The End of the Oil Age*

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Abstract

Change is coming faster than most can appreciate, much less plan for. As time passes, new technology has emerged and it has radically changed lifestyles. Other changes such as an increase in warming temperatures are already causing mass migrations and the displacement of ever-increasing populations into mega-cities. An important, but barely noticed change is that the fossil fuel industries (that have led the unprecedented economic growth and technical progress during the last 250 years) are starting to run out of affordable energy sources. The objective of this paper is to examine one of these industries: oil; and the possible changes to be seen in the next decade or two.

Keywords

Civilization's growth, lack of affordable oil, End of age of oil, Climate Change.

JEL Classification

Q01, Q4, Q41, Q43, Q56

Contents

* The article is the result of a reflection not derived from research on general trends, analysis of the world oil market and its estimates for the future.

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El fin de la era del petróleo

Resumen

El cambio está llegando más rápido de lo que la mayoría puede apreciar, mucho menos planificar. Con el paso del tiempo, la nueva tecnología ha surgido y ha cambiado radicalmente nuestros estilos de vida. Otros cambios como el aumento de las temperaturas de calentamiento ya están causando migraciones masivas y el desplazamiento de poblaciones cada vez más grandes hacia las megaciudades. Un cambio importante, pero apenas notado, es que a las industrias de combustibles fósiles (que han liderado el crecimiento económico sin precedentes y el progreso técnico durante los últimos 250 años) se les están empezando a agotar las fuentes de energía asequibles. El objetivo de este trabajo es examinar una de estas industrias: petróleo; y los posibles cambios que se verán en la próxima década o dos.

Palabras clave

Desarrollo de la civilización, escasez de petróleo a bajo costo, fin de la era del petróleo, Cambio climático.

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Contenido

O fim da era do petróleo

Resumo

A mudança está chegando mais rápido do que a maioria pode apreciar, e muito menos planejar. Com o passar do tempo, surgiu uma nova tecnologia e mudou radicalmente nosso estilo de vida. Outras mudanças, como o aumento das temperaturas de aquecimento, já estão causando migrações massivas e o descolamento de populações cada vez maiores para as megacidades. Uma grande mudança, mas mal percebida, é que as indústrias de combustíveis fósseis (que levaram o crescimento econômico sem precedentes e progresso técnico nos últimos 250 anos) estão começando a esgotar fontes de energia acessíveis. O objetivo deste artigo é examinar uma dessas industrias: o petróleo; e as possíveis mudanças que serão observadas na próxima década ou duas.

Palavras-chave

Desenvolvimento da civilização, falta de petróleo a baixo custo, fim da idade do petróleo, mudança climática.

Classificação JEL

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Conteúdo

Introduction

Oil has shaped the growth of civilization for over a century so that the world we know is a much different place than that of our forefathers. However, the era of oil-based growth is drawing to a close and it is obvious that we must stop burning fossil fuels or face extinction from excess heat trapped in the atmosphere. There are now solid indications that the world is running out of cheap, easy to produce oil. Ten years ago production of "conventional" oil peaked and is gradually being replaced by costly shale and deepwater oils. Production from existing oil wells currently shrinks at around 6-8 percent each year and the world must spend circa $1 trillion each year to maintain production at our annual consumption of 35 billion barrels. Oil currently is selling well below the $100+ a barrel necessary to finance new production. The world's total oil supply has already started to shrink. It seems unlikely that the world can afford oil prices high enough to sustain production much longer. By the next decade, it will be obvious to all that the oil age is coming to a close and that major changes are in store.

1. The oil age, ¿is it coming to an end?

For the last 150 years, civilization has been shaped in significant ways by the discovery and use of large quantities of petroleum to perform useful work. The advent of the internal combustion engine, which now powers nearly all transportation, has for good or ill brought significant changes. However, the oil age is rapidly drawing to a close. New sources of oil, which can be produced at an affordable cost, are becoming difficult to find, and we know that, if our planet is to remain habitable, we will have to stop releasing carbon from combustion into the atmosphere at anywhere close to the current pace. For these reasons -- a lack of affordable oil and climate change -- the age of oil and other fossil fuels is nearly over.

