March 17, 2015

We have a bunch of stuff on fossil fuels and how they will save the world. **WSJ Weekend Essay** is first.

The environmental movement has advanced three arguments in recent years for giving up fossil fuels: (1) that we will soon run out of them anyway; (2) that alternative sources of energy will price them out of the marketplace; and (3) that we cannot afford the climate consequences of burning them.

These days, not one of the three arguments is looking very healthy. In fact, a more realistic assessment of our energy and environmental situation suggests that, for decades to come, we will continue to rely overwhelmingly on the fossil fuels that have contributed so dramatically to the world's prosperity and progress.

In 2013, about 87% of the energy that the world consumed came from fossil fuels, a figure that—remarkably—was unchanged from 10 years before. This roughly divides into three categories of fuel and three categories of use: oil used mainly for transport, gas used mainly for heating, and coal used mainly for electricity.

Over this period, the overall volume of fossil-fuel consumption has increased dramatically, but with an encouraging environmental trend: a diminishing amount of carbon-dioxide emissions per unit of energy produced. The biggest contribution to decarbonizing the energy system has been the switch from high-carbon coal to lower-carbon gas in electricity generation.

On a global level, renewable energy sources such as wind and solar have contributed hardly at all to the drop in carbon emissions, and their modest growth has merely made up for a decline in the fortunes of zero-carbon nuclear energy. ...

... Although the world has certainly warmed since the 19th century, the rate of warming has been slow and erratic. There has been no increase in the frequency or severity of storms or droughts, no acceleration of sea-level rise. Arctic sea ice has decreased, but Antarctic sea ice has increased. At the same time, scientists are agreed that the extra carbon dioxide in the air has contributed to an improvement in crop yields and a roughly 14% increase in the amount of all types of green vegetation on the planet since 1980.

That carbon-dioxide emissions should cause warming is not a new idea. In 1938, the British scientist Guy Callender thought that he could already detect warming as a result of carbon-dioxide emissions. He reckoned, however, that this was "likely to prove beneficial to mankind" by shifting northward the climate where cultivation was possible.

Only in the 1970s and 1980s did scientists begin to say that the mild warming expected as a direct result of burning fossil fuels—roughly a degree Celsius per doubling of carbon-dioxide concentrations in the atmosphere—might be greatly amplified by water vapor and result in dangerous warming of two to four degrees a century or more. That "feedback" assumption of high "sensitivity" remains in virtually all of the mathematical models used to this day by the U.N. Intergovernmental Panel on Climate Change, or IPCC.

And yet it is increasingly possible that it is wrong. As Patrick Michaels of the libertarian Cato Institute has written, since 2000, 14 peer-reviewed papers, published by 42 authors, many of

whom are key contributors to the reports of the IPCC, have concluded that climate sensitivity is low because net feedbacks are modest. They arrive at this conclusion based on observed temperature changes, ocean-heat uptake and the balance between warming and cooling emissions (mainly sulfate aerosols). On average, they find sensitivity to be 40% lower than the models on which the IPCC relies. ...

... We should encourage the switch from coal to gas in the generation of electricity, provide incentives for energy efficiency, get nuclear power back on track and keep developing solar power and electricity storage. We should also invest in research on ways to absorb carbon dioxide from the air, by fertilizing the ocean or fixing it through carbon capture and storage. Those measures all make sense. And there is every reason to promote open-ended research to find some unexpected new energy technology.

The one thing that will not work is the one thing that the environmental movement insists upon: subsidizing wealthy crony capitalists to build low-density, low-output, capital-intensive, land-hungry renewable energy schemes, while telling the poor to give up the dream of getting richer through fossil fuels.

Also from the **Wall Street Journal** we learn a new wave of fracked oil is held in reserve by producers and will hit the market when prices stabilize.

The ocean of oil from U.S. shale drove crude prices back toward six-year lows Friday, and American energy companies say they are poised to unleash a further flood that would keep prices from returning to lofty levels for a long time.

The International Energy Agency reinforced the prospect of a prolonged slump in energy prices Friday, saying U.S. oil output was surprisingly strong in February and rapidly filling all available storage tanks. The Paris-based energy watchdog said this could lead to another sharp drop in crude prices, which fell by about 50% late last year.

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companies store oil in the ground in a way that enables them to tap it unusually quickly if they wish—and flood the market again. ...

Walter Issacson writes on innovation.

... Some of those advances seem almost trivial, but progress comes not only in great leaps but also from hundreds of small steps. Take for example punch cards, like those Babbage saw on [weaving] looms and proposed incorporating into his Analytical Engine. Perfecting the use of punch cards for computers came about because Herman Hollerith, an employee of the U.S. Census Bureau, was appalled that it took close to eight years to manually tabulate the 1880 census. He resolved to automate the 1890 count.

