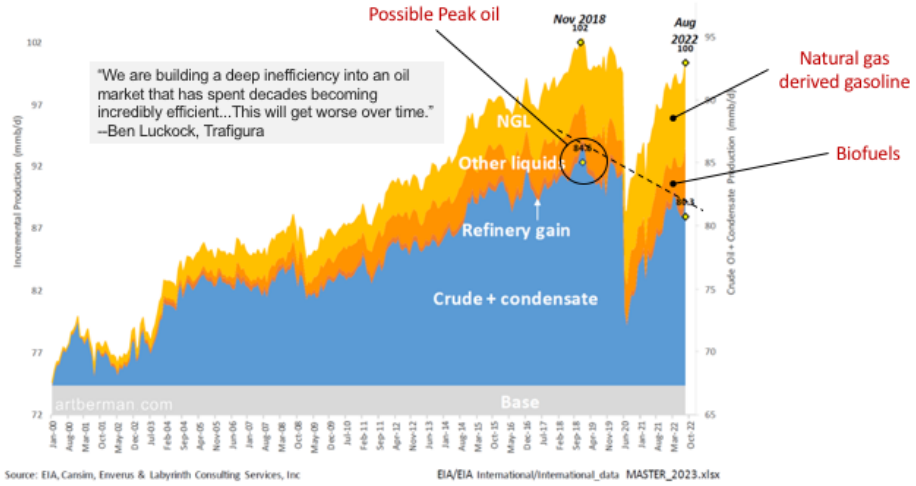
- A case can be made that the GFC was caused by a chain reaction with its genesis in the oil industry
- Quantitative Easing resolved the GFC crash
- Fracking or Tight Oil was able to make up the supply short fall
- US is now the global industry swing producer, with the majority of growth coming from Tight Oil



Developed from previous work, Labyrinth Consulting Services, Inc., Art Berman

26.6.2023

Total world liquids production has recovered to 99% of 2018 average level but crude oil plus condensate remains more than 4 mmb/d below late 2018 levels



Source: EIA, Cansim, Enverus & Labyrinth Consulting Services, Inc

EIA/EIA International/International_data MASTER_2023.xlsx

Gas supply

Russia is attempting to do what the US did with the 1973 petrodollar agreement, by insisting gas is purchased with Rubles ₽ (which is now asset backed with a basket of commodities)

Country	Production 2021 (bcm)	Consumption 2021 (bcm)	2021 Net Import/Export (bcm)
Russia	701.7	474.6	227.1
Qatar	177.0	40.0	137
Norway	114.3	4.3	110
Australia	147.2	39.4	107.8
U.S.	934.2	826.7	107.5
Canada	172.3	119.2	53.1
Iran	256.7	241.1	15.6
China	209.2	378.7	-169.5
European Union	44.0	396.6	-352.6

(Source: BP Statistical Review of World Energy 2022)

~~Russia supplied to market = 227.1 bcm~~

European Union needs a net 352.6 bcm

Qatar + Norway + U.S.

137.0 + 110.0 + 107.5 = 354.5 bcm

To do this, these countries would have to cancel all existing contracts

Russian gas cannot be replaced from somewhere else in the market

Europe is now in a conflict that has no acceptable possible outcome

26.6.2023

ALTHOUGH IT IS WELL KNOWN THAT
OIL, GAS AND COAL RESERVES ARE FINITE

THE GLOBAL STRATEGIC DECISION ADOPTED BY MOST NATIONS

TO PHASE OUT FOSSIL FUELS SYSTEMS AND REPLACE THEM WITH RENEWABLE ENERGY GENERATION SYSTEMS

IS LARGELY DRIVEN BY

CO2 EMISSIONS & ASSOCIATED CLIMATE CHANGE

NOT BY

DWINDLING FINITE RESOURCES

26.6.2023

GTK

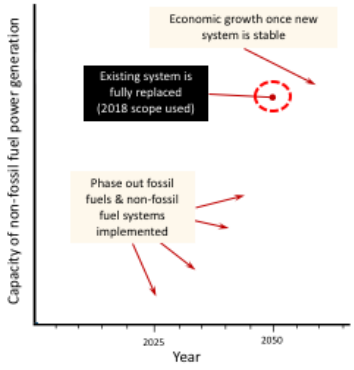
A novel bottom-up approach was used to address the underlying questions

What is needed to fully replace the existing system and work back from there

26.6.2023

GTK

What would it take to replace the existing fossil fuel system?



What was considered

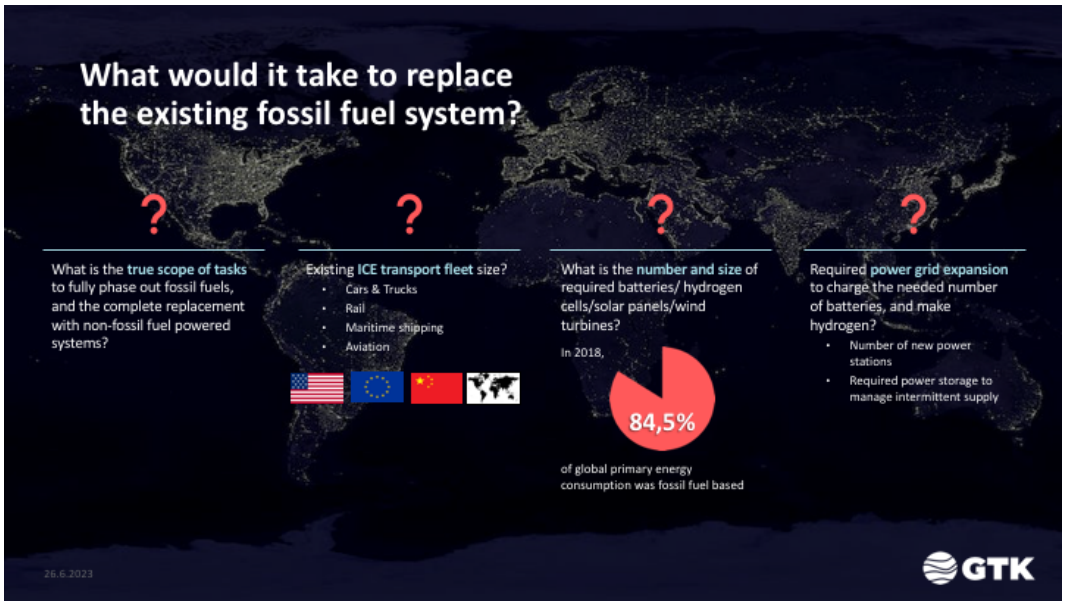
- Physical non fossil fuel units
- Infrastructure required for support
- Metals needed
- Where might we get those metals from

RoW

What was not considered

- Market price
- Carbon emissions
- Heat generation for manufacture using fossil fuels

05.10.2022



Baseline calculation

- The global fleet of vehicles is estimated to be 1.416 billion, which travelled an estimated 15.87 trillion km in the year 2018
  - *0.7% is EV in 2020*
- For the same energy output:
  - *…an Electric Vehicle system requires **battery storage** mass **3.2 times** the fuel tank (@700bar) mass of a hydrogen H-Cell system*
  - *…meanwhile a hydrogen H-Cell system will require **2.5 times** more **electricity** compared to a Electric Vehicle system*
- All short-range transport could be done by Electric Vehicle systems
  - *All passenger cars, commercial vans, delivery trucks and buses (1.39 billion vehicles), would travel 14.25 trillion km in 365 days*
  - *This would require 65.19 TWh of batteries (282.6 million tonnes of Li-Ion batteries)*
- All long-range distance transport could be powered with a hydrogen fuel cells
  - *All Class 8 HCV trucks, the rail transport network (including freight), and the maritime ship fleet*
  - *In total, 200.1 million tonnes of hydrogen would be needed annually*

GLOBAL SYSTEM I

1.39 billion Electric Vehicles	Charging Batteries
695.2 million Passenger Cars 5.4 trillion km	1 128.5 TWh
29 million Buses & Delivery Trucks 803 billion km	1 166.1 TWh
601 million Vans, Light Trucks 7.9 trillion km	2 181.7 TWh
62 million Motorcycles 160 billion km	19.4 billion kWh

→ 4 495.7 TWh

*updates in EV energy efficiency reduced this number by 4% from (Michaux 2021)

Industry	
Electrical Power Generation	17 086.1 TWh
Building Heating	2 816.0 TWh
Steel Manufacture	56.5 TWh

→ 19 958.6 TWh

GLOBAL SYSTEM II

Hydrogen Economy

H_2-Cell Vehicles	Hydrogen	Manufacture of H_2
Existing H_2 industry (petroleum product refining removed)	35.7 million tonnes	1 963.5 TWh
28.9 million Class 8 HCV Trucks Travelled 1.62 trillion km	129.9 million tonnes	7 503.7 TWh
Rail Transport 9 407 billion tkm freight 1 720 billion passenger-kilometers	13.7 million tonnes	793.1 TWh
Maritime Shipping cargo 72 146 billion tonne-km	44.6 million tonnes	2 575.1TWh

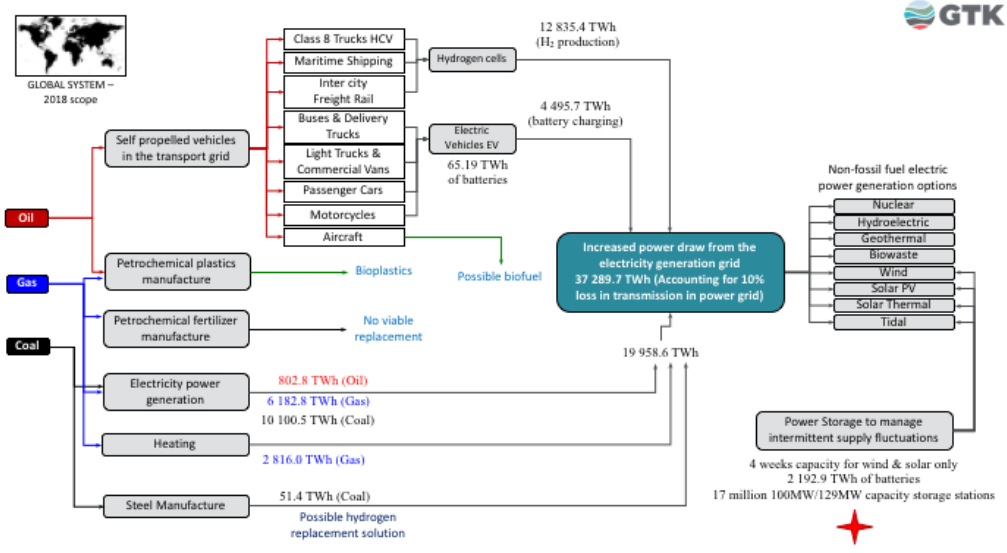
224.0 million tonnes

→ 12 835.4 TWh

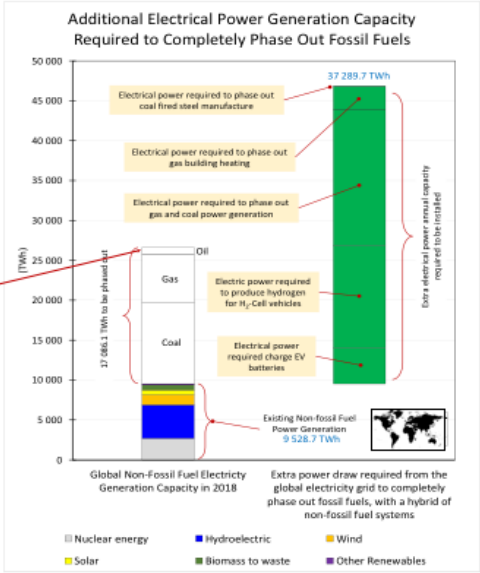
Biomass Economy

Biomass Sustainably Sourced from the Planetary Environment	
Aviation	Biofuel ??? liters
Plastics Manufacture	Biomass Feedstock ??? tonnes

Sustainability audit requried



Total electrical power production in 2018 was **26 614 TWh**



We wish to construct an electrical system much larger than the existing power grid, using energy that is more expensive and not as effective as what we have now

This does not include coal and gas used directly by industry to generate heat for manufacture (more than half of coal)

26.6.2023

GLOBAL SYSTEM III

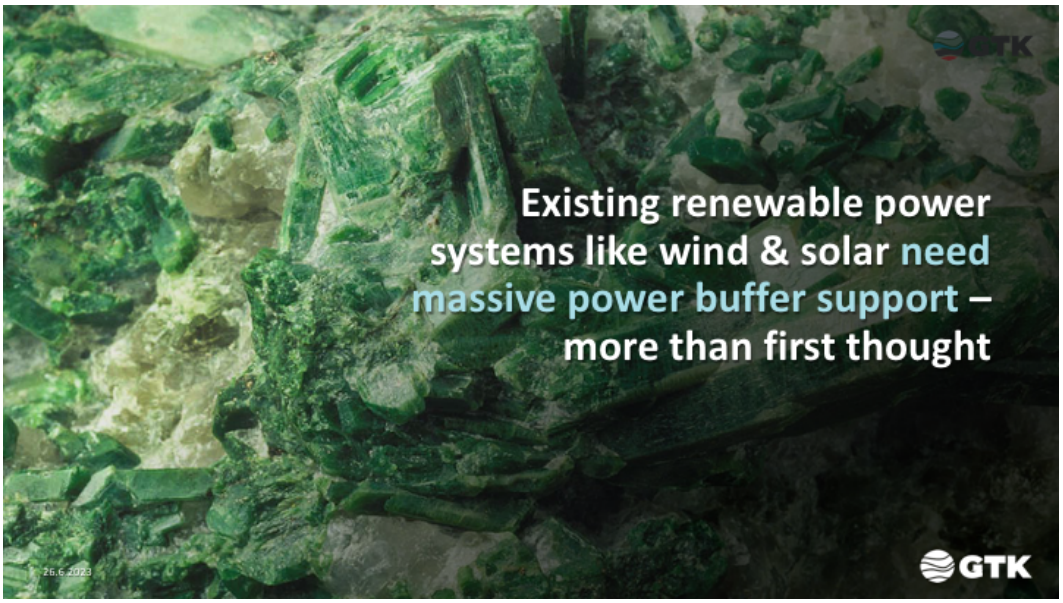
Additional Annual Electrical Power Requires **37 289.7 TWh** = **607 052** NEW Non-Fossil Fuel Power Stations

Power plant fleet in 2018 was **46 423** stations

HYDRO POWER 4 981.9 TWh 3 758 stations	NUCLEAR POWER 2 796.7 TWh 218 stations	
WIND POWER 14 293.1 TWh 175 933 stations	SOLAR POWER 14 293.1 TWh 407 922 stations	Power storage buffer
OTHER RENEWABLES Geothermal & Tidal 275.9 TWh 457 stations	BIOWASTE TO ENERGY 648.8 TWh 18 762 stations	

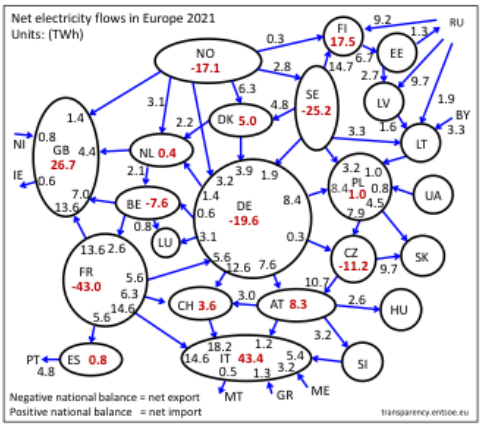
11 to 357 x amount of today

GTK



GTK

European net electricity exchanges in 2021



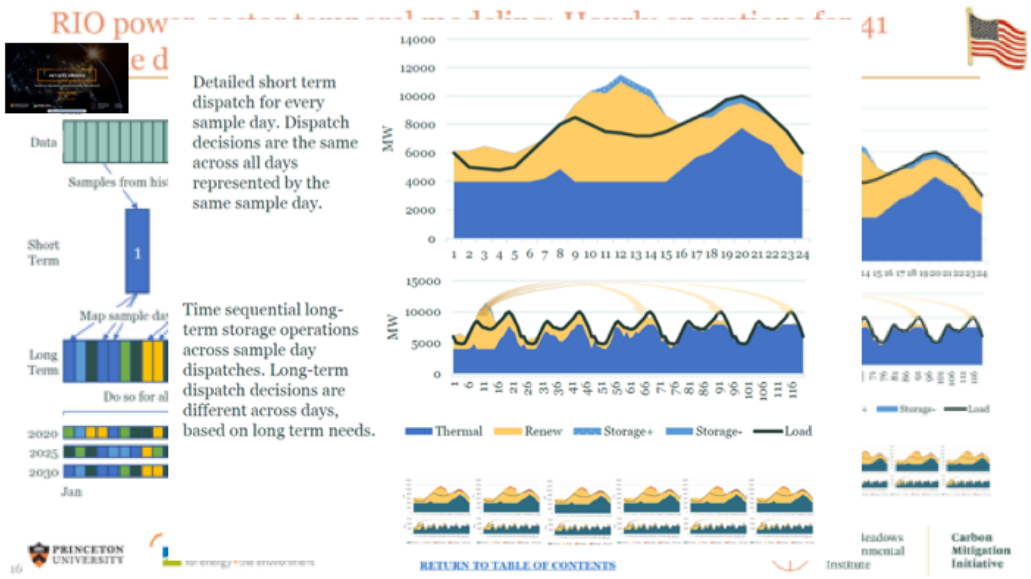
(Source: Entsoe)

All networks are balanced and buffered by other external networks

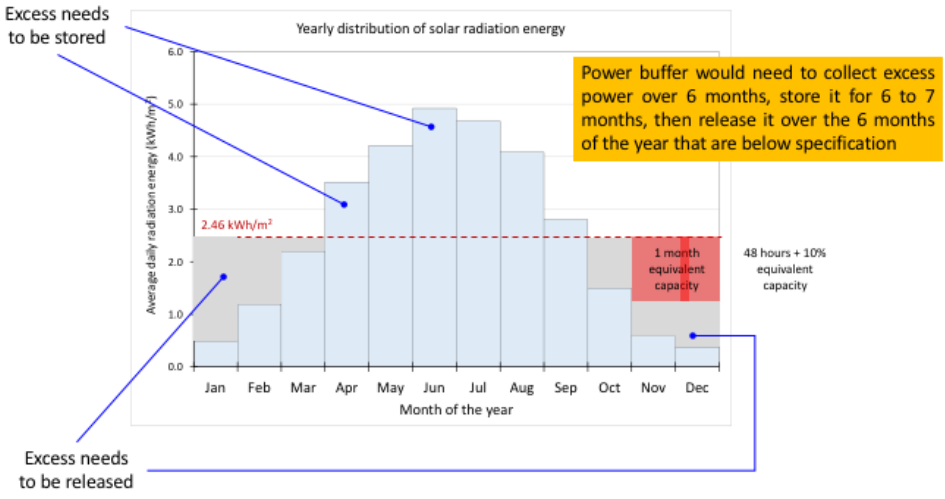
Almost always using fossil fuel sourced power generation (gas in particular)

Most existing renewable power grids are balance with fossil fuels systems

We have never had to run a large renewable network in a self sufficient manner



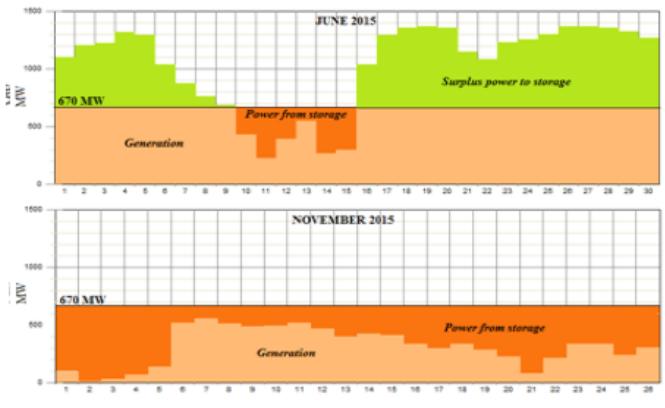
Distribution of the sun's radiation energy over the year in Germany
(Wesselak & Voswinckel 2016)



Power buffer would need to collect excess power over 6 months, store it for 6 to 7 months, then release it over the 6 months of the year that are below specification

26.6.2023

Average daily CSP generation, June and November 2015



Spain

Power storage and release requirements that would have been needed to maintain a constant 670 MW of baseload generation during June and November (equivalent to 5.9 TWh per year)

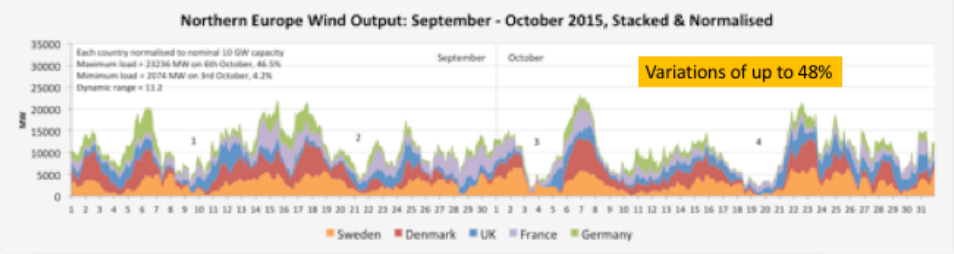
Approximately 260 GWh of storage would have been needed to cover the shortfalls in November alone. This is 16.2 days of buffer capacity, to be stored for approx. 4-6 months.

Mearns, E. (2015, Nov 17): A review of concentrated solar power (CSP) in Spain, Energy Matters blog, http://euanmearns.com/a-review-of-concentrated-solar-power-csp-in-spain/

Wind is highly variable

- Reliable capacity as a % of max capacity for wind 7-25% (UK Parliament 2014)
  - *Power production was so erratic it could not be predicted*
- Variations in power produced can last weeks and, in some cases, months
- In practical terms, global power generation operating hours in 2018 (Global Energy Observatory)
  - *Solar PV units produced 11.4% of the calendar year*
  - *Wind units produced 24.9% of the calendar year*

Highly variable of when power was produced



The full year of renewable generation capacity factors in the PJM RTO in the U.S.

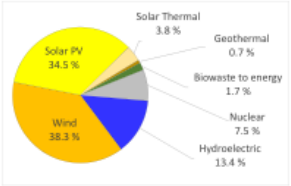
the largest regional transmission organization, directly or indirectly affecting the electricity supply to nearly 100 million people

PJM Monthly Wind and Solar Capacity Factors 2022/2023

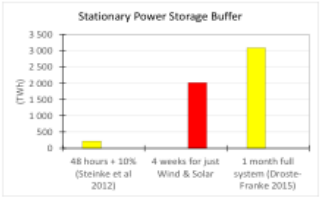
		January 1/31/22 thru 1/30/23	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Total
Solar	MWh potential	2,837,616	2,563,008	2,837,616	2,746,080	2,837,616	2,746,080	2,837,616	2,837,616	2,746,080	2,837,616	2,746,080	2,837,616	33,410,640
3,184 MW	Actual MWh	336,822	432,939	586,966	718,934	745,154	865,656	771,788	765,286	677,478	524,646	420,135	311,577	7,157,381
Capacity	Capacity Factor	11.9%	16.9%	20.7%	26.2%	26.3%	31.5%	27.2%	27.0%	24.7%	18.5%	15.3%	11.0%	21.4%
Wind	MWh potential	7,433,304	6,713,952	7,433,304	7,193,520	7,433,304	7,193,520	7,433,304	7,433,304	7,193,520	7,433,304	7,193,520	7,433,304	87,521,160
9,991 MW	Actual MWh	2,985,067	3,303,952	3,452,911	3,379,448	2,754,655	1,911,078	1,568,729	1,335,725	1,709,928	3,011,020	3,575,208	3,113,890	32,101,611
Capacity	Capacity Factor	40.2%	49.2%	46.5%	47.0%	37.1%	26.6%	21.1%	18.0%	23.8%	40.5%	49.7%	41.9%	36.7%
Blended Renewables Monthly and Annual Capacity Factors		32.3%	40.3%	39.3%	41.2%	34.1%	27.9%	22.8%	20.5%	24.0%	34.4%	40.2%	33.4%	32.5%

Not only are the capacity factors low, it turns out that both wind and solar capacity factors reach low points at precisely the seasonally worst possible times, wind at the peak of summer demand and solar at the peak of winter demand.