The end of this age already is causing much controversy. The use of coal, which releases the most carbon and hazardous particulate matter during combustion, is declining rapidly in many advanced countries. However, those who enjoy the benefits that come from burning fossil fuels, such as electric power and automobiles, are for obvious reasons not willing to curtail our current lifestyles before satisfactory substitutes become available unless forced to by circumstances. These will come from oil prices being so high that most can no longer afford to use it for heat or transportation, or from climatic conditions becoming so bad that governments across the world will place severe restrictions on the burning of fossil fuels. Following is a brief history of the milestones of the oil age that are important to understanding the years ahead and a discussion of the factors that will shape the way the age ends.

From 1865, when the production of oil in commercial quantities was first mastered until around 2000, the production and use of oil were rather straightforward to understand. Crude oil was not hard to find, plentiful once a new field was located and drilled, and extremely cheap to produce considering its utility. In the early days, it took less than a barrel's worth of oil or the equivalent amount of energy to find and extract 100 barrels of oil from the earth. For decades, oil sold for $5-10 a barrel. When an oil field was depleted, the oil drillers simply moved on to another field that was waiting to be drilled. There were always plenty of newly discovered oil fields waiting to go into production. As geological and extraction techniques improved, new oil fields became easier to find. Even the extraction of oil from deep below the ocean floor was mastered – only it was very expensive to do. Although deepwater oil was not generally profitable, it amounted to only a small percentage of the major oil companies' annual production so that the large profits coming from conventional land-based wells covered any losses.

For over a century the only restrictions on producing ever-increasing quantities of oil came from geopolitical problems, not geology. Wars, revolutions, sanctions, economic downturns, and nationalist expropriations of oil fields were largely responsible for the ups and downs in oil production and prices over the 140 golden years of the oil age.

In the early decades of the oil age, the use of petroleum was confined largely to its distillation into kerosene for lamps, cooking, and heating. With the invention of the internal combustion engine and oil powered transportation, around the beginning of the 20th century, the demand for oil grew exponentially so that some 115 years later the world was consuming some 35 billion barrels of oil or its equivalent each year.

As the 20th century drew to a close, a few prescient geologists began to warn that the earth's oil supply would not last forever at the current pace of extraction and that a downturn in crude production for geological reasons was in sight. Familiar with the increasingly unsatisfactory results of the major oil companies' efforts to locate new sources of oil, they warned that the world was using oil faster than new sources were being found. Moreover, the new sources that were being found, such as deep below the oceans, under the Arctic ice cap, and in the tar coating found on grains of sand would cost far more to produce than oil from conventional wells located on land or in shallow water.

Starting around 2002, the price of oil began to rise quickly, climbing from around $20 a barrel to an all-time peak of $144 on July 3rd, 2008. This increase was caused by supply and demand. China's and India's economies had been growing rapidly for

several decades, and in general, the global economy was doing well, so there was a demand for ever-increasing amounts of oil. By then, much of the new oil was starting to come from deepwater deposits and tar sands and in some cases was costing far more to produce than it was selling for at the going prices in the early 2000s. As market prices climbed to $50 a barrel, $100 a barrel, and higher, the selling price of oil soon caught up with the costs of producing; even the most expensive oils were making their producers a lot of money.

This situation was particularly true of those companies and countries that still had a lot of conventional oil from older land-based oil fields where production costs were as little as $10 a barrel or less. Large producers and exporters such as the Middle East and Russia were making fantastic amounts of money when prices got well over $100 a barrel. Some exporters were making money faster than they could reasonably spend it resulting in the establishment of "sovereign wealth funds" to store and invest their profits from oil.

