Doomsday Delayed, But Not Deleted

How the fracking boom and soaring U.S. oil and gas output postpone the inevitable reckoning between energy and population to another day

By Leon Kolankiewicz

LIVING ON 'ANCIENT SUNLIGHT'

Some years back, it dawned on me that whenever I filled up the 8-gallon fuel tank of my VW Beetle with gasoline, after driving for a few days or about 240 miles, sooner or later — but inevitably — the needle on the fuel gauge would point toward "empty."

The fuel would be used up, but not before the concentrated chemical potential energy it contained — 114,000 British Thermal Units (BTUs) or 120 million joules in each and every gallon — was converted through controlled combustion into productive work and waste heat. The "productive work" was the force applied to a piston, which was transmitted to the crankshaft, and then the transmission, eventually spinning the wheels — hence the tires gripping a road surface through friction — resulting in forward motion. Ultimately, my two-ton bug was propelled forward towards its destination: typically a hiking trailhead in the Southern Appalachians in the East or British Columbia's Coast Range in the West.

Alternatively, if I ignored the fuel gauge's "empty" warning, or couldn't reach a gas station in time, which happened more than once, my bug would splutter and shudder to a stop and refuse to budge despite my coaxing or whining. It would move no further, unless I got out and physically pushed its two tons of metal and miscellaneous materials using my own muscles, which themselves utilized yet another chemical transformation of energy. And then any forward progress would be measured arduously in feet per minute rather than miles per hour. No amount of wishful thinking, or even the wind to my back, ever seemed to soften this harsh reality.

With energy, you can't have your cake and eat it too. This is thanks to the First and Second Laws of Thermodynamics, which among other things, outlaw perpetual motion machines, or contraptions which, once set into motion, require no external input of energy to keep moving and performing work.

This seemingly banal or trivial observation — that fuel is used up and not magically replenished on its own — corresponds to the implacable and inescapable reality that as humans pump (or "produce," in the arrogant lingo of oil companies) petroleum (crude oil and natural gas) out of the geologic strata in which it formed or was trapped tens to hundreds of millions of years ago, that petroleum too is not replenished. Neither God, nor Hades, nor hidden geologic processes, nor some dark lord of the underworld replaces it on any time scale meaningful to humans. It is gone for good, used up, its energy content irrevocably dissipated and its long chains of covalently bonded carbon atoms converted into simpler carbon dioxide and water molecules. A "fossil fuel" is just that — non-renewable — no ifs, ands, or buts.

This bracing geological reality is not very comforting, to put it mildly. But as the Oxford University biologist Richard Dawkins once remarked in another context, "Reality doesn't owe us comfort."

The late Washington State University environmental sociologist, Professor William R. Catton, Jr., accurately characterized the dilemma industrial civilization faces nearly four decades ago in his landmark book, *Overshoot: The Ecological Basis of Revolutionary Change*. By tapping into the one-time and unsustainable bonanza of the fossil fuels, and increasing our daily per capita extrasomatic energy consumption by perhaps two orders of magnitude (100 times) or more, *Homo sapiens* had, in essence, morphed into a new species, which Catton dubbed *Homo colossus*. *H. colossus* and our massive, intricate industrial infrastructure and voracious, growth-obsessed global economy had become utterly dependent upon the byproducts of long-ago photosynthesis in the "phantom lands" and "ghost acreage" of ancient swamps and shallow seas hundreds

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of millions of years ago in the Carboniferous Period and other geologic eras.

On this ghost acreage, the microscopic chloroplasts of primitive photosynthetic plants manufactured glucose ($C_6H_{12}O_6$) molecules out of water and air (specifically, the carbon dioxide in air), using readily available sunlight as an energy source. Then they produced polymers such as cellulose and proteins, lived their lives, and died. *En masse*. Over the eons. Over many, many eons. Some fraction of the organic materials that comprised these plants did not decompose, but their remains retained their carbon chains and energy content in anaerobic (oxygen-starved) environments at the bottom of swamps and shallow seas; as the sediments piled on, the plant remains were compressed and subjected to increasing heat and pressure for tens of millions of years.