Projected New energy split for 2050



Power Generation System	Proposed Energy Split non-fossil fuel electrical power systems (%)	Expanded extra required annual capacity to phase out fossil fuels (kWh)	Power Produced by a Single Average Plant in 2018 (kWh)	Estimated number of required additional new power plants of average size to phase out fossil fuels (number)	Estimated Installed capacity (GW)
Nuclear	7.50 %	2.80E+12	1.28E+10	218	447
Hydroelectric	13.36 %	4.98E+12	1.33E+09	3 758	847
Wind	38.33 %	1.43E+13	8.12E+07	175 933	6 545
Solar PV	34.50 %	1.29E+13	3.30E+07	389 367	12 888
Solar Thermal	3.83 %	1.43E+12	7.70E+07	18 555	1 428
Geothermal	0.74 %	2.76E+11	6.03E+08	457	43
Biowaste to energy	1.74 %	6.49E+11	3.46E+07	18 762	595
	100.00 %	3.73E+13 37 289.7 Total (TWh)		607 052	22 793 Giga Watts



- Global Wind & Solar capacity only (76%) = 26 220.7 TWh
- 4 weeks Wind & Solar capacity only = **2192.9 TWh**
- 48+10% hours Wind & Solar capacity only = **172.3 TWh**

This is the size of the needed power buffer

Power storage methods compared

Table 2.1.1 Techno-Ec… adapted from US Hydrowires Report [8] a…

More favorable

Parameter	Flyw…	ZEBRA (NaNiCl)[b]	Flow Battery[c]
Efficiency* (%) (DC+AC)	70	80-85	65-70
Response (seconds)	0.	0.1-1	1-10
Lifetime (cycles to 80% DOD)	10	3.5K	10K
Lifetime (years)	2	10-15	15
CAPEX (DC+AC) (USD/kW)	1080	2810-5094	2742-5226
CAPEX (DC+AC) (USD/kWh)	4320-	703-1274	686-1307
Energy Density (Wh/L)	20	170-190	20-70
Power Density (W/L)	50	250-260	0.5-2
Self-discharge per day (%)	1.3-	1-14	0.2
Typical charging rate* [10], [11],[12]	N	0.1-0.15 C	0.1-0.15 C

(a) E/P = 0.25 h, (b) E/P = 0.0125h, (c) E/P = 4 h

(Source: EMA (2020): Energy Storage Systems Technology Roadmap for Singapore, PUBLIC VERSION, Prepared for Energy Market Authority (EMA), Lead Authors: Dr. Sivanand SOMASUNDARAM, EPGC, ERI@N, NTU, https://www.ntu.edu.sg/docs/librariesprovider60/publications/ess-technology-roadmap-singapore.pdf?sfvrsn=c91c9ae8_2)

Super capacitors were limited by the required time of power storage

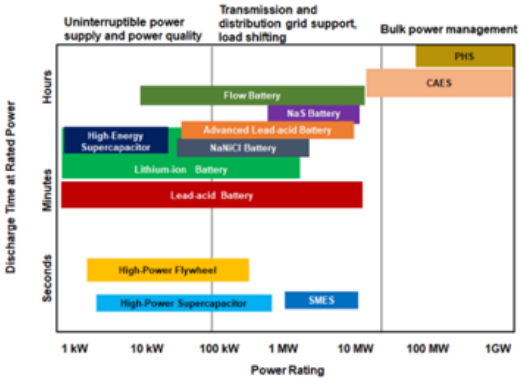


Figure 2.1.2 ESS technology suitability depending on discharge duration [13]

Battery Stations in some form are preferred by policy makers

- These devices are modular and can be installed quickly
- Are not constrained by location
- Are easy to maintain
- Can also be moved to other locations as and when required cost-effectively.

(Source: EMA (2020): Energy Storage Systems Technology Roadmap for Singapore, PUBLIC VERSION, Prepared for Energy Market Authority (EMA), Lead Authors: Dr. Sivanand SOMASUNDARAM, EPGC, ERI@N, NTU, https://www.ntu.edu.sg/docs/librariesprovider60/publications/ess-technology-roadmap-singapore.pdf?sfvrsn=c91c9ae8_2)

Number of technology units

Renewable Technology Unit or Service	Number (number)	Estimated total battery capacity (TWh)	Estimated extra annual power output required (TWh)	Estimated extra total installed power generation capacity (MW)
Electric Vehicles				
Bus + Medium Delivery Truck	29 002 253	5.98		
Light Truck/Van + Light-Duty Vehicle	601 327 324	25.32		
Passenger Car	695 160 429	32.53		
Motorcycle	62 109 261	1.34		
Hydrogen Fuel Cells				
HCV Class 8 Truck	28 929 348		1 949.0	
Rail Freight Locomotive ♣	104 894		277.0	
Maritime Small Vessel (100 GT to 499 GT) ♣	53 854		7.75	
Maritime Medium Vessel (500 GT to 24 999 GT) ♣	44 696		131.73	
Maritime Large Vessel (25 000 GT to 59 999 GT) ♣	12 000		255.72	
Maritime Very Large Vessel (>60 000 GT) ♣	6 307		379.70	
Nuclear Power (Annual Production)			2 796.7	447 037
Hydroelectricity (Annual Production)			4 981.9	847 010
Geothermal Power (Annual Production)			275.9	43 320
Wind Turbines				
3MW Onshore wind turbines (70% share)	1 527 101		10 005.2	4 581 304
3MW Offshore wind turbines (30% share)	654 472		4 287.9	1 963 416
Solar Panels				
450 Watt commerical grade solar panels	28 640 112 291		12 864.9	12 888 051
Stationary power storage buffer				
28 days capacity for wind & solar PV only		2 192.92		
	Total	**2 258.1**		

♣ Numbers drawn from Michaux 2023, and Michaux 2021

- Electric Vehicles
- EV Batteries
- Hydrogen fuel cells
- Wind Turbines
- Solar Panels
- Power Storage Batteries

Number of technology units

WIND TURBINES | SOLAR PANELS | POWER STORAGE BATTERIES

All of these tech units are to replace a fossil fuel technology system

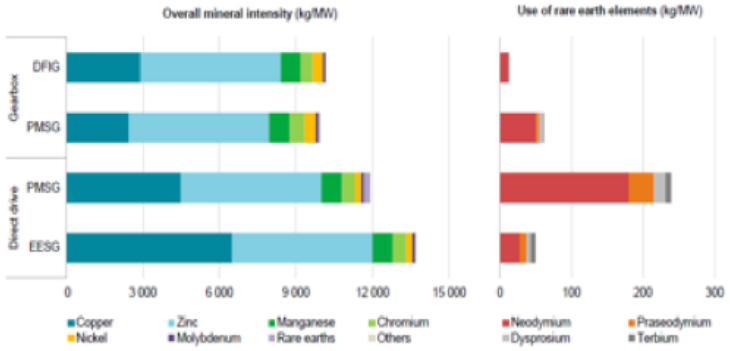
They harvest renewable energy like wind and sunshine. The units themselves are not renewable as they wear out (20 years). **They are replaceable.**

Each one is **manufactured from metals.**

As this system has yet to be constructed, it **cannot be recycled.**

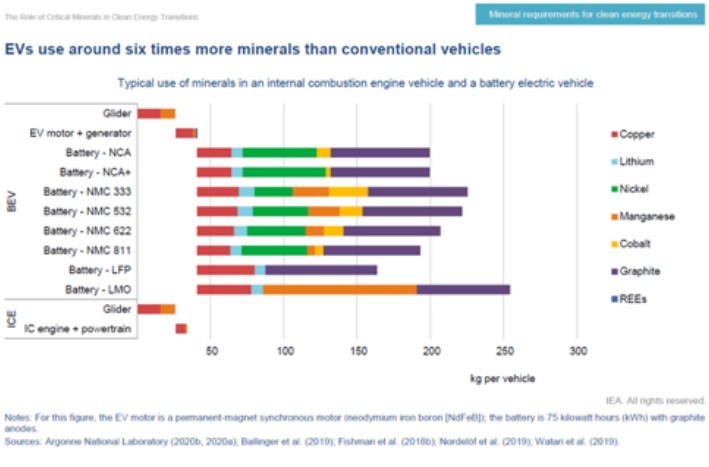
The first generation at least will be sourced from the **mining of minerals.**

Minerals are the new oil



Metal content of different wind turbine units (Note: metal content intensity numbers are based on the onshore installation environment. More copper is needed in offshore applications due to much longer cabling requirements)

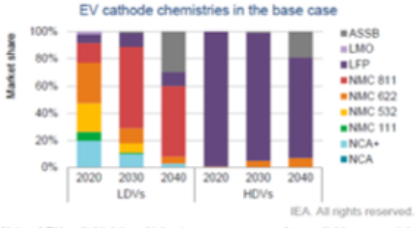
(Source: IEA) (Copyright IEA)



(Source: The Role of Critical Minerals in Clean Energy Transitions IEA)

Table A17. Global market proportions of EV battery chemistries in 2040 (Source: IEA 2021)

Battery Chemistry	Acronym	Light Duty Vehicle (LDV) (%)	Heavy Duty Vehicle (HDV) (%)
Lithium Nickel Cobalt Aluminium Oxides	NCA+	3.5 %	
Nickel Manganese Cobalt	NMC 622	5.2 %	7.2 %
	NMC 811	52.2 %	
Lithium Iron Phosphate	LFP	10.1 %	73.9 %
All Solid State Batteries	ASSB	29.0 %	18.8 %
		100.0 %	100.0 %



Notes: LDVs = light-duty vehicles (passenger cars and vans, light commercial vehicles, and 2- and 3-wheelers); HDVs = heavy-duty vehicles (trucks and buses).

(Source: The Role of Critical Minerals in Clean Energy Transitions IEA)

Table A11. Global market proportions of power storage chemistries in 2040 (Source: drawn from IEA 2021, Diouf & Pode 2015)

Battery Chemistry	Acronym	Specific Energy Density (Wh/kg)	Projected Market Proportion for Power Storage in 2040 (%)	Battery capacity in total power storage in 2040 (TWh)
Lithium Nickel Manganese Cobalt Oxides	NMC 532	100-135	3.3 %	66.3
	NMC 622	100-135	9.9 %	199.0
	NMC 811	100-135	9.9 %	199.0
Lithium Iron Phosphate	LFP	90-120	73.7 %	1 486.2
Vanadium Redox Battery	VRB	20 - 32	3.3 %	66.3
Total			100.0 %	2 017.0

2nd generation of work done

Table A28. Metal required for stationary power storage batteries to phase out fossil fuels

Battery Chemistry	NMC 532 (tonne)	NMC 622 (tonne)	NMC 811 (tonne)	LFP (tonne)	VRB (tonne)	Total (tonnes)
Copper (Cu)	70 636 359	208 323 452	208 166 274	3 671 625 026		4 158 751 111
Lithium (Li)	27 167 830	75 351 036	72 616 142	704 147 265		879 282 274
Manganese (Mn)	52 977 269	101 945 519	48 410 761			203 333 550
Cobalt (Co)	39 393 354	110 810 347	48 410 761			198 614 462
Vanadium (V)					647 928 875	647 928 875
Nickel (Ni)	95 087 406	327 998 627	396 968 244			820 054 277
Graphite (C)	169 798 939	540 754 493	590 611 290	7 091 768 885		8 392 933 607

GTK

Metal Needed

Table 37-1. Total metal quantity required to manufacture one generation of technology units to phase out fossil fuels

Metal	Metal quantity required for onshore wind turbines (tonnes)	Metal quantity required for offshore wind turbines (tonnes)	Metal content in 12 442 636 MW of solar panels (tonnes)	Metal content in Nuclear power plant construction (tonnes)	Metal content in Hydro power plant construction (tonnes)
Steel					
Aluminium	*	*	154 656 606		
Copper	14 844 726	18 051 487	36 614 952	657 145	889 361
Zinc	25 206 016	10 802 578			
Magnesium Metal	*	*			
Manganese	3 460 864	1 475 814			169 402
Chromium	2 211 119	1 026 381		979 012	
Nickel	1 917 323	514 430		581 149	25 410
Lithium					
Cobalt					
Graphite					
Molybdenum	483 785	207 660			
Silicon (Metallurgical)			51 345 993		
Silver			150 790		
Platinum					
Vanadium					
Zirconium					
Germanium	*	*	*		
Rare Earth Element					
Neodymium	191 128	319 889	*		
Lanthanum	*	*	*		
Praseodymium	26 395	59 311	*		
Dysprosium	15 290	29 837	*		
Terbium	6 248	11 122	*		
Hafnium	*	*	*	224	
Yttrium	*	*	*	224	

* no data available

GTK

Table 37-2. Total metal quantity required to manufacture one generation of technology units to phase out fossil fuels

Metal	Metal content in Geothermal power plant construction (tonnes)	Metal content in Electric Vehicle construction (tonnes)	Metal content in hydrogen fuel cell construction (tonnes)	Metal content in EV batteries (tonnes)	Metal content in 28 day capacity stationary storage batteries (tonnes)	Metal content in 48 hours + 10% capacity stationary storage batteries (tonnes)	Total including 28 days buffer (tonnes)	Total including 48 hours + 10% buffer (tonnes)
Steel		1 685 939 336	(only Pt data available)				1 685 939 336	1 685 939 336
Aluminium		150 687 921					305 344 528	305 344 528
Copper		74 209 446		63 251 218	4 521 524 892	355 262 670	4 730 043 227	563 781 004
Zinc				936 793			36 945 387	36 945 387
Magnesium Metal		500 400					500 400	500 400
Manganese				9 317 606	221 070 625	17 369 835	235 494 311	31 793 521
Chromium	2 794 852						7 011 364	7 011 364
Nickel	5 190 439			70 999 643	891 588 779	70 053 404	970 817 173	149 281 798
Lithium				20 291 338	955 983 318	75 112 975	976 274 657	95 404 313
Cobalt				9 713 443	215 939 885	16 966 705	225 653 328	26 680 148
Graphite				155 212 285	9 125 061 157	716 969 091	9 280 273 442	872 181 376
Molybdenum	449 173						1 140 617	1 140 617
Silicon (Metallurgical)							51 345 993	51 345 993
Silver							150 790	150 790
Platinum			2 681.9				2 682	2 682
Vanadium					704 448 633	55 349 535	704 448 633	55 349 535
Zirconium				2 614 126			2 614 126	2 614 126
Germanium		*	*	4 163 162	*		4 163 162	4 163 162
Rare Earth Element								
Neodymium		472 600	*	*	*		983 617	983 617
Lanthanum		*	*	5 970 738	*		5 970 738	5 970 738
Praseodymium		152 900	*	*	*		238 605	238 605
Dysprosium		152 900	*	*	*		198 027	198 027
Terbium		*	*	*	*		17 370	17 370
Hafnium		*	*	*	*		224	224
Yttrium		*	*	*	*		224	224

* no data available

Table 39. Total metal quantity required to manufacture one generation of technology units to phase out fossil fuels compared to 2019 global production

Metal	Element	Total metal required produce one generation of technology units to phase out fossil fuels (28 days buffer) (tonnes)	Total metal required produce one generation of technology units to phase out fossil fuels (48 hours + 10% buffer) (tonnes)	Global Metal Production 2019 (tonnes)	Years to produce metal at 2019 rates of production (assuming the 28 day buffer) (years)
Aluminium	Al	305 344 528	305 344 528	63 136 000	4.8
Copper	Cu	4 730 043 227	563 781 004	24 200 000	195.5
Zinc	Zn	36 945 387	36 945 387	13 524 000	2.7
Magnesium Metal	Mg	500 400	500 400	1 120 000	0.4
Manganese	Mn	235 494 311	31 793 521	20 591 000	11.4
Chromium	Cr	7 011 364	7 011 364	37 498 478	0.2
Nickel	Ni	970 817 173	149 281 798	2 350 142	413.1
Lithium	Li	976 274 657	95 404 313	95 170	10 258.2
Cobalt	Co	225 653 328	26 680 148	126 019	1 790.6
Graphite (natural flake)	C	9 280 273 442	872 181 376	1 156 300	6 778.8
Graphite (synthetic)	C			1 573 000 ♦	
Molybdenum	Mo	1 140 617	1 140 617	277094 ‡	4.0
Silicon (Metallurgical)	Si	51 345 993	51 345 993	8 410 000	6.1
Silver	Ag	150 790	150 790	26282 ‡	5.5
Platinum	Pt	2 682	2 682	190 ‡	14.1
Vanadium	V	704 448 633	55 349 535	96021 ‡	6 747.8
Zirconium	Zr	2 614 126	2 614 126	1 338 463 ‡	2.0
Germanium	Ge	4 163 162	4 163 162	143	29 113.0
Rare Earth Element	-				
Neodymium	Nd	983 617	983 617	23 900	41.2
Lanthanum	La	5 970 738	5 970 738	35 800	166.8
Praseodymium	Pr	238 605	238 605	7 500	31.8
Dysprosium	Dy	198 027	198 027	1 000	198.0
Terbium	Tb	17 370	17 370	280	62.0
Hafnium	Hf	224	224	66	3.4
Yttrium	Y	224	224	14 000	0.016

‡ Estimated from mining production. All other values are refining production values.
♦ Natural flake graphite and synthetic graphite was combined to estimate total production

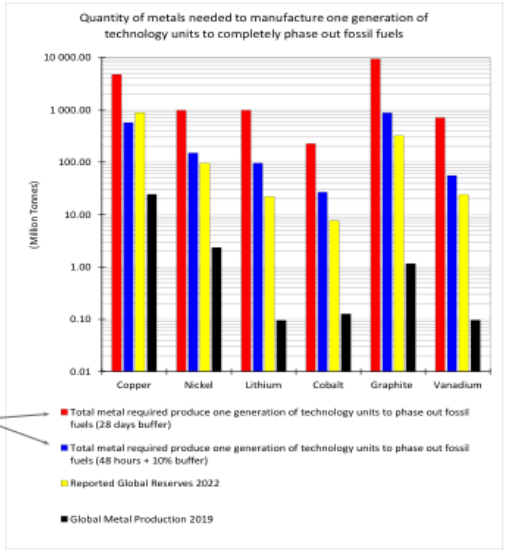
Metal produced in 2019

Metal in 2022 global reserves

Metal Source: USGS	Total metal required produce one generation of technology units to phase out fossil fuels (tonnes)	Reported Global Reserves 2022 (tonnes)	Global Reseves as a proportion of metals required to phase out fossil fuels (%)
Copper	4 730 043 227	880 000 000	18.60 %
Nickel	970 817 173	95 000 000	9.79 %
Lithium	976 274 657	22 000 000	2.25 %
Cobalt	225 653 328	7 600 000	3.37 %
Graphite (natural flake)	9 280 273 442	320 000 000	3.45 %
Vanadium	704 448 633	24 000 000	3.41 %

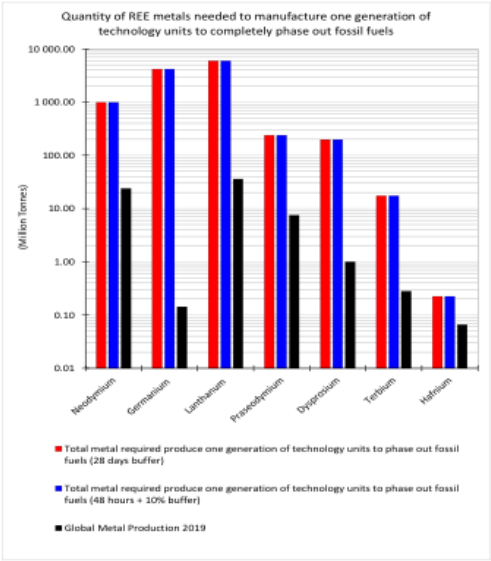
We can make batteries out of something else (Zinc, fluoride, sodium, etc.)

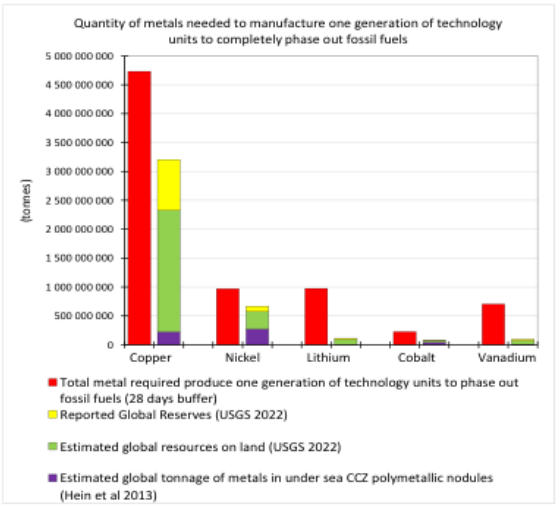
- For every 1000 deposits discovered, 1 or 2 become mines
- Time taken to develop a discovered deposit to a mine 20 years
- For every 10 producing mines, 2 or 3 will lose money and shut down



Remember, this is for just the first generation of units.

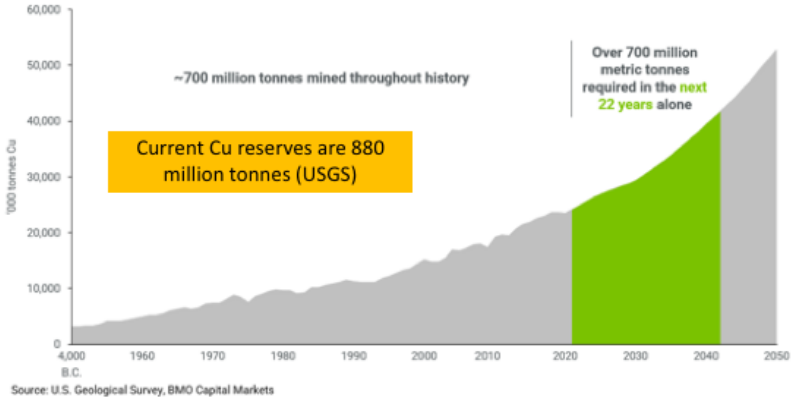
They will wear out in **10 to 25 years**, after which they will need to be replaced


Quantity of REE metals needed to manufacture one generation of technology units to completely phase out fossil fuels
10 000.00
1 000.00
100.00
10.00
1.00
0.10
0.01
(Million Tonnes)
Neodymium
Germanium
Lanthanum
Praseodymium
Dysprosium
Terbium
Hafnium
Total metal required produce one generation of technology units to phase out fossil fuels (28 days buffer)
Total metal required produce one generation of technology units to phase out fossil fuels (48 hours + 10% buffer)
Global Metal Production 2019


Quantity of metals needed to manufacture one generation of technology units to completely phase out fossil fuels
5 000 000 000
4 500 000 000
4 000 000 000
3 500 000 000
3 000 000 000
2 500 000 000
2 000 000 000
1 500 000 000
1 000 000 000
500 000 000
0
(tonnes)
Copper
Nickel
Lithium
Cobalt
Vanadium
Total metal required produce one generation of technology units to phase out fossil fuels (28 days buffer)
Reported Global Reserves (USGS 2022)
Estimated global resources on land (USGS 2022)
Estimated global tonnage of metals in under sea CCZ polymetallic nodules (Hein et al 2013)


Mining production & existing reserves are not enough to manufacture the first generation of renewable technology
26.6.2023

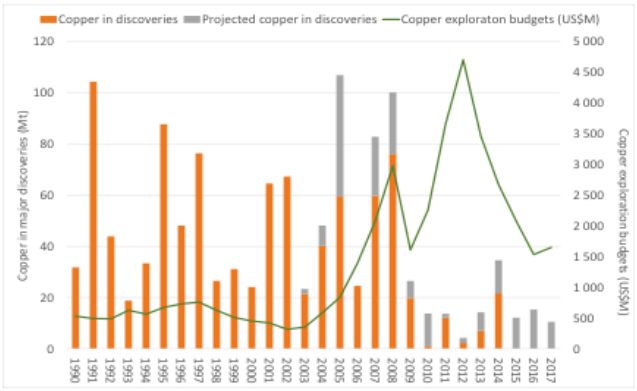
Economic growth and resource supply



Source: U.S. Geological Survey, BMO Capital Markets

We want 4.73 billion tonnes of Cu, just to manufacture one generation of renewable technology (6.75 x historical Cu mining)

Copper in major discoveries by year, 1990-2017 (Data as of July 18, 2018)



(Source: S&P Global Market Intelligence)

Copper discovery

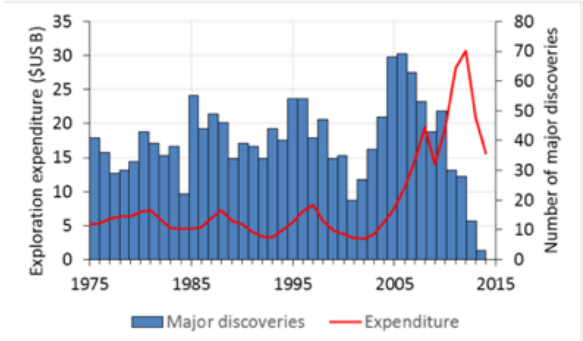
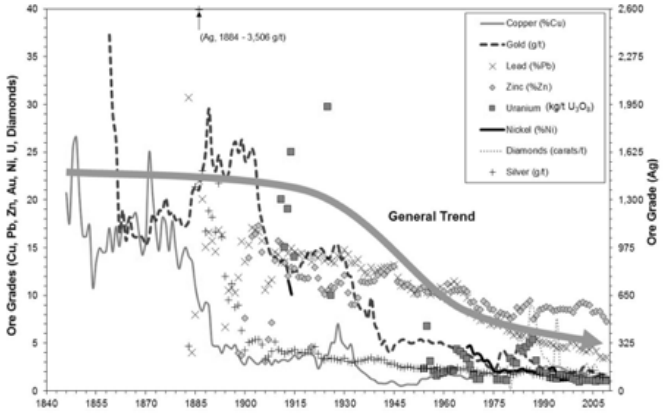


Figure 1: Exploration expenditures versus number of major discoveries, where major is defined as, for example, a gold deposit containing more than 1 Moz of gold or a copper deposit with more than 1 Mt of copper. (Data courtesy of MinEx Consulting)

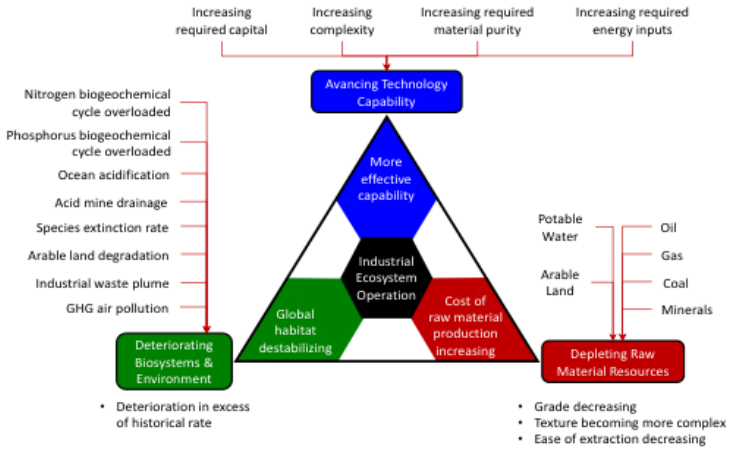
(Source: Dunbar *et al.* 2016)

Mineral grade decreasing (Southern Hemisphere)



Source: Mudd, G. (2007, Revised April 2009) The Sustainability of Mining in Australia - Key Production Trends and Their Environmental Implications for the Future, Department of Civil Engineering, Monash University and the Mineral Policy Institute

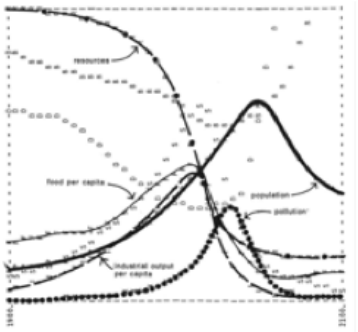
The big picture – long term industrial sustainability



- Deterioration in excess of historical rate

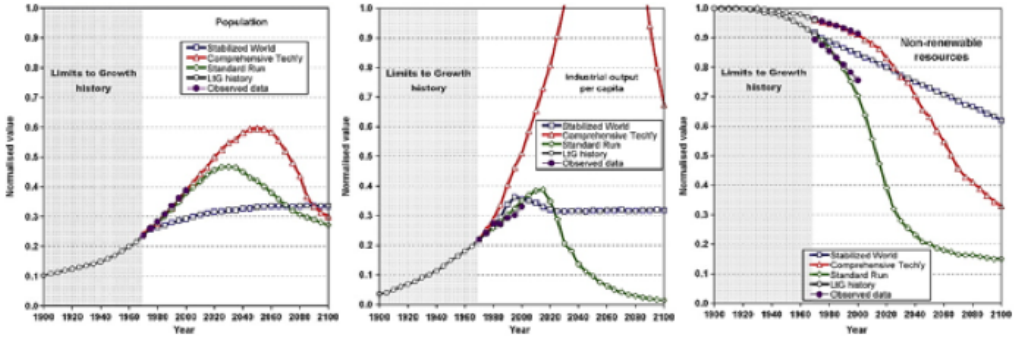
- Grade decreasing
- Texture becoming more complex
- Ease of extraction decreasing

The standard run base case projected outcome of 1972 systems analysis modelling of global industrial society



The "standard" world model run assumes no major change in the physical, economic, or social relationships that have historically governed the development of the world system. All variables plotted here follow historical values from 1900 to 1970. Food, industrial output, and population grow exponentially until the rapidly diminishing resource base forces a slowdown in industrial growth. Because of natural delays in the system, both population and pollution continue to increase for some time after the peak of industrialization. Population growth is finally halted by a rise in the death rate due to decreased food and medical services.