In the midst of the oil price boom, around 2005, however, global production of "conventional" oil, the kind which flows freely from a traditional well in an easily accessible location, stopped growing. This slowing of the supply of conventional oil gave the final impetus to the great price surge of 2002-2006 and took oil prices to their all-time peak. The increasing scarcity of low-cost conventional oil and the high costs of producing oil from unconventional sources – deepwater, tar sands, shale, the Arctic -- was one of the first signs that the end of the oil age was underway.

In recent years, some what we call "oil" has been in the form of other hydrocarbons, such as biofuels or natural gas, some of which cost far more to produce or contain less energy than conventional oil. Crude from land-based wells that is forced to the surface by the pressurized gas that is found with the oil deposits is usually the cheapest to produce. Oil that comes from deposits miles beneath the surface of the sea; or has to be cooked out of the tar coating sand; or blasted out of hard rock by using hydraulic fracturing is usually the most expensive – sometimes costing five to ten times as much to produce as conventional wells. These high costs of production and lower energy content are another sign that the oil age is drawing to a close.

A major turning point for oil prices came just before the Beijing 2008 Summer Olympics when the Chinese imported -- cost no object – an extra large amount oil to ensure that oil would be plentiful for the Olympics. The day the Chinese decided they had enough oil and cut back sharply on their imports that summer eight years ago, oil prices broke from their all-time high.

Economists have debated at length the causes of the 2008 economic crash which sent the world into a lengthy recession from which it has not yet really recovered. Some believe it was too many sub-prime housing loans in the US, and some say it came from freeing banks to engage in more forms of speculation. A few even think that the price of oil which drove up the cost of everything and at $140 a barrel was certainly too high for many who had to cut other expenditures to pay for their essential transportation was one of the causes.

In the second half of 2008, oil prices fell from $144 to $34 a barrel, but quickly rebounded to $80 in the next two years, and then upwards again to average around $120 a barrel between 2011 and 2014. By historical standards, this was a very high price for oil. In inflation-adjusted terms, prices this high had only been seen in the 1860s during the American Civil War and again around 1980 during Middle Eastern wars which curtailed oil supplies.

As oil prices rebounded towards $100 a barrel, horizontal drilling and hydraulic fracturing of shale oil deposits grew rapidly. This technology, which had been known for years but rarely used because of high costs, consisted of drilling for oil in very solid, or as they are known "tight," rock formations where oil could not be extracted by regular drilling. A well was drilled down to oil-bearing shale thousands of feet below the surface, and then the drill was turned 90 degrees so that it continued through the oil-bearing rock horizontally for thousands of feet. Finally, a mixture of water, chemicals and sand was pumped into the well under very high pressure. The pressurized water broke open tiny fissures in the rock; the sand propped the fissures open, and the chemicals smoothed the passageway – out came oil, and a new rush was on. The shale oil industry as it is usually called, named after the type of rock in which this kind of "tight" oil is found, grew almost beyond belief. In six or seven years, shale oil drillers in the US were producing some 4-5 million barrels of oil each year. Many believed that a new age of plentiful oil had arrived, and fears of limits to oil production largely faded away.

As noted above, global production of "conventional" oil peaked about 2005 so that for the last ten years the oil produced by the drilling of new "conventional" wells has been just about balanced by the depletion of older oil fields. The only growth in world "oil" production in the last ten years has come from the shale oil boom and to a lesser extent from the increase in natural gas production, which produces a type of light "oil" known as natural gas liquids along with the natural gas. Biofuels which come largely from corn and sugar have also contributed to the growth of "oil."

In the decade or so that fracking of shale to produce oil has been in widespread use, the technique has grown only in the United States, Canada, and to a lesser

extent in China for a number of reasons. First, it is necessary to have large shale oil deposits in flat terrain. So far these have been found mainly in south and west Texas and along the US-Canadian border, mostly in North Dakota. For a while, it was believed that the world's largest shale oil deposit would be found in California, but closer examination showed that the shale there had been so twisted and distorted by movements of the earth's crust that it could not be economically exploited.

