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The Third Carbon Age. Nonrenewable "Unconventional" Oil and Gas

Don't for a Second Imagine We're Heading for an Era of Renewable Energy

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When it comes to energy and economics in the climate-change era, nothing is what it seems. Most of us believe (or want to believe) that the second carbon era, the Age of Oil, will soon be superseded by the Age of Renewables, just as oil had long since superseded the Age of Coal. President Obama offered exactly this vision in a much-praised June address on climate change. True, fossil fuels will be needed a little bit longer, he indicated, but soon enough they will be overtaken by renewable forms of energy.

Many other experts share this view, assuring us that increased reliance on "clean" natural gas combined with expanded investments in wind and solar power will permit a smooth transition to a green energy future in which humanity will no longer be pouring carbon dioxide and other greenhouse gases into the atmosphere. All this sounds promising indeed. There is only one fly in the ointment: it is not, in fact, the path we are presently headed down. The energy industry is not investing in any significant way in renewables. Instead, it is pouring its historic profits into new fossil-fuel projects, mainly involving the exploitation of what are called "unconventional" oil and gas reserves.

The result is indisputable: humanity is *not* entering a period that will be dominated by renewables. Instead, it is pioneering the third great carbon era, the Age of Unconventional Oil and Gas.

That we are embarking on a new carbon era is increasingly evident and should unnerve us all. Hydro-fracking — the use of high-pressure water columns to shatter underground shale formations and liberate the oil and natural gas supplies trapped within them — is being undertaken in ever more regions of the United States and in a growing number of foreign countries. In the meantime, the exploitation of carbon-dirty heavy oil and tar sands formations is accelerating in Canada, Venezuela, and elsewhere.

It's true that ever more wind farms and solar arrays are being built, but here's the kicker: investment in unconventional fossil-fuel extraction and distribution is now expected to outpace spending on renewables by a ratio of at least three-to-one in the decades ahead.

According to the International Energy Agency (IEA), an inter-governmental research organization based in Paris, cumulative worldwide investment in new fossil-fuel extraction and processing will total an estimated $22.87 trillion between 2012 and 2035, while investment in renewables, hydropower, and nuclear energy will amount to only $7.32 trillion. In these years, investment in oil alone, at an estimated $10.32 trillion, is expected to exceed spending on wind, solar, geothermal, biofuels, hydro, nuclear, and every other form

of renewable energy combined.

In addition, as the IEA explains, an ever-increasing share of that staggering investment in fossil fuels will be devoted to unconventional forms of oil and gas: Canadian tar sands, Venezuelan extra-heavy crude, shale oil and gas, Arctic and deep-offshore energy deposits, and other hydrocarbons derived from previously inaccessible reserves of energy. The explanation for this is simple enough. The world's supply of conventional oil and gas — fuels derived from easily accessible reservoirs and requiring a minimum of processing — is rapidly disappearing. With global demand for fossil fuels expected to rise by 26% between now and 2035, more and more of the world's energy supply will have to be provided by unconventional fuels.

In such a world, one thing is guaranteed: global carbon emissions will soar far beyond our current worst-case assumptions, meaning intense heat waves will become commonplace and our few remaining wilderness areas will be eviscerated. Planet Earth will be a far — possibly unimaginably — harsher and more blistering place. In that light, it's worth exploring in greater depth just how we ended up in such a predicament, one carbon age at a time.

The First Carbon Era

The first carbon era began in the late eighteenth century, with the introduction of coal-powered steam engines and their widespread application to all manner of industrial enterprises. Initially used to power textile mills and industrial plants, coal was also employed in transportation (steam-powered ships and railroads), mining, and the large-scale production of iron. Indeed, what we now call the Industrial Revolution was largely comprised of the widening application of coal and steam power to productive activities. Eventually, coal would also be used to generate electricity, a field in which it remains dominant today.

This was the era in which vast armies of hard-pressed workers built continent-spanning railroads and mammoth textile mills as factory towns proliferated and cities grew. It was the era, above all, of the expansion of the British Empire. For a time, Great Britain was the biggest producer and consumer of coal, the world's leading manufacturer, its top industrial innovator, and its dominant power — and all of these attributes were inextricably connected. By mastering the technology of coal, a small island off the coast of Europe was able to accumulate vast wealth, develop the world's most advanced weaponry, and control the global sea-lanes.