Comparing 'Limits to Growth' scenarios to observed global data – human population



(Source: Turner 2008)

DISCUSSION

WHAT DOES IT MEAN?

The current plans for 'after oil' are simply not good enough on multiple levels

- Complexity of supply chain needed
- Energy requirements of manufacture
- Logistical capability of existing fossil fuels

Current thinking has seriously underestimated the scale of the task ahead

Battery chemistries other than lithium-ion should/will be developed, each with different mineral resources required

The ERoEI ratio for renewable energy systems is much lower than fossil fuel energy systems. Renewable energy technology may not be strong enough to replace fossil fuels

Hopes for future technology breakthroughs to 'somehow' deliver more commodity resources do not seem to consider the nature of what mineral resources that are left

The current ecosystem has no concept of its dependency on minerals and does not consider long term concepts like continuous growth in production against finite resources

IN CONCLUSION

THIS REPORT SUGGESTS

Replacing the existing fossil fuel powered system (oil, gas, and coal), using renewable technologies, such as solar panels or wind turbines, **will not be possible for the entire global human population.**

There is simply just **not enough time, nor resources** to do this by the current target set by the world's most influential nations.

What may be required, therefore, is **a significant reduction of societal demand** for all resources, of all kinds.

This implies a very different social contract and **a radically different system of governance** to what is in place today.

Inevitably, this leads to the conclusion that the existing renewable energy sectors and the EV technology systems are **merely steppingstones to something else**, rather than the final solution.

It is recommended that some thought be given to this and **what that something else might be.**

Ecological reality and biophysical limitations will reassert itself

GTK

NEXT STEPS

TASKS TO BE DONE

Conduct a Maslow hierarchy of needs analysis loop in context of industrial activity and capacity

- What is truly needed for society to function – work back from there
- What is truly needed for industry to function – work back from there

Reorganize industrial value chain around a low energy future and very short supply chains that are inconsistent in performance

Re-tool the existing power grid into a network of microgrids, that can transfer power between them and can still function if part of the grid is temporarily shut down. Each grid supports a vital industrial or social activity

Develop engineering technology that can cope with variable power supply, and power spikes

Power buffer to intermittency would no longer be needed

Plan for a re-prioritization of industrial capacity. For example pyrolysis of plastics and rubber to produce fuel oil may become more important

Plan for a systemic merging of energy and raw material feedstock supply with all industrial action – they are no longer just a costs of doing business, but are now rate determining steps

Plan for a economy where some industrial capability **can periodically shutdown and start-up without damage.** Also a possible period of dormancy over part of winter.

Develop an engineering decision making system that can defined whether an industrial outcome is logistically sensible or economically viable to a new set of constraints (e.g. using exergy)

Develop the capability to quickly find substitutions for material products, or industrial outcomes as their supply becomes non-linear, unreliable or unavailable.

Evaluate what is really needed, then plan to do it in a regional scope

GTK

Bio

Associate Professor of geometallurgy at the Geological Survey of Finland (GTK) in KTR, the Circular Economy Solutions Unit. Basic degree Bach App. Sc in Physics and Geology, Phd in Mining Engineering from JKMRC University of Queensland. Work experience 18 years in the Australian mining industry in research and development, 12 months at Ausenco in the private sector, 3 years in Belgium at the University of Liege researching Circular Economy and industrial recycling. Work experience in Finland has been at GTK has been in the Minerals Intelligence in the MTR unit, before joining the KTR. Mineral processing and geometallurgy being developed.

Long term objectives include the development and transformation of the Circular Economy, into a more practical system for the industrial ecosystem to navigate the twin challenges of the scarcity of technology minerals and the transitioning away from fossil fuels.

Rob Mielcarski
un-Denial

un-Denial Manifesto: Energy and Denial

[Published November 12, 2015)

This essay launched and defined un-Denial.com.

This is the story of the two most important things that enabled the success and possible demise of humans: energy and denial.

Simple single cell (prokaryotic) life emerges as a gradual and predictable transition from geochemistry to biochemistry, in the presence of rock, water, CO2, and energy, all of which are found within alkaline hydrothermal vents on geologically active planets, of which there are 40 billion in our galaxy alone, and probably a similar number in each of the other 100 billion galaxies.

Simple life like bacteria and archaea is therefore probably common throughout the universe. Strong evidence for this is that prokaryotes appeared 4 billion years ago, as soon as the earth cooled down enough to support life, and never once winked out despite many calamities throughout geologic history.

LUCA (the Last Universal Common Ancestor), and all life that followed, is chemiosmotic meaning that it powers itself with an unintuitive mechanism that pumps protons across a membrane. This strange proton pump makes sense in the light of its hydrothermal vent origins. For a sense of the scale of life's energy, consider that the human body pumps a staggering 10**21 protons per second of life.

The transition to, and existence of, complex multicellular life, like plants and animals, is much less predictable and certain. All of the complex life on earth has a common eukaryote ancestor, and it appears this ancestor emerged only once on Earth about 2 billion years ago. This is a vital but rarely acknowledged singularity in biology.

The eukaryote cell was created by a rare endosymbiosis (merging) of prokaryotes (simple cells) somewhat analogous to a freak accident. The resulting LECA (Last Eukaryotic Common Ancestor), having 2 genomes that needed to cooperate and evolve in harmony, was probably fragile, sickly, and vulnerable to extinction

which forced it to evolve many unusual characteristics common to complex life such as the nucleus, sex, two sexes, programmed cell death, germline-soma distinction, and trade-offs between fitness and fertility, adaptability and disease, and ageing and death.

As the endosymbiont (cell within the cell) evolved into mitochondria (energy powerhouses), eukaryotes were able to break through the energy per gene barrier that constrained the morphological complexity of bacteria and archaea for 2 billion years. Suddenly there was enough energy to power the evolution of complex structure, multi-cellular life, a symphony of fungi, plants and animals, and one single hominid with an extended theory of mind that took over the planet.

> *The magnificent and varied life we enjoy on Earth may not be unique in the universe, but is probably very rare, and our existence and ability to understand and discuss the origin of this life, is extraordinarily rare and precious.*

Life at its core is chemical reactions that consume energy to replicate themselves. There is a minimum quantity of energy required to sustain life. This subsistence energy supports growth to sexual maturity, finding and winning a mate, reproducing, and feeding the offspring. It also includes the energy for shelter and clothing to create a hospitable environment for the chemical reactions to operate, energy to power the muscles used to evade or fight threats, and energy for the cells to repair damage from sickness or injury.

All of this subsistence energy must come from the surplus left after using energy to gather, hunt, grow, steal, or purchase energy. In other words, life must obtain more food than the food it takes to obtain food. Otherwise it dies. For example, if a coyote burns 2 rabbits worth of energy to capture 1 rabbit then it will die. If on the other hand, a coyote burns 1 rabbit of energy to capture 2 rabbits then it might be able to produce offspring that survive to repeat the achievement. Similarly, an ape that sells life insurance and uses its wages to buy food must be employed by a life insurance company that makes a profit. Without a profit the ape will lose its job and ability to buy food. Profit is an energy surplus.

Energy is required to produce anything and everything. For example, your coffee mug required diesel-powered machines to dig up and transport clay to a factory that used natural gas-fired furnaces to fuse the clay into a durable ceramic container that was then transported by a diesel-powered ship and diesel-powered trucks to a store that you drove to in a gasoline-powered car and purchased with wages your earned from a company that generated a profit by using energy to create something worth more energy. Money is a token we can exchange for real things. Therefore money is a claim on energy.

If a species finds a way to capture more energy than is required to subsist, then its probability of survival and population increases. Additional surplus energy is first used by life to increase fertility and decrease mortality. This makes intuitive sense because the chemical reactions at the core of life are replicators that replicate until some resource shortage constrains them. The most important resource, by far, is energy because with sufficient energy many other resource shortages can be overcome. For example, a well fed coyote can range farther to find water, and an ape can use natural gas generated steam to extract oil from sand.

Until recently all species obtained their energy from the current flow of sunlight (e.g. grass) or the recent flow of sunlight (e.g. wood). As an aside, a few species use instead chemical energy from geothermal processes but I will not discuss this since the ideas are analogous. An ape that eats a cow uses current solar energy via the photosynthetic grass eaten by the cow to produce flesh, and recent solar energy via the wood used to predigest (cook) the meat.

The sun shines at a relatively constant intensity and the earth is a fixed size at a relatively constant distance from the sun. Therefore the available sunlight on earth is finite and fairly constant. If one species captures more energy it must come at the expense of a different species. This tension is the driving force behind evolution.

The competition for finite resources as governed by the laws of evolution has created many amazing variations of life. For example, trees that grow tall to capture more sunlight than its neighbors, cheetahs that run faster than their prey, giraffes that eat high leaves, and birds that migrate with the seasons. One species emerged with a unique capability to out-compete all other species for available sunlight, and then used this same capability to break through the sunlight barrier.

About 100,000 years ago there were several intelligent social species of hominids spread around the world, all with about the same brain size and power. For some period of time, perhaps several million years, these species bumped up against evolving an extended theory of mind, which would have been advantageous for these social species because it enhances cooperation by enabling an individual to understand the minds of other individuals. Each time an individual was born with a mutation for an extended theory of mind they would have observed, through the normal course of daily activities like hunting and childbirth, other individuals being killed or injured, and therefore would have come to understand their own mortality. All animals have a very useful inherited behavior that causes them to fear and avoid injury, and therefore mortality awareness caused fear, depression, and risk avoidance, which reduced their reproductive fitness, and so the mutation for an extended theory of mind did not fix in the gene pool.

Then one day, through random chance, a member of one tribe in east Africa was born with a mutation for an extended theory of mind plus denial of reality. The two independently maladaptive behaviors, when improbably combined, became highly adaptive. The genes from that individual became fixed in her tribe and the resulting improvement to the tribe's ability to communicate and cooperate increased the success of the tribe.

Having broken through the mortality barrier, it now became advantageous and probable for natural selection to evolve a larger and more powerful brain with complex symbolic language, planning and analytic skills, and increased memory capacity. An additional fortuitous side effect of denial of reality was the optimism bias it created which the intelligent species used to advance technology, hunt dangerous animals, wage war, and explore new continents.

This new species that emerged from a small tribe of hominids, that we now call human, and that is sometimes referred to as the chosen people, used its new abilities to out compete all other hominid species.

The mutation for denial of reality, which was essential for dampening the inherited fear of injury and death, caused each new human tribe to create life after death stories which served to define, unite, govern, and entertain the tribe. Thousands of different stories, which we now call religions, were created by thousands of tribes, with their one and only common feature being, due to its genetic foundation, a life after death subplot.

Over this same period of time, and probably even longer, there were other intelligent social species like chimpanzees, dolphins, elephants, and crows that were bumping up against the mortality barrier to evolving an extended theory of mind. Some of these species achieved partial theory of mind as

demonstrated, for example, by behavior consistent with mourning their dead and revenge, however because of the improbability of mutating an extended theory of mind simultaneous with denial of reality, these species never evolved brains similar to humans.

The enlarging human brain soon became constrained by the size of the birth canal and associated pregnancy health risks. Because of the strong fitness advantage a larger brain provided, evolution found a clever way to work around the birth canal constraint by delivering babies with undeveloped brains. Therefore, as humans became smarter, parents were required to care for their offspring for a longer period before they became independent and able to breed. This led to other behavioral and cultural changes, such as pair bonding, and religions with stories that discouraged adultery.

The humans used their intelligence and social skills to develop technologies to capture a larger share of solar energy. Examples of these technologies include mastery of fire for cooking, heating, and land clearing; domestication of animals initially for protection and hunting assistance and later for transportation, agricultural labor, and sources of food; metal for weapons and tools; projectile weapons for extending its lethal range; replacement of indigenous plants with cultivated food plants; redirection and storage of water; methods and vehicles for migrating to all available continents and islands; shelter and clothing to survive in all climates; architectural structures for defense; and written language to store and transmit the technologies.

The human population increased rapidly and spread to all continents. Large prey went extinct everywhere shortly after the arrival of humans, except in Africa, where the large animals co-evolved with early humans. All of the humans' close relatives were out-competed and went extinct. Human civilizations like the Egyptians, Romans, Mound Builders, and Mayans, experienced cycles of growth, overshoot, and collapse as they bumped up against the barrier imposed by finite solar energy.

Then, 200 years ago, humans used their intelligence to discover a new technology that fundamentally changed the rules. Humans learned how to exploit a new source of energy to augment finite sunlight. This energy is ancient buried biomass commonly called fossil energy. Unlike sunlight that is constrained to the real-time flow from the sun, fossil energy accumulated over millions of years and therefore acts as a giant solar energy battery. Now humans could not only exploit current solar energy (e.g. grass) and recent solar energy (e.g. wood) but also ancient solar energy (e.g. coal, oil, natural gas).

Because energy is the master resource that can be used to extract other resources, including more energy, fossil energy created a positive feedback driven 200 year period of explosive population, wealth, and technology growth. With surplus energy available to replace human labor with machines such as tractors and combines, fewer humans were required to work on subsistence activities and more humans could specialize in a wide variety of scientific, engineering, and cultural domains.

Food production was increased through the use of natural gas derived nitrogen fertilizer, oil based pesticides, diesel-powered tractors, combines, and irrigation, and diesel-powered trucks, trains, and ships to deliver it. More food enabled the population to increase from 1 billion to 7 billion. New technologies that used the surplus fossil energy improved the quality of human life such as housing, drinking water, sanitation, medical and dental care, communications, transportation, labor-saving machines, and entertainment. Humans used the surplus fossil energy to make amazing advances in science and technology including traveling to the moon and understanding the origin of life and its respiration, replication, and photosynthesizing chemical reactions, and invented light speed digital networked communications technology to share and discuss this understanding with other members of the species

anywhere on the planet.

Some side effects of the new technologies also reduced the quality of life for some humans. These included health problems caused by pollution and the new abundance of delicious but unhealthy foods such as sugar that were evolutionarily scarce.

Almost all other species, except those cultivated or domesticated by humans, and those that piggyback on the success of humans, like rats, suffered from the success of humans. The rate of species extinction increased to unprecedented levels. Rather than using fossil energy to replace sunlight energy, thereby freeing some energy for other species, humans used fossil energy to add to the solar energy they already commanded, and most wild species declined. Fast and powerful fishing boats capable of scooping and scraping all life from the ocean anywhere on the planet are one of many examples.

> *The purpose of the universe, if it can be said to have a purpose, is to increase entropy. The universe abhors an energy gradient and life is its best invention for degrading energy gradients. Humans are the champions of life at degrading energy, and from this perspective, may be the universe's pinnacle of invention.*

Conflict between tribes is a persistent feature of human history with periods of calm and periods of extreme violence. The inherited denial of reality enables a high level of violence without the temper of empathy because tribes with different gods are viewed as lesser humans. For example, one large civilized tribe exterminated millions of "inferior" humans using gas chambers. Another large civilized tribe routinely kills innocents labeled as terrorists with automated drones to protect sources of fossil energy while telling itself it is spreading democracy.

There are three dark clouds looming over human success.

First, climate change and pollution.

The use of fossil energy releases CO2 into the atmosphere which acts as a blanket to trap solar energy which increases the temperature of the planet. Human released CO2 has already increased the earth's temperature by about 1 degree resulting in many problems including droughts, storms, ice loss, and sea level rise. The CO2 already released by humans guarantees another 1 degree of rise, even if all fossil energy emissions were stopped today. It is now clear that the 2 degree limit agreed by many countries is not a safe target and is in fact very dangerous for civilization. Worse still, probable future human emissions will cause a 4-6 degree rise which raises the possibility of human extinction.

Sea level rise predictions from melting ice on Greenland and the Antarctic increase with each new study. At least a meter of sea level rise by the end of the century is now probable and subsequent predictions are expected to worsen. This is a significant problem because much important land for agriculture and cities is near sea level. There will be heartbreaking refugee migrations, starvation from decreased food production, and loss of capital property this century.

CO2 also acidifies the ocean which harms many species such as shellfish and corals, both of which are in sharp decline. Another large and widely unrecognized problem is that byproducts of fossil energy combustion create ozone which harms plants and trees. There is evidence that trees are in global decline. This should concern humans for many obvious reasons. One not so obvious reason is that planting trees is

one of the few things humans can do that might succeed in removing CO2 from the atmosphere. If trees are being killed by the same activity that puts CO2 in the air then this strategy will not work.

Climate change is a wicked problem. A rising temperature creates other self-reinforcing feedback loops such as ice loss and methane release which act to further increase the temperature. At some point these feedback loops may dominate over human influences thus eliminating any ability for humans to affect the outcome. No one knows for sure, but we may be near or passed this tipping point.

Choosing to act on climate change in a meaningful way will also create new problems. Wealth is proportional to energy consumption. More specifically, $1 US adjusted for inflation to 1990 equals about 10 mW of energy. Over 90% of our energy comes from fossil energy. Therefore any meaningful reduction in CO2 emissions must shrink the economy, and because we have a debt backed fractional reserve monetary system with a large and rising quantity of outstanding debt, a meaningful reduction in CO2 emissions will probably cause an economic depression, at best. Thus a political platform promising to actually do something about climate change is unlikely to be elected, or re-elected.

Furthermore, a decline in economic activity will result in a rapid reduction of aerosols that currently mask some UV radiation resulting in a warming impulse of about 0.5 degrees thus making climate change worse in the short-term.

Second, finite and non-substitutable fossil energy.

The fossil energy that supports 7 billion humans is finite and rapidly depleting. The easy low cost oil is gone. The oil that remains, while substantial, is expensive, and becoming more expensive to find and extract. Each year it takes more energy to produce the same quantity of energy.

The fossil energy that remains is also dirtier and creates more pollution and CO2.

As the cost of energy goes up, the amount of energy society can afford to leverage productivity goes down. Thus productivity and incomes are falling at the same time that the cost of producing energy is increasing. This is the root cause of the worldwide economic problems that began in 2008 and persist today.

The price of energy required for energy companies to produce the quantity of energy necessary to maintain our current standard of living is now higher than society can afford. We have masked this problem with near zero interest rates and a huge increase in debt. These are temporary solutions that will soon be overridden by the laws of thermodynamics and mathematics, and will most likely end with an economic depression more painful than that had we chosen to take our medicine in 2008.

> *Think of a coyote forced, because rabbits are becoming faster, to burn 2 rabbits worth of energy to catch 1 rabbit. Even though there are plenty of rabbits, the coyote is in serious trouble. The coyote could switch his diet to mice (solar & wind energy) but then he'd have to burn 3 mice of energy to catch 1 mouse. The coyote is able to lead a fairly normal life for a while because he burns fat (debt) that he built up in previous good years. The coyote knows it could make do with less food if it quit fighting, played slower games, and had fewer pups, but prefers not to change its lifestyle. Over time, the coyote becomes weak and sick, and then decides to change, but no longer has the strength to catch even mice.*

Any system in nature, including human civilization, is sustainable only if it survives on the interest generated by the capital of the system. For example, bison on prairie is a sustainable system surviving on

the interest generated by sunlight, soil, and rainfall. Replacing the bison and grass with wheat fertilized with natural gas generated nitrogen and irrigated with diesel pumped non-renewable aquifers converts the capital (soil, aquifer, and fossil energy) into income (calories).

Debt at near zero interest rate is a means of converting capital into income. Our recent increase in debt can therefore be viewed as energy that would otherwise have been available to future generations. We are aggressively impoverishing our grandchildren (and other species) in an attempt to maintain our current privileged lifestyles.

Depleting fossil energy is a wicked problem. A law of thermodynamics states that energy cannot be created. The battery we have been relying on is running low and will take millions of years to recharge, and may never recharge unless the planet's biological and geological processes realign in the necessary and fortuitous configuration that created fossil energy the first time.

Renewable energies such as wind and solar do not have the density, scalability, or storability necessary to replace the fossil energy humans currently depend on. Most importantly, we do not have a viable alternative to the diesel that powers our critical life support network of trucks, trains, ships, tractors, combines, and mining machines. If trucks stop running, for any reason, all of civilization will be in immediate and extreme danger.

Renewable energies cannot stand on their own without fossil energy to create, install, and maintain their materials and infrastructure. For example, wind turbines use large quantities of concrete, steel, and copper that cannot be made without fossil energy. Renewables are at best fossil energy extenders. At worst they accelerate economic growth and burn up the remaining fossil energy faster to capture some wind or solar energy with equipment that will wear out in less than 50 years when there will be little or no fossil energy needed to replace the equipment.

Nuclear energy has the required density and scalability but lacks the storability necessary to replace vital diesel discussed above. In addition, current nuclear technologies rely on non-renewable and possibly peaked uranium fuel, plus non-renewable fossil energy for infrastructure, materials, transportation, construction, and maintenance. Future nuclear technologies might address these shortcomings but are many years and trillions of dollars away from deployment. Finally, and perhaps most importantly, the combined threats of climate change, fossil energy depletion, and limits to growth caused economic instability, make it a very dangerous bet that we will be able to properly govern and maintain nuclear facilities in the future.

Third, denial of reality.

Humans succeeded as a species due in large part to their evolved denial of reality. This behavior is now a disadvantage because it prevents the majority of humans from recognizing and acting on climate change and fossil energy depletion. It is noteworthy that there is not one senior leader in any country on any continent that has publicly communicated an understanding of what is going on and what we should be doing at this time, even after leaving office. Likewise, all groups including climate scientists, climate deniers, fossil energy experts, renewable energy experts, environmentalists, capitalists, socialists, communists, conservatives, liberals, Christians, Muslims, Scientologists, you name it, everyone is in denial about human overshoot. This is of course what we should expect given the genetic basis for denial. But it is nevertheless a concern.

The human brain, the God it believes in, and the overshoot it enabled and denies, all resulted from the same improbable genetic adaptation that occurred about 100,000 years ago.

What should we do?

There are no painless solutions to our predicament. The problems are wicked and politically intractable:

- problems are complex and difficult to understand;
- there are no easy or short-term solutions;
- solutions that improve the long-term are likely to worsen the short-term;
- solutions usually conflict with evolved human behavior;
- some problems are out of our control.

We are in a severe state of overshoot which guarantees some form of bottleneck and collapse. Our aim should be to slow the descent and prepare a softer landing zone.

Despite the depletion of fossil energy we still have a lot more surplus energy than is required for subsistence. Remaining surplus energy should be redirected from activities that have no future such as air travel, automobiles, military, and advanced technology; and towards infrastructure and skills that will be required in a simpler low energy world such as local food production, resilient water supplies, and energy conservation.

Policies should be implemented to reduce the population as quickly and humanely as possible. Paraphrasing Albert Bartlett, there is no problem on the planet that does not improve with fewer people.

After the inevitable economic reset, a new monetary system will be required, preferably an energy-backed full-reserve system, as we move into a long-term energy constrained contracting economy. Wealth redistribution and rationing policies should be developed in anticipation of their need.

Citizens should be proactively educated on the root causes of our problems to avoid inappropriate blame and wars which will only worsen the situation by accelerating the depletion of non-renewable resources.

What will we do?

Evolved denial of reality will probably continue to block any constructive discussion or proactive action. When a crisis forces action we will probably blame the wrong actors. Our responses are not likely to be rational or optimal. Expect chaos.

A few people have broken through inherited denial. So it is possible. But scaling this to the majority will be a challenge.