Drawing on the way that railway conductors punched holes in various places on a ticket in order to indicate the traits of each passenger (gender, approximate height, age, hair color), Hollerith devised punch cards with twelve rows and twenty-four columns that recorded the salient facts about each person in the census. The cards were then slipped between a grid of mercury cups and a set of spring-loaded pins, which created an electric circuit wherever there was a hole. The machine could tabulate not only the raw totals but also combinations of traits, such as the number of married males or foreign-born females. Using Hollerith's tabulators, the 1890 census was completed in one year rather than eight. It was the first major use of electrical circuits to process information, and the company that Hollerith founded became in 1924, after a series of mergers and acquisitions, the International Business Machines Corporation, or IBM.

One way to look at innovation is as the accumulation of hundreds of small advances, such as counters and punch-card readers. At places like IBM, which specialize in daily improvements made by teams of engineers, this is the preferred way to understand how innovation really happens. Some of the most important technologies of our era, such as the fracking techniques developed over the past six decades for extracting natural gas, came about because of countless small innovations as well as a few breakthrough leaps. ...

Steve Hayward posts on the closing of Sweet Briar College.

Along with the OU expulsions, the big story in higher education over the last week or so is the surprise announcement that Sweet Briar College will be closing its doors at the end of this academic year. Although the college as an endowment somewhere near $90 million, declining enrollment at the all-womens' college has led the trustees to conclude that there is no future for a single-sex school out in rural Virginia. Sweet Briar's fate is being heralded as a harbinger of the coming collapse of the "higher education bubble" (Glenn Reynolds™), especially small liberal arts colleges, which wouldn't necessarily be a bad thing.

But there is an amazing failure of imagination here—rooted in the institutional liberalism pervasive in higher ed—and a terrific opportunity for an educational entrepreneur.

One of the claims about why the college has no future is that its location is too remote from the attractions of urban civilization necessary for today's students. Excuse me, but has anyone around Sweet Briar ever heard of Hillsdale College, which is much more remote than Sweet Briar, and yet

thrives for the simple reason that it is self-consciously different (that is, conservative) from other liberal arts colleges.

So what if Sweet Briar had decided that instead of trying to compete head-to-head with Smith and Wellesley, they self-consciously set out to be the anti-Smith and anti-Wellesley? I have little doubt that a women's college that advertised its deliberate rejection of the gender politics of "mainstream" womens' educational institutions would have no shortage of applicants for admission.

This would have required an act of imagination on the part of Sweet Briar's president, James F. Jones, Jr., and the trustees. But of course Jones is your typical mediocre liberal. ...

WSJ

Fossil Fuels Will Save the World (Really)

There are problems with oil, gas and coal, but their benefits for people—and the planet—are beyond dispute

by Matt Ridley

Workers tend to a well head during a hydraulic fracturing operation outside Rifle, Colo., on March 29, 2013. Increased production has driven down oil prices.

The environmental movement has advanced three arguments in recent years for giving up fossil fuels: (1) that we will soon run out of them anyway; (2) that alternative sources of energy will price

them out of the marketplace; and (3) that we cannot afford the climate consequences of burning them.

These days, not one of the three arguments is looking very healthy. In fact, a more realistic assessment of our energy and environmental situation suggests that, for decades to come, we will continue to rely overwhelmingly on the fossil fuels that have contributed so dramatically to the world's prosperity and progress.

In 2013, about 87% of the energy that the world consumed came from fossil fuels, a figure that—remarkably—was unchanged from 10 years before. This roughly divides into three categories of fuel and three categories of use: oil used mainly for transport, gas used mainly for heating, and coal used mainly for electricity.

Over this period, the overall volume of fossil-fuel consumption has increased dramatically, but with an encouraging environmental trend: a diminishing amount of carbon-dioxide emissions per unit of energy produced. The biggest contribution to decarbonizing the energy system has been the switch from high-carbon coal to lower-carbon gas in electricity generation.

On a global level, renewable energy sources such as wind and solar have contributed hardly at all to the drop in carbon emissions, and their modest growth has merely made up for a decline in the fortunes of zero-carbon nuclear energy. (The reader should know that I have an indirect interest in coal through the ownership of land in Northern England on which it is mined, but I nonetheless applaud the displacement of coal by gas in recent years.)

The argument that fossil fuels will soon run out is dead, at least for a while. The collapse of the price of oil over the past six months is the result of abundance: an inevitable consequence of the high oil prices of recent years, which stimulated innovation in hydraulic fracturing, horizontal drilling, seismology and information technology. The U.S.—the country with the oldest and most developed hydrocarbon fields—has found itself once again, surprisingly, at the top of the energy-producing league, rivaling Saudi Arabia in oil and Russia in gas.

The shale genie is now out of the bottle. Even if the current low price drives out some high-cost oil producers—in the North Sea, Canada, Russia, Iran and offshore, as well as in America—shale drillers can step back in whenever the price rebounds. As Mark Hill of Allegro Development Corporation argued last week, the frackers are currently experiencing their own version of Moore's law: a rapid fall in the cost and time it takes to drill a well, along with a rapid rise in the volume of hydrocarbons they are able to extract.

