

The energy transition tipping point is here

The economic foundations supporting fossil fuels investments are collapsing quickly, as the business case for renewables such as solar and wind finds a new center of balance.

I have waited a long time—decades, really—for a tipping point in the energy transition from fossil fuels to renewables beyond which there can be no turning back. Fresh evidence pertaining to many themes I have explored in this column over the past three years suggests that tipping point is finally here.

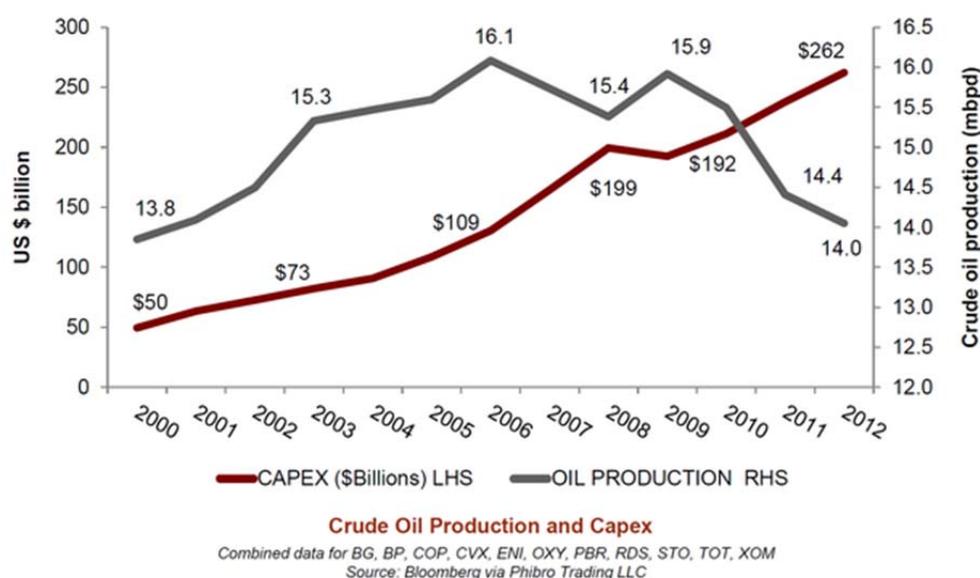
Oil and gas

Underlying the abundance hype over tight oil, tar sands and other "unconventional" sources of liquid fuel has been a dirty little secret: They're expensive.

The soaring cost of producing oil has far outpaced the rise in oil prices as the world has relied on these marginal sources to keep production growing since conventional oil production peaked in 2005. Those who ignored the hype and paid attention to the data have known this for years. I have detailed this evidence repeatedly (for example, in "[The cost of new oil supply](#)," "[Oil majors are whistling past the graveyard](#)," and "[Trouble in fracking paradise](#)"), but now the facts are earning mainstream recognition.

The *Wall Street Journal* recently [pointed out](#) that oil and gas production by Chevron, ExxonMobil and Royal Dutch Shell has declined during the past five years even as the companies spent more than a half-trillion dollars on new projects. Chevron's costs alone have jumped [56 percent since 2010](#).

A marvelous new [presentation](#) by Steven Kopits, Managing Director of the Douglas-Westwood consultancy, details oil supply, demand, cost and price trends with merciless precision. If you can take an hour to watch Kopits' presentation I highly recommend it, as it's the most comprehensive perspective you'll find on the global dynamics of oil.



The graphic above shows how capital spending (capex) by the world's publicly listed oil majors has increased by more than a factor of five since 2000, while their production of oil has fallen back to the 2000 level after a few years of very modest increases. In Kopits' earthy metaphor, the companies kept watering the plant but it just wouldn't grow anymore—precisely [as the peak oil model predicted](#).

In late February, [Bloomberg finally addressed](#) the most problematic issue in shale gas and tight oil wells: their incredible decline rates and diminishing prospects for drilling in the most-profitable "sweet spots" of the shale plays. I have documented that issue at length (for example, "[Oil and gas price forecast for 2014](#)," "[Energy independence, or impending oil shocks?](#)," "[The murky future of U.S. shale gas](#)," and [my Financial Times critique](#) of Leonardo Maugeri's widely heralded 2012 report).