The singular emergence of human intelligence, and its ability to write and read this paragraph, evolved in a gene controlled machine with an unusually powerful computer, that was created by an improbable simultaneous adaptation for an extended theory of mind with denial of reality, and whose complexity was enabled by the increased energy per gene provided by mitochondria, that resulted from an accidental endosymbiosis of two prokaryotes, powered by an unintuitive chemiosmotic proton pump, that originated in an alkaline hydrothermal vent, on 1 of 40 billion planets, in 1 of 100 billion galaxies,

and that planet had an improbable store of photosynthetic and geothermal generated fossil energy, that the species leveraged to understand and appreciate, the peak of what may be possible in the universe, before it vanished, because it denied the consequences of its success.

A good place to go next is Why My Interest in Denial?

Bio

Dr. Tim Morgan
Surplus Energy Economics

#258: Written in the skies

[Published June 17, 2023]

'PEAK OIL' AND THE UNFOLDING INFLEXION

On a glorious summer's day towards the end of the Second World War, a German fighter ace, his squadron grounded for lack of fuel, sat in a deck-chair watching the vapour trails of American bombers write the end of the Third Reich across azure skies.

Metaphorically, a similar message is being sky-written now. According to Goehring & Rozencwajg – who are as good as it gets where energy analysis is concerned – Hubbert's peak is finally here. Only hindsight, of course, can conclusively determine the moment at which "peak oil" became a reality, but G&R are very probably right.

With conventional oil production in decline since 2016, the only source of unconventional supply which remains capable of further increase is the Permian basin, located in six counties in West Texas.

This basin, say G&R, is within a year of its own peak, and we know how rapidly shale production declines once a basin slips onto the down-slope of the 'drilling treadmill'. The rates of decline of individual shale wells tend to be very rapid, and a point inevitably arrives at which operators can no longer drill enough new wells to stop overall output declining.

OPEC claims to have 4 mmb/d of spare production capacity, but this – even if true, which is highly debateable – wouldn't tide us over for long, with demand growing, and other sources of supply in relentless decline.

The peaking and impending decline of oil supply is sky-writing dramatic changes to activities hitherto taken for granted. It's almost impossible to overstate the importance of oil for so many aspects of daily life.

Some examples are obvious, though many others are less so. Unless you believe, for instance, we can replace avgas with recycled cooking-oil, *mass* air travel is finished, not necessarily imminently, but inevitably. Flying may remain an option for the well-to-do, but huge economies of scale will be lost, and industries structured around low-cost flights will be left high and dry.

Much the same applies to motoring, despite the euphoria around EVs. Again, the better off will be able to transition to these, particularly in the world's more prosperous countries. But we don't have enough raw materials (or the energy to extract, process and deliver them) to replace all of the world's 2 billion cars and commercial vehicles with electric alternatives and, even if we did, we'd have to power a large proportion of them with coal.

Technology – do not pass go

This, of course, is where those of a cornucopian persuasion play their supposed trump card, which is technology. The limitless potential of technological innovation is – alongside infinite growth, and the boundless beneficial potential of neoliberal economics – one of the three great myths of the age.

We have indeed taken enormous technological strides over the past two centuries, but that has been possible *because the supply of low-cost energy has always*, hitherto, *been abundant*. **Technologies evolve to suit the energy available to power them**, and the contrary proposition is ludicrous.

The critical issue, so often dismissed or ignored by the high priests of the new and shiny, is that **the capabilities of technology are bounded by the laws of physics**. The fact of the matter is that we can't repeal Betz' Law (which sets the maximum potential efficiency of wind turbines), or set aside the Shockley-Quiesser limit (which does the same for solar power).

With these limits understood, transformational improvements in conversion efficiencies are off the table, leaving us with the hard, costly and resource-intensive heavy slog of building capacity sufficient, not just to replace fossil fuel energy, but to offset intermittency as well.

This is where the term "renewable" ought to be subjected to far more critical examination than it has tended to receive so far. We can't source the plastics required for the renewables sector without hydrocarbon feedstocks. Renewables can't, of themselves, power the extraction, processing and delivery of the vast amounts of concrete, steel, copper, cobalt, lithium and a host of other resources required for the development, maintenance *and eventual replacement* of wind and solar power.

In short, "renewables" would merit that label only if they were capable of renewing – that is to say, *replacing* – themselves over time. This isn't possible now, and there are few reasons to suppose that it will become so in the future.

Any pilot worth his or her licence knows that "Isaac (Newton) is always waiting" if they get something wrong. The starry-eyed visionaries of energy transition need to develop an equivalent awareness of the hard limits of physics.

Investors, incidentally, have their own version of tech mystique, which is the concept of infinite profitable growth vouchsafed by technology. Some of today's technologies, such as online retailing, are of undoubted value, and a sizeable (though niche) future role exists for EVs.

But a large proportion of "tech" relies on a business model mistakenly assumed to be invulnerable to economic change. Huge swathes of "tech" are funded from the twin sources of subscriptions and advertising revenues, both of which are capable of rapid contraction as household discretionary prosperity shrinks, and as businesses endeavour to adapt to a less prosperous world. The 'technology of "tech"' may have moved on, but the business model has not.

A different kind of innovation

Those of us who favour a strong private enterprise component within a mixed economy recognize the stimulus to innovation provided by the competitive pursuit of increased profitability. There is no reason to suppose that innovation will decelerate, let alone cease, in a post-growth economy.

But the emphasis can be expected to shift fundamentally, as businesses seek cost control and resilience through the simplification of product and process, delayering, shortening supply-lines and circumventing 'critical mass risk'. Leadership cadres don't, as yet, have a body of knowledge about the management of contraction – and the necessary learning curve is likely to be steep – but, as ever, the innovative will lead the pack.

The coming decline in oil and broader fossil fuel supply, coupled with continuing cost increases and the lack of full-replacement alternatives, provides significant visibility on future trends. The world's average person

will become gradually less prosperous, a process exacerbated by rises in the real costs of energy-intensive necessities including food, water, housing and essential travel.

The result will be a leveraged contraction in the affordability of *discretionary* (non-essential) products and services. Labour intensity in the economy will reverse its long decline, absorbing workers released by contraction in the discretionary sectors.

To this extent, economic contraction is capable, at least in theory, of happening gradually. The same, though, **cannot be said of the financial system**. If the current financial system was a car, you wouldn't buy it – it has no reverse gear, no brakes worthy of the name, steering that is rudimentary at best, a near-opaque windscreen giving almost no forward visibility, and a tendency to accelerate of its own volition.

As you may know, I believe that we can only seek to understand economic trends effectively if we embrace the concept of "two economies" – a "real economy" of material products and services, and a parallel "financial economy" of money and credit.

From this, it follows that money, having no *intrinsic* worth, commands value **only** as a 'claim' on the goods and services made available by the "real economy". These "claims" exist in two forms – those that we exercise, transactionally, in the present, and those which we set aside for exercise in the future. Measured in relation to material prosperity, the exercise of excessive claims in the present is mediated by inflation, but the real problem resides in a huge excess of monetary 'claims on the future'.

Buy now, crash later

This problem, too, might be arbitraged by inflation, *but only if the inflationary degradation of forward claims isn't cancelled out by the continuing creation of new excess claims to replace them*. The authorities have considerable oversight and regulatory powers where orthodox, deposit-taking banks are concerned, but the locus of the problem has now shifted from conventional banking to the largely unregulated (and even largely unquantified) "shadow credit" sector.

Whenever somebody buys, say, a new refrigerator, a new car or an expensive holiday which he or she cannot afford – and which conventional banks would be unwilling to finance – we see the "shadow credit" system in action. Even if nothing more dramatic happens – and the dramatic is actually a great deal likelier to happen than not – the probability is that the system will be sunk by the unsustainable burden of continuing financial outflows imposed on households by the irresponsible funding of the unaffordable.

We aren't, it should be emphasised, about to 'run out of' oil. Rather, what we face is a comparatively gradual decrease in supply, compounded by a continuing rise in ECoEs (the Energy Costs of Energy). Oil prices are unlikely to give us much in the way of forewarning – they might rise, in response to scarcity, but equally they might fall, driven lower by consumer impoverishment. The decline in oil supply is likely to accelerate, through switching, similar dynamics in other fuels.

It may seem obvious that less oil means less driving and less flying, but the real significance of oil contraction lies in what it means for 'behind the scenes' activities such as food production, petrochemical supply, and the distribution of products and raw materials.

The moment, as well as the implications, of "peak oil" have been debated over decades, and there is no particular practical significance attached to the precise date of its arrival. Moreover, **surplus** oil – that is, supply less its ECoE-cost of delivery – has already turned down, both on an aggregate and a per-capita basis.

But the symbolic meaning of the peak oil “moment” could hardly be more profound.

Bio

Described in the press as “Dr Gloom” and “Terrifying Tim”, Tim Morgan has never avoided controversy, whether he is pointing out the crippling weaknesses of the British economy, calling for greater justice for a younger generation robbed by its elders, or explaining the link between inner-city riots and thwarted materialism. He developed the Essentials Index, which provides invaluable insights into the real cost of living.

Educated at Cambridge, Tim has always been fascinated by economic, political and military issues. His fascination with maritime warfare has taken him from commando exercises to the flight-deck of an aircraft carrier.

As head of research at leading finance house Tullett Prebon from 2009 to 2013, Dr Tim Morgan gained a reputation for supplying radical answers to pressing economic and political issues, and garnered significant media coverage for leading-edge reports including his Project Armageddon study of the British economy.

Since August, 2013, Tim has been publishing his work and thinking through his website where he argues that “...the economy is, first and foremost, a *surplus energy* equation onto which a financial ‘corollary’ or ‘shadow’ economy has been grafted.”

In addition, Tim has developed the energy-based SEEDS economic model (Surplus Energy Economics Data System) that is a powerful tool for the interpretation of critical trends in economics, finance and government–find more about this model here.

Dr. Bill Rees

The human eco-predicament: Overshoot and the population conundrum

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In this article I make the case that *H. sapiens* is not only *not* in control of current events but that there is virtually no possibility that we will gain control over our own species fate as we surge ever deeper into overshoot (climate change is only one symptom). Modern humans are equipped with a paleolithic brain that tends to think in simplistic, mechanistic, immediate, 'cause/effect' terms. Yet we have created a different world of overlapping complex social, technical and ecological subsystems of such mind-bending complexity that no one can really understand its functioning and behaviour, let alone take charge of its evolution. The reality is that fast-paced cultural change, particularly the techno-industrial variety, has so vastly outstripped our biological evolution that *H. sapiens* is no longer adapted to the integrated fast-changing socio-ecological global environment of our own making. To make matters worse, misdirected 'political correctness' makes it difficult even to discuss such primary drivers of the ecocrisis as egregious inequality and overpopulation. Is *H. sapiens* (or at least techno-industrial society) about to be ignominiously 'selected out'?
Place your bets!

Abstract

The human enterprise is in overshoot, depleting essential ecosystems faster than they can regenerate and polluting the ecosphere beyond nature's assimilative capacity. Overshoot is a meta-problem that is the cause of most symptoms of eco-crisis, including climate change, landscape degradation and biodiversity loss. The proximate driver of overshoot is excessive energy and material 'throughput' to serve the global economy. Both rising incomes (consumption) and population growth contribute to the growing human eco-footprint, but increasing throughput due to population growth is the larger factor at the margin. (Egregious and widening inequality is a separate socio-political problem.) Mainstream approaches to alleviating various symptoms of overshoot merely reinforce the *status quo*. This is counter-productive, as overshoot is ultimately a terminal condition. The continuity of civilisation will require a cooperative, planned contraction of both the material economy and human populations, beginning with a personal to civilisational transformation of the fundamental values, beliefs, assumptions and attitudes underpinning neoliberal/capitalist industrial society.

Keywords: overshoot; eco-footprint; carrying capacity; sustainability; population; contraction

1 Introduction: Contrasting approaches to population

My thesis in this paper is that modern techno-industrial (MTI) society is in a state of dangerous ecological overshoot—i.e., that there are too many people consuming and polluting too much on a finite planet. It is not too late, however, to take a lesson in sustainability from the tiny tropical island society of Tikopia. Hardly anyone has ever heard of Tikopia, but its history should be known by everyone who cares about the future of Earth. Tikopia is the remnant of an extinct volcano in the south- west Pacific Ocean with an area of less than five square kilometres, 80% of which is arable. First settled by people about 900 before the Common Era, the island has been occupied continuously for nearly 3000 years (Wikipedia, 2021). Most remarkably, for perhaps two millennia, Tikopians have practiced as many as seven forms of birth control and employed other means of harmonising their life-styles with local ecosystems. In short, *by cultural tradition*, Tikopians have managed continuously to maintain their population in the vicinity of 1200

individuals, or about 300 people per square kilometre of arable land. Even today, islanders explicitly assert that their contraceptive and other regulatory behaviours are practiced to prevent the island from becoming overpopulated (Diamond, 2005).

Contrast Tikopia with the modern global community. Planet Earth is also an island in space with a limited productive land area, but it is threatened by rampant ecological degradation (including accelerating climate change), continuous conflict over habitable territory, evidence of incipient energy and food shortages, and growing numbers of political and ecological refugees who can already be counted in the millions. Nonetheless, there are no national or global plans for population management. On the contrary, those few high-income nations whose populations have stabilised or fallen are worried about the expected negative consequences of this trend for economic growth, political influence and social stability; some world religions explicitly consider contraception to be intrinsically evil; and advocates of population policy are often vilified as being neo-Malthusian, anti-human, eco-fascist or racist (Kopnina and Washington, 2016).[11]1 In short, the 'population question' is still largely a taboo subject in official MTI policy—and even popular—circles. It should therefore be no surprise that in 2022, Earth's population of 7.9 billion people is still growing by more than 1% (80 million people) per year (Worldometer, 2022). Indeed, some authorities suggest that the rate is closer to 90 million per year, and that UN demographers tend to understate population growth for political reasons. According to O'Sullivan (2022), "Where *World Population Prospects 2022* [see UN, 2022] should have been a call to action, it makes an explicit call to inaction".

Against this as background, my aim in this paper is to demonstrate that the present size and continued growth of the human enterprise are anomalies, that population growth is the major contributor to dangerous degradation of the ecosphere at the margin, and that the largest potholes on the road to sustainability are the global spread of consumer life-styles and resistance to family and national population planning.

1.1 The material roots of overshoot

Continuous, rapid population growth is a recent phenomenon. For most of our species' time on Earth—including most of the agricultural era—humanity's natural propensity to expand has been held in check by negative feedback; e.g., by food and other resource shortages, disease and inter-group conflict. Circumstances changed with the scientific/industrial revolution, and particularly with the increasingly widespread use of fossil fuels (FF) abetted by globalisation and trade. *Homo sapiens* had been around for perhaps 250,000 years before our population topped one billion early in the 19th century, but it took only 200 years (1/1250th as much time!) for it to balloon to nearly eight billion by early in the 21st century. While improvements in medicine, public sanitation and population health contributed, it was mainly the consumption of coal, oil and gas that made this spectacular expansion possible (half the FF ever used have been burned since 1990.) Fossil fuels are the energetic means by which humans extract, transport and transform the prodigious quantities of food and other material resources needed to support our burgeoning billions all over the world (Rees, 2020a). In short, science and fossil energy enabled *H. sapiens* to eliminate or reduce historically normal negative feedback and let positive feedback take over. For the first time in human evolutionary history, the scientific and industrial revolutions enabled our species to exhibit its full biological potential for geometric growth on a global scale (Figure 1).

The 1300-fold increase in fossil energy use also drove economic growth. Between 1800 and 2016, Earth experienced a 100-fold increase in real global GDP; i.e., a 13- fold surge in average per capita incomes (25-fold in the richest countries) (Roser, 2019). Material consumption and pollution expanded accordingly.

[11] For a recent example that attacks and misrepresents me and my co-author, see Kaufman (2022).

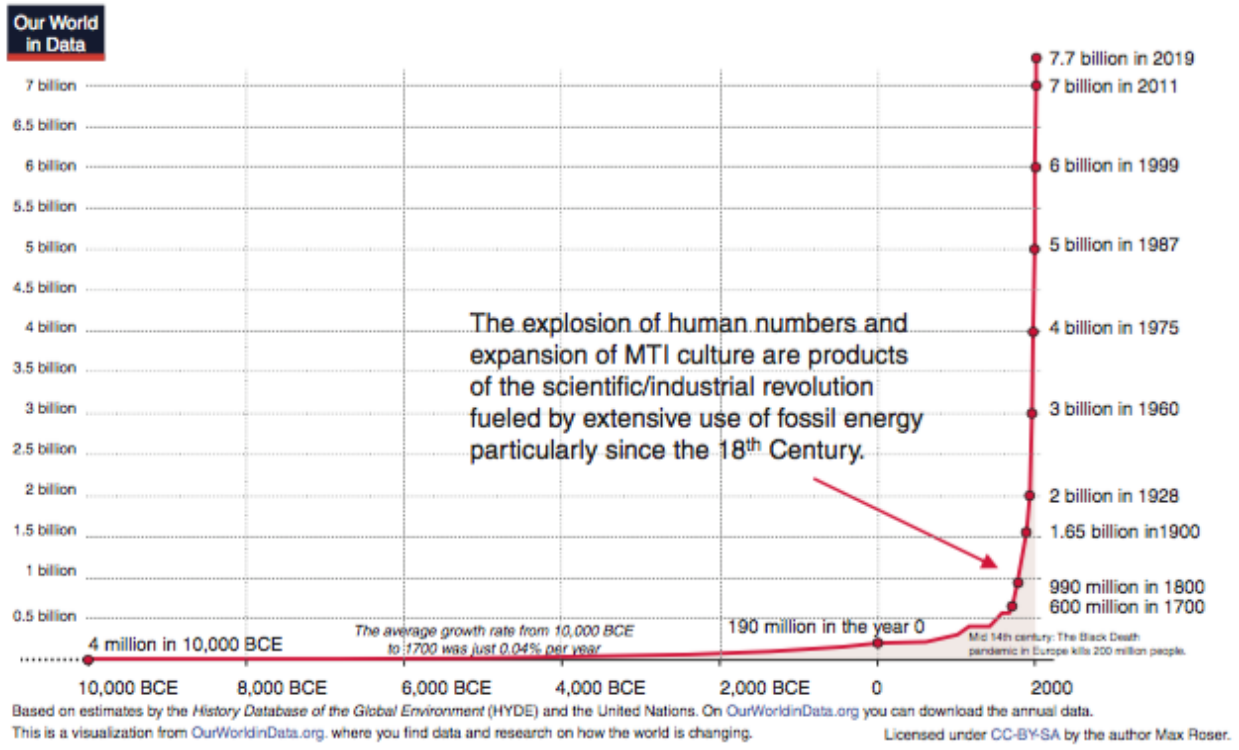
As William Catton wryly observed, the world was being asked to support not only more people, but ecologically larger people (Catton, 1982).

The explosion of the human enterprise is truly an unprecedented phenomenon. A mere glance at Figure 1 should be enough to convince anyone that only the most recent 10 generations of perhaps 10,000 generations of *H. sapiens* have witnessed sufficient global population and economic growth in their lifetimes to even notice such trends. Growth rates that modern techno-industrial society has come to accept as the norm actually define the single most *anomalous* period in human evolutionary history.

Unfortunately, Earth has not become any larger. Thus, the immediate consequence of unconstrained population and economic growth is that *H. sapiens* is well into a state of *ecological overshoot*. Overshoot means that the human enterprise is consuming even renewable resources faster than ecosystems can regenerate them, and is producing more waste than the ecosphere can assimilate. This is the very definition of biophysical unsustainability.

Overshoot is a meta-problem: climate change, ocean acidification, over-fishing, tropical deforestation, plunging biodiversity, soil/land degradation, falling human sperm counts, pollution of everything, etc., are co-symptoms of overshoot. *No major co-symptom can be fully addressed in isolation, but all can be solved by eliminating overshoot.* Mainstream efforts to slow climate change through the adoption of modern renewable energy technologies, for example, will not solve the climate problem, and can only exacerbate overshoot (Seibert and Rees, 2021).

Figure 1:
The growth of human numbers over the past 12,000 years



Source: Adapted from Roser et al. (2019) (CC BY-SA 4.0).

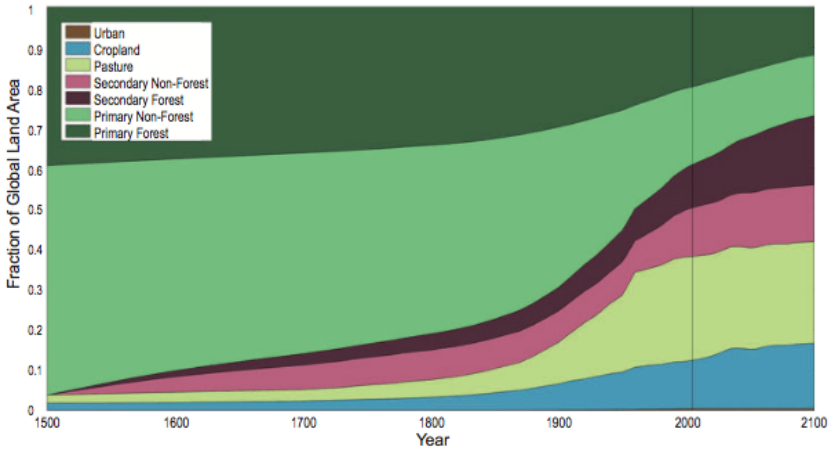
The growing list of so-called 'environmental problems' is empirical evidence that we humans are literally depleting and contaminating the biophysical basis of our own existence. We are the problem. The destruction of essential natural capital erodes the functional integrity of the ecosphere and undermines life-support functions vital to human survival. The long-term costs are incalculable. Ecological economist Herman Daly has suggested that overshoot coincides with uneconomic growth; i.e., with growth that impoverishes rather than enriches (Daly, 2014). Overshoot is ultimately a terminal condition. The acceleration of climate change is merely the most popularised single symptom. (Humans tend to think in simplistic, reductionist terms.)

2 Humanity's competitive displacement of nature

Beginning with the dawn of agriculture (perhaps the most ecologically damaging of human technologies) 10,000 years ago, humans have gradually become the major geological force changing the face of the Earth. Consider alone the human takeover of ecologically productive landscapes and the displacement (or extinction) of non-human vertebrates and other species from their habitats. In the past millennium, about 75% of Earth's land area has been affected by human activity, 50% in just the past 300 years (Figure 2). In the process, up to a third of the world's forests have been permanently converted, mostly to agriculture, which now appropriates about 30% of the land surface. Tens of millions of square kilometres of land have been lost to production or are recovering from degradation (Hurtt et al., 2006, 2011; Ritchie, 2021; Winkler et al., 2021).

The increase in human numbers *on a finite planet* necessarily 'competitively displaces' wild species. Habitats and food sources appropriated by humans are irreversibly unavailable to other life forms. Thus, the massive conversion of productive ecosystems from their natural state to serve ever more people has had a proportionate effect on the distribution of biomass among land-dwelling vertebrate species. *H. sapiens* accounts for only .01% of Earthly biomass, but the conversion of global ecosystems to support human expansion has eliminated 83% of wild animal and 50% of natural plant biomass. Scientists estimate that Palaeolithic humans represented less than 1.0% of mammalian biomass. However, with the agricultural and the more recent industrial revolutions, we now constitute 36%, and our domestic

Figure 2:
Changes in relative distribution of terrestrial ecosystems since 1500 (projection beyond 2000 assumes a low emissions scenario and global warming <2 C◦) Note the rapid acceleration associated with the use of fossil fuels and increasing population in the 19th century



Source: Adapted from Hurtt et al. (2011) (CC BY-NC 2.0).

livestock another 60%, of the planet's (much expanded) mammalian biomass. All wild mammals combined now comprise only 4% of the mammalian total. Nor have birds been spared. Wild populations of many species are in freefall, and domestic poultry now represent 70% of Earth's remaining avian biomass (Bar-On et al., 2018; see also Smil, 2011; OP, 2022).

The story is being repeated at sea. Fossil-powered commercial fishing competes directly with marine birds and mammals for food-fish. Gremillet et al. (2018) report that seabirds suffered a 70% community-level population decline between 1950 and 2010 as their natural food sources were redirected to human consumption. In general, the World Wildlife Fund documents a 68% average decline of monitored birds, amphibians, mammals, fish and reptiles since 1970, which points to a dramatic loss of the health and resilience of ecosystems (WWF, 2020). There is little question that the inexorable increase in human numbers and related resource extraction are the cause. Fowler and Hobbs (2003) found that humanity's technology-aided material demands on exploited ecosystems often dwarf those of competing species by orders of magnitude—in 22 of 31 tests, human demands lie outside the 99% confidence limits of variation among those of dozens of other ecologically similar species, often at the expense of the latter. Bottom line: The growth of human populations and material consumption is driving the 'sixth extinction' (Kolbert, 2014; Shragg, 2022). Fowler and Hobbs (2003) even ask: *Is humanity sustainable*?

3 The population factor in overshoot

We can estimate the extent of overshoot using eco-footprint analysis (EFA). A population's ecological footprint (EF) is defined as: *the area of productive ecosystems required, on a continuous basis, to produce the renewable resources that the population consumes and to assimilate its carbon wastes* (Rees, 2013). In effect, a population EF is the product of average per capita consumption/carbon assimilation multiplied by total population, converted to a corresponding ecosystem area. EFA uniquely enables rough but informative comparisons of humanity's demand on the ecosphere (population EFs) with nature's supply (biocapacity).

We should note that for methodological reasons and due to data limitations, published EFA data generally *underestimate* human demand. For example, while EFA may compile a population's use of arable land, forest, carbon sinks and fishing- grounds, the method cannot reflect whether the appropriated ecosystems are being used sustainably (which they often are not). Nor does EFA account directly for the effects of most forms of pollution.

Even with these limitations, in 2017, the human EF (20.9 billion hectares) was *at least* 73% larger than available biocapacity (12.1 billion productive hectares) (GFN, 2022). The excess of demand over supply represents humanity's *ecological deficit* and provides a rough estimate of overshoot. Any eco-deficit underscores the fact that the maintenance and growth of the human enterprise is being 'financed' not only by the annual production by ecosystems, but also by the liquidation/pollution of the ecosphere. (Climate change is, in part, a pollution problem—carbon dioxide is the greatest single waste product by weight of industrial economies.)