Next, you must have cheap, not-very-productive and preferably largely uninhabited land on top of the shale oil deposit that is available for leasing drilling sites by the owner of the mineral rights. Although there are believed to be shale oil deposits in some European countries, so far local opposition to large and environmentally risky drilling and fracking operations have prevented much drilling outside of the US and China. Each fracked well requires thousands of gallons of water which must be disposed of after the fracking. Pumping this water into abandoned wells is already causing small earthquakes in Oklahoma and may be contaminating water supplies in other places. All things considered, fracking is in general only viable in sparsely populated areas.

Other resources necessary for the production of fracked oil are the infrastructure to move the oil to refineries and the availability of sufficient capital to finance this expensive method of producing oil. Fortunately for the shale oil industry, the situation ten years ago in the United States had the necessary ingredients to increase the production of fracked oil rapidly. The land under which the oil was located in Texas and North Dakota was not particularly valuable so that farmers and ranchers were happy to lease their land for drilling wells. In the US, there was a tradition of small independent oil companies doing new and innovative kinds of the drilling, while the major oil companies concentrated on large projects around the world and deep below the sea.

In the US there was already in place an extensive network of roads, pipelines, and railroads to move the newly extracted shale oil to wherever it was needed. Large quantities were moved over the very flexible and extensive rail system. Above all, however, the 2008 economic recession led to extremely low-interest rates; a federal policy of "quantitative easing" which gave the banks access to nearly interest-free money; and banks eager to loan billions of dollars to anybody with a record of finding and producing oil. Lost in this equation, however, was the issue of whether the oil was costing more to produce than it was selling for. In the years when oil was over $100 a barrel, this was not an issue. Today, the issue of cost vs. selling price of oil has come to dominate the industry and is speeding its demise.

One of the important attributes of fracked oil wells, aside from the high costs associated with producing it, is the rapidity with which fracked oil wells deplete and the paucity of their production as compared to conventional wells. Most fracked wells produce well below 1,000 b/d when they are first opened as compared to several thousand barrels per day or more from good conventional wells. This meager rate of production from shale oil wells then falls rapidly following a well's start of production so that in a few years most fracked wells are producing so little oil they are hardly worth keeping open. This means that a large number of new wells have to be drilled or more recently re-drilled and re-fracked, to keep production from a fracked oil field from falling rapidly.

When oil prices began to slip from $120 a barrel in 2014 to below $30 earlier this year, the nature of the oil business began to change rapidly. The cause of the "great oil price drop" which began in June of 2014 was simply that more oil was being produced than was being consumed, with the excess going into storage facilities and being stored aboard tankers around the world. Almost half of the 4-5 million b/d increase in production that came from the advent of shale fracking along with increasing natural gas condensate started going into storage rather than into people's gasoline tanks. To compound the oversupply situation, the demand for oil products began to slip as the Chinese economy slowed and demand in most of the developed world moderated despite the low oil prices.

The decline in oil prices that we have seen during the last two years has been broken by the occasional short-lived price rally as speculators, eager to make money from the higher oil prices that must come someday, attempted to pick the bottom of the price slide. For the oil companies, that must invest billions of dollars each year just to keep their production level, the great price slide has been a disaster. Numerous smaller companies that were dependent completely on shale oil revenues to pay the debt service on the money they had borrowed to drill and frack their shale oil wells went into bankruptcy. The cost of acquiring the drilling lease, and then fracking and drilling shale oil wells was so high that many companies were not even profitable when oil was selling for more than $100 a barrel. When oil started selling below $60 it was all over.

Oil companies that typically drill several wells a month with each drilling rig they operate are very light on their feet, however. Costs can be cut in a matter of days simply by cancelling rig contracts or operations, laying off workers, and reducing new drilling to only the best locations where the initial yields of oil will be the highest. All shale oil fields have highly productive "sweet spots" where the wells will produce far more oil more quickly than in other locations.