The sources for the *Bloomberg* article are shockingly candid about the difficulties facing the shale sector, considering that their firms have been at the forefront of shale hype.

The vice president of integration at oil services giant Schlumberger notes that four out of every 10 frack clusters are duds. Geologist Pete Stark, a vice president of industry relations at IHS—yes, that IHS, where famous peak oil pooh-pooher [Daniel Yergin](#) is the spokesman for its CERA unit—actually said what we in the peak oil camp have been saying for years: "The decline rate is a potential show stopper after a while...You just can't keep up with it."

The CEO of Superior Energy Services was particularly pithy: "We've drilled all the good stuff...These are very poor quality formations that I don't believe God intended for us to produce from the source rock." Source rocks, as [I wrote last month](#), are an oil and gas "retirement party," not a revolution.

The toxic combination of rising production costs, the rapid decline rates of the wells, diminishing prospects for drilling new wells, and a drilling program so out of control that it caused a glut and destroyed profitability, have finally taken their toll.

Numerous operators are taking major write-downs against reserves. [WPX Energy](#), an operator in the Marcellus shale gas play, and Pioneer Natural Resources, an operator in the Barnett shale gas play, each have announced balance sheet "impairments" of more than \$1 billion due to low gas prices. Chesapeake Energy, Encana, Apache, Anadarko Petroleum, BP, and BHP Billiton have disclosed similar substantial reserves reductions. Occidental Petroleum, which has made the most significant attempts to frack California's Monterey Shale, [announced](#) that it will spin off that unit to focus on its core operations—something it would not do if the Monterey prospects were good. EOG Resources, one of the top tight oil operators in the United States, [recently said](#) that it no longer expects U.S. production to rise by 1 million barrels per day (mb/d) each year, in accordance with my [2014 oil and gas price forecast](#).

Coal and nuclear

When I wrote "[Why baseload power is doomed](#)" and "[Regulation and the decline of coal power](#)" in 2012, the suggestion that renewables might displace baseload power sources like coal and nuclear plants was generally received with ridicule. How could "intermittent" power sources with just a few percentage points of market share possibly hurt the deeply entrenched, reliable, fully amortized infrastructure of power generation?

But look where we are today. Coal plants are being retired much faster than most observers expected. The [latest projection](#) from the U.S. Energy Information Administration (EIA) is for 60 gigawatts (GW) of coal-fired power capacity to be taken offline by 2016, [more than double](#) the retirements the agency predicted in 2012. The vast majority of the coal plants that were planned for the United States in 2007 have since been cancelled, abandoned, or put on hold, [according to SourceWatch](#).

Nuclear power plants were also [given the kibosh](#) at an unprecedented rate last year. More nuclear plant retirements appear to be on the way. Earlier this month, utility giant Exelon, the nation's largest owner of nuclear plants, [warned](#) that it will shut down nuclear plants if the prospects for their profitable operation don't improve this year.

Japan has just [announced](#) a draft plan that would restart its nuclear reactors, but the plan is "vague" and, to my expert nose, stinks of political machinations. What we do know is that the country has [abandoned its plans](#) to build a next-generation "fast breeder" reactor due to mounting technical challenges and skyrocketing costs.

Grid competition

Nuclear and coal plant retirements are being driven primarily by competition from lower-cost wind, solar, and natural gas generators, and by rising operational and maintenance costs. As more re-

newable power is added to the grid, the economics continue to worsen for utilities clinging to old fossil-fuel generating assets (a topic I have covered at length; for example, "[Designing the grid for renewables](#)," "[The next big utility transformation](#)," "[Can the utility industry survive the energy transition?](#)" "[Adapt or die - private utilities and the distributed energy juggernaut](#)" and "[The unstoppable renewable grid](#)").

Nowhere is this more evident than in Germany, which now obtains about 25 percent of its grid power from renewables and which has the most solar power per capita in the world. I have long viewed Germany's transition to renewables (see "[Myth-busting Germany's energy transition](#)") as a harbinger of what is to come for the rest of the developed world as we progress down the path of energy transition.