Artist's rendition of an ancient forest in the Carboniferous Period, from which originated vast seams of coal around the Earth.

Now humanity is using up the lion's share of these fossil fuels in a couple of centuries, a mere wink of the eye in the long sweep of geologic time. Figure 1 (lower right) depicting Hydrocarbon Man is inspired by petroleum geologist M. King Hubbert's "pimple" or peak. A day will come — although it appears to have been delayed by some decades due to the advent of the drilling and production technique known as hydraulic fracturing ("hydrofracking") — on which production of petroleum will reach a peak and then begin to fall. Whether or not that loss of energy, and the innumerable contributions it makes to human well-being, will or can be replaced by affordable, renewable, sustainable, environmentally friendly (that's a lot of qualifiers!) substitutes is the burning question, not just of the day, but of the century, and indeed, of all time. For if our civilization fails to replace fossil fuels as they are depleted, then our civilization itself will fail.

In his 1998 book, *The Last Hours of Ancient Sunlight*, author and radio host Thom Hartmann has written eloquently and elegiacally of the predicament contemporary humankind faces. Hartmann writes:

> We have created this overcrowded world of overtaxed resources by consuming ancient sunlight, converting it into contemporary foods, and consuming those foods to create more human flesh. Without this ancient sunlight, the planet could perhaps sustain between a quarter of a billion and one billion humans — the number it did support prior to the discovery of oil and coal. Without oil and coal, however, the other five billion would starve.

Since Hartmann wrote these worrisome words two decades ago, about one and a half billion more people have been crammed onto the Earth, adding to the burden the planet must bear. We're pouring more water into the proverbial pressure cooker and turning up the temperature.

REACHING TO THE DEPTHS, ENDS OF THE EARTH TO FEED OUR INSATIABLE APPETITE FOR ENERGY

Supplying the massive energy demand of a nation of 327 million voracious American consumers would be no easy task even if our population were stable and non-growing. After all, each year we consume prodigious quantities of gasoline, diesel, jet fuel, heating oil, kerosene, natural gas, coal, and other hydrocarbons; all told, these fossil fuels supply more than 80 percent of our total primary energy consumption. They are energy-dense, versatile, and absolutely vital to our (unsustainable) way of life.

Even to maintain a constant level of fossil energy consumption at current high levels would be well nigh impossible over the long run, because high-quality, inexpensive, accessible (that is, conventional) stocks of fossil fuels are being inexorably depleted. These conventional fuels must then be replaced by lower-quality, costlier, less accessible, non-conventional, and sometimes even dangerous fossil resources or by capital-intensive and intermittent renewables (primarily wind and solar), most of which generate electricity, not the liquid fuels so crucial for transportation.

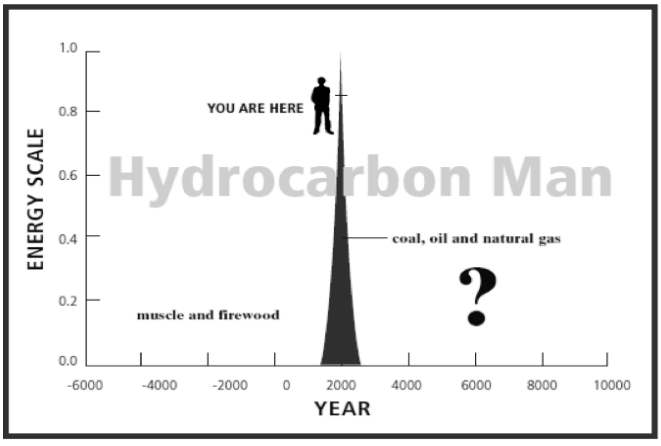


Figure 1. Whither Hydrocarbon Man?

This is why we hear more and more of disasters like the tragic and deadly 2010 Deepwater Horizon explosion and massive oil spill in the Gulf of Mexico, and of environmentally dubious energy sources such as shale gas, tar sands, oil shale, tight oil, heavy oil, and Arctic oil. It is why destructive methods like mountaintop removal (denounced as "strip mining on steroids") to reach deep coal seams and potentially harmful methods like hydrofracking to obtain shale gas and tight oil are becoming more and more commonplace, in spite of their grave risks and higher environmental and economic costs (Figure 2).