And the shale revolution has yet to go global. When it does, oil and gas in tight rock formations will give the world ample supplies of hydrocarbons for decades, if not centuries. Lurking in the wings for later technological breakthroughs is methane hydrate, a seafloor source of gas that exceeds in quantity all the world's coal, oil and gas put together.

So those who predict the imminent exhaustion of fossil fuels are merely repeating the mistakes of the U.S. presidential commission that opined in 1922 that "already the output of gas has begun to wane. Production of oil cannot long maintain its present rate." Or President Jimmy Carter when he announced on television in 1977 that "we could use up all the proven reserves of oil in the entire world by the end of the next decade."

That fossil fuels are finite is a red herring. The Atlantic Ocean is finite, but that does not mean that you risk bumping into France if you row out of a harbor in Maine. The buffalo of the American West were infinite, in the sense that they could breed, yet they came close to extinction. It is an ironic

truth that no nonrenewable resource has ever run dry, while renewable resources—whales, cod, forests, passenger pigeons—have frequently done so.

The second argument for giving up fossil fuels is that new rivals will shortly price them out of the market. But it is not happening. The great hope has long been nuclear energy, but even if there is a rush to build new nuclear power stations over the next few years, most will simply replace old ones due to close. The world's nuclear output is down from 6% of world energy consumption in 2003 to 4% today. It is forecast to inch back up to just 6.7% by 2035, according the Energy Information Administration.

Nuclear's problem is cost. In meeting the safety concerns of environmentalists, politicians and regulators added requirements for extra concrete, steel and pipework, and even more for extra lawyers, paperwork and time. The effect was to make nuclear plants into huge and lengthy boondoggles with no competition or experimentation to drive down costs. Nuclear is now able to compete with fossil fuels only when it is subsidized.

As for renewable energy, hydroelectric is the biggest and cheapest supplier, but it has the least capacity for expansion. Technologies that tap the energy of waves and tides remain unaffordable and impractical, and most experts think that this won't change in a hurry. Geothermal is a minor player for now. And bioenergy—that is, wood, ethanol made from corn or sugar cane, or diesel made from palm oil—is proving an ecological disaster: It encourages deforestation and food-price hikes that cause devastation among the world's poor, and per unit of energy produced, it creates even more carbon dioxide than coal.

Wind power, for all the public money spent on its expansion, has inched up to—wait for it—1% of world energy consumption in 2013. Solar, for all the hype, has not even managed that: If we round to the nearest whole number, it accounts for 0% of world energy consumption.

Both wind and solar are entirely reliant on subsidies for such economic viability as they have. World-wide, the subsidies given to renewable energy currently amount to roughly $10 per gigajoule: These sums are paid by consumers to producers, so they tend to go from the poor to the rich, often to landowners (I am a landowner and can testify that I receive and refuse many offers of risk-free wind and solar subsidies).

It is true that some countries subsidize the use of fossil fuels, but they do so at a much lower rate—the world average is about $1.20 per gigajoule—and these are mostly subsidies for consumers (not producers), so they tend to help the poor, for whom energy costs are a disproportionate share of spending.

The costs of renewable energy are coming down, especially in the case of solar. But even if solar panels were free, the power they produce would still struggle to compete with fossil fuel—except in some very sunny locations—because of all the capital equipment required to concentrate and deliver the energy. This is to say nothing of the great expanses of land on which solar facilities must be built and the cost of retaining sufficient conventional generator capacity to guarantee supply on a dark, cold, windless evening.

The two fundamental problems that renewables face are that they take up too much space and produce too little energy. Consider Solar Impulse, the solar-powered airplane now flying around the world. Despite its huge wingspan (similar to a 747), slow speed and frequent stops, the only cargo that it can carry is the pilots themselves. That is a good metaphor for the limitations of renewables.

To run the U.S. economy entirely on wind would require a wind farm the size of Texas, California and New Mexico combined—backed up by gas on windless days. To power it on wood would require a forest covering two-thirds of the U.S., heavily and continually harvested.

John Constable, who will head a new Energy Institute at the University of Buckingham in Britain, points out that the trickle of energy that human beings managed to extract from wind, water and wood before the Industrial Revolution placed a great limit on development and progress. The incessant toil of farm laborers generated so little surplus energy in the form of food for men and draft animals that the accumulation of capital, such as machinery, was painfully slow. Even as late as the 18th century, this energy-deprived economy was sufficient to enrich daily life for only a fraction of the population.

Our old enemy, the second law of thermodynamics, is the problem here. As a teenager's bedroom generally illustrates, left to its own devices, everything in the world becomes less ordered, more chaotic, tending toward "entropy," or thermodynamic equilibrium. To reverse this tendency and make something complex, ordered and functional requires work. It requires energy.

The more energy you have, the more intricate, powerful and complex you can make a system. Just as human bodies need energy to be ordered and functional, so do societies. In that sense, fossil fuels were a unique advance because they allowed human beings to create extraordinary patterns of order and complexity—machines and buildings—with which to improve their lives.

