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*This month's Museletter brings together two recent essays. The first, [Goldilocks is Dead](#), was published as a [Reuters op-ed](#) and talks about the consequences of oil price volatility. *Only Less Will Do* looks at the problems of scale in our growth society. And last, but by no means least, I want to introduce you to my new book *Afterburn: Society Beyond Fossil Fuels*.*

Goldilocks is Dead

Five years ago I wrote an article for Reuters titled "[Goldilocks and the Three Fuels](#)." In it, I discussed what I call the Goldilocks price zone for oil, natural gas, and coal, a zone in which prices are "just right"—high enough to reward producers but low enough to entice consumers. Ever since the start of the fossil fuel era, such a zone has existed. Sometimes price boundaries were transgressed on the upside, sometimes the downside, but it was always possible to revert to the zone.

But now, for oil, the Goldilocks zone has ceased to exist. This will have staggering consequences throughout the economy for the foreseeable future.

During the past dozen years, the Goldilocks zone for oil steadily migrated higher. As conventional crude reservoirs depleted and production rates leveled off, drillers had to spend proportionally more to develop the capacity to pump the next marginal barrel. Oil prices soared from \$30 in 2003 to nearly \$150 in 2008, collapsed during the economic crisis, then clawed their way back to roughly \$100—a price that was maintained through mid-2014. But the economy did not do well with oil prices at elevated levels. Despite massive bailouts, stimulus spending, and low interest rates, the recovery following the 2008 crash was anemic.

However, at \$100 a barrel, the oil price was high enough to incentivize fracking. Small, risk-friendly companies leased land and used expensive drilling techniques to free oil from rocks that geologists had previously described as too impermeable to bother with. This entailed a tenuous business model that required not only high oil prices but easy money as well, as low interest rates enabled producers to pile on enormous amounts of debt.

Oil production in the United States rose sharply as a result, and this eventually impacted prices. Since mid-2014, the oil price has declined

by half, settling around the historic, inflation-adjusted mean price of \$50 a barrel. Consumers are much happier than they were with oil at \$100, but producers are wilting. The American petroleum industry has seen over 75,000 layoffs, the balance sheets of fracking companies are bleeding, and drilling rigs are being idled by the score.

For consumers, experience suggests the acceptable oil price zone is \$40 to \$60 in today's dollars: higher than that, and goods and services (particularly transportation) become more expensive than current spending patterns can handle. For producers, the acceptable zone is more like \$80 to \$120: lower than that, and upstream investments make little sense, so production will inevitably stall and decline—eventually making consumers even less happy.

You will have noticed that there is no overlap. An oil price of \$70 would not be high enough to give the industry a rebound of confidence sufficient to inspire another massive round of investment. Clearly, consumers would be happier with \$70 oil than they were with \$100 oil, but if \$70 isn't a high enough price to incentivize production growth, then it's not really in the Goldilocks zone.

According to the narrative emanating from most mainstream energy economists, oil production rates will soon slow, prices will rebound, and everyone will be happy. That narrative misses the all-important news that Goldilocks is dead. There is no longer a price that everyone can live with. And that's a recipe for price volatility.

For oil traders, price volatility may offer opportunities for profit. But for everyone else, it is treacherous. Price volatility only hints at the real extent of our peril: we have built an economic system overwhelmingly reliant on a nonrenewable, depleting resource. This is not a sustainable situation. Unless our dependency on oil somehow magically disappears, we are in for a wild ride on an unmapped road.

Only *Less Will Do*

When I'm not writing books or essays on environmental issues, or sleeping or eating, you're likely to find me playing the violin. This has been an obsessive activity for me since I was a boy, and seems to deliver ever more satisfaction as time passes. Making and operating the little wooden box that is a violin is essentially a pre-industrial activity: nearly all its parts are from renewable sources (wood, horsetail, sheepgut), and playing it requires no electricity or gasoline. Violin playing therefore constitutes an ecologically benign hobby, right?