The human EF nearly tripled from ~7.0 billion to 20.9 billion global average productive hectares (gha) between 1960 and 2017 (GFN, 2022). While both rising per capita incomes (consumption) and increasing populations contribute to material growth, we can use EFA to show that the ballooning human EF is caused primarily by swelling populations, particularly in middle-income countries (Figure 3).

We begin by considering high-income nations. Wealth-driven growth in mate- rial consumption has

historically outstripped population growth in wealthy countries to produce per capita EFs averaging ~6.0 gha in 2016. This is 2.2 times the global average of ~2.7 gha in that year. On average, the wealthy demand almost four times their proportional share (1.6 gha/capita) of global biocapacity.

The total eco-footprint of high-income consumers increased by 3.2 billion gha (from 3.6 billion to 6.8 billion) between 1961 and 2016. The 2016 figure equates to 34% of the total human EF and a grossly inequitable 57% of global biocapacity. Because of their elevated consumption and outsized EFs, the addition of just 0.4 billion high-income people (5.4% of world population) added 2.4 billion gha (12%) to the 2016 total human EF. In short, the 54% increase in high-income population since 1961 accounts for ~75% of the 3.2 billion gha increase in high-income consumers' demand on nature (data from the upper-left quadrant of Figure 3)

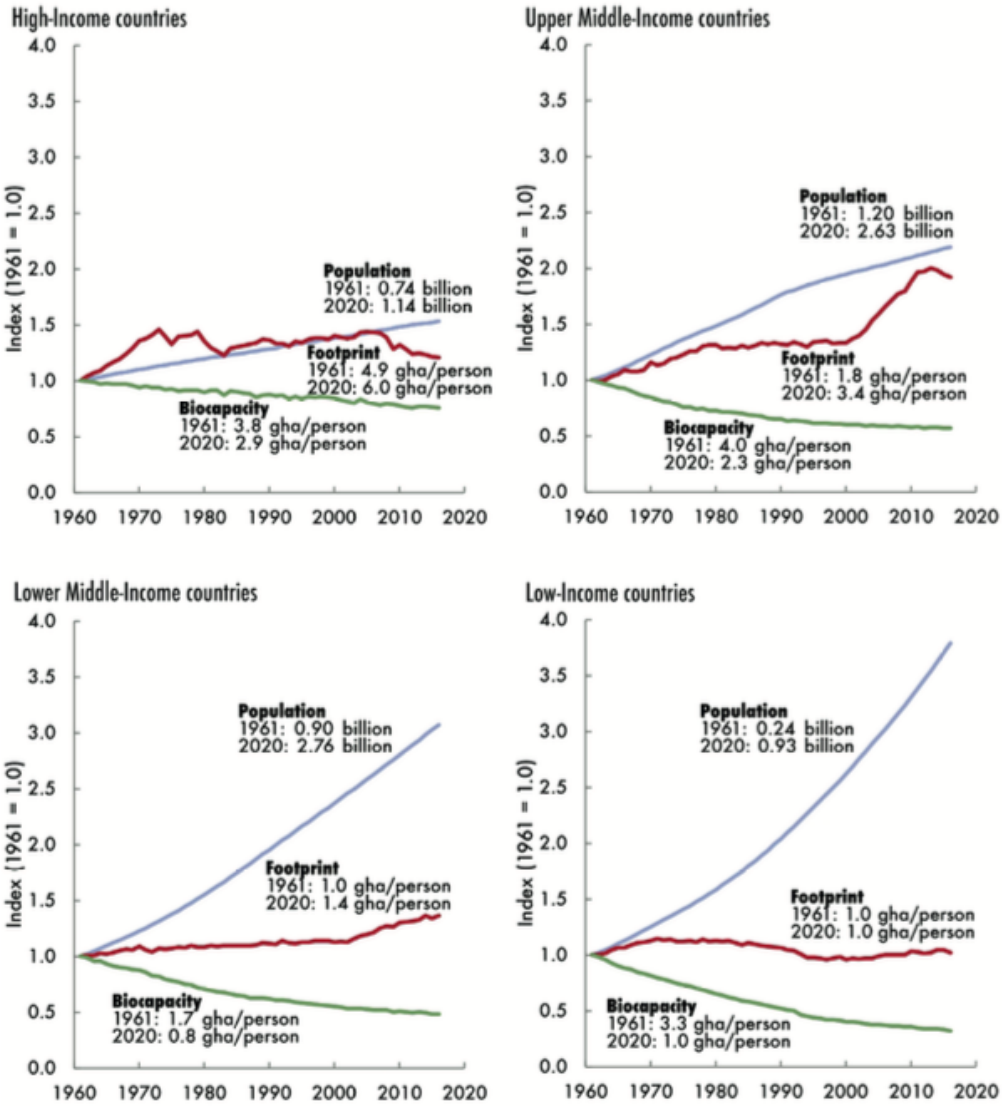
Turning to upper-middle-income countries, per capita EFs nearly doubled to 3.4 gha and the population more than doubled to 2.63 billion between 1961 and 2016, for a >four-fold increase in impact. The total EF of upper-middle-income consumers increased by 6.7 billion gha (from 2.2 to 8.9 billion). The additional 1.43 billion people accounted for 4.9 billion gha, ~73% of the increase and 55% of the upper-middle-income total. This increase alone contributed 24% to the total human EF (Figure 3, upper-right quadrant).

In the lower-middle-income countries, the average EF expanded by only 40% to 1.4 gha between 1961 and 2016, but population increased more than three-fold from 0.9 to 2.76 billion. Lower-middle-income demand on nature increased by 2.96 billion gha (from .90 to 3.86 billion gha), of which the 1.86 billion increase in population accounted for 2.6 billion (88%). This increase added 13% to the total 2016 human eco-footprint (Figure 3, lower-left quadrant).

Finally, low-income countries saw no increase in their average 1.0 gha footprints between 1961 and 2016, while their populations ballooned almost four-fold from 0.24 to 0.93 billion people. The population increase of 0.69 billion neutralised any benefits of GDP growth, but accounted for the entire ~0.69 billion gha increase in the total low-income EF to 0.93 billion gha (still only 4.6% of the global total) (Figure 3, lower-right quadrant).

Summing the above estimates shows that, between 1961 and 2016, the addition of ~4.4 billion human consumers contributed ~10.6 billion gha to the growing consumption-based human eco-footprint. The total EF in 1961 was about 7.0 billion gha, expanding to 20.2 billion gha in 2016, an increase of 13.2 billion gha (GFN, 2022). Thus, *population growth accounted for ~80% of the increase in the total human EF* above what would have accrued had populations remained constant while income/consumption and per capita EFs increased, as shown in Figure 3.

Figure 3:
Ecological footprint, biocapacity and population for high-income, upper middle-income, lower middle income and low income countries, 1961–2016



Source: Reproduced with permission from Wackernagel (2020).

4 What it all means: Population and sustainability on a finite planet

We can draw several lessons from these data. Most important, while over- consumption and population growth have long been recognised as co-drivers of overshoot (Ehrlich and Ehrlich, 2014; Ehrlich and Holdren, 1971), population growth is currently the major contributor to total consumption growth and associated negative ecological impacts in all four income categories. Those who object to serious discussion of the relationship between population growth and the human eco-crisis must confront this reality. That said, it is crucial to recognise that EFs per capita differ greatly among income groups—increasing the popu- lation of an upper-income country by one average citizen imposes *at least* the same ecological load on Earth as a six-person increase in a typical low-income country (remember, EFs, particularly among high-end consumers are generally underestimates).

This fact serves, first, to underscore the egregious, inexcusable, yet still increasing material inequality

between rich and poor people and nations in today's world. Globalisation and unfair terms of trade in world markets enable the citizens of wealthy countries to appropriate legally, by commercial means, several times their equitable share of Earth's biocapacity from other countries and the global commons. Many wealthy importing countries are running large eco-deficits. Figure 3 shows that available biocapacity per capita is declining in all income quadrants. However, remember that 1.14 billion rich consumers (15% of the human population) lay claim to 57% of global biocapacity, and that forms of eco-degradation not captured by EFA (e.g., soil depletion, overfishing, non-carbon pollution, ocean acidification, etc.) are everywhere disproportionately driven by consumers in the richest nations. Since the human enterprise is in overshoot and is rapidly eroding its own ecological foundations, *any effort to achieve sustainability within global carrying capacity must address the fundamental inequities generated by the present world economic order*.

Second, these data show that 'peak population' and subsequent population decline in high-income countries should be cause for celebration. Population growth in the richest nations generates almost an order of magnitude greater demand for biocapac- ity than an equivalent numerical gain in low-income countries. Even greater income disparities are revealed by studies of national 'material footprints'; i.e., the total quantity of raw materials extracted to meet a country's final consumption demands. The per capita 'material footprint' in high-income countries (26.3 tonnes/capita) is more than 13 times the 2.0 tonnes/capita generated by low-income countries (UN, 2019; Wiedmann et al., 2013). Again, it follows that the most *ecologically* significant macro-level gains from policies to reduce populations would come from accelerated population decline among high-income consumers.

But this does not mean we can ignore population growth in middle-income and poor countries. There are both socio-economic and ecological reasons for concerted non-coercive population reduction policies. First, despite the 3.9-fold increase in the total EF (consumption) in the most impoverished countries, the material well- being of the average person in these countries has remained unchanged. Ballooning populations have negated any gains from increased GDP among ordinary citizens. It follows that the most significant *social* benefits from stable populations would accrue at the micro level to the low-income families of poor countries who would enjoy larger slices of the economic pie. At the very least, a falling population would empower the poor by giving them more bargaining power in national labour market.

Second, as was previously emphasised, humanity is already in overshoot and running a massive ecological deficit; the world community is financing aggregate population and economic growth by liquidating essential natural capital. Clearly, mere income/wealth redistribution would not correct this problem.

Nor can eco-deficit financing continue. Like a rocket, the human enterprise can accelerate only to the point that it runs out of fuel, and humanity's fuel gauge is already in the yellow zone of over-fishing, disappearing tropical forests, plunging biodiversity, receding glaciers, falling water tables, degraded soils/landscapes, incipient energy and resource shortages, etc. In particular, there are now fewer than .18 ha/capita of arable land on Earth (Ritchie and Roser, 2019; World Bank, 2022) (which compares poorly with .33 ha/capita on Tikopia, *a ratio that the island's stable population has maintained for centuries*). Population growth only further drains the global tank and shortens the time until the reckoning. Arable land/capita is declining globally, and the productivity of even our remaining .18 ha/capita is dependent on the continued use of dangerously polluting fossil fuel derivatives (pesticides and fertilisers), and on climate-wrecking fossil-powered irrigation, cultivating and harvesting equipment. What is our fall-back if we abandon FF?

In this context, consider the scale of the sustainability challenge. Let's first assume we could at least stabilise world population, Tikopia-like, in the vicinity of 2022's eight billion people. Eight billion is already

~73% too high at the global average eco-footprint of 2.75 gha (2017 data), and with rising incomes/consumption and the spread of consumer culture, everyone is striving to match the six gha ecological footprints of today's average high-income consumers. This is an impossible scenario that would fatally gut the ecosphere. Total demand would exceed 48 billion hectares on a planet with only ~12 billion productive hectares. In short, we would need the bio-capacity equivalent of three additional Earth-like planets to supply the demands of just the present population sustainably. As some wag once remarked, "good planets are hard to find". And, of course, there are no plans to hold the population constant—demographically at least, we're headed toward ~10 billion by 2050, and perhaps 11 billion by century's end.

Alternatively, the present world community might strive to live *within* global carrying capacity—to work toward achieving 'one-planet living'. This would require a reduction in the aggregate human eco-footprint of at least 42%. Assuming we would also choose to capture the benefits of greater equity (Wilkinson and Pickett, 2010), we might begin by redistributing the stock of global biocapacity equally among the human population. (For illustration's sake, we ignore the needs of non-human species.) Based on this criterion, each person alive today would be entitled to 1.5 global average hectares (12 billion ha/8 billion people)—that is, everyone would have to learn to live off the productive output and waste assimilation capacity of just 1.5 gha (~3.8 acres), and *this assumes no further population growth*.

Since the consumer lifestyles of residents in high-income countries demand, on average, the productivity of 6.0 gha/capita, the world's wealthy would have to reduce their eco-footprints by ~75%. While the lifestyle changes implied by this requirement seem impossibly extreme and would be strenuously resisted, this estimate is quite conservative for the methodological reasons previously noted. Indeed, as early as 1993, the Business Council for Sustainable Development reported that: "Industrialised world reductions in material throughput, energy use, and environmental degradation of over 90% will be required by 2040 to meet the needs of a growing world population fairly within the planet's ecological means" (BCSD, 1993, 10). Several recent estimates of necessary rich country reductions fall within the same ballpark (e.g., Bringezu, 2015; IGES, 2019). (These analyses typically fail to explore the need for population reductions.)

On the positive side, global sustainability with justice would mean that citizens of low-income countries would theoretically be able to *increase* their consumption by 50%. Their materially improved life-styles would increase their one gha EFs to the targeted 1.5 gha/capita.

This analysis makes clear that without the equity provision and significant population reductions, the world community could achieve sustainability *only* if its impoverished billions remain poor and the presently wealthy greatly reduce their material consumption.

5 The lesson of population ecology: What goes up will come down

In the real world, of course, the population is still growing and there is zero international interest in sizing the global economy to fit within carrying capacity or to share the world's bounty more equitably.

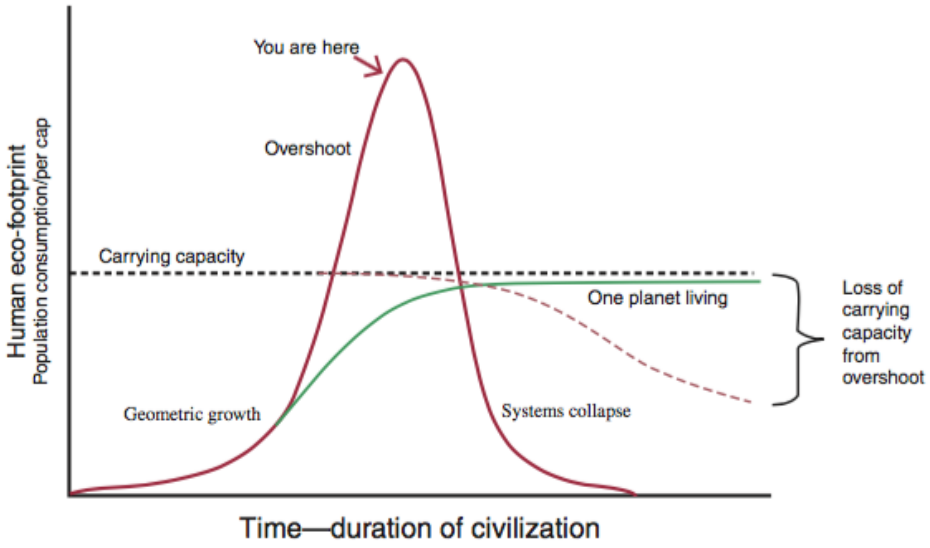
Perhaps this is to be expected. Despite our much-vaunted high intelligence, *H. sapiens* is not primarily a rational species. We tend to be foolishly short-sighted and are prone to selfishness (Pratarelli, 2008); emotions, instinct, cognitive dys- function and acquired habits—often operating beneath consciousness—dominate personal and political behaviour (Damasio, 1994; Wexler, 2006). For example, humans share with all other organisms the inherent propensity to expand to fill all accessible habitats and to use up available resources, but with the major difference being that our technological prowess is

constantly upgrading the resources that are 'accessible' and 'available'. (Even Tikopians eliminated much of their island's original fauna before being forced by their self-created circumstances to control their numbers). To complicate matters, MTI culture's natural propensity to expand (nature) is being reinforced by a neoliberal econo-cultural narrative (nurture) centred on continuous material growth propelled by technological innovation. The result is that, in many respects, humanity's expansion and depletion of Earth are analogous to a bacterium species' colonisation and depletion of nutrient broth in a Petri dish (Rees, 2020a, 2020b).

Human population dynamics are similar to those of non-human species in other ways. All living organisms, when exposed to a temporary abundance of some previously limiting resource, have the capacity to respond with a rapid population outbreak that leads to overshoot. In such cases, the inherent ability to reproduce exponentially (positive feedback) is released from the resource shortage that previously kept it in check (negative feedback). Some species in simple ecosystems exhibit regular cycles of outbreak followed by collapse, with the outbreak sometimes being called the 'plague phase' of the cycle. Whether cyclical or not, population outbreaks invariably end when resources run out or other forms of negative feedback (e.g., disease, predation) emerge and re-establish balance (Rees, 2020b).

There is no reason to think that *H. sapiens* is exempt from this phenomenon. Figure 1 shows the explosive expansion of the human population enabled by public health improvements, and particularly by the extraordinary resource abundance afforded by extensive use of fossil fuels. We are well into overshoot. As was previously emphasised, the sheer size of the human enterprise now threatens its own long-term survival as we deplete various essential biophysical resources and undermine vital life-support services (e.g., the Holocene climate). Meanwhile, poverty is again increasing; epidemic disease is becoming more common; climate change and food shortages portend famine and mass migrations; and political strife and violence, including competition for limited habitable land, is increasing. Indeed, the available evidence supports the hypothesis that modern humans may well be nearing the peak of an unprecedented and likely one-off plague-like global population outbreak affecting virtually the entire planet (Rees, 2020b). Such an outbreak invariably ends in contraction or collapse (Figure 4).

Figure 4:
The one-off human population outbreak



Source: Adapted with permission from Rees (2022).
Note: The human population, at present average levels of consumption, exceeds the carrying capacity of the ecosphere and is well into overshoot, as revealed by eco-footprint analysis and myriad other data (solid red line). However, consumption continues to grow, depleting resource stocks and undermining remaining biocapacity. A truly rational species would have maintained its population below carrying capacity (solid green line), consistent with one-planet living (as on Tikopia). This option is no longer available. As we near peak population, the global community must choose between cooperation to manage a controlled population contraction within the remaining regenerative capacity of the ecosphere (dashed red line) or enduring a violently chaotic systems collapse in which billions will suffer.

The pattern described above and in Figure 4 is consistent with the thesis of various authors that civilisations follow a common, inexorable developmental trajectory from youthful vibrancy and resilience to brittle maturity that is characterised by political corruption, material inequality, failing institutions, ecological decay and, finally, decline or collapse (e.g., Ophuls, 2012; Tainter, 1988). This thesis is also wholly compatible with the business-as-usual or 'standard run' scenario of the (in)famous *Limits to Growth* analysis (Meadows et al., 1972), in which population peaks around mid-century, then rapidly declines (see also Heinberg, 2022; Herring- ton, 2020; Turner, 2008). There seems to be something in human nature and patterns of socio-political organisation that drives societies toward self-destruction. As they grow and complexify, they eventually overshoot the competence of crumbling governance structures and social institutions to cope with cumulative socio-cultural disorder, resource shortages and ecological decay.

6 Conclusion: Can we break the cycle?

Knowing history, must we repeat it? Humanists and other optimists insist that *H. sapiens* has unique qualities that we have arguably yet to exercise fully in addressing overshoot, among them the capacities to reason logically from the evidence and the ability to plan ahead in ways that could dramatically alter future prospects. It helps that in times of stress we are capable of cooperation, compassion and sacrifice, and that we possess a unique appreciation of our own vulnerability and mortality. The scientific evidence tells us *that some form of contraction of the human enterprise is a biophysical necessity if we are to maintain the functional integrity of the ecosphere*. Context and history therefore present us with a choice: either we accept biophysical reality, rise to our full human potential and 'engineer' an orderly way down; or we challenge the evidence and do everything we can to maintain the status quo. The former option would require the world community to plan and execute a dramatic but controlled down-sizing of the human enterprise; the latter option would ultimately force nature to impose its own contraction; humanity would suffer the ugly consequences of a chaotic implosion condemning billions to suffering and death.

6.1 Where we stand

In 2022, the only 'plans' on the official table are two variations on the second option—maintaining the status quo:

Variation 1: Standard 'business-as-usual-as-usual'—This plan calls for the technologically-assisted maintenance of economically extractable supplies of fossil fuels (FF), supplemented by renewable energy, to enable maintenance of the economic status quo at least for several decades, based on the assumption that we can cope with any negative 'feedback' when it occurs. This approach (*which seems to be the default position of governments*) would continue to grow the economy, exacerbate inequity, waste resources, precipitate runaway climate change, gut the ecosphere and undermine crucial life-support functions; i.e., it has a high probability of generating socio-geo-political chaos and the collapse of global civilisation.

Variation 2: 'Business-as-usual-by-alternative-means'—With the ostensible goal of avoiding the worst effects of climate change (but still not acknowledging overshoot), this plan would implement an all-out renewable energy (RE) strategy quantitatively sufficient to maintain current levels of population and material growth, i.e., the status quo. This option, the dream of RE and Green New Deal advocates (but arguably not technically feasible in a climate-friendly time frame) (Seibert and Rees, 2021), would not really halt climate change, and would otherwise generate the same negative social and ecological impacts as Scenario 1a; i.e., socio-geo-political chaos and the collapse of global society.

Both variations suggest that humanity's techno-hubris is exceeded only by collective denial and ignorance of systems behaviour.

The as-yet-unacceptable alternative—acknowledging overshoot and recognising that a major reduction of both population and economic throughput (consumption and pollution) is the only way to eliminate it—is barely beginning to take form. Vic- tor (2019), for example, explores realistic possibilities of living without economic growth; and the degrowth movement contemplates simpler, localised lifestyles, much reduced production and consumption, and greater social equality—but not reduced populations (see R&D, 2022).

But full realisation of the controlled contraction option requires a deeper dive beginning with a personal and cultural—indeed, 'civilisational'—transformation of the fundamental values, beliefs, assumptions and attitudes that underpin neolib- eral/capitalist industrial (MTI) society. Crucially, the new cultural narrative must acknowledge that the human enterprise is a fully dependent subsystem of the non-growing ecosphere that we ourselves are destroying. This, in turn, demands a shift from the prevailing obsession with material growth (quantitative increase) and technological efficiency towards true development (qualitative betterment, such as improvements in nature reserves, public facilities, health care, education, opportunities for personal development, etc.) and greater equity, but all on a much- reduced scale. The world must also formally acknowledge that (un)sustainability is a collective problem requiring collective solutions; the present individualistic competitive race to mutual destruction must give way to unprecedented international cooperation in developing an inclusive survival plan.

In short, the continuity of civilisation requires a cooperative, planned major contraction of both the material economy and human populations. The overall goal must be to establish and maintain the necessary conditions for a smaller human family (one to two billion people) to enjoy both economic and ecological security through 'one-planet living'. Rees (2020a) provides examples of policy directions consistent with this change of course. People will learn to thrive on less and live more justly in a 'steady-state' relationship with nature (see Daly, 1991), well within the remaining regenerative and assimilative capacities of the ecosphere (see Figure 4). Can there possibly be a more riveting intellectual and practical challenge?

Of course, not all problems are solvable at a global scale. To be brutally clear- eyed, the prospect that our increasingly fractious world community will happily collaborate to achieve the one-planet goal is hardly the brightest star in the constellation of possible human futures. Failure would indeed be tragic—if the world's nations cannot come together to fully engage their common fate, humanity proclaims itself to have no more practical intelligence or conscious moral agency when it comes to its own inclusive survival than does any other species in overshoot at the brink of collapse.

Thankfully there is always some good news—having long since learned 'the way', Tikopean society, at least, might well continue to thrive for another three millennia, regardless of what happens elsewhere.

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Bio

William Rees is a population ecologist, ecological economist, Professor Emeritus and former Director of the University of British Columbia's School of Community and Regional Planning in Vancouver, Canada. He researches the implications of global ecological trends for the longevity of civilization, with special foci on urban (un)sustainability and cultural/cognitive barriers to rational public policy. Prof Rees is best known as the originator and co-developer with his former student, Dr Mathis Wackernagel of 'ecological footprint analysis' (EFA), a quantitative tool that estimates human demands on ecosystems and the extent to which humanity is in 'ecological overshoot.' He has authored hundreds of peer reviewed and popular articles on these and related topics. Dr Rees is a founding member and former President of the Canadian Society for Ecological Economics; a founding Director of the One Earth Living Initiative (https://www.oneearthliving.org/); a Fellow of the Post-Carbon Institute and an Associate Fellow of the Great Transition Initiative. Internationally recognized, Prof Rees was elected to the Royal Society of Canada in 2006; received both the international Boulding Memorial Prize in Ecological Economics and a Blue Planet Prize (jointly with Dr Mathis Wackernagel) in 2012; the Herman Daly Award (in ecological economics) in 2015 and the Dean's Medal of Distinction (UBC Faculty of Applied Science) in 2016. He was a full member of the Club of Rome from 2014-2019.

Mike Stasse
Damn the Matrix

Turning marginal land into fertile soil

[Published January 20, 2018]

Since having my soil epiphany brought on from doing the NRM Small Farm Planning Course, I have been arguing with people who keep banging on about how we have to abandon meat eating to 'save the planet'….. I disagree. It's just another silver bullet, as far as I am concerned, and they simply don't exist……. sure, most people might eat too much meat, but for anyone to tell me that marginal land can be turned into crop land, and easily at that, just riles me up…… they obviously have no idea what they're talking about, nor do they have any experience at doing this.

As I have said before, it took me ten years at my last project to convert that marginal land into something capable of feeding two to three people. Making compost by hand, even when using your own humanure, takes years. And while you are waiting for the soil to improve, you have to buy food from some unsustainable source or other….

From where I sit, we probably have a couple of years of relatively 'normal' times left.

Matt smoothing out the terrain.

2020 is when things will get suddenly worse, never to improve again. Even if I'm out by as much as five years, it makes no difference at all. The scale of the problem we face is totally out of control.