The result of this great boost in energy is what the economic historian and philosopher Deirdre McCloskey calls the Great Enrichment. In the case of the U.S., there has been a roughly 9,000% increase in the value of goods and services available to the average American since 1800, almost all of which are made with, made of, powered by or propelled by fossil fuels.

Still, more than a billion people on the planet have yet to get access to electricity and to experience the leap in living standards that abundant energy brings. This is not just an inconvenience for them: Indoor air pollution from wood fires kills four million people a year. The next time that somebody at a rally against fossil fuels lectures you about her concern for the fate of her grandchildren, show her a picture of an African child dying today from inhaling the dense muck of a smoky fire.

Notice, too, the ways in which fossil fuels have contributed to preserving the planet. As the American author and fossil-fuels advocate Alex Epstein points out in a bravely unfashionable book, "The Moral Case for Fossil Fuels," the use of coal halted and then reversed the deforestation of Europe and North America. The turn to oil halted the slaughter of the world's whales and seals for their blubber. Fertilizer manufactured with gas halved the amount of land needed to produce a given amount of food, thus feeding a growing population while sparing land for wild nature.

To throw away these immense economic, environmental and moral benefits, you would have to have a very good reason. The one most often invoked today is that we are wrecking the planet's climate. But are we?

Although the world has certainly warmed since the 19th century, the rate of warming has been slow and erratic. There has been no increase in the frequency or severity of storms or droughts, no acceleration of sea-level rise. Arctic sea ice has decreased, but Antarctic sea ice has increased. At the same time, scientists are agreed that the extra carbon dioxide in the air has contributed to an improvement in crop yields and a roughly 14% increase in the amount of all types of green vegetation on the planet since 1980.

That carbon-dioxide emissions should cause warming is not a new idea. In 1938, the British scientist Guy Callender thought that he could already detect warming as a result of carbon-dioxide emissions. He reckoned, however, that this was “likely to prove beneficial to mankind” by shifting northward the climate where cultivation was possible.

Only in the 1970s and 1980s did scientists begin to say that the mild warming expected as a direct result of burning fossil fuels—roughly a degree Celsius per doubling of carbon-dioxide concentrations in the atmosphere—might be greatly amplified by water vapor and result in dangerous warming of two to four degrees a century or more. That “feedback” assumption of high “sensitivity” remains in virtually all of the mathematical models used to this day by the U.N. Intergovernmental Panel on Climate Change, or IPCC.

And yet it is increasingly possible that it is wrong. As Patrick Michaels of the libertarian Cato Institute has written, since 2000, 14 peer-reviewed papers, published by 42 authors, many of whom are key contributors to the reports of the IPCC, have concluded that climate sensitivity is low because net feedbacks are modest. They arrive at this conclusion based on observed temperature changes, ocean-heat uptake and the balance between warming and cooling emissions (mainly sulfate aerosols). On average, they find sensitivity to be 40% lower than the models on which the IPCC relies.

If these conclusions are right, they would explain the failure of the Earth’s surface to warm nearly as fast as predicted over the past 35 years, a time when—despite carbon-dioxide levels rising faster than expected—the warming rate has never reached even two-tenths of a degree per decade and has slowed down to virtually nothing in the past 15 to 20 years. This is one reason the latest IPCC report did not give a “best estimate” of sensitivity and why it lowered its estimate of near-term warming.

Most climate scientists remain reluctant to abandon the models and take the view that the current “hiatus” has merely delayed rapid warming. A turning point to dangerously rapid warming could be around the corner, even though it should have shown up by now. So it would be wise to do something to cut our emissions, so long as that something does not hurt the poor and those struggling to reach a modern standard of living.

We should encourage the switch from coal to gas in the generation of electricity, provide incentives for energy efficiency, get nuclear power back on track and keep developing solar power and electricity storage. We should also invest in research on ways to absorb carbon dioxide from the air, by fertilizing the ocean or fixing it through carbon capture and storage. Those measures all make sense. And there is every reason to promote open-ended research to find some unexpected new energy technology.

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Mr. Ridley is the author of “The Rational Optimist: How Prosperity Evolves” and a member of the British House of Lords.

WSJ

U.S. Producers Ready New Oil Wave

Even as crude plummets, energy firms are waiting to unleash more supply, capping any price gains

Pumpjacks outside Williston, N.D

The ocean of oil from U.S. shale drove crude prices back toward six-year lows Friday, and American energy companies say they are poised to unleash a further flood that would keep prices from returning to lofty levels for a long time.

The International Energy Agency reinforced the prospect of a prolonged slump in energy prices Friday, saying U.S. oil output was surprisingly strong in February and rapidly filling all available storage tanks. The Paris-based energy watchdog said this could lead to another sharp drop in crude prices, which fell by about 50% late last year.