It probably was, a couple of centuries ago; now, not so much. You see, most violin bows are made from pernambuco, a Brazilian hardwood that's endangered because too many bows have already been made from it. Ebony, too, is over-harvested; it's used for making fingerboards, tuning pegs, and bow parts. Some fancy older violin bows are even decorated with tortoiseshell, ivory, and whalebone. And while maple and spruce (the main woods from which violins are constructed) are not endangered, whole forests are being

cut in China to meet the burgeoning global demand for student instruments. Modern strings (most of which are made using petroleum derivatives) are often wound with nonrenewable silver or aluminum, and almost nobody tries to recycle them.

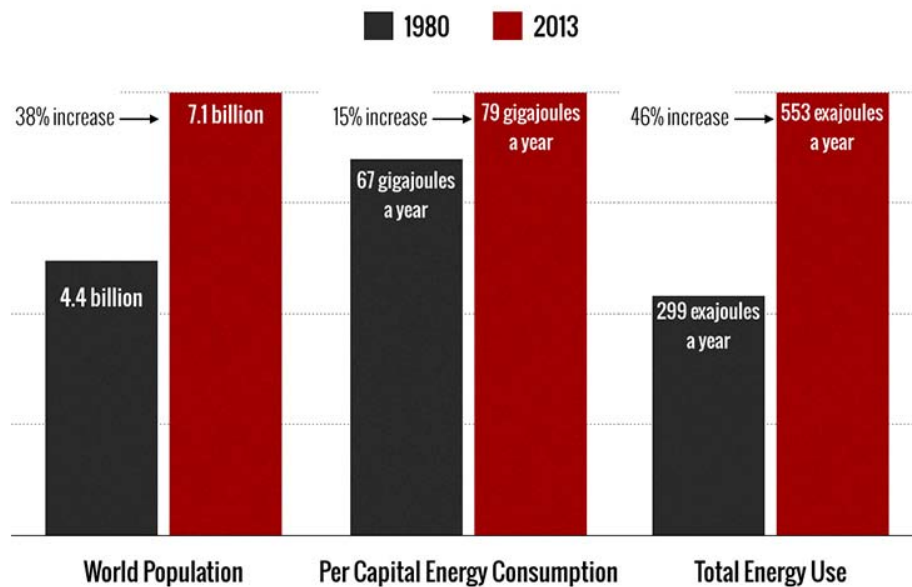
You see, the real problem with violins is one of scale. If there were only a few thousand violinists in the world, making and playing fiddles would have negligible environmental impact. But multiply these activities by tens of millions and the results are deforestation and species extinctions.

Yes, efforts are being made to make violin playing more sustainable. Brazil is protecting its remaining pernambuco forests, and many bow makers seek out “sustainably harvested” wood. Bow makers are also replacing elephant ivory with steer bone or synthetic materials, and the shafts of many bows are now made from carbon fiber. Tortoiseshell and whalebone are off limits for new bows, and synthetic replacements for these materials are available. One company offers to [recycle the silver in old violin strings](#). All of this helps. But if the number of violinists continues to increase, these gains will sooner or later be overwhelmed by the sheer size of the demand for everything from glue to rosin.

Violin playing is a fairly specialized, unusual activity. But the basic problem I’ve outlined is endemic to just about every human pursuit, from eating breakfast in the morning to watching television before bedtime. In the quest to make human society sustainable, the problem of scale crops up absolutely everywhere. We can make a particular activity more energy-efficient and benign (for example, we can increase the fuel economy of our cars), but the improvement tends to be overwhelmed by changes in scale (economic expansion and population growth lead to an increase in the number of cars on the road, and to the size of the average vehicle, and hence to higher total fuel consumption).

Almost nobody likes to hear about the role of scale in our global environmental crisis. That’s because if growth is our problem, then the only real solution is to shrink the economy and reduce population. Back in the 1970s, many environmentalists recommended exactly that remedy, but then came the Reagan backlash—a political juggernaut promising endless economic expansion if only we allowed markets to work freely. Many environmentalists recalibrated their message, and the “bright green” movement was born, claiming that efficiency improvements would enable humans to eat their cake (grow the economy) and have it too (protect the planet for the sake of future generations).