Figure 2. Mountaintop removal coal mining in West Virginia

We are not only scouring the very ends of the earth for every last retrievable scrap and drop of hydrocarbons, we are using ever more powerful and energy-intensive technologies, equipment, and methods to wring, wrest, cajole, and squeeze tightly gripped fossil fuels from the very fabric of the planet's crust.

It takes energy to extract or "recover" energy, as well as to process, refine, or mill it, and as the quality or density of carbon-based energy resources declines — as the "low-hanging fruit" is inevitably used up — the ratio of energy output to energy input declines as well. Energy analysts refer to this as a declining Energy Return on Energy Invested (EROEI). EROEI is a concept that every educated American should grasp, because it relates to how much net or surplus energy is actually left over from the energy production process to heat, cool, and light our homes, offices, and schools, and to run our vehicles and factories; to generate electricity; in sum, to run our economy and our lives.

The EROEI of fossil fuels is in gradual but terminal decline. Without a doubt, a day is approaching later this century when oil, gas, and coal will supply no more than a small fraction of our energy needs at most, but not because they are all used up. That day will come when the EROEI drops to a certain threshold, below which it will no longer behoove us to drill, pump, and blast to recover what remains underground.

As astute analysts like the Post Carbon Institute's Richard Heinberg have pointed out, we will never "run out" of the fossil fuels per se; there will always be coal, oil, and gas left in the ground, vast quantities indeed, but only because it will be too expensive economically and/or energetically to extract these fuels. Their EROEI is too low. That is the point of the "Resource Pyramid" diagram (Figure 3). The conventional resources we have been mining, drilling, and pumping are at the apex of the pyramid; these are the "cream of the crop," the highest-quality, densest fuels with the largest net energy. Down below, at the base of the resource pyramid, are enormous *in situ* volumes of unconventional resources with much lower net energy. Extracting these entails higher and higher economic, environmental, and energy cost. At some point, the costs exceed the benefits, and it's not worth it or even possible anymore.

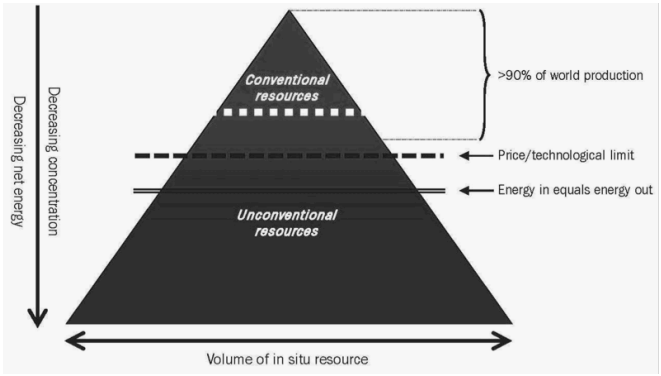


Figure 3. Resource Pyramid Showing Petroleum Resource Volume vs. Resource Quality. Source: *Drill Baby Drill: Can Unconventional Resources Usher in a New Era of Energy Abundance?*, by J. David Hughes, 2013, Post Carbon Institute

ENTER FRACKING TECHNOLOGIES: SAVIORS OR SIRENS?

David Hughes is a veteran earth scientist at the Post Carbon Institute (PCI) who previously spent three decades as a scientist and research manager with the Geological Survey of Canada, studying the energy resources of our northern neighbor. Hughes writes in his 2018 PCI report *Shale Reality Check* that as recently as 2005, U.S. oil and gas production were widely accepted to be in terminal decline. Indeed, U.S. domestic crude oil production had peaked more than three decades earlier. Increasing U.S. domestic oil consumption was boosted only by larger and larger imports, often from politically volatile regions like the Middle East, kleptocracies like Nigeria, and hostile powers like socialist Hugo Chavez's Venezuela. These imports supported the extravagant American energy expenditures and luxurious lifestyles

former Vice-President Dick Cheney once declared as "non-negotiable."