Another important factor is that when the oil price drop started in 2014, there were thousands of wells that had been drilled but not yet fracked. These could be brought into production at about half the cost of a new well as the well site was already prepared and the drilling completed. Moreover, the shale drillers quickly found they could reduce the cost of each well considerably by drilling multiple wells from one location, thereby increasing the pace of drilling and saving the costs of moving rigs and preparing new drill sites. As the industry contracted and thousands of people were let go, pay for oil workers tumbled to a fraction of what it was during the heady days of a few years ago. Taken together, these factors allowed many oil companies to keep producing and even drilling a few new wells despite the fact they were losing large amounts of money or were even in bankruptcy. Once a well starts to produce it costs very little to keep it in operation.

The world's big oil companies, known as "majors," faced a different problem when prices plunged. These companies had been in business for decades, and they were not part of the shale oil boom in the US, or it was a small part of their activity. In recent years, most majors had been concentrating on large deep-water production platforms. These facilities took years to construct, tow into location, and then drill all the wells necessary to make the platform an economical proposition. Deepwater wells are usually "flooded" by pumping water into the earth below the oil deposits that forces the oil to the surface rapidly. As a result, oil can be extracted from the earth very quickly as some of these platforms are capable of producing 100,000 b/d or more. Payback for the $100s of millions that these platforms cost can be very quick once production starts, but a lot of money has to be invested before the first barrel is produced.

The problem with offshore "megaprojects" is that they can't be halted once a commitment has been made and hundreds of millions have already been spent with zero return until production starts. Thus, only the largest and wealthiest oil companies can participate in deep-water drilling projects. Once they start, they must have the resources to continue drilling until the project starts to produce; otherwise, they would suffer a large loss. Most of the major oil companies also have another problem which is the generous dividends they have been paying for decades. Investors expect these dividends to continue no matter what the price of oil. Thus, dividends and investment already sunk in major projects leave the large international oil companies with no alternatives but to cut their annual capital investment in exploring for oil and drilling new oil wells.

In the last two years nearly every oil company has made very large cuts in capital spending which in many cases has been reduced by 50 to 60 percent from the levels

that were seen in 2014. While reducing capital expenditure has little or no impact on current oil production or on production in the next one or two years, it will have an impact on production three or four years from now. The global oil industry has been spending nearly a trillion dollars a year just to keep production growing. Unless oil prices rebound to much higher levels, very quickly, by the end of the decade global oil production will almost certainly be lower than it is currently. This is why some are saying we may have already reached the peak of all-time oil production.

Predicting the future of oil's place in our civilization is difficult. There are simply too many factors influencing the production and consumption of fossil fuels. These range from the course of climate change, to the health of the world's economy, to new scientific discoveries, to geopolitical upheavals. These factors and numerous others will play a role in determining just how much oil we are consuming, and at what price, five, ten, or twenty years from now. However, industries as massive and as integrated into the world's economy as that of petroleum move slowly so there will be much resistance to change that is not forced by circumstances.

The world's oil consumption currently is about 95 million barrels per day or 35 billion barrels a year. It is this oil, accompanied by natural gas, which powers much of the global economy and nearly all of the transportation. In recent years, the demand for petroleum and its substitutes such as biofuels has been growing at about 1 to 2 million barrels per day each year. For the next decade an increase of this general size, which is driven by economic growth and world's population, which increases by nearly 80 million each year, is unlikely to change. When consumption of oil stops growing and starts shrinking, as it will someday, the decline will be due to unaffordable oil prices, concerns over the climate, or cheaper ways of producing the energy necessary to keep civilization running and growing.

The most important factor that will almost certainly affect oil and coal production is the earth's deteriorating climate, brought about by emissions of carbon from the combustion of fossil fuels. Many already are very concerned about the melting of polar ice, rising sea levels, and ever-increasing temperatures. However, the impact of these trends has as yet not been sufficient to occasion the widespread abandonment of fossil fuels so long as they remain cheaper than the available alternatives. The global fossil fuel industry is massive as will be the disruptions if we are ever forced to abandon all or much of it. People are already talking of some $3 trillion of already invested "stranded capital" when fossil fuel production slows significantly.