Yet here we are, decades after the eclipse of old-style, conservation-centered environmentalism, and despite all sorts of recycling programs, environmental regulations, and energy efficiency improvements, the global ecosystem is approaching collapse at ever-greater speed.



sources: IEA: UN

Population has grown from 4.4 billion in 1980 to 7.1 billion in 2013. Per capita consumption of energy has grown from less than 70 gigajoules to nearly 80 GJ per year. Total energy use has expanded from 300 exajoules to 550 EJ annually. We've used all that energy to extract raw materials (timber, fish, minerals), to expand food production (converting forests to farmland or rangeland, using immense amounts of freshwater for irrigation, applying fertilizers and pesticides). And we see the results: the world's oceans are dying; species are going extinct at a thousand times the natural rate; and the global climate is careening toward chaos as multiple self-reinforcing feedback processes (including polar melting and methane release) kick into gear.

The environmental movement has responded to that last development by adopting a laser-like focus on reducing carbon emissions. Which is certainly understandable, since global warming constitutes the most pervasive and potentially deadly ecological threat in all of human history. But the proponents of "green growth," who tend to dominate environmental discussions (sometimes explicitly but more often implicitly), tell us the solution is simply to switch energy sources and trade carbon credits; if we do those simple and easy things, we can continue to expand population and per-capita consumption with no worries.

In reality, entirely switching our energy sources will not be easy, as I have explained in [a lengthy recent essay](#). And while climate change is the mega-crisis of our time, carbon is not our only nemesis. If global warming threatens to undermine civilization, so do topsoil, freshwater, and mineral depletion. These may just take a little longer.

The math of compound growth leads to absurdities (one human for every square meter of land surface by the year 2750 at our current rate of population increase) and to tragedy. If confronted by this simple math, bright greens will say, "Well yes, ultimately there are

limits to population and consumption growth. But we just have to grow some more now, in order to deal with the problem of economic inequality and to make sure we don't trample on people's reproductive rights; later, once everyone in the world has enough, we'll talk about leveling off. For now, substitution and efficiency will take care of all our environmental problems."

Maybe the bright greens (or should I say, pseudo-greens?) are right in saying that "less" is a message that just doesn't sell. But offering comforting non-solutions to our collective predicament accomplishes nothing. Maybe the de-growth prescription is destined to fail at altering civilization's overall trajectory and it is too late to avoid a serious collision with natural limits. Why, then, continue talking about those limits and advocating human self-restraint? I can think of two good reasons. The first is, limits are real. When we decline to talk about what is real simply because it's uncomfortable to do so, we seal our own fate. I, for one, refuse to drink that particular batch of Kool-Aid. The second and more important reason: If we can't entirely avoid the collision, let us at least learn from it—and let's do so as quickly as possible.

All traditional indigenous human societies eventually learned self-restraint, if they stayed in one place long enough. They discovered through trial and error that exceeding their land's carrying capacity resulted in dire consequences. That's why traditional peoples appear to us moderns as intuitive ecologists: having been hammered repeatedly by resource depletion, habitat destruction, overpopulation, and resulting famines, they eventually realized that the only way to avoid getting hammered yet again was to respect nature's limits by restraining reproduction and protecting other forms of life. We've forgotten that lesson, because our civilization was built by people who successfully conquered, colonized, then moved elsewhere to do the same thing yet again; and because we are enjoying a one-time gift of fossil fuels that empower us to do things no previous society ever dreamed of. We've come to believe in our own omnipotence, exceptionalism, and invincibility. But we've now run out of new places to conquer, and the best of the fossil fuels are used up.

As we collide with Earth's limits, many people's first reflex response will be to try to find someone to blame. The result could be wars and witch-hunts. But social and international conflict will only deepen our misery. One thing that could help would be the widely disseminated knowledge that our predicament is mostly the result of increasing human numbers and increasing appetites confronting disappearing resources, and that only cooperative self-limitation will avert a fight to the bitter end. We can learn; history shows that. But in this instance we need to learn fast.

So I keep plugging away with the same old message in as many different ways as I can, updating it as events unfold. And I play my violin—with a carbon fiber bow.

Announcing AFTERBURN: Society Beyond Fossil Fuels

The advent of fossil fuels changed the world profoundly (giving us everything from plastics and automobiles to global warming); the inevitable and rapidly approaching end of the oil-coal-and-gas era will likewise bring overwhelming transformation in its wake. My new book *Afterburn* explores that transformation—its opportunities and challenges—in sixteen essays that address subjects as varied as energy politics, consumerism, localism, the importance of libraries, and oil price volatility.