Then, the abrupt appearance of hydraulic fracturing (fracking), in combination with horizontal drilling, changed everything. It allowed the exploitation of oil and gas resources long known to exist in large but dispersed quantities in impermeable source rocks, primarily shales, but for just as long believed to be unexploitable. Fracking technology was first developed and implemented in the late 1990s by Texas oilman and philanthropist George P. Mitchell, "the father of fracking," in gas plays of the Barnett Shale formation of east Texas.

Fracking technology and techniques spread rapidly to shale gas plays in other regions of the country. It was later applied to tight oil (aka shale oil), starting with the Bakken shale of North Dakota; in just the past decade, fracking has *doubled* domestic crude oil production, which had been declining for the three previous decades. America has now regained its stature as one of the leading crude oil producers in the world, and has once again become an oil exporter. How long can the shale fracking boom last and where will it all end?

It never will, according to the brash cornucopians at the *Wall Street Journal* and other worshippers at the altar of infinite growth. A 2012 *WSJ* headline crowed: "The U.S. will be the world's leading energy producer, if we allow it." President Donald J. Trump has every intention of not just allowing it, but encouraging it at every turn. When it comes to the environment and natural resources, Trump is Reagan Redux. There are no limits to what man can accomplish and how large the economy can grow, as long as government wisely knows to get out of the way of Real Men and their drilling rigs. Climate change from burning fossil fuels? Phooey! A hoax concocted by China to hogtie America.

The U.S. Department of Energy (DOE)'s Energy Information Administration (EIA) under President Trump and his Energy Secretary Rick Perry, who wanted to abolish DOE when he was governor of Texas, has quickly adopted the new party line. EIA's recent projections of oil and gas production in their *Annual Energy Outlook* publications, which for years showed declining future petroleum production, now show ever-increasing output for as far as the eye can see (Figures 4 and 5). Have we truly entered (or returned to) a glitzy new era of limitless, ever-increasing output from supposedly depletable, non-renewable natural resources? Can we turn our backs once and for all on doom-and-gloom and become Reagan's "Shining City on a Hill," or in Trump's re-boot, "Make America Great Again?"

Not so fast, argue PCI's Hughes and other knowledgeable critics such as oil tycoon Harold Hamm, researchers at MIT, Texas petroleum geologist Art Berman, and Prof. Tad Patzek, now of the King Abdullah University of Science and Technology in Saudi Arabia, and formerly of the University of Texas and UC Berkeley. For one thing, shale gas and oil reservoirs decline swiftly, with production from individual wells dropping 70–90 percent in the first three years alone. Entire field production typically declines 20–40 percent per year unless offset by constant new drilling. Thus, nonstop investment in new drilling is essential to forestall steep production declines. Mature fields like the Barnett Shale, where fracking was first pioneered just two decades ago by George Mitchell, are already in terminal decline and new drilling has virtually ceased.

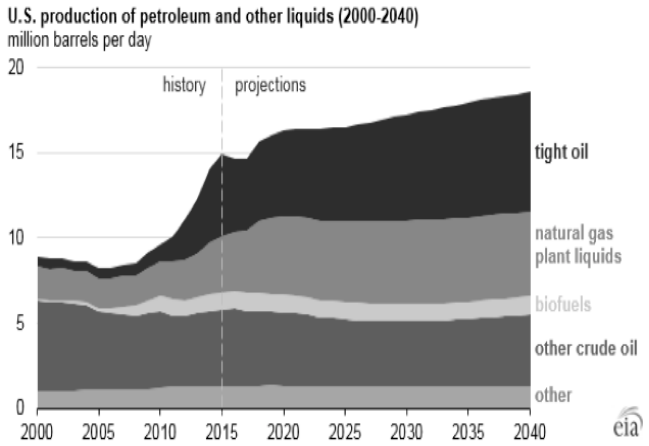
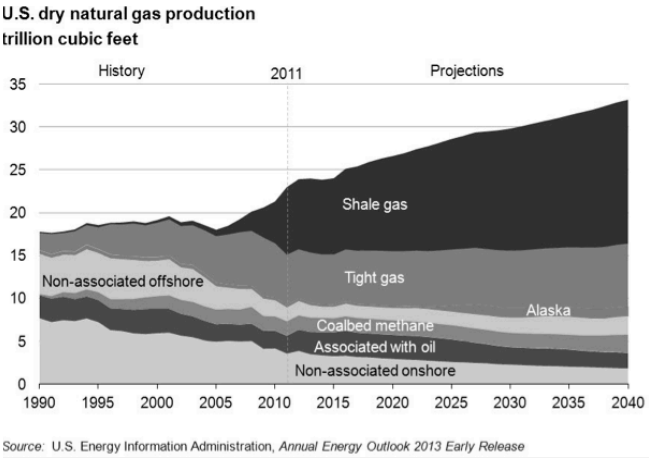