While most of the world's governments now recognize that the Earth may have an existential problem from a run-away climate, so far there has been much opposition

to the huge costs of making the changes in our economies and lifestyles necessary to halt and cope with climate change. How soon the climate situation will become too serious to ignore and a significant reduction in the combustion of fossil fuels will start to happen is still an open question that is key to forecasting the future of the oil industry.

However, we are already seeing parts of the globe becoming uninhabitable due to high temperatures, failing crops, and the lack of water. Mass migrations of peoples toward more hospitable climatic conditions are already taking place, but within a decade or two these movements are like to involve tens if not hundreds of millions of people. The most probable problem that will drive change will be flooding from increased amounts of rain, melting glaciers, and the expansion of the ocean's waters due to heating. These problems will come slowly, but new estimates of Arctic melting are talking about a global sea level rise on the order of 2-3 meters in the next 30 years. The costs of mitigating the damage this will cause to the world's coastal cities will be so massive that any increase in the price of energy or reductions in its use will pale in comparison.

We are already seeing restrictions on the use of coal, which is the dirtiest of the fossil fuels, in the US, EU, and China. However, so far the pressure to reduce the use of oil products has come mainly through increased fuel efficiency standards for motor vehicles in the US and carbon emission standards in the EU. The growing interest in electric-powered cars is a sign of things to come, but in a business-as-usual scenario, it is likely to be at least a decade or two before there is a significant drop in the demand for oil products as motor fuels.

By far the most interesting question surrounding the future of petroleum is the nexus between the geology of fossil fuels and money. This means how much recoverable oil is left and what will be the costs of extracting it. Until the 21st century, the cost of finding and producing oil was rarely a factor in its use. Most wells were relatively cheap to drill and continued to produce oil for years. Even as oil or close substitutes became much more expensive to produce such as when drilling in deep water, melting from tar deposited on sand, or using hydraulic fracturing to extract oil from tight shale deposits, the percentage of oil coming from these sources was relatively small. As most oil was coming from older, low-cost wells, the high cost of oil from new more expensive sources was hardly noticed when old and new oil sources were averaged.

As the older sources of oil dried up, however, the average cost began to climb. Countries with lots of older conventional wells such as in Russia and the Middle East made large profits while those dependent on fracked oil or tar sands never

made much, or any, money when all the costs of production were considered. Thus, any consideration of how much oil is left must include close attention to how much it costs to produce, for, at a certain price, oil will become so expensive that consumption will start dropping rapidly. We saw this happen in 2008 when oil prices were above $140 a barrel; discretionary uses of oil declined, and people scrambled to find substitutes.

Few of us fully appreciate that oil wells, oil fields, and even a country's total oil supply will eventually dry up or become insignificant. When an oil well, oil field, or a country is no longer a profitable place to extract oil from, the industry moves on to places where oil can be produced at a profit. When there is nowhere left to go, global oil production starts to fall. Such production, however, is unlikely to fall to zero in the remainder of this century as there are always some uses for very expensive oil, but production at anything close to the current rate of 35 billion barrels a year is unlikely to continue much longer, possibly only a decade or less.

As noted above production of "conventional" oil, the kind that comes out of vertical wells, located in moderate climates, on land or in shallow water, stopped growing about ten years ago. Since then the growth in world oil production to meet increasing demand has come almost entirely from the rise in the US's fracked shale oil production. This too, however, is now in decline as the selling price of oil is well below the cost of its production. Oil companies can stand losses for a few months, but as below-cost selling stretches out into years, production will eventually dry up.