The same coal technology that gave Britain such global advantages also brought great misery in its wake. As noted by energy analyst Paul Roberts in *The End of Oil*, the coal then being consumed in England was of the brown lignite variety, "chock full of sulfur and other impurities." When burned, "it produced an acrid, choking smoke that stung the eyes and lungs and blackened walls and clothes." By the end of the nineteenth century, the air in London and other coal-powered cities was so polluted that "trees died, marble facades dissolved, and respiratory ailments became epidemic."

For Great Britain and other early industrial powers, the substitution of oil and gas for coal was a godsend, allowing improved air quality, the restoration of cities, and a reduction in respiratory ailments. In many parts of the world, of course, the Age of Coal is not over. In China and India, among other places, coal remains the principal source of energy, condemning their cities and populations to a twenty-first-century version of nineteenth-

century London and Manchester.

The Second Carbon Era

The Age of Oil got its start in 1859 when commercial production began in western Pennsylvania, but only truly took off after World War II, with the explosive growth of automobile ownership. Before 1940, oil played an important role in illumination and lubrication, among other applications, but remained subordinate to coal; after the war, oil became the world's principal source of energy. From 10 million barrels per day in 1950, global consumption soared to 77 million in 2000, a half-century bacchanalia of fossil fuel burning.

Driving the global ascendancy of petroleum was its close association with the internal combustion engine (ICE). Due to oil's superior portability and energy intensity (that is, the amount of energy it releases per unit of volume), it makes the ideal fuel for mobile, versatile ICEs. Just as coal rose to prominence by fueling steam engines, so oil came to prominence by fueling the world's growing fleets of cars, trucks, planes, trains, and ships. Today, petroleum supplies about 97% of all energy used in transportation worldwide.

Oil's prominence was also assured by its growing utilization in agriculture and warfare. In a relatively short period of time, oil-powered tractors and other agricultural machines replaced animals as the primary source of power on farms around the world. A similar transition occurred on the modern battlefield, with oil-powered tanks and planes replacing the cavalry as the main source of offensive power.

These were the years of mass automobile ownership, continent-spanning highways, endless suburbs, giant malls, cheap flights, mechanized agriculture, artificial fibers, and — above all else — the global expansion of American power. Because the United States possessed mammoth reserves of oil, was the first to master the technology of oil extraction and refining, and the most successful at utilizing petroleum in transportation, manufacturing, agriculture, and war, it emerged as the richest and most powerful country of the twenty-first century, a saga told with great relish by energy historian Daniel Yergin in *The Prize*. Thanks to the technology of oil, the U.S. was able to accumulate staggering levels of wealth, deploy armies and military bases to every continent, and control the global air and sea-lanes — extending its power to every corner of the planet.

However, just as Britain experienced negative consequences from its excessive reliance on coal, so the United States — and the rest of the world — has suffered in various ways from its reliance on oil. To ensure the safety of its overseas sources of supply, Washington has established tortuous relationships with foreign oil suppliers and has fought several costly, debilitating wars in the Persian Gulf region, a sordid history I recount in *Blood and Oil*. Overreliance on motor vehicles for personal and commercial transportation has left the country ill-equipped to deal with periodic supply disruptions and price spikes. Most of all, the vast increase in oil consumption — here and elsewhere — has produced a corresponding increase in carbon dioxide emissions, accelerating planetary warming (a process begun during the first carbon era) and exposing the country to the ever more devastating effects of climate change.

The Age of Unconventional Oil and Gas

The explosive growth of automotive and aviation travel, the suburbanization of significant parts of the planet, the mechanization of agriculture and warfare, the global supremacy of the United States, and the onset of climate change: these were the hallmarks of the exploitation of conventional petroleum. At present, most of the world's oil is still obtained from a few hundred giant onshore fields in Iran, Iraq, Kuwait, Russia, Saudi Arabia, the United Arab Emirates, the United States, and Venezuela, among other countries; some additional oil is acquired from offshore fields in the North Sea, the Gulf of Guinea, and the Gulf of Mexico. This oil comes out of the ground in liquid form and requires relatively little processing before being refined into commercial fuels.

But such conventional oil is disappearing. According to the IEA, the major fields that currently provide the lion's share of global petroleum will lose two-thirds of their production over the next 25 years, with their net output plunging from 68 million barrels per day in 2009 to a mere 26 million barrels in 2035. The IEA assures us that new oil will be found to replace those lost supplies, but most of this will be of an unconventional nature. In the coming decades, unconventional oils will account for a growing share of the global petroleum inventory, eventually becoming our main source of supply.