And what's to come for the utilities isn't good. Earlier this month, *Reuters* reported that Germany's three largest utilities, E.ON, RWE, and EnBW are struggling with what the CEO of RWE called "the worst structural crisis in the history of energy supply." Falling consumption and growing renewable power have cut the wholesale price of electricity by 60 percent since 2008, making it unprofitable to continue operating coal, gas and oil-fired plants. E.ON and RWE have announced intentions to close or mothball 15 GW of gas and coal-fired plants. Additionally, the three major utilities still have a combined 12 GW of nuclear plants scheduled to retire by 2020 under Germany's nuclear phase-out program.

RWE said it will write down nearly \$4 billion on those assets, but the pain doesn't end there. Returns on invested capital at the three utilities are expected to fall from an average of 7.7 percent in 2013 to 6.5 percent in 2015, which will only increase the likelihood that pension funds and other fixed-income investors will look to exchange traditional utility company holdings for "[green bonds](#)" invested in renewable energy. The green bond sector is growing rapidly, and there's no reason to think it will slow down. Bond issuance jumped from \$2 billion in 2012 to \$11 billion in 2013, and the now-\$15 billion market is expected to [nearly double again this year](#).

A [new report](#) from the Rocky Mountain Institute and CohnReznick about consumers "defecting" from the grid using solar and storage systems concludes that the combination is a "real, near and present" threat to utilities. By 2025, according to the authors, millions of residential users could find it economically advantageous to give up the grid. In his [excellent article](#) on the report, Stephen Lacey notes that lithium-ion battery costs have fallen by half since 2008. With technology wonder-kind Elon Musk's new [announcement](#) that his car company Tesla will raise up to \$5 billion to build the world's biggest "Gigafactory" for the batteries, their costs fall even farther. At the same time, the average price of an installed solar system has fallen by 61 percent since the first quarter of 2010.

At least some people in the utility sector agree that the threat is real. Speaking in late February at the ARPA-E Energy Summit, CEO David Crane of NRG Energy suggested that the grid will be obsolete and used only for backup within a generation, calling the current system "[shockingly stupid](#)."

Non-hydro renewables are outpacing nuclear and fossil fuel capacity additions in much of the world, wreaking havoc with the incumbent utilities' business models. The value of Europe's top 20 utilities has been halved since 2008, and their credit ratings have been downgraded. According to [The Economist](#), utilities have been the worst-performing sector in the Morgan Stanley index of global share prices. Only utilities nimble enough to adopt [new revenue models](#) providing a range of services and service levels, including efficiency and self-generation, will survive.

In addition to distributed solar systems, utility-scale renewable power plants are popping up around the world like spring daisies. [Ivanpah](#), the world's largest solar "power tower" at 392 megawatts (MW), just went online in Nevada. [Aura Solar I](#), the largest solar farm in Latin America at 30 MW, is under construction in Mexico and will replace an old oil-fired power plant. India just opened its largest solar power plant to date, the 130 MW [Welspun Solar MP](#) project. Solar is increasingly seen as the best way to provide electricity to power-impooverished parts of the world, and growth is expected to be stunning in Latin America, India and Africa.

Renewable energy now supplies [23 percent](#) of global electricity generation, according to the National Renewable Energy Laboratory, with capacity having doubled from 2000 to 2012. If that growth rate continues, it could become the dominant source of electricity by the next decade.

Environmental disasters

Faltering productivity, falling profits, poor economics and increasing competition from power plants running on free fuel aren't the only problems facing the fossil-fuels complex. It has also been the locus of increasingly frequent environmental disasters.

On Feb. 22, a barge hauling oil collided with a towboat and spilled an estimated [31,500 gallons](#) of light crude into the Mississippi River, closing 65 miles of the waterway for two days.

More waterborne spills are to be expected along with more [exploding trains](#) as crude oil from sources like the Bakken shale seeks alternative routes to market while the Keystone XL pipeline continues to fight an uphill political battle. According to the Association of American Railroads, the number of tank cars shipping oil jumped from about 10,000 in 2009 to more than [230,000 in 2012](#), and more oil spilled from trains in 2013 [than in the previous four decades](#) combined.