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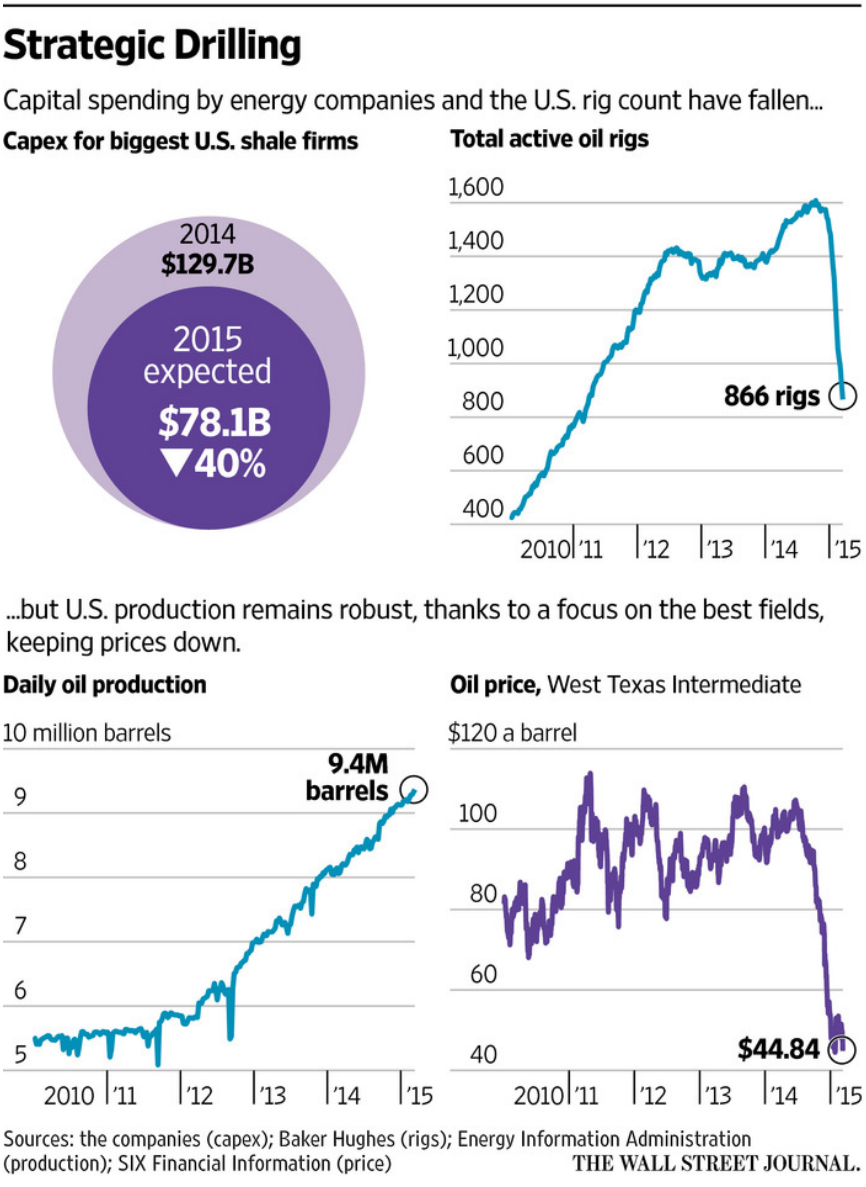
Independent shale-oil producers have slashed their planned 2015 spending on drilling by $50 billion, compared with last year's, but have promised to increase production by focusing on their best oil fields. Total U.S. crude oil production hit a high of 9.4 million barrels a day in the week ended March 6, according to federal data.

Now many are adopting a new strategy that will allow them to pump even more crude as soon as oil prices begin to rise. They are drilling wells but holding off on hydraulic fracturing, or forcing in water and chemicals to free oil from shale formations. The delay in the start of fracking lets companies store oil in the ground in a way that enables them to tap it unusually quickly if they wish—and flood the market again.

This strategy could put a cap on how high oil prices can rise once they are recovering, said Ed Morse, global head of commodities research at Citigroup Inc.

"We're in slightly unexplored territory," Mr. Morse said. "It's an experiment—a big, big experiment."



EOG Resources Inc., an oil producer based in Texas, is drilling about 285 wells that it won't start finishing off until crude oil's price rebounds to between $60 and $65 a barrel.

"When oil prices recover, EOG will be prepared to resume strong double-digit oil growth," Chief Executive Bill Thomas said recently.

Some other big names in U.S. energy also are delaying well completions, among them Anadarko Petroleum Corp., Apache Corp., Chesapeake Energy Corp. and Continental Resources Inc. These four plus EOG pumped 312 million barrels of oil in the U.S. in 2014, or almost 10% of American crude production.

The number of wells in Texas and North Dakota that have been drilled but aren't yet pumping is at least 3,000, RBC Capital Markets estimates. That oil still in the ground "provides a war chest that could temper fundamental price spikes in the coming year," RBC analyst Scott Hanold wrote in a Friday note.

This essentially is more U.S. crude in storage, akin to that in the tanks now brimming. The U.S. has 449 million barrels of oil sloshing around in tanks, the highest level on record and almost 70% of capacity, according to the U.S. Energy Information Administration.