Figure 4. Domestic Petroleum Production, 2000 to 2040, according to the EIA.

As Hughes points out, shale plays also show highly variable reservoir quality; so-called "sweet spots" containing the highest quality reservoir rock typically comprise just 20 percent or less of the overall play area. In the post-2014 era of relatively low oil prices, drilling has understandably focused on sweet spots which contain the most economically viable wells.



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2013 Early Release*

Figure 5. Domestic Natural Gas Production, 1990 to 2040, according to the EIA.

Hughes concludes that, "EIA projections of production through 2050 at the play-level are highly to be extremely optimistic, and are therefore very unlikely to be realized."

Why does this matter? Because the lure or mirage of affordable, abundant petroleum with no end in sight not only discourages energy conservation but also investment in and commitment to alternative, renewable, climate-friendly, sustainable energy sources. Ultimately, shale oil and gas, once touted idealistically (or naively) by their boosters as "bridge fuels" to a cleaner, renewable, sustainable energy future, amount to little more than a seductive trap. In spite of the *Wall Street Journal*'s feverish fantasies and delusions, "peak oil" is a reality. We can postpone but not wish away the day of reckoning.

THE GREAT POPULATION AND ENERGY SQUEEZE: DEFERRED BUT NOT DISMISSED

As stated above, supplying the massive energy demand of a nation of 327 million voracious consumers in the face of declining EROEI would be a formidable, and perhaps insurmountable, task, even if our already enormous population were stable and non-growing. This alone would be a predicament worthy of considerable concern and herculean effort.

Yet the dilemma we actually face is far more worrisome, because in recent decades our national population has been growing by about 30 million energy consumers per decade. Just to keep per capita energy consumption constant means increasing energy and electricity production by 10 percent or so per decade — decade after decade. Yet over the long term, however long the fracking boom lasts, the energy resources that we have relied upon for the last century and a half to give us a standard of living and quality of life that are, or were, the envy of the world, will become scarcer and more costly.

We are in a bind, squeezed between increasing fossil energy scarcity and costs on the one hand, and rising energy demand on the other. In the U.S., the rising demand is virtually all from population growth, since our per capita energy consumption has been level or even declining modestly for several decades.

While there is no panacea to rescue us painlessly from that bind, America should pursue three priorities that will at least point us in the right direction: First, conserve energy and use it much more efficiently — in our vehicles, homes, and workplaces; Second, invest much more heavily in promising energy alternatives such as wind, solar, geothermal, hydro, and battery storage, and yes, even in newer generation nuclear fission; and Third, slow and then stop U.S. population growth (i.e., stabilize or reduce our population). To accomplish the latter, the U.S. fertility rate, already below replacement level, can be left alone, but bloated immigration levels, both legal and illegal, have to be reduced substantially.

This is the medicine we need to self-administer. It's eminently doable, if we acknowledge there's no getting around it. Cancer victims in chemo and radiation therapy must subject themselves to far tougher trials and tribulations. And if we opt out or procrastinate for too long, Nature itself will administer its own remedy for our excesses and hallucinations. That harsh reckoning we will surely want to avoid at all costs. ■