Although the definitive answer as to when global oil production will reach its all-time peak will not be known for at least a few years, it currently appears as if 2015 will be recorded as at least a temporary or perhaps even the all-time peak in world oil production. As production contracts, particularly in the US, we are likely to see less oil production in 2016 than last year, despite continuing increases in OPEC production.

The key questions are: When will oil prices rise again to levels that will stop the current decline in oil production and encourage more production of high-price oil? At what level will prices be high enough to stimulate this increase in production? If selling prices do get back above the cost of exploiting the remaining sources of new oil production, such as deepwater, Arctic, tar sands, and shale oil, will the high prices needed to sustain production from these sources lead to a drop in demand, lower prices, and another recession? Will the cycle be repeated?

The world's oil supply historically has depleted at the rate of about six percent a year. This number, however, is probably higher today due to the increased share

of production that comes from fast-depleting fracked shale oil wells and deepwater production. If no new wells are brought into production during a year, the following year the supply would be at least six percent lower. If this continues for too many years, the world's oil supply will soon wither from a lack of replacement wells.

In recent years, the world's oil companies have been investing about $1 trillion each year to maintain and increase their oil supplies. This massive expenditure has only kept conventional oil supplies roughly level and has filled the additional demand from shale oil and gas thanks to the development of horizontal drilling and fracking. Due to the much lower oil prices in the last two years, however, this enormous investment in exploration and drilling of new wells has dropped to less than half its level of three years ago. As of the spring of 2016, this decline in investment to find and develop new sources of oil shows no sign of abating. The implications are obvious – in two or three years, there is going to be a marked drop in global oil production.

The shale oil industry, however, is light on its feet in that new wells can be drilled and brought into production in a few months after a decision to increase drilling is taken. Other means of oil production, particularly from deepwater or Arctic platforms, can take years between when a decision is made to invest and the first oil production comes to the surface. In the middle, between quick-starting shale oil and slow-starting deepwater/Arctic/tar sands oil are the few remaining conventional fields that have not yet been fully exploited. These are mostly concentrated in Iraq and Iran and in remote areas of Africa and Central Asia where decades of geopolitical turmoil or their location have delayed exploitation. Even now there is so much political instability in some places it may be impossible to continue drilling or even producing oil within the next few years.

As the marginal cost of exploiting the remaining sources of oil rises above $100 a barrel, alternative sources of energy become more attractive. In the US, the use of oil to generate electricity largely disappeared as coal and natural gas have become cheaper sources of fuel, and there is less problem with environmental regulations. New restrictions on the burning of coal are pushing the US coal industry towards extinction. Solar and wind power are rapidly becoming competitive sources of energy for electricity production in many places as the costs of producing this power has been dropping rapidly in recent years. Although the capital costs are high, the lack of fuel costs becomes highly attractive. Progress is being made on ways to store the intermittent electricity generated by wind, solar, and even tidal/wave power.

If electric motor vehicles come into widespread use in the next decade or two, there will be a substantial reduction in the demand for gasoline. This will be especially

true if the price of petroleum returns to levels above $100 a gallon and price and range of electric-powered motor vehicles becomes competitive with those powered by internal combustion. Some believe that batteries based on graphene technology rather than lithium offer the most promise for powering electric cars and storing intermittent wind and solar power in the future.

Finally, we come to what might be termed exotic sources of energy that can completely replace fossil fuels. There seems to have been good progress developing these technologies in recent years. Two of the most promising are based on novel ways of extracting energy from atomic nuclei – other than by nuclear fusion and high-temperature fusion. While these technologies are still at the laboratory stage, they have the potential to provide all the energy that humankind can ever use without producing any harmful byproducts. Knowledge of these developments is likely to become more widespread in another year or two, but the beginning of their implementation on a commercial scale still is likely five to ten years away.

What does all this mean for the future of oil and energy in general? For now, our energy supply is plentiful, but we are rapidly burning our way through the affordable-to exploit fossil fuel resources the earth has endowed upon us. Arguments between optimists and pessimists continue as to just how much affordable fossil fuel is left. It