Even so, Jim Krane, an energy fellow at Rice University's Baker Institute for Public Policy, questioned whether U.S. producers would be able to adjust oil production as quickly as, for instance, Saudi Arabia has proved able to do in the past. "We'll probably have more price volatility because even as nimble as shale is, it's not as nimble as OPEC," he said. The shale producers "can't just go out and turn a valve."

It isn't as though the price plunge hasn't affected production.

The number of oil rigs drilling in the U.S. declined by 56 this week to 866, a 46% drop since early October when oil was traded for about $90 a barrel, according to oilfield-service company Baker Hughes Inc. Some production cutbacks are starting to materialize.

North Dakota regulators said Thursday the state's oil output declined 3% in January from the record level reached in December.

Market observers have been waiting for U.S. shale production to cool down since November, when Saudi Arabia said it would keep pumping oil at high levels to preserve its own customer base. Some members of the Organization of the Petroleum Exporting Countries said at the time that the move would force American producers to cut pumping because their oil is relatively expensive to produce.

U.S. companies aren't necessarily looking to fill OPEC's shoes as the so-called swing producer that can adjust production to help set price levels.

For many, delaying oil production from drilled wells is a financial decision; finishing off a well and putting it into service accounts for 60% of the well's total price.

By pushing off that expense, companies hope they can earn more from higher oil prices once they finally do pump and sell their crude. They also are expecting their costs will fall as oilfield-service providers vie for their business.

Harold Hamm, chief executive of Continental Resources Inc., a producer in North Dakota, has urged peers to hold off on completing as many wells as possible.

Continental is waiting to hook up 127 already-drilled wells, postponing up to $1 million in spending apiece.

“Save that money,” Mr. Hamm said recently.

“Avoid selling that production in this poor market and wait for service costs to fall before completing those wells. Most people are doing that,” he said.

Scientific American

What Computer Innovation and Fracking Have in Common [Excerpt]

In this excerpt from his new book, The Innovators, Walter Isaacson explores the origin of new technologies and the nature of new ideas

by Walter Isaacson

Excerpted with permission from The Innovators: How a Group of Hackers, Geniuses and Geeks Created the Digital Revolution, *by Walter Isaacson. Published by Simon & Schuster, Inc. Printed by permission. Copyright © 2014, by Walter Isaacson.*

Sometimes innovation is a matter of timing. A big idea comes along at just the moment when the technology exists to implement it. For example, the idea of sending a man to the moon was proposed right when the progress of microchips made it possible to put computer guidance systems into the nose cone of a rocket. There are other cases, however, when the timing is out of kilter. Charles Babbage published his paper about a sophisticated computer in 1837, but it took a hundred years to achieve the scores of technological advances needed to build one.

Some of those advances seem almost trivial, but progress comes not only in great leaps but also from hundreds of small steps. Take for example punch cards, like those Babbage saw on [weaving] looms and proposed incorporating into his Analytical Engine. Perfecting the use of punch cards for computers came about because Herman Hollerith, an employee of the U.S. Census Bureau, was appalled that it took close to eight years to manually tabulate the 1880 census. He resolved to automate the 1890 count.

Drawing on the way that railway conductors punched holes in various places on a ticket in order to indicate the traits of each passenger (gender, approximate height, age, hair color), Hollerith devised punch cards with twelve rows and twenty-four columns that recorded the salient facts about each person in the census. The cards were then slipped between a grid of mercury cups and a set of spring-loaded pins, which created an electric circuit wherever there was a hole. The machine could tabulate not only the raw totals but also combinations of traits, such as the number of married males or foreign-born females. Using Hollerith’s tabulators, the 1890 census was completed in one year rather than eight. It was the first major use of electrical circuits to process information, and the company that Hollerith founded became in 1924, after a series of mergers and acquisitions, the International Business Machines Corporation, or IBM.

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by teams of engineers, this is the preferred way to understand how innovation really happens. Some of the most important technologies of our era, such as the fracking techniques developed over the past six decades for extracting natural gas, came about because of countless small innovations as well as a few breakthrough leaps.

In the case of computers, there were many such incremental advances made by faceless engineers at places like IBM. But that was not enough. Although the machines that IBM produced in the early twentieth century could compile data, they were not what we would call computers. They weren't even particularly adroit calculators. They were lame. In addition to those hundreds of minor advances, the birth of the computer age required some larger imaginative leaps from creative visionaries.

The machines devised by Hollerith and Babbage were *digital*, meaning they calculated using digits: discrete and distinct integers such as 0, 1, 2, 3. In their machines, the integers were added and subtracted using cogs and wheels that clicked one digit at a time, like counters. Another approach to computing was to build devices that could mimic or model a physical phenomenon and then make measurements on the analogous model to calculate the relevant results. These were known as *analog* computers because they worked by analogy. Analog computers do not rely on discrete integers to make their calculations; instead, they use continuous functions. In analog computers, a variable quantity such as electrical voltage, the position of a rope on a pulley, hydraulic pressure, or a measurement of distance is employed as an analog for the corresponding quantities of the problem to be solved. A slide rule is analog; an abacus is digital. Clocks with sweeping hands are analog, and those with displayed numerals are digital.