My current wwoofer, a vegetarian Frenchman who eats non stop (I liken it to livestock eating all day long because grass is useless food…) believes likewise. Even though I am teaching him the hard way how much work is involved!

Unloading another tonne and a quarter of compost.

When Glenda was still here, I took her to Hobart to pick up a load of compost (about 1250kg, they are very generous cubic metres down there!) and on the way back, I suspect, the thermostat started playing up making ute I overheat on the big hills between here and there…. I could not even get my market garden close to finished without fossil fuels. Certainly in the time constraint I am feeling every day, as I get older, and 2020 gets closer as the clock ticks away….

I even had to get my neighbour to come back with the excavator to level off the soil we moved at the last Permablitz last year. There's no way my back would have handled doing it by hand with a shovel. As I keep saying…… the power of fossil fuels.

Adding sheep manure.

The soil on the second half of the garden, without the advantage of all that black stuff full of decomposed cow manure we scraped off the drive 18 months ago, was even more marginal than what I started with on the first half. I'll have to get another four loads – five tonnes – to finish the middle section that still needs doing. Plus I will have to drive god knows how far to get another tonne of Calcium rock to amend the pH of the soil to something veggies will grow in…….

To be sure, the feeding of grain to livestock is pure madness and only done to maximise profits. The meat derived therefrom is not even healthy, as it's full of Omega 6 fatty acids that cause chronic inflammation. Is it any wonder so many people are sick with diets like that which all the shops supply to unsuspecting consumers……

Tilling it all in with chickens and the rotary hoe.

George Monbiot's latest effort is what got me started on this – even though I feel the need to chronicle the improvements happening on the Fanny farm. Monbiot writes:

When we feed animals on crops, we greatly reduce the number of people that an area of cropland can support. This is because, on average, around two-thirds of the food value of the crops fed to livestock is lost in conversion from plant to animal.

Of course he's right…. we should *not* be feeding crops to animals that are perfectly happy to eat grass! The problem is industrial agriculture, not meat eating. And he's wrong calling his article "Eating the Earth", because what we are in fact doing, is eating fossil fuels, and that's not even close to the same predicament.

And finally, here's a short video of what two of my neighbours have achieved after attending the above mentioned Small Farm Planning course.

[More soil building on the Fanny Farm]
[Published January 26, 2018]

I always try to source my materials as close to home as possible, and sometimes that can be frustrating…….! My ever so knowledgeable neighbour told me some months ago that Dolomite was locally available, and dirt cheap at that. Of course, he has about seven times as much land as I do, and when he buys some, he gets, well… seven times as much as I need.. and it comes by truck of course, and all I wanted was one ute load. So I rang the guy who runs this enterprise, and the dolomite saga began…

When I first rang him, it was "next Monday". Luckily I rang first, and I got "sorry, there's no one there today, but on Wednesday…" Sounds like Tasmania all over.

Anyhow, I eventually got my Dolomite. The depot is inside Ta An's 'sustainable' plywood factory (!) whose trucks drive past my shed at least four or five times a day, and who knows how many during the night. The place never seems to stop with logging trucks going *in* the forest, as well as *out*. Don't ask, I don't know, and it could only occur in Tassie!

I had been on that road once before with Glenda many years ago while we were still investigating which part of the Huon we might choose. We only had a tourist map, and we somehow got lost in among the forestry roads that criss-cross this logging area, and they weren't on the tourist map, and I still didn't have a GPS. We eventually saw signs pointing to Geeveston, and at least I knew where that was! We even drove right past this place, not realising of course that one day we'd own it…. The poor little hire car took a pounding on the

incredibly rough roads, the sort that shake the fillings from your teeth. So I knew what I was in for, except that an unloaded ute with 65psi in its tyres was even worse….

3m high mountain of Dolomite.

I eventually found the mountain of Dolomite waiting for me, and the biggest front end loader I've ever seen, designed to fill trucks for Matt's place, not a one ton ute! The machine has a weighing facility, so the operator knew how much he was serving me, and I got 1400kg for fifty bucks…… which in the shops might buy three or four 20kg bags. Let me tell you, I'm getting my money's worth out of those old utes…

Ouch…!

Rather than going back the same way with a now overloaded ute (they're only rated 1300kg max) I opted to do the loop back through Huonville which is farther, but with way less than half the distance of rough gravel road. By the time I got home, I had less than 1400kg anyway, because even at just 60 km/h, I was donating acid rectification material to the whole Huon Valley as it flew out the back..! It's just like flour in texture, and any wind will blow it away. Nonetheless, the car still looked way down on its haunches by the time I had it parked in the middle of the next half of the market garden.

My wwoofer Nathan and I spread the entire load over the area to be worked, and now it just needs more compost to be worked in to finish the job, if the job ever gets finished….

Dolomite is an anhydrous carbonate mineral composed of calcium magnesium carbonate, ideally $CaMg(CO_3)_2$. It's used to modify the pH of acidic soils like we have everywhere (mostly) throughout Australia, but here in particular. It's why apples and cherries do so well here, they love acid soils, as do most berries like strawberries, blueberries and blackberries. The problem with acid soils is that they dissolve the nutrients you want in your veggies, and until you rectify the pH back to normal, adding those nutrients is a waste of effort…… but we'll get there.

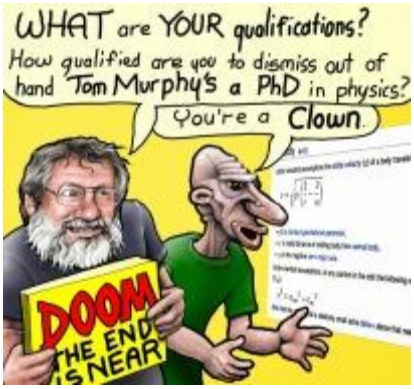
Rome wasn't built in one day, and neither was the Fanny farm.

My new pump in action, watering in preparation for the three day heat wave about to hit Tasmania.

Bio

Ever see those BBC shows about Grumpy Old Men? I'm one of them! The world's unravelling, and what's everybody doing about it? They're going shopping.

In previous lives I trained as a civil engineering draftsman, ran a very successful photographic studio for fifteen years, attempted (and failed…) to become a professional greenie after retraining in Renewable Energy Technology, eventually turning to full time stay at home fatherhood.



I spent eleven years designing and building a sustainable settlement for me and my family. We've won a sustainability award for our house in 2007, a 'Glossy' handed out by Livingsmart Noosa. Our aim is to be self-sufficient, so we can tell the Matrix to get stuffed.

We were maybe 50% of the way there in Queensland, but now……..

It's a big job abandoning the Matrix and all its failings when it's got you by the short and curlies…..

Being a glutton for punishment, I've now moved to Tasmania in a vain attempt to escape from Climate Change. There's no escape I now realise… Tassie gets weather just as weird as everywhere else, but at least it *is* cooler. But I've done it all over again, building another house from scratch and setting up food systems in the ever looming face of peak oil and economic collapse, happening as you read this….

Today, I have lost faith in humanity. Greed rules, and it will bring us down.

> **"If you go into battle hoping to live, you will surely die, if you go into battle expecting to die, you might live."**

Tim Watkins

The Consciousness of Sheep

The narrative problem after peak oil

[Published November 6, 2020]

Photo Credit: Gary Denham

In the 1970s, the developed states were shaken by oil shortages. Although largely artificial – the result of OPEC flexing its muscles, and later the Iran-Iraq war – the oil shocks briefly caused people to take seriously the prospect of running out of oil. The shock was all the more profound because, with the earlier exception of the USA, all of the developed states had completed the transition of their economies from coal to oil during the unprecedented boom years 1953-1973. In Britain, for example, the national coal-powered rail network which might have mitigated the impact of the oil shocks had it followed Europe and been electrified was savagely cut in 1963. Instead, Britain followed America's lead; building a new network of three-lane motorways and building a massive fleet of freight lorries to replace much of the rail freight.

The switch from coal to oil had primarily been driven by the huge value provided by both the additional energy-density of oil and by the storage and transportation benefits of liquid fuels. Unspoken though, was the assumption that oil reserves would – for all practical purposes – be infinite. If one oil field ran dry, geologists would find another while engineers provided the means to extract it.

This *appeared* to be the story of the 1970s too. Yes, the economies of the developed states took an inflationary hit. But the increased cost of oil paved the way for new deposits in Alaska, the North Sea and the Gulf of Mexico to be opened up. And while prices never quite fell back to their pre-1970s level, they fell sufficiently by the mid-1980s to allow a new round of economic expansion to begin.

In 1956, though, a geologist working for the Shell oil company published a report which showed, among other things, that the process of discovering, drilling and extracting an oil deposit took approximately four decades. It followed that if we calculate the point at which the maximum quantity of oil within a country is discovered, then we can expect that its rate of extraction will begin to decline four decades later. This, he argued, was a particular problem for the USA, whose peak of oil discovery was in 1930. This suggested that the USA's production peak would be reached sometime around 1970.

Although in 1970 the media mocked the prediction, this is precisely what happened; and it precipitated the oil shocks of the 1970s. But what happened is not what the proponents of "peak oil theory" said would happen. In large part, this is because the early peak oilers were geologists and engineers. And like so many modern scientists, once they had discovered that economists are – with a few notable exceptions – complete imbeciles, they wrongly concluded that the economy doesn't matter… or at least, that the economy would simply adjust to the new situation.

The geology of US oil might have been straightforward; the economics was a little trickier. In the course of the Second World War, the USA supplied six out of every seven barrels of oil consumed. Venezuela accounted for most of the seventh barrel; with small contributions from British Persia and the Soviet Caucasus. Germany's oil sources had been inadequate to power its civilian economy; and its failure to capture *and bring online* the Caucasus oil in 1942 is the primary reason why it lost the war.

The war-torn economies which emerged from the ashes of war in 1945, then, were almost entirely dependent upon oil from the USA. And this allowed an internal American oil cartel – the Texas Railroad Commission – to extend its price fixing to the entire world. So long as US oil made up a large part of global oil production, and so long as US oil fields had excess capacity, the TRC could regulate the global oil price. If prices began to rise too high, the TRC would order companies to produce more oil. If prices sank too low, the TRC would order production cuts. As a result, throughout the boom years 1953 to 1973, the world oil price remained stable at around $25 per barrel (at today's prices).

When the US *conventional* oil fields peaked in 1970, the TRC lost its ability to prevent prices from rising by expanding production. This was a boon for Middle East and North African producers whose production costs were higher than those in the USA. And although the first – 1973 – oil shock was in part a response to western support for Israel in the Arab-Israeli war, sooner or later the newly empowered OPEC was going to cut supply to drive up prices.

It is an irony that a capitalist system which claims to be built upon competition and free markets has proved stable only in those periods when its source of value – energy – has been controlled by cartels. Once OPEC-led price stability was regained in the mid-1980s, the stage was set for the global debt-boom of the 1990s and early 2000s. And with the fall of the Soviet Union and the apparent conversion of China to state capitalism, for a brief moment the world seemed content.

Peak oil had not, though, gone away; it had merely been postponed. Britain discovered this the hard way after its North Sea deposits – which had once produced more oil than Kuwait – peaked in 1999. By 2005 – the year global *conventional* oil extraction peaked – Britain had become a net importer of oil and gas. Today, Britain's North Sea deposits produce 60 percent less oil than in 1999; and the projected price of the remaining oil is not enough to cover the decommissioning costs.

By 2005 though, had we but known it at the time, we had bigger problems to deal with. The experience of the oil shocks of the 1970s convinced many peak oilers that once the peak of global oil extraction had been reached, prices would rise remorselessly as a consequence of supply and demand imbalance. This, indeed, is what *appeared* to happen after the 2005 peak was reached.

Inflation adjusted WTI price 2000 to 2020

By 2012, Michael Kumhof and Dirk V Muir from the International Monetary Fund were anticipating global oil prices of more than $200 per barrel by 2020. But that isn't what happened. Instead, from 2014 the oil price slumped and has been on a steadily downward trend ever since. The reason is because there is more to peak oil than geology and engineering.

Indeed, many peak oilers make the same mistake as economists in treating oil – and energy in general – as being just another relatively low-cost factor of production. The wage bill, for example, is always far higher than the energy costs of running a business. But as economist Steve Keen explains; "capital without energy is a statue, labour without energy is a corpse." Or as engineering professor Jean-Marc Jancovici explains: "energy is what quantifies change." Nothing happens in the world without energy. And when the cost of the world's biggest primary energy source – oil – begins to spike upward, the impacts are felt in every area of our lives.

The story of the 2008 crash is usually told in financial terms; and is used to blame the victims. The cause of the crisis, we are told, was so-called sub-prime borrowers taking on mortgages that they couldn't possibly pay back. Except, of course, prior to 2008 they *had* been paying them back. So what happened to change their circumstances so that they could no longer repay debts? The answer is interest rate rises. The banks had based their lending on the assumption that the economy was stable; that inflation would grow at around two percent; and that interest rates would remain relatively low. With house prices supposedly guaranteed to keep rising, and having securitised the risks, banks – with the assistance of governments – could extend home ownership to the masses. But from 2006, central banks had been raising interest rates; tipping borrowers into default.

Why had the central banks been raising interest rates? Because from 2005, inflation began to break out of the 1 to 3 percent band that they were charged with maintaining. According to all of the textbooks they had been brought up on, the central bankers had been taught that the way to bring inflation back under control was to raise interest rates. But they – and the economics textbooks – were wrong. What they believed to be inflation – too much currency chasing too few goods – was actually an economy adjusting to its first supply-side shock since the 1970s.

This is not an obvious distinction, because to most ordinary people the result of both demand-side and supply-side shocks is the same; rising prices. But the cause of a demand-side shock is merely that too much currency is circulating (or is flowing at the wrong velocity) to remain in balance with the real economy. Most often when governments and banks create more currency than there is economic activity to absorb it. In such circumstances, consumers seek to spend the excess currency and cause prices to rise. By raising interest rates, the currency supply can be cut and prices brought down. In a supply-side shock, in contrast, the stock of currency remains stable while some factor of production runs short; forcing up the price of everything that depends upon it. When this occurs, raising interest rates cannot solve the problem because the shortage persists irrespective of how much currency is in circulation.

The 2005 supply side shock was particularly profound because it impacted our primary energy source – oil. Look around your home and you will be hard pressed to find a single thing which was not made from oil; constructed using machinery powered with oil; or transported on vehicles that run on oil. The same is true for every household and business in the developed world. So that when the price of oil increases so, too, does the price of everything else. And the solution to it is not to raise interest rates, but to let the economy adjust to the new conditions. As Frank Shostak from the Mises Institute explains:

> *"If the price of oil goes up and if people continue to use the same amount of oil as before then this means that people are now forced to allocate more money for oil. If people's money stock remains unchanged then this means that less money is available for other goods and services, all other things being equal. This of course implies that the average price of other goods and services must come off.*
>
> *"Note that the overall money spent on goods does not change. Only the composition of spending has altered here, with more on oil and less on other goods. Hence, the average price of goods or money per unit of good remains unchanged."*

In putting up interest rates in the face of a supply-side shock that they did not understand, the central bankers set off the chain of events that caused the entire global banking and financial system to unravel. The correct – but painful – play would have been to allow the peak oil shock to work its way through the economy. The result would have been a dramatic shift away from discretionary consumption as businesses and households were obliged to spend more on essentials like food, utilities, housing/rental and, of course, energy. After all, that is where we eventually ended up… only with the added cost of bailing out and more or less permanently having to underwrite the financial system.

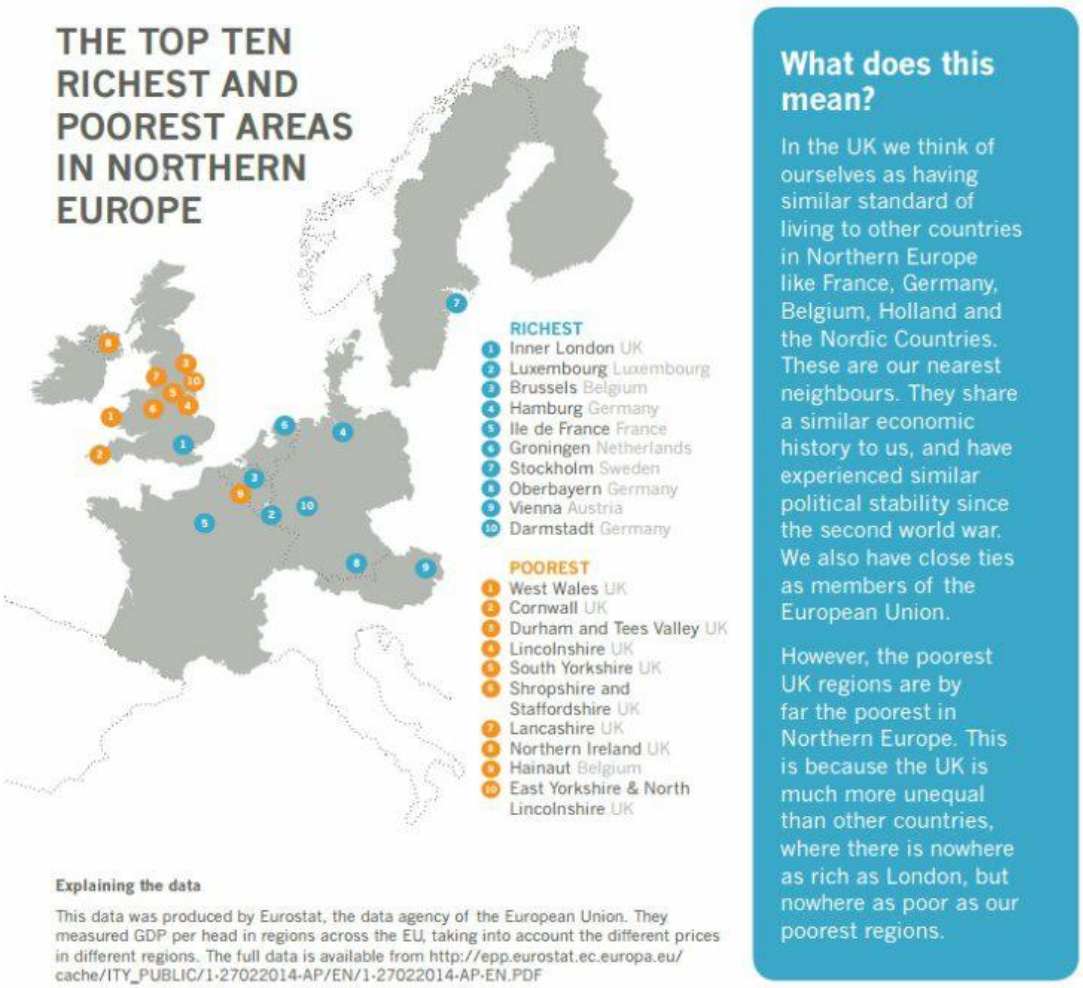
Globally, what anaemic economic growth there was in the aftermath of the crash was the result of massive – and ultimately unsustainable – debt. As Tim Morgan explains:

> *"Over the period between 1999 and 2019, World economic output … averaged 3.2%, for a total increase*
> *of 95%, or $64.5 trillion. During this same period, however, annual borrowing, expressed as a*

percentage of GDP, averaged 9.6%, with total debt expanding by $193tn, or 177%, between 1999 ($109tn) and 2019 ($302tn).

"Another way of putting this is that each dollar of reported 'growth' was accompanied by $3 of net new debt. Even this comparison understates the gravity of the situation, in that it does not include huge increases in pension and other commitments over two decades, with the overall situation worsening markedly after the 2008 global financial crisis (GFC)."

In the UK, the average wage (not including bonuses) was the same in 2019 as it had been in 2010. Over the same period, household spending has shifted dramatically toward non-discretionary items; fuelling the retail apocalypse that was already decimating retailing prior to the arrival of SARS-CoV-2. The impact though, was experienced differently according to class and location. The UK contains both the richest and nine of the ten poorest regions in Northern Europe:



The metropolitan middle classes living in London and the archipelago of top-tier university towns continued to enjoy rising prosperity throughout the period. Meanwhile, large swathes of ex-industrial, rundown seaside and small town rural Britain experienced declining standards of living. But since the

establishment media, the permanent government and the various lobby groups are staffed by the metropolitan middle classes, little thought was given to the needs of the majority whose living standards and future prospects were being crushed. This, more than any other reason, is why Brexit happened in 2016.

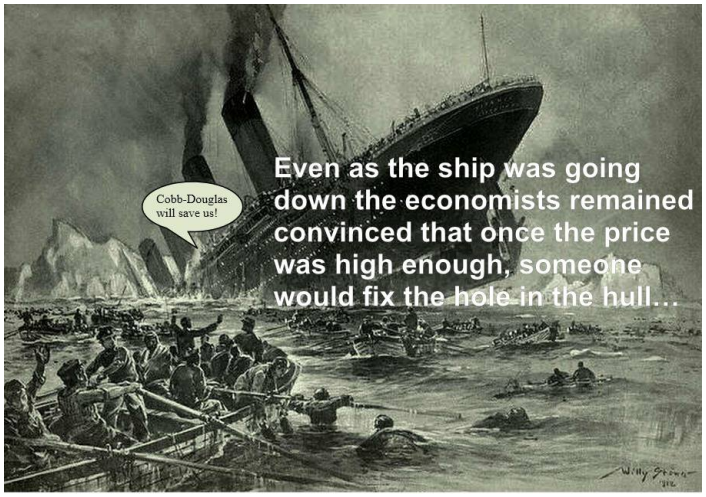
The other key distortion which followed from the central bank response to the 2008 crash is that investment income plummeted. Prior to peak conventional oil, interest rates were running at around 4.5%. In response to the oil shock they rose above 6%. But after the crash they fell to less than 1%. And despite periodic reassurances that rates would be going up soon, only the US Federal reserve never did raise rates; and the impact was so bad that they very quickly cut them again.

Historically low interest rates have unquestionably kept millions of "zombie" businesses and households on life support. At the same time, they have crushed the incomes of institutional investors like pension and insurance funds which need returns above 5% (and some more than 8%) to meet their obligations. An unforeseen consequence of this is that the years after 2008 saw a "search for yield" in which investors became far more amenable to purchasing so-called "junk bonds." And one industry which reaped the benefit of this trend was US hydraulic fracturing.

Unconventional – i.e. expensive and difficult – oil from the US shale plays and Canadian and Venezuelan bitumen sands was only economically viable because investors were prepared to spend billions of dollars producing millions of dollars' worth of oil and gas. But although it was economically unviable in the long-term, in the course of the last decade it drove global oil extraction to new highs.

The myth of "Saudi America" and the "century of energy independence" was born. But more sober analysts pointed out that fracking wells have a nasty habit of depleting by 90 percent in just three years. This dictated a kind of "red queen syndrome" in which the frackers have to drill more and more wells just to keep the oil flowing. Far from a century of oil and gas, the frackers would be lucky to continue for more than a decade.

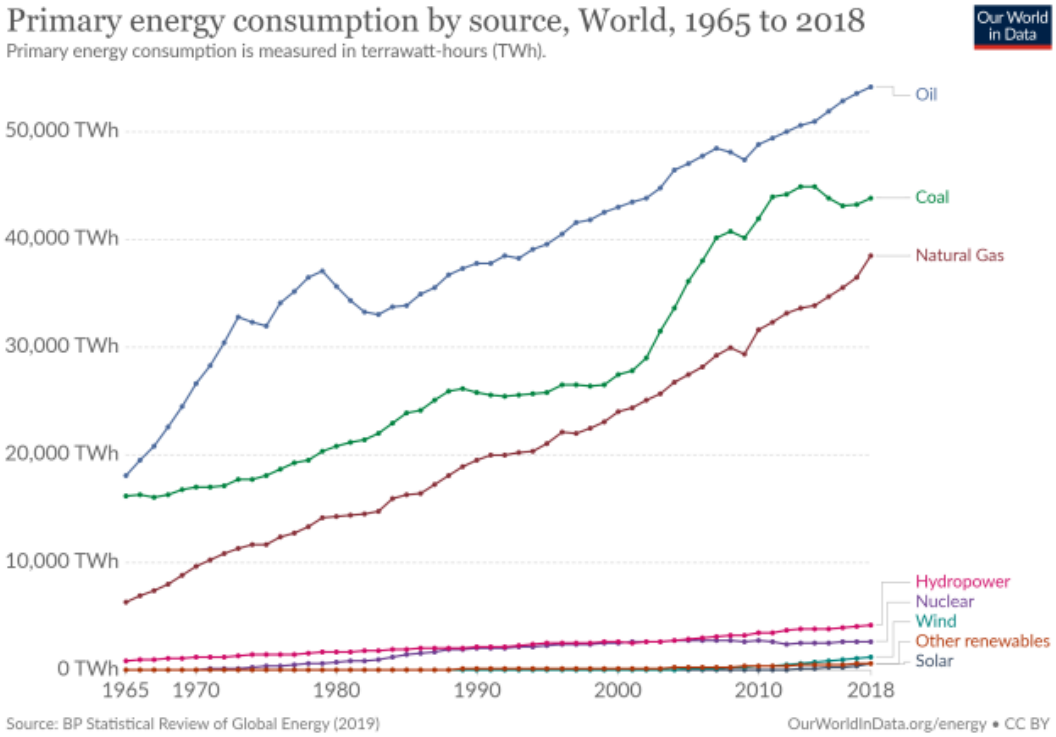
But for all of the irrationality behind fracking, it effectively silenced concerns about peak oil. The very existence of fracking and tar sands seemed to confirm the economists' myth of infinite substitutability – that whenever a resource runs out, price increases will lead to an alternative being developed:



For most of the last decade, we have been sold a techno-utopian fairy tale about "peak oil demand." Instead of "running out" of oil, the problem for the oil industry, we were told, was that the switch to "clean energy" and to technologies like electric cars and hydrogen-powered buses meant that *demand* for oil was declining. Within a decade or so, they claimed, our need for oil would disappear entirely as we ushered in a "fourth industrial revolution" based around digital products and services powered by renewable energy.