The same is true for natural gas, the second most important source of world energy. The global supply of conventional gas, like conventional oil, is shrinking, and we are becoming increasingly dependent on unconventional sources of supply — especially from the Arctic, the deep oceans, and shale rock via hydraulic fracturing.

In certain ways, unconventional hydrocarbons are akin to conventional fuels. Both are largely composed of hydrogen and carbon, and can be burned to produce heat and energy. But in time the differences between them will make an ever-greater difference to us. Unconventional fuels — especially heavy oils and tar sands — tend to possess a higher proportion of carbon to hydrogen than conventional oil, and so release more carbon dioxide when burned. Arctic and deep-offshore oil require more energy to extract, and so produce higher carbon emissions in their very production.

"Many new breeds of petroleum fuels are nothing like conventional oil," Deborah Gordon, a specialist on the topic at the Carnegie Endowment for International Peace, wrote in 2012. "Unconventional oils tend to be heavy, complex, carbon laden, and locked up deep in the earth, tightly trapped between or bound to sand, tar, and rock."

By far the most worrisome consequence of the distinctive nature of unconventional fuels is their extreme impact on the environment. Because they are often characterized by higher ratios of carbon to hydrogen, and generally require more energy to extract and be converted into usable materials, they produce more carbon dioxide emissions per unit of energy released. In addition, the process that produces shale gas, hailed as a "clean" fossil fuel, is believed by many scientists to cause widespread releases of methane, a particularly potent greenhouse gas.

All of this means that, as the consumption of fossil fuels grows, increasing, not decreasing, amounts of CO_2 and methane will be released into the atmosphere and, instead of slowing, global warming will speed up.

And here's another problem associated with the third carbon age: the production of unconventional oil and gas turns out to require vast amounts of water — for fracking operations, to extract tar sands and extra-heavy oil, and to facilitate the transport and

refining of such fuels. This is producing a growing threat of water contamination, especially in areas of intense fracking and tar sands production, along with competition over access to water supplies among drillers, farmers, municipal water authorities, and others. As climate change intensifies, drought will become the norm in many areas and so this competition will only grow fiercer.

Along with these and other environmental impacts, the transition from conventional to unconventional fuels will have economic and geopolitical consequences hard to fully assess at this moment. As a start, the exploitation of unconventional oil and gas reserves from previously inaccessible regions involves the introduction of novel production technologies, including deep-sea and Arctic drilling, hydro-fracking, and tar-sands upgrading. One result has been a shakeup in the global energy industry, with the emergence of innovative companies possessing the skills and determination to exploit the new unconventional resources — much as occurred during the early years of the petroleum era when new firms arose to exploit the world's oil reserves.

This has been especially evident in the development of shale oil and gas. In many cases, the breakthrough technologies in this field were devised and deployed by smaller, risk-taking firms like Cabot Oil and Gas, Devon Energy Corporation, Mitchell Energy and Development Corporation, and XTO Energy. These and similar companies pioneered the use of hydro-fracking to extract oil and gas from shale formations in Arkansas, North Dakota, Pennsylvania, and Texas, and later sparked a stampede by larger energy firms to obtain stakes of their own in these areas. To augment those stakes, the giant firms are gobbling up many of the smaller and mid-sized ones. Among the most conspicuous takeovers was ExxonMobil's 2009 purchase of XTO for $41 billion.

That deal highlights an especially worrisome feature of this new era: the deployment of massive funds by giant energy firms and their financial backers to acquire stakes in the production of unconventional forms of oil and gas — in amounts far exceeding comparable investments in either conventional hydrocarbons or renewable energy. It's clear that, for these companies, unconventional energy is the next big thing and, as among the most profitable firms in history, they are prepared to spend astronomical sums to ensure that they continue to be so. If this means investment in renewable energy is shortchanged, so be it. "Without a concerted policymaking effort" to favor the development of renewables, Carnegie's Gordon warns, future investments in the energy field "will likely continue to flow disproportionately toward unconventional oil."

In other words, there will be an increasingly entrenched institutional bias among energy firms, banks, lending agencies, and governments toward next-generation fossil-fuel production, only increasing the difficulty of establishing national and international curbs on carbon emissions. This is evident, for example, in the Obama administration's undiminished support for deep-offshore drilling and shale gas development, despite its purported commitment to reduce carbon emissions. It is likewise evident in the growing international interest in the development of shale and heavy-oil reserves, even as fresh investment in green energy is being cut back.