Around the time that Hollerith was building his digital tabulator, Lord Kelvin and his brother James Thomson, two of England's most distinguished scientists, were creating an analog machine. It was designed to handle the tedious task of solving differential equations, which would help in the creation of tide charts and of tables showing the firing angles that would generate different trajectories of artillery shells. Beginning in the 1870s, the brothers devised a system that was based on a planimeter, an instrument that can measure the area of a two-dimensional shape, such as the space under a curved line on a piece of paper. The user would trace the outline of the curve with the device, which would calculate the area by using a small sphere that was slowly pushed across the surface of a large rotating disk. By calculating the area under the curve, it could thus solve equations by integration—in other words, it could perform a basic task of calculus. Kelvin and his brother were able to use this method to create a "harmonic synthesizer" that could churn out an annual tide chart in four hours. But they were never able to conquer the mechanical difficulties of linking together many of these devices in order to solve equations with a lot of variables.

Innovation occurs when ripe seeds fall on fertile ground. Instead of having a single cause, the great advances of 1937 came from a combination of capabilities, ideas, and needs that coincided in multiple places. As often happens in the annals of invention, especially information technology invention, the time was right and the atmosphere was charged. The development of vacuum tubes for the radio industry paved the way for the creation of electronic digital circuits. That was accompanied by theoretical advances in logic that made circuits more useful. And the march was quickened by the drums of war. As nations began arming for the looming conflict, it became clear that computational power was as important as firepower. Advances fed on one another, occurring almost simultaneously and spontaneously, at Harvard and MIT and Princeton and Bell Labs and an apartment in Berlin and even, most improbably but interestingly, in a basement in Ames, Iowa.

One of these leaps led to the formal concept of a "universal computer," a general-purpose machine that could be programmed to perform any logical task and simulate the behavior of any other

logical machine. It was conjured up as a thought experiment by a brilliant English mathematician with a life story that was both inspiring and tragic: Alan Turing.

Power Line

In the Matter of Sweet Briar College

by Steven Hayward

Along with the OU expulsions, the big story in higher education over the last week or so is the surprise announcement that Sweet Briar College will be closing its doors at the end of this academic year. Although the college as an endowment somewhere near $90 million, declining enrollment at the all-womens' college has led the trustees to conclude that there is no future for a single-sex school out in rural Virginia. Sweet Briar's fate is being heralded as a harbinger of the coming collapse of the "higher education bubble" (Glenn Reynolds™), especially small liberal arts colleges, which wouldn't necessarily be a bad thing.

But there is an amazing failure of imagination here—rooted in the institutional liberalism pervasive in higher ed—and a terrific opportunity for an educational entrepreneur.

One of the claims about why the college has no future is that its location is too remote from the attractions of urban civilization necessary for today's students. Excuse me, but has anyone around Sweet Briar ever heard of Hillsdale College, which is much more remote than Sweet Briar, and yet thrives for the simple reason that it is self-consciously *different* (that is, conservative) from other liberal arts colleges.

So what if Sweet Briar had decided that instead of trying to compete head-to-head with Smith and Wellesley, they self-consciously set out to be the anti-Smith and anti-Wellesley? I have little doubt that a women's college that advertised its deliberate rejection of the gender politics of "mainstream" womens' educational institutions would have no shortage of applicants for admission.

This would have required an act of imagination on the part of Sweet Briar's president, James F. Jones, Jr., and the trustees. But of course Jones is your typical mediocre liberal. This fragment from the Slate story gives away the whole game in one compact sentence:

Speaking with *IHE*, Sweet Briar College President James F. Jones Jr. lamented the closing of the college as a part of a broader change in "the diversity of American higher education." Jones added, "The landscape is changing and becoming more vanilla."

"*Becoming more vanilla"?* This is beyond idiotic even by the low standards of college presidents. When Jones offers the telltale magic incantation "diversity of American higher education," he means of course exactly the opposite: ritual conformity to the stifling doctrines of campus PC. If he wanted true "diversity" for Sweet Briar, he'd have broken from the crowd, and offered a different flavor than vanilla.

Beyond just conformity to leftist PC, Jones has a track record of hostility toward conservatives on campus. As Martin Morse Wooster explained in detail recently for the Pope Center, while president of Trinity College in Connecticut, Jones tried to hijack an endowment specifically created to support a professor and program in free enterprise:

Jones tried to divert the assets of the Davis Endowment to other purposes, including funding scholarships for foreign students. In October 2008, according to a 2009 article in the *Wall Street Journal*, Jones had a particularly angry meeting with Gunderson where he called Gunderson "a liar and a bully" and said that he would, in the future, personally approve all expenditures "down to a box of paperclips."