Afterburn is a book of “greatest hits”—that is, popular essays that have been previously published—similar in that respect to an earlier book of mine, *Peak Everything* (2007). Like that previous collection, this one has been carefully selected and arranged, and features an all-new Introduction.

Here are just a few of the highlights:

“Ten Years After” reviews the debate about “peak oil” from the perspective of over a decade’s work in tracking petroleum forecasts, prices, and production numbers. As we’ll see, forecasts from oil supply pessimists have generally turned out to be accurate, far more so than those of official energy agencies or petroleum industry spokespeople.

Environmentalists tend to agree that consumerism is a deal-breaking barrier to the creation of a sustainable society. It’s helpful, therefore, to know exactly what consumerism is (not merely a greedy personal attitude but a system of economic organization) and how it originated (not as a natural outgrowth of “progress,” but as the deliberate creation of advertising and marketing firms). **“The Brief, Tragic Reign of Consumerism”** tells this story, and explores how we might go about building an alternative *sufficiency* economy.

Some long-time environmentalists have been anticipating global social and ecological catastrophe for many years, yet it has so far failed to manifest in all its devastating glory; what we see instead are periodic localized economic and environmental disasters from which at least partial recovery has so far been possible. **“Fingers in the Dike”** explains why industrial society has been able to ward off collapse for as long as it has, and suggests ways to best make use of borrowed time.

In 2011 a student organization at Worcester Polytechnic Institute invited me to give an alternative commencement address to the graduating class (the official commencement speaker was Rex Tillerson, CEO of ExxonMobil). **“Your Post-Petroleum Future”** is the text of that address.

Environmental philosophers are currently debating the significance of our new geological epoch—which has been dubbed the *Anthropocene*, in acknowledgment of humanity’s dramatically expanding impact upon Earth’s natural systems. Some commentators take extreme positions, arguing the new epoch will usher in either

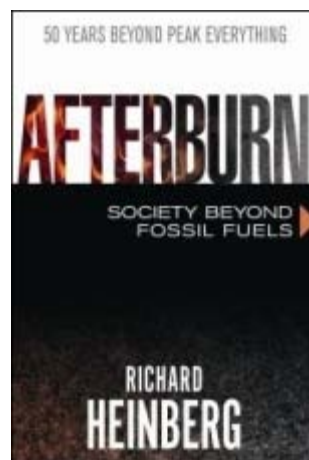
human godhood or human extinction. **“The Anthropocene: It’s Not All About Us”** suggests instead that we are about to bump against the limits of human agency and thereby regain a sense of humility in the face of natural forces beyond our control.

“Conflict in the Era of Economic Decline” discusses the kinds of social conflict we are likely to see in the decades ahead as economies contract and weather extremes worsen—including conflict between rich and poor, conflict over dwindling resources, and conflict over access to places of refuge from natural disasters. This chapter also proposes a “post-carbon theory of change” that encourages building resilience into societal systems in order to minimize trauma from foreseeable economic and environmental stresses.

“Our Cooperative Darwinian Moment” points out that, while we inevitably face a critical bottleneck of overpopulation, resource depletion, and climate change, it’s up to us *how* we go through the bottleneck—whether in ruthless competition for the last scraps of food and natural resources, or in a burst of social innovation that brings more cooperation and sharing. Biology and history suggest the latter path is viable; it is certainly preferable. However, our chances of taking it successfully will improve to the degree that we devote much more effort now at developing cooperative institutions and attitudes.

Advocates for social change today face a nearly unprecedented opportunity, as I argue in **“Want to Change the World? Read This First.”** However, in order to make the most of it, they will need to understand historic and current revolutionary transformations in the relationship between society and ecosystem. As society’s energy systems inevitably change, this will bring the necessity for a reinvention of our economy, our political systems, and the explicit and implicit ideologies with which we explain and justify our world. With so much at stake, there has—quite literally—never been a more crucial moment to be aware and active in helping shape the process of societal change.

Welcome to life beyond fossil fuels.



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