As with all narratives, there is just enough truth in this story to give it a veneer of credibility. *Per capita* demand for oil – and, indeed, for fossil fuels generally – has been declining. So that if you are a middle class metropolitan liberal – the kind of people who edit and write for the establishment media – you look around and notice your friends driving electric cars; you uncritically swallow the press statements of the windfarm owners; and you observe the declining *per capita* consumption of oil; and you tell yourself that this is peak oil demand in action.

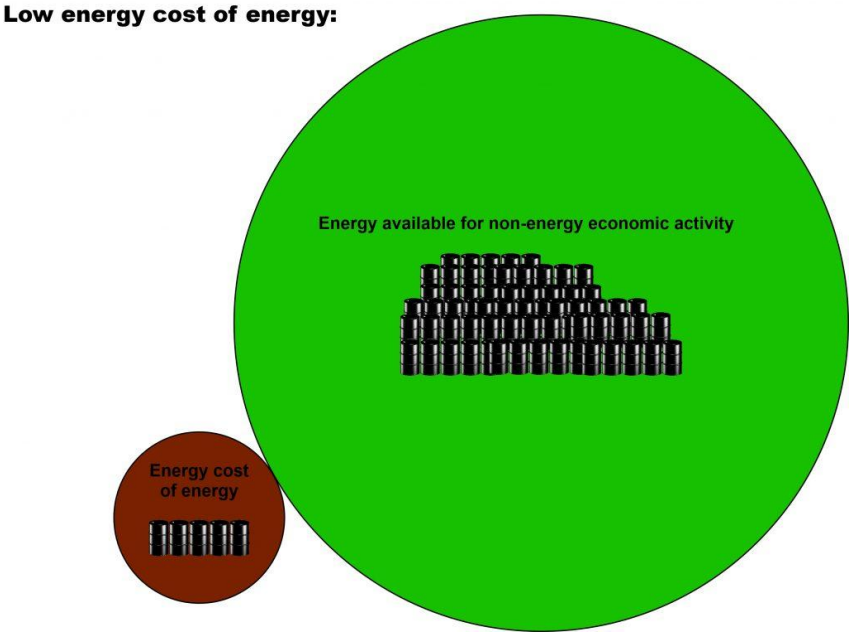
The data says something very different:



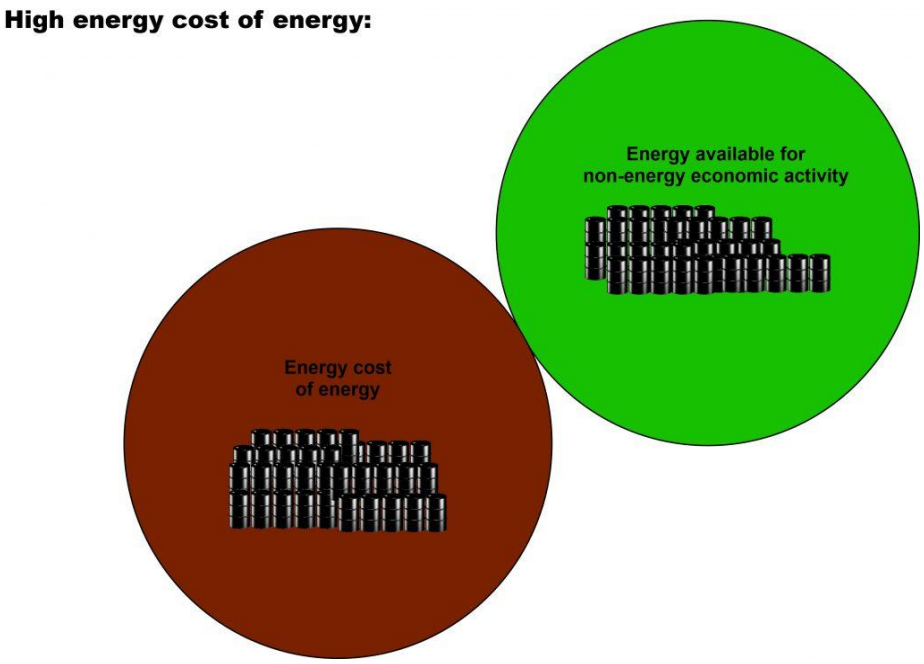
Despite a Herculean effort to bring non-renewable renewable energy-harvesting technologies online, they still account for less than five percent of global primary energy consumption. Worse still, they have not *replaced* fossil fuels; they have just been added to the global mix. And while developed states like Germany and the UK have gone a long way toward decarbonising their domestic *electricity* generation, a large part of their true pollution has been offshored to Asia. Only if they are prepared to forego all of the fossil-fuel powered goods they import can they truly claim to be embarking upon a new industrial revolution. Until then, the "green new deal" is just another name for the same old imperialism that they have always practiced.

Peak oil – including from fracking and tar sands – finally occurred in 2018. Hardly anyone noticed because – as happened in the USA in 1970 – everyone assumed that it would be a temporary blip. Oil extraction in 2019 was not substantially lower than 2018; but there was no month in 2019 when extraction was higher than it had been in November 2018. And, of course, in 2020 the world discovered more urgent issues to worry about. Nevertheless, oil extraction – and oil demand – plummeted as a result of the various state responses to the pandemic. Some wells will be shut permanently as the cost of reopening them is too high. Others will reopen, but only if the price of oil rises considerably. Pipelines and refineries will also have to be repaired. On the demand side, even the most optimistic economists and politicians have ceased talking about "V-shaped recoveries." With Europe and parts of the USA embarking on pre-Christmas lockdowns, demand across the *global* economy is expected to be crushed. This spells *lower* rather than higher oil prices in the next couple of years.

It is in this that we glimpse the part of the peak oil story that was often overlooked by the first peak oilers. The simple assumption that falling oil production would lead to higher oil prices failed to examine the impact of oil prices on the wider economy. Nevertheless, the economy is *primarily* an energy system upon which the *secondary* financial economy is merely a claim. Rather than examining the *price* of oil, we have to understand its *energy* cost. If we begin with a certain amount of energy, then a fraction *must* be devoted to supplying today's energy. Another fraction must be set aside for maintaining the infrastructure required to keep the system running. A third fraction must be set aside to invest in the *future* energy supply. These, though, will only account for a small part of the energy available to us. The remainder will power the much larger, non-energy economy; comprising almost all of the goods and services we consume:



If, then, the *energy cost* of energy increases – i.e. we have to divert more energy away from the non-energy economy; the non-energy economy *must* shrink:



This has a dramatic impact on the living standards of the majority of the population. On the one side, their income is squeezed as the non-energy sectors of the economy struggle to remain profitable. On the other, the rising cost of energy-intensive non-discretionary goods and services (housing, transport, utilities, food, etc.) forces them to curb their consumption.

As Gail Tverberg has warned many times, it is consumption rather than production which drives the post-peak oil economy. That is, although the oil industry needs higher prices to remain profitable, it is consumers' collective lack of purchasing power which forces prices down. Temporary increased prices – such as those immediately after the 2008 crash – are unaffordable. As consumers have to pay more for essentials, they cut spending on discretionary items; driving the retail apocalypse and forcing manufacturers to cut production… thereby lowering demand for oil. Thus oil prices are forced down to a level consumers can afford:

While, from a metropolitan liberal perspective, this decline in demand for oil may look like a good thing, it actually points to a major unravelling of the global economy in the near future as much of the non-energy economy that we have constructed since the Second World War can no longer be sustained.

In his recent presentation, Simon Michaux from the Finnish Geological Survey highlights the downward trend in oil prices since the 2008 crash:

Another way of viewing this is that all of the central bank efforts at quantitative easing and ever lower interest rates have failed to resolve the consequences of peak oil. Not enough people have been left with disposable income (after the bills have been paid) to consume sufficiently to raise the price of oil to a point where the industry can remain profitable.

Ironically, one of the oil industry's response to this problem has been to go "green." Energy companies are using non-renewable renewable energy-harvesting technologies to lower the energy cost of their operations in a final attempt to lower the oil price at which they can be profitable. But even this can only be a short term solution if the discretionary spending power of the wider economy continues to decline. Perhaps the more sobering interpretation of the post-2008 trends is that when those two trend lines meet, industrial civilisation is over.

For the moment, however, the continuing slump in oil prices will be treated by economists, politicians and establishment media journalists as proof that the transition from fossil fuels to renewable energy is gathering pace. As a result, instead of making serious attempts to mitigate the damage that severe energy shortages will cause, they will continue to push the narrative that their mythical fourth industrial revolution is well under way.

Yes, humanity will eventually revert to "green energy," but not in the way techno-utopian fantasists imagine. Rather, as the energetic basis of the industrial economy collapses, those who survive will mainly

be left with energy technologies like water wheels, windmills and sails to supplement human and animal labour power at an economic level not dissimilar, at best, to the early nineteenth century… that's just what happens when you run out of gas!

Bio

Max Wilbert
Biocentric

Climate Profiteers Are the New War Profiteers

[Published October 12, 2022]

At Thacker Pass, "National Security" is Being Abused to Cover Up Atrocities

I was a kid when the invasions of Iraq and Afghanistan began, but I could see what was happening.

Corporations were cashing in however possible: selling beans, bullets and band-aids, signing lucrative construction contracts for new military bases, replacing public employees with private contractors from combat units to the VA hospital, and capitalizing on opportunities to make big money in reconstruction and oil.

Now, as an environmental activist and author, I apply the same logic to the climate crisis.
There are surprising parallels between the "war on terror" in Iraq and Afghanistan and climate change. Both are characterized by public fear, existential risks, geopolitical power struggles, manipulation of public opinion, and huge sums of money.

As global warming intensifies, trillions of dollars in government subsidies and consumer spending are flowing to makers of "green technology." Car manufacturers from Ford to Volkswagen have announced plans to stop making gas and diesel cars, and instead manufacture only electric vehicles. And as more intermittent wind and solar is added to electricity grids, utilities are investing in massive, warehouse-sized battery banks to stabilize power supplies.

All this is driving skyrocketing demand for raw materials such as lithium, graphite, cobalt, nickel, and rare earth metals. The International Energy Agency, for example, expects demand for lithium to spike by 4200% over the next 20 years. Lithium prices have quintupled in the past year alone as demand vastly outstrips supply. And that growing demand is driving mining companies to explore and develop new mines around the world.

One hotspot for this is Nevada, where there are currently 17,375 lithium mining claims and some 50 lithium mining projects in development, the largest of which is Thacker Pass, located in the northern portion of the state. But herein lies the conflict: beyond a rich source of lithium, Thacker Pass is also a highly biodiverse habitat home to rare wildlife and is culturally important as the site of two massacres of Northern Paiute and Western Shoshone people.

I've been fighting the fossil fuel industry and reporting from the frontlines of climate chaos for decades, and it's clear to me that we must stop burning fossil fuels immediately. Yet I question the idea that technology is the solution. In at least one important way, "green tech" is no different than fossil fuels: the natural world bears the costs of its extraction and development.

The environmental and cultural significance of Thacker Pass, and questions about lithium's efficacy as climate crisis panacea, has catalyzed a serious resistance movement to "Protect Thacker Pass" consisting of protests, regulatory battles, a year-long occupation of the planned mine site, and lawsuits.

Thacker Pass, Nevada. Photo by the author.

Arguing in Federal Court against the two Indian Tribes, four environmental groups, and local rancher who have sued to stop the Thacker Pass lithium mine, Lithium Nevada Corporation's lawyer recently wrote that "The [Thacker Pass] project is important… to ensure that the U.S. is not dependent on foreign sources for critical minerals **as a matter of national security**."

I'm not buying it.

Maybe it's because I'm old enough to remember the world before ubiquitous cell phones, but it's obvious to me that lithium is no more "critical" than Hummers or TikTok. What's really critical are the basics: food, water, shelter, clean air, and a living planet.

When Lithium Nevada's lawyers and the U.S. government argue that lithium is a "critical mineral," and that blowing up a mountainside, destroying wildlife habitat and Native American sacred sites, and polluting more than 4 million gallons of water per day is unimportant because building a lithium mine is "a matter of national security" that could "have significant consequences for the economy," I call bullshit.

Their logic, that we must "compete" with other nations on the world stage to establish dominance, is a sad relic of the colonial imperialist legacy of this country.

In February 1948, George Kennan[12], head of US State Department Policy Planning and one of the most influential people in government, wrote an extraordinary Top-Secret report that wouldn't be declassified for

[12] Kennan was granted the Medal of Freedom by George H. W. Bush in 1989, and would later become known as one of "The Wise Men," a group of 6 Federal Government officials which also included the Secretary of State, the Ambassador to the Soviet Union, the Special Envoy to the President, the Secretary of Defense, and a prominent member of War Department who later served as President of the World Bank.

26 years.

“[The United States has] about 50 percent of the world's wealth but only 6.3 percent of its population,” Kennan wrote in memo PPS23. “Our real task in the coming period is to devise a pattern of relationships, which will permit us to maintain this position of disparity without positive detriment to our national security.”

This, perhaps more than any quote, lays bare the goals of the national security apparatus: not to protect lives, but to “maintain this position of disparity.”

Kennan continued: “To do so, we will have to dispense with all sentimentality and day-dreaming; and our attention will have to be concentrated everywhere on our immediate national objectives. We need not deceive ourselves that we can afford today the luxury of altruism and world-benefaction.”

Now, minerals are the new white gold, and a “Minerals Security Partnership” has been formed between the United States, Canada, Australia, Finland, France, Germany, Japan, the Republic of Korea, Sweden, the United Kingdom and the European Commission. Reuters called this a “Metallic NATO” — fitting, when you consider that mining itself is a war against the land and modern war is impossible without mining. President Biden recognized this last March when he amended the Defense Production Act, a Cold War-era law, to allow the Department of Defense to promote domestic mining.

Big profits, while the land is destroyed. This is the so-called national security that Lithium Nevada is talking about.

Sagebrush at Thacker Pass. Photo by the author.

All this is not new. The wealthy and powerful have long abused the concept of national security as a disguise for selfish goals.

For instance, look at the 9/11 World Trade Center bombings, which led to the aforementioned wars in Afghanistan and Iraq, 900,000 dead, illegal mass surveillance, extraordinary rendition, "enhanced interrogation," and $8 trillion in costs — much of which went to companies like Halliburton (where Vice President Dick Cheney was CEO before taking office).

Or look at the Vietnam war, where a decade of battle resulted in millions of dead Vietnamese, 300,000 dead U.S. and allied troops, an entire country poisoned by Agent Orange, and spectacular profits for "defense" companies like KBR, Boeing, and Dow Chemical.

We can even look back further, at the wars of colonization, where the U.S. military committed massacres from Sand Creek to the Swamp Cedars in service of "Manifest Destiny," then took possession of valuable land for agriculture, mining, logging, and towns.

Northern Paiute activist and author Sarah Winnemucca wrote in her 1884 book *Life Among the Paiutes: Their Wrongs and Claims* that war profiteering and greed were major drivers of the Snake War, the bloodiest Indian war in the West and the context for the Thacker Pass massacre of September 12, 1865 that has become a flashpoint for the lithium mine protests.

"[In the summer of 1865] soldiers were sent from California," Winnemucca wrote, "and a great many companies came. They went after my people all over Nevada. Reports were made everywhere throughout the whole country by the white settlers, that the red devils were killing their cattle, and by this lying of the white settlers the trail began which is marked by the blood of my people from hill to hill and from valley to valley. The soldiers followed after my people in this way for one year, and the Queen's River Piutes were brought into Fort Churchill, Nevada, and in that campaign poor General [sic] McDermit was killed. These reports were only made by those white settlers so that they could sell their grain, which they could not get rid of any other way. The only way the cattle-men and farmers get to make money is to start an Indian war, so that the troops may come and buy their beef, cattle, horses, and grain."

Is it really any different now, with billions of dollars at stake at Thacker Pass? What is national security for one people is genocide for another — and ecocide for the land.

All that has changed since 1865 is that the problems have become more entrenched. As technology has escalated, war profiteers have become permanent adjuncts to government, with personnel rotating between high-paying corporate jobs and government roles in what is called a "revolving door." In most countries, they call this corruption.

This danger is why, on January 17, 1961, President Dwight D. Eisenhower — former Supreme Commander of the Allied Expeditionary Force in Europe, and a man intimately familiar with every facet of the military and national security — ended his presidential term with a warning about the pernicious effects of a permanent war footing.

"In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex," Eisenhower said in his televised speech. "The potential for the disastrous rise of misplaced power exists and will persist. We must never let the weight of this combination endanger our liberties or democratic processes. We should take nothing for granted."

We all want safety. But the term “national security” should not make us stop thinking critically. Democracy, human rights, and justice all depend on us making deliberate and well-informed choices about our path as a society.

Members of the Reno-Sparks Indian Colony and other regional tribes gather at Thacker Pass regularly to discuss the 1865 massacre and pray. Photo by the author.

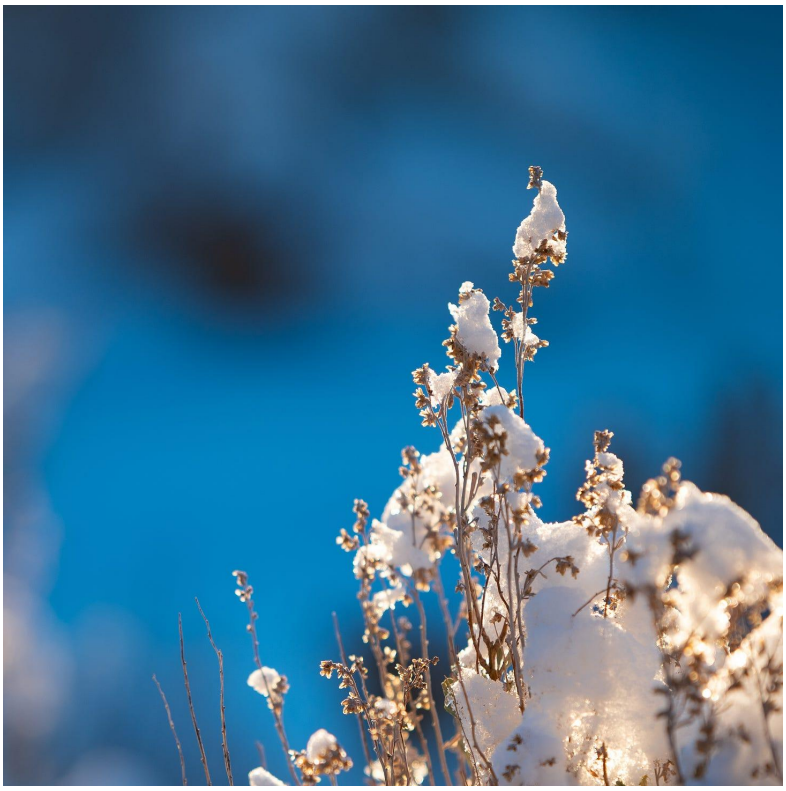
My friend Lierre Keith often says that “in the wealthy nations of the west, we live behind a military barricade.” The slavery, violence, and brutality that go into producing an electric car battery or a modern smartphone happens in rural communities and countries far away, while the wealthy reap the benefits. As someone born and raised in the United States, I’ve benefitted from that exploitation without ever choosing to. I live on stolen native land, and with the U.S. dollar as the reserve currency of the world, the economic warfare conducted by organizations like the World Bank and military warfare conducted by U.S. forces preserves a situation where the middle class in the U.S. could pass for the upper class in most of the rest of the world.

With U.S. influence waning globally and lithium supply chains dependent on China, this country’s wealth and power is indeed at stake. To fuel that wealth, the mine at Thacker Pass is being rammed through despite determined opposition.

On a technical level, transitioning to EVs will be extremely challenging. It will demand huge expansion in electric power plants and transmission grids. There may not even be enough economically recoverable lithium in the world to manufacture the batteries to replace the world’s 1.5 billion cars. And some analyses show that EVs will only reduce emissions by ~6% - better than nothing, but not a particularly good use of energy and resources, and not even close to the 100% emissions cuts that scientists are telling us are required to avoid catastrophic global warming.

EVs, then, are a fantasy. They allow people to believe that car culture itself—indeed, industrial civilization—can be made sustainable with mere technical changes. This is a lie. We can’t simply swap out what is underneath the hoods of our cars and expect to reach sustainability. In this sense, a focus on electric vehicles is dangerous because it obscures the true scope of changes which are needed. To halt and reverse

global warming will require changes to our society that are far more significant and sweeping.



Sacred land or future mine site? Photo by the author.

Recently I was called “delusional” for saying what most people know but are too polite to say: cars are unsustainable, and if we want to live sustainably, we won’t have cars. Just because a truth is inconvenient and politically unacceptable in some quarters doesn’t make it any less true. You can’t argue with the laws of ecology any more than you can argue with physics. If I’m delusional, then so was Galileo.

Energy company executives and political leaders alike don’t want to imagine a world where the U.S. no longer has economic and military dominance of the planet, a world where we make deliberate choices to live within the limits of the planet rather than exploiting and destroying for temporary power and wealth, a world where we voluntarily choose to live with less, a world where Native American sacred sites are respected, a world without an Earth-destroying economy. Doing so, after all, would mean the end of their wealth and their power.

But I can imagine that world, and I think you can too.

They can call us delusional all they like, but we’ll keep fighting for it until our last breath.

Bio

Max Wilbert is a writer and biocentric community organizer. He has been part of grassroots political work for 20 years, and is the founder of Protect Thacker Pass. Max is the author of two books, most recently "*Bright Green Lies: How The Environmental Movement Lost Its Way and What We Can Do About It*" (Monkfish 2021). His work has been featured on CNN, The New York Times, NPR, Le Monde, BBC, and elsewhere.

Michael Dowd
Post-Doom

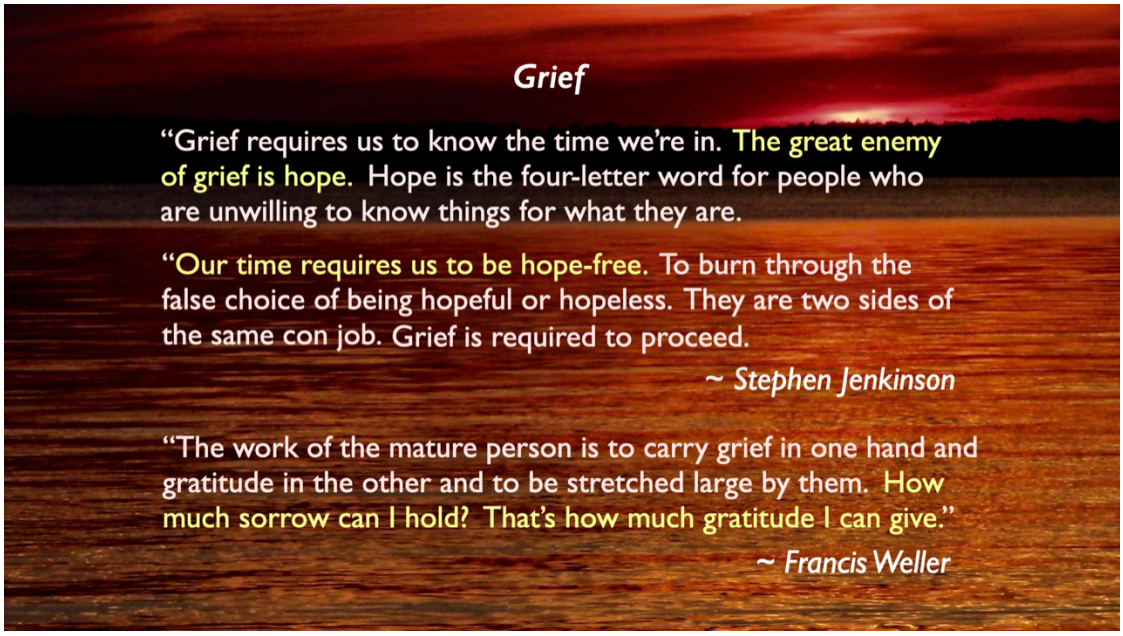
Afterword
(August 2023)

I trust that the reader has found value in this superb collection of essays and teachings on various aspects of ecological overshoot, its challenges and opportunities, and its inevitable consequences. Processing this kind of knowledge, of course, takes time, and can be emotionally grueling. "Awareness is hell. Only acceptance transforms lives" has been the experience of many of us in (what I like to think of as) the Post Doom, No Gloom tribe.

In addition to educating (teaching and preaching) about ecological overshoot and collapse, my main focus in recent years has been more "pastoral" — that is, helping people of all ages and backgrounds to adapt and cope with the knowledge that we are living in a biosphere and civilization in an unstoppable process of collapse. This is hard enough to accept on its own, of course, but is all too often exacerbated by the fact that most people's family, friends, neighbors, and colleagues will studiously avoid thinking about such things for as long as possible!

For those interested in exploring the question of "**How do I live with this sobering knowledge and still have a good life, much joy, and healthy relationships?**", what I recommend most highly the five main posts written by Collapsasaurus Rex (text / audio: #s 3-7) and the emotionally supportive videos and discussion forums on the Discussions (Connect) page of the post-doom website.

Below are twelve key slides I typically use when discussing this more adaptation/emotional resilience side of overshoot. Echoing what I said in the Foreword to this volume, I invite the reader to carefully read (rather than merely skim) the text on the following slides. To experience how I present these slides to a live audience, check out "The Big Picture: Beyond Hope and Fear". (The Q&A is quite helpful, too.)