As in the environmental and economic fields, the transition from conventional to unconventional oil and gas will have a substantial, if still largely undefined, impact on political and military affairs.

U.S. and Canadian companies are playing a decisive role in the development of many of the

vital new unconventional fossil-fuel technologies; in addition, some of the world's largest unconventional oil and gas reserves are located in North America. The effect of this is to bolster U.S. global power at the expense of rival energy producers like Russia and Venezuela, which face rising competition from North American companies, and energy-importing states like China and India, which lack the resources and technology to produce unconventional fuels.

At the same time, Washington appears more inclined to counter the rise of China by seeking to dominate the global sea lanes and bolster its military ties with regional allies like Australia, India, Japan, the Philippines, and South Korea. Many factors are contributing to this strategic shift, but from their statements it is clear enough that top American officials see it as stemming in significant part from America's growing self-sufficiency in energy production and its early mastery of the latest production technologies.

"America's new energy posture allows us to engage [the world] from a position of greater strength," National Security Advisor Tom Donilon asserted in an April speech at Columbia University. "Increasing U.S. energy supplies act as a cushion that helps reduce our vulnerability to global supply disruptions [and] affords us a stronger hand in pursuing and implementing our international security goals."

For the time being, the U.S. leaders can afford to boast of their "stronger hand" in world affairs, as no other country possesses the capabilities to exploit unconventional resources on such a large scale. By seeking to extract geopolitical benefits from a growing world reliance on such fuels, however, Washington inevitably invites countermoves of various sorts. Rival powers, fearful and resentful of its geopolitical assertiveness, will bolster their capacity to resist American power — a trend already evident in China's accelerating naval and missile buildup.

At the same time, other states will seek to develop their own capacity to exploit unconventional resources in what might be considered a fossil-fuels version of an arms race. This will require considerable effort, but such resources are widely distributed across the planet and in time other major producers of unconventional fuels are bound to emerge, challenging America's advantage in this realm (even as they increase the staying power and global destructiveness of the third age of carbon). Sooner or later, much of international relations will revolve around these issues.

Surviving the Third Carbon Era

Barring unforeseen shifts in global policies and behavior, the world will become increasingly dependent on the exploitation of unconventional energy. This, in turn, means an increase in the buildup of greenhouse gases with little possibility of averting the onset of catastrophic climate effects. Yes, we will also witness progress in the development and installation of renewable forms of energy, but these will play a subordinate role to the development of unconventional oil and gas.

Life in the third carbon era will not be without its benefits. Those who rely on fossil fuels for transportation, heating, and the like can perhaps take comfort from the fact that oil and natural gas will not run out soon, as was predicted by many energy analysts in the early years of this century. Banks, the energy corporations, and other economic interests will undoubtedly amass staggering profits from the explosive expansion of the unconventional oil business and global increases in the consumption of these fuels. But most of us won't be

rewarded. Quite the opposite. Instead, we'll experience the discomfort and suffering accompanying the heating of the planet, the scarcity of contested water supplies in many regions, and the evisceration of the natural landscape.

What can be done to cut short the third carbon era and avert the worst of these outcomes? Calling for greater investment in green energy is essential but insufficient at a moment when the powers that be are emphasizing the development of unconventional fuels. Campaigning for curbs on carbon emissions is necessary, but will undoubtedly prove problematic, given an increasingly deeply embedded institutional bias toward unconventional energy.

Needed, in addition to such efforts, is a drive to expose the distinctiveness and the dangers of unconventional energy and to demonize those who choose to invest in these fuels rather than their green alternatives. Some efforts of this sort are already underway, including student-initiated campaigns to persuade or compel college and university trustees to divest from any investments in fossil-fuel companies. These, however, still fall short of a systemic drive to identify and resist those responsible for our growing reliance on unconventional fuels.

For all President Obama's talk of a green technology revolution, we remain deeply entrenched in a world dominated by fossil fuels, with the only true revolution now underway involving the shift from one class of such fuels to another. Without a doubt, this is a formula for global catastrophe. To survive this era, humanity must become much smarter about this new kind of energy and then take the steps necessary to compress the third carbon era and hasten in the Age of Renewables before we burn ourselves off this planet.

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