By this time, Gunderson had reported Jones to the Connecticut Attorney General's Office, which regulates charities in that state. In February 2009, the attorney general's office issued a ruling that declared that there was no evidence that Shelby Cullom Davis wanted either the college or his family to use the endowment's income for any purpose "other than the study and promotion of the economic theories of the free enterprise system."

In addition, the attorney general's office found that Trinity College had illegally diverted $191,337 from the Davis Endowment to pay for an internship program. The regulators ordered Trinity College to restore the money to the endowment.

For the next four years, according to Gunderson, the battle over the Davis Endowment was "a stalemate," with Jones proposing various schemes for diverting the endowment's assets and the Connecticut attorney general's office vetoing them.

So Jones is an especially low-rent form of academic administrator. Then there's this little footnote:

The issue was ultimately resolved when Jones left Trinity College after the 2013-14 academic year, a year before his contract expired. Jones's downfall was the result of a plan he announced in October 2012, which would have forced all fraternities and sororities to be co-ed by 2016 with no more than 55 percent of the members being of one gender. The plan earned Trinity a "red light" from the Foundation for Individual Rights in Education, which condemned the move as severely restricting student rights to free association. Alumni contributions plummeted in reaction to the plan.

Why Sweet Briar thought Jones was the answer to their problems is hard to fathom, though I suspect the soft-headedness of most college trustees explains it.

Meanwhile, the Sweet Briar campus is spectacular, and raises the obvious idea: why not form a consortium of conservative philanthropists to buy Sweet Briar and reopen it as a self-consciously conservative college—possibly coed? I'm sure there's room for another Hillsdale. There are plenty of excellent conservative faculty available. In fact, there's a buyers market for good conservative

faculty: ask any of the few conservative deans scattered here and there, and they'll tell you that the ideological discrimination against conservatives in higher ed has enabled them to get first rate people are market rates.

Yes, I gather there is a thicket of legal tangles around Sweet Briar, but with the alternative being a defunct institution and a vacant 3,300 acre campus, I think Virginia courts could find a workaround.


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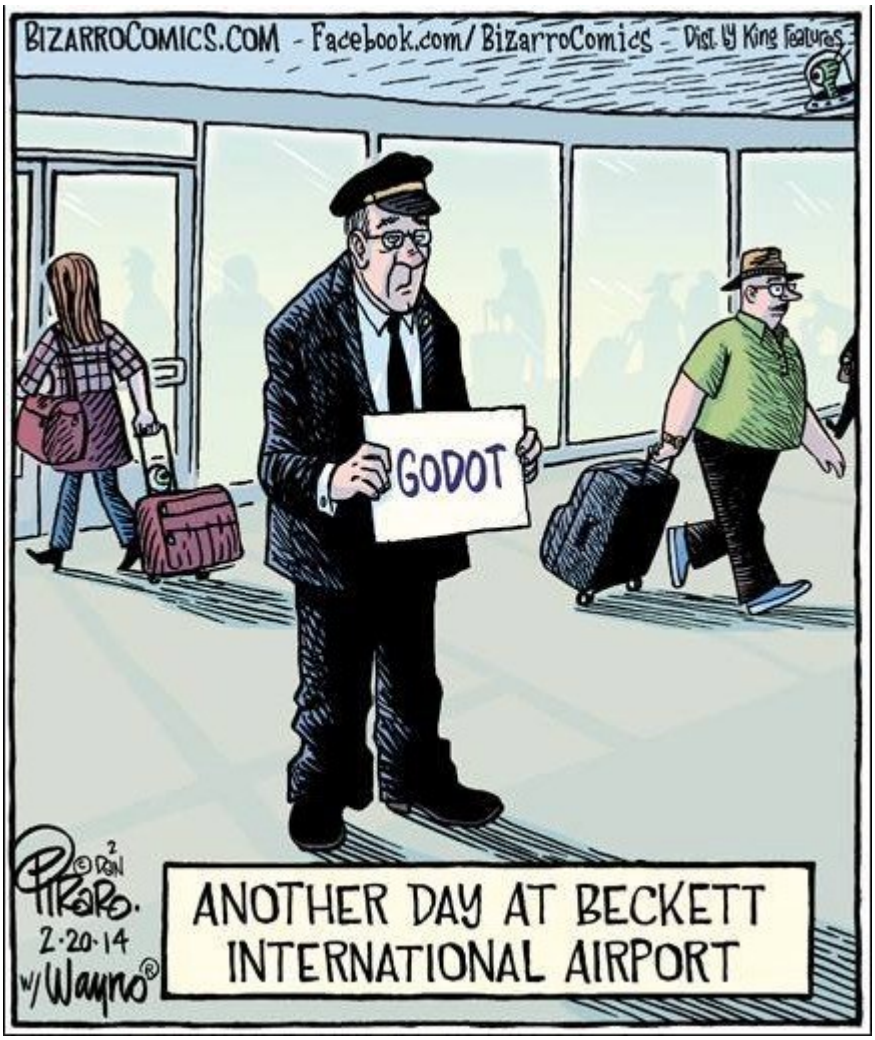
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