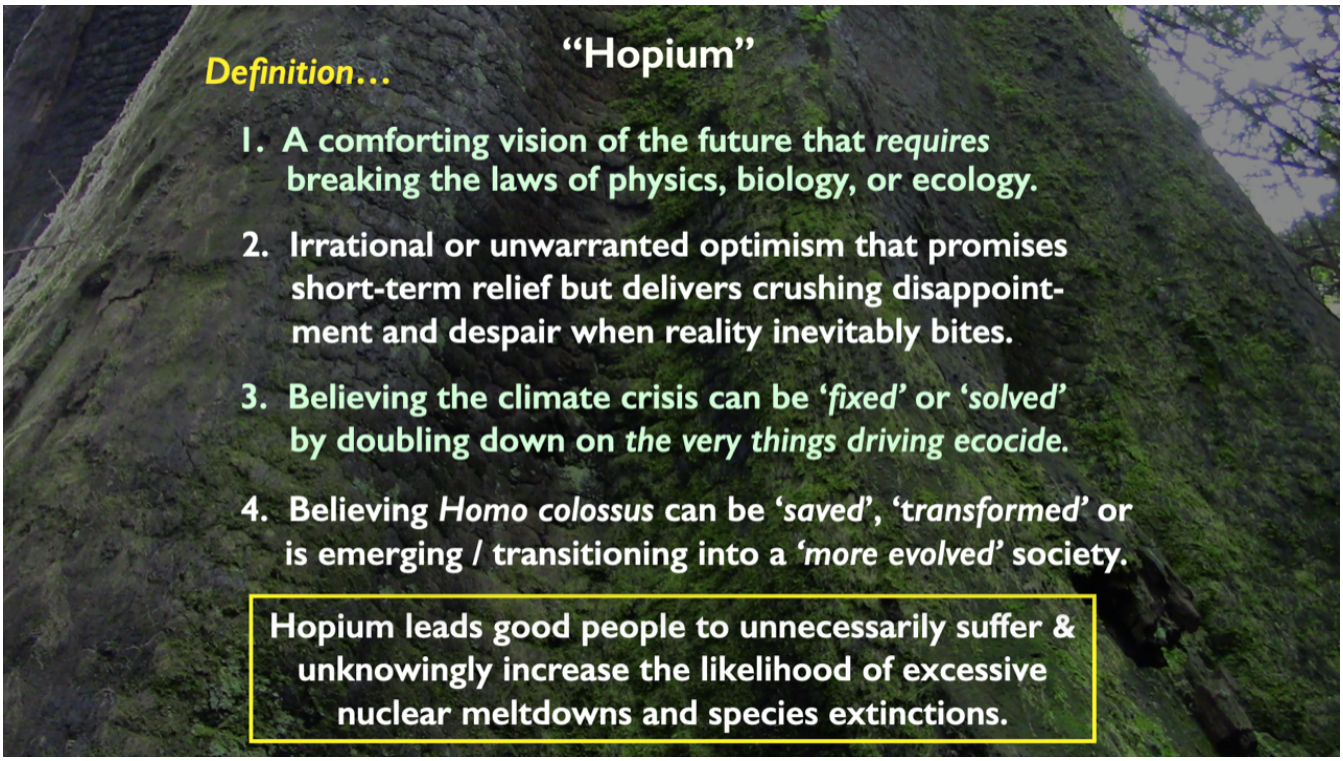


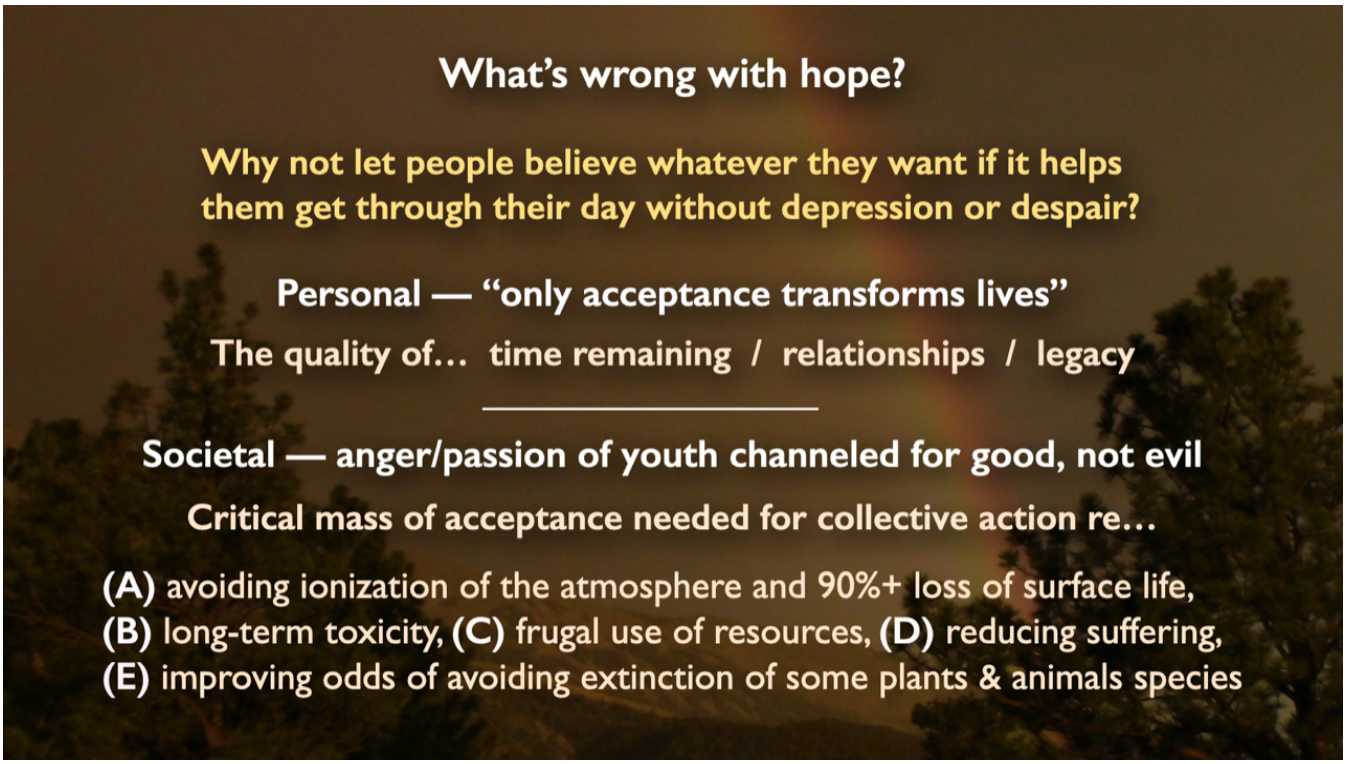
In today's world it is imperative that all of us learn the following core principle: Human society is inextricably part of a global biotic community, and in that community human dominance has had and is having self-destructive consequences.
-William R. Catton, Jr. (Overshoot, 1980)


Commonly experienced "Stages of Grief"
(on the way to Accepting & Trusting unstoppable loss)
Denial
Anger
Bargaining
Depression
"Doom"
(Excruciating, resentful grief)
Acceptance
(Sweet, generous grief)
"Post-doom"
(Hope-free)
Trust / Faith (Benefits)
• Finding the Gift
• Gallows humor
• Calm, courageous love-in-action


It's not too late …
(Changing what we can)
• Ecological integrity
• Social coherence
• Personal wholeness
… to reduce suffering and adapt to LESS
… to resist further destruction and evil
… to assist trees / other plants in migrating
… to support Indigenous resistence
… to be a blessing to friends, family, community
… to engage in regenerative love-in-action

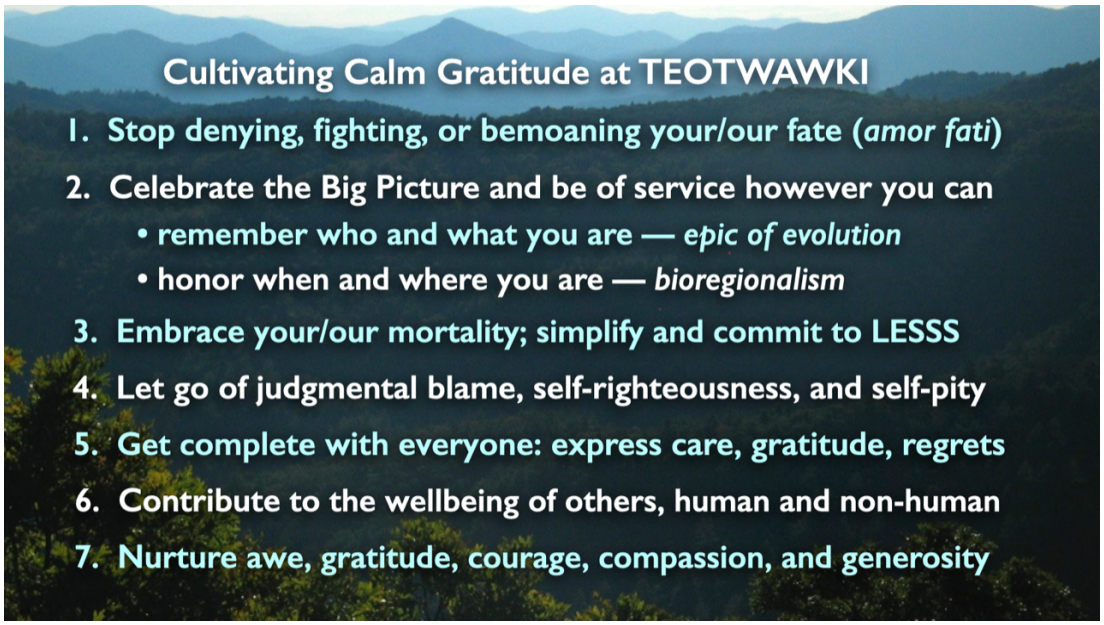

"It is too late…" (or was never possible)
Accepting what we cannot change
1. …to change the narrative or awaken enough people to transform social, political, and economic systems.
2. …to slow, stop, or reverse abrupt climate mayhem and the accelerating collapse of the biosphere and BAU.
3. …to prevent the loss of most of the world's forests, ice, insects, coral reefs, and protective ozone layer.
4. …to spare Homo colossus the ecocidal consequences of human ingenuity, technology, and the market.
5. …to prevent billions of humans and other mammals and vertebrates from dying this decade or next.





"The purpose of this book, therefore, is to illuminate the nature and causes of the human predicament, so as to make possible some mitigation of its social, emotional, and moral effects. To mitigate the effects of post-exuberant pressures, we must recognize their deepest roots. We must learn to relate personally to what may be called 'the ecological facts of life'. We must see that those facts are affecting our lives far more importantly and permanently than the events that make headlines. To understand the human predicament now requires a truly ecological perspective."

-William R. Catton, Jr. (Overshoot, 1980)



Doom *definition*

1. A normal feeling of disgust or dread upon realizing that technological progress and economic growth and development are the root of our predicament, not our way out.

2. A name for the anxiety and fear called forth when living in a corrupt, dysfunctional civilization causing a mass extinction.

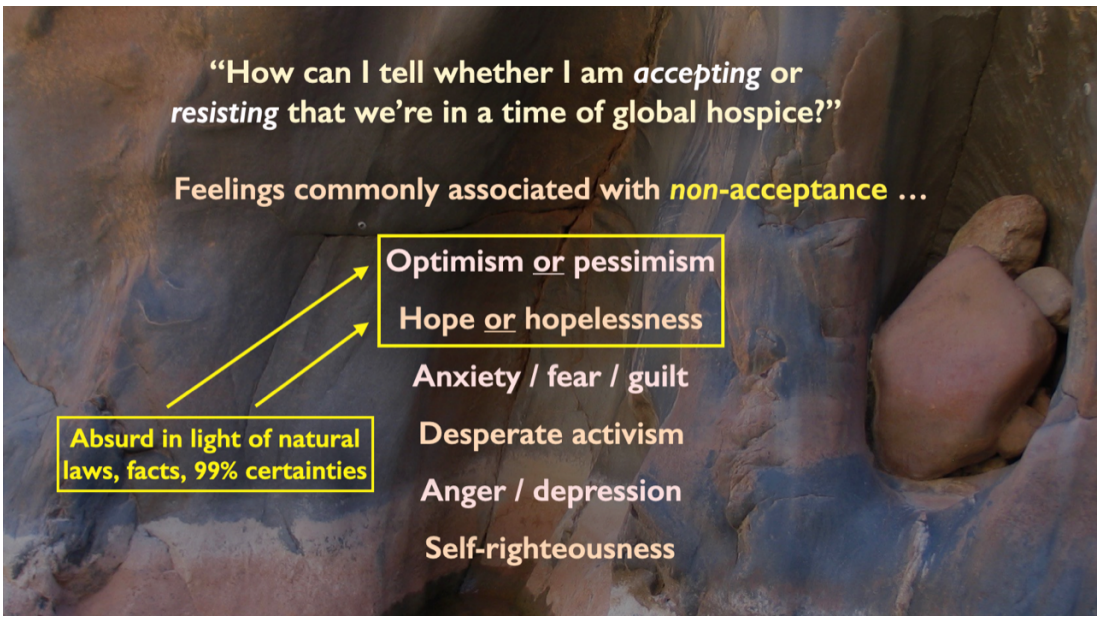
3. The mid-point between denial and regeneration . . . with or without us.

Post-doom *definition*

1. What opens up when we remember who we are and how we got here, accept the inevitable, honor our grief, and prioritize what is pro-future and soul-nourishing.

2. A fierce and fearless reverence for life and expansive gratitude — even in the midst of abrupt climate mayhem and the runaway collapse of societal harmony, the health of the biosphere, and business as usual.

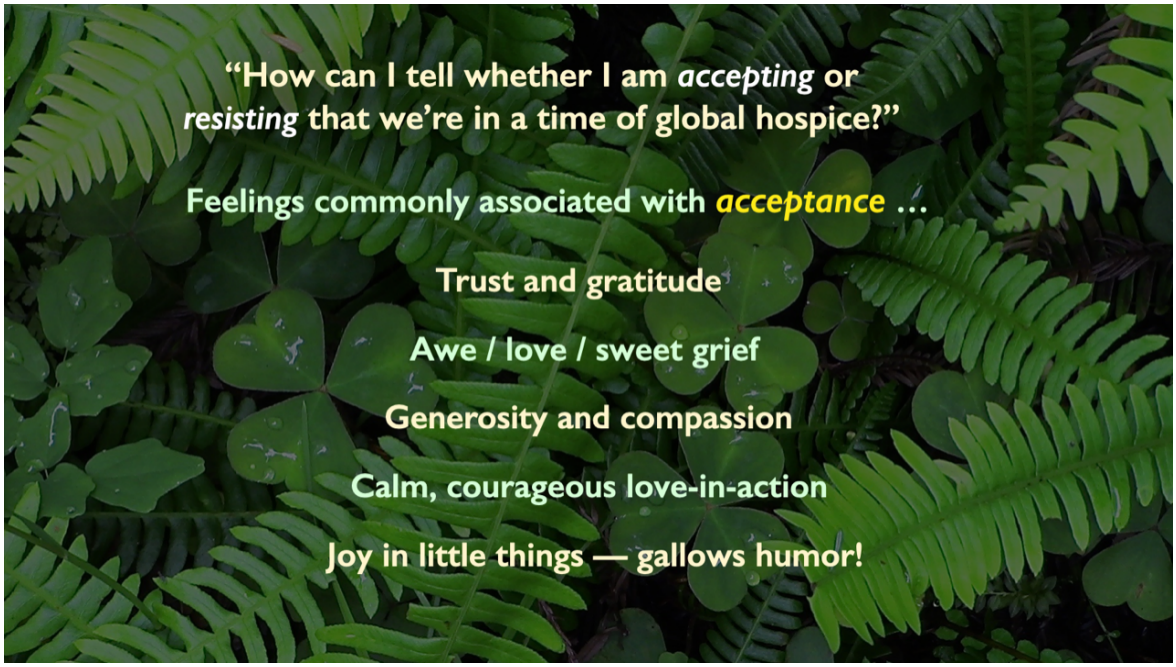
3. Living meaningfully, compassionately, and courageously no matter what.

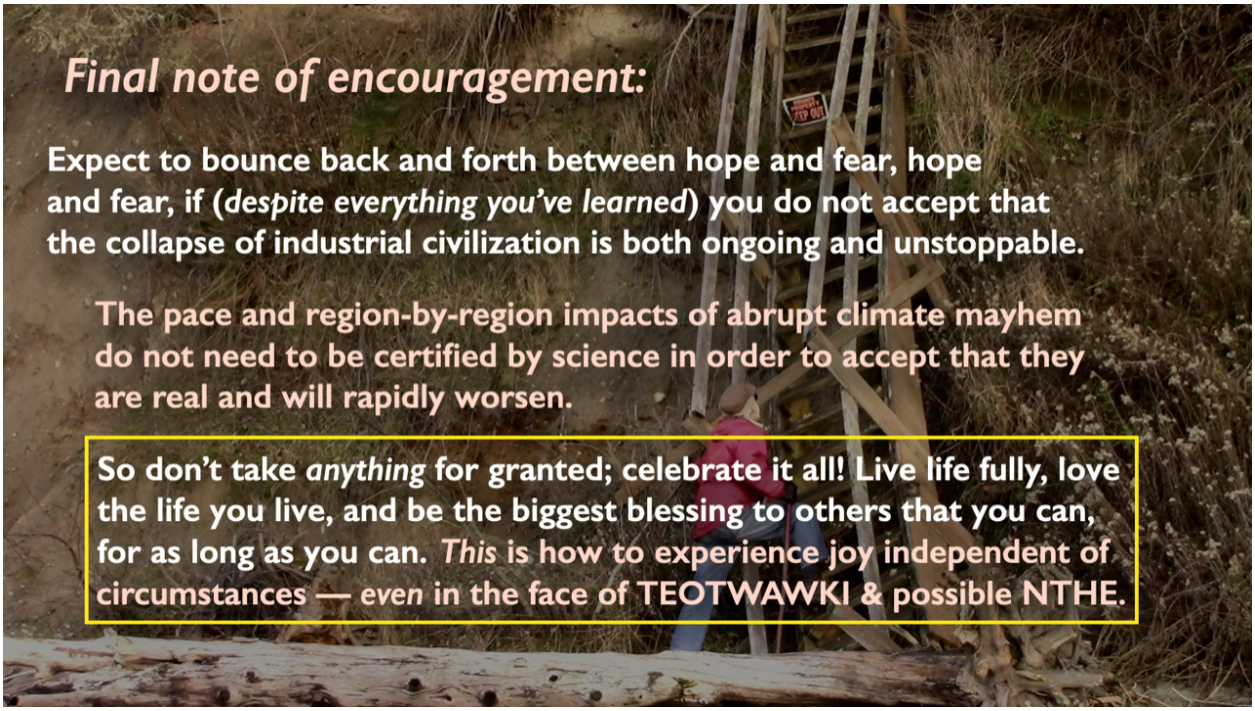


"With active effort, the reader may find it possible to accept the view that, since human beings are not the first creatures to foul their own nest, no special burden of shame or guilt need fall upon us for the present and future condition of our world. As we discover and encounter 'the wages of overshoot' mankind's humane tendencies will be strained to the breaking point. They will need the solid rein- forcement they can obtain from knowledge that our species has not been unique in proliferating beyond carrying capacity. It will be essential to realize that what is happening to us is a mere sequel to our past achievements.

As we reap the whirlwind of troubles necessitated by excessive success, thinking ecologically of our global predicament may reduce the temptation to hate those who seem to be trespassing against us."

-William R. Catton, Jr. (Overshoot, 1980)





Finding overshoot- and collapse-accepting friends, colleagues, mentors, and exemplars: One of the reasons I remain so enthusiastic about this collection of teachings on overshoot is because it represents such a wide diversity of esteemed hearts and minds on the subject. My original intention with the postdoom.com website was to showcase (now nearly one hundred!) deep and meaningful conversations that I have had over the last 4-5 years with many of the world's leading thinkers, activists, and others who (A) get the big picture, (B) have done the heart work, and (C) who have come to a place of inspired local action of one sort or another.

As a possible next step beyond re-reading this volume, I encourage you to take time to carefully watch or listen to my post-doom conversations at your leisure. (Note the 7 questions I typically ask.) In doing so, I am confident that you will find some new overshoot and collapse accepting friends, colleagues, mentors, and exemplars to enrich your own journey in this sacred time of Global Hospice.

Bio

Michael Dowd is a bestselling eco-theologian and "post doom, no gloom" educator whose book, *Thank God for Evolution*, was endorsed by 6 Nobel Prize-winning scientists, noted skeptics and atheists, and by dozens of diverse religious leaders. He has delivered two TEDx talks, a program at the United Nations, and he and his wife, Connie Barlow, a popular science writer and Assisted Migration tree activist, have addressed some 3,000 religious and secular groups throughout North America.

Having settled in Ypsilanti, Michigan in 2020 to live near their 3-year-old granddaughter, Michael is known today for his leadership in the realm of "**post-doom**," which his website defines as: "**A fierce and fearless reverence for life and expansive gratitude — even in the midst of abrupt climate mayhem and the runaway collapse of societal harmony, the health of the biosphere, and business as usual**." Michael's passion these days is helping people of all ages understand our predicament in ways that offer clarity over confusion, compassion over blame, and calm, courageous love-in-action over fearful, desperate activism. His 90 post-doom conversations and a variety of educational materials and more pastoral offerings, such as a free 5-week "Skills for Post Doom, No Gloom Living" course, can be found at postdoom.com

Connie Barlow
The Great Story

Addendum: The Legacy of Catton's 1980 book, Overshoot

William Catton began working on *Overshoot* during a three year post as Professor of Sociology at the University of Canterbury in New Zealand, (Goodrich, et.al., 2016) then returning to his home country in 1973 as Professor of Sociology at Washington State University. (Dillman, 2015) As referenced above, during this period Catton, in collaboration with fellow scholar, Riley E. Dunlap, produced a series of influential articles on ecological issues. (Catton, 2008:10-30) In an obituary for Catton published in the journal New Zealand Sociology, Dunlap wrote, "I always describe *Overshoot* as a superb ecological history of Homo sapiens and analysis of our evolution into what Bill called *Homo colossus*, yielding a profound understanding of our current ecological dilemma." (Goodrich, et. al., 2016)

Catton put his coinage of *Homo colossus* in context on p. 170 of *Overshoot*:

> When the earth's deposits of fossil fuels and mineral resources were being laid down, Homo sapiens had not yet been prepared by evolution to take advantage of them. As soon as technology made it possible for mankind to do so, people eagerly (and without foreseeing the ultimate consequences) shifted to a high-energy way of life. Man became, in effect, a detritivore, *Homo colossus*. Our species bloomed, and now we must expect a crash (of some sort) as the natural sequel.

Other writers who credit Catton's book with greatly influencing their own work also point to his facile use of memorable descriptors. Such terms include ghost/phantom acreage, trade acreage, fish acreage, and his name for the brief period of human excess that he himself had enjoyed but was (at the time of publication) already waning: Age of Exuberance. (Montague, 2009)

That the manuscript itself attracted an icon of the environmental movement, former U.S. Interior Secretary Stewart Udall, to write the book's foreword was a sign of the popular (and activist) reach the book would garner. That reach included wilderness advocate Dave Foreman, a cofounder of EarthFirst! and of Wild Earth magazine. In a reflection upon Catton's death, Foreman wrote:

> William Catton's *Overshoot* is one of the most important books I've ever read, and Bill was one of my greatest teachers." (Dowd and Barlow, 2015) Catton attributed his own wilderness experiences in national parks of the USA as the source of his drive to understand ecological systems and ecological limits—including the fundamental ecological principle of carrying capacity. (Catton, 2008:10-30)

As with carrying capacity, overshoot is a standard term in the ecological sciences. In his 2015 obituary for Catton, John Michael Greer put this ecological term into its activist context: "The core of *Overshoot*, which is also the core of the entire world of appropriate technology and green alternatives ... is the recognition that

the principles of ecology apply to industrial society just as much as they do to other communities of living things." (Greer, February 5, 2015)

Indigenous writer and advocate Vine Deloria officially endorsed *Overshoot* in his quotation on the book's back cover. He called it "one of the most important books I have read in my lifetime." As if to not be outdone, Harold B. Weiss, in his review of *Overshoot* for the NIH National Center for Biotechnology Information, writes, "I not only consider it one of the most influential books I have ever read, but I believe it ranks as one of the most important books ever written, period." (Weiss, 2009)

The 30th anniversary of the book's publication elicited an 8-page article in Human Ecology Review urging academics to reacquaint themselves with Catton's synthesis:

> Environmental sociology and related disciplines should seek to rediscover the message in Overshoot and actively pursue a cohesive theoretical direction that challenges the assumptions that drive environmentally destructive behaviors and threaten humanity's very survival. (Schultz and York, 2011)

Summing up the purpose of all his sociological writings after the publication of *Overshoot*, Catton wrote in 2008:

> From about 1980 onward, my writing, either solo or in tandem, has sought to spread awareness of the urgent need for everyone, including sociologists, to recognize that our lifestyles, mores, institutions, patterns of interaction, values, and expectations are shaped by a cultural heritage that was formed in a time when carrying capacity exceeded the human load. A cultural heritage can outlast the conditions that produced it. That carrying capacity surplus is gone now, eroded both by population increase and immense technological enlargement of per capita resource appetites and environmental impacts. Human life is now being lived in an era of deepening carrying capacity deficit. All of the familiar aspects of human societal life are under compelling pressure to change in this new era when the load increasingly exceeds the carrying capacities of many local regions — and of a finite planet. Social disorganization, friction, demoralization, and conflict will escalate. (Catton, 2008:10-30)

Bio
Connie Barlow is a science writer, evolutionary educator, and professional audio, video, and text editor. Her 2001 book, The Ghosts of Evolution (Basic Books), was Amazon.com's top-recommended science book for several months. Her previous books, Green Space, Green Time: The Way of Science (Copernicus Books), Evolution Extended: Biological Debates on the Meaning of Life (MIT Press), and From Gaia to Selfish Genes: Selected Writings in the Life Sciences (MIT Press), all explore the nexus of science, meaning, and inspiration. Now mostly retired from speaking, Connie is a leader in the rapidly emerging field of assisted migration (See her "Climate, Trees, and Legacy" video blog.)