Federal regulators issued [emergency rules](#) on Feb. 25 requiring Bakken crude to undergo testing to see if it is too flammable to be moved safely by rail, but I am not confident this measure will eliminate the risk. Light, tight oil from U.S. shales tends to contain more light molecules such as natural gas liquids than conventional U.S. crude grades, and is more volatile.

Feb. 11 will go down in history as a marquee [bad day for fossil fuels](#), on which 100,000 gallons of coal slurry spilled into a creek in West Virginia; a natural gas well in Dilliner, Pa., exploded (and burned for two weeks before it was put out); and a natural gas pipeline ruptured and exploded in Tioga, ND. Two days later, another [natural gas line exploded](#) in the town of Knifely, Ky., igniting multiple fires and destroying several homes, barns, and cars. The same day, another train carrying crude oil [derailed](#) near Pittsburgh, spilling between 3,000 and 7,500 gallons of crude oil.

And don't forget the [spill of 10,000 gallons](#) of toxic chemicals used in coal processing from a leaking tank in West Virginia in early January, which sickened residents of Charleston and rendered its water supply unusable.

No return

At this point you may think, "Well, this is all very interesting, Chris, but why should we believe we've reached some sort of tipping point in energy transition?"

To which I would say, ask yourself: Is any of this reversible?

Is there any reason to think the world will turn its back on plummeting costs for solar systems, batteries, and wind turbines, and revert back to nuclear and coal?

Is there any reason to think we won't see more ruptures and spills from oil and gas pipelines?

What about the [more than 1,300](#) coal-ash waste sites scattered across the United States, of which about half are no longer used and some are lacking adequate liners? How confident are we that authorities will suddenly find the will, after decades of neglect, to ensure that they'll not cause further contamination after damaging drinking water supplies in at least 67 instances so far, such that we feel confident about continuing to rely on coal power?

Like the disastrous natural gas pipeline that exploded in 2010 and turned an entire neighborhood in San Bruno, Calif., into a raging inferno, coal-ash waste sites are but one part of a deep and growing problem shot through the entire fabric of America: [aging infrastructure and deferred maintenance](#). President Obama just outlined his vision for a \$302 billion, four-year program of investment in transportation, but that's just a drop in the bucket, and it's only for transportation.

Is there any reason to think citizens will brush off the death, destruction, environmental contamination of these disasters—many of them happening in the backyards of rural, red-state voters—and not take a second look at clean power?

Is there any reason to believe utilities will swallow several trillion dollars worth of stranded assets and embrace new business models en masse? Or is it more likely that those that can will simply adopt solar, storage systems, and other measures that ultimately give them cheaper and more reliable power, particularly in the face of increasingly frequent climate-related disasters that take out their grid power for days or weeks?

Is there any reason to think the billions of people in the world who still lack reliable electric power will continue to rely on filthy diesel generators and kerosene lanterns as the price of oil continues to

rise? Or are they more likely to adopt alternatives like the SolarAid solar lanterns, of which [half a million](#) have been sold across Africa in the past six months alone? (Here's a hint: Nobody who has one wants to go back to their kerosene lantern.) Founder Jeremy Leggett of SunnyMoney, who created the SolarAid lanterns, intends to sell 50 million of them across Africa by 2020.

Is there any reason to believe solar and wind will not continue to be the preferred way to [bring power to the developing world](#), when their fuel is free and conventional alternatives are getting scarcer and more expensive?

Is there any reason a homeowner might not think about putting a solar system on his or her roof, without taking a single dollar out of his or her pocket, and using it to charge up an electric vehicle instead of buying gasoline?

Is there any reason to think that drilling for shale gas and tight oil in the United States will suddenly resume its former rapid growth rates, when new well locations are getting harder to find, investment by the oil and gas companies is being slashed, share prices are falling, reserves are getting taken off balance sheets and investors are getting nervous?

I don't think so. All of these trends have been developing for decades, and new data surfacing daily only reinforces them.

The energy transition tipping point is here, and there's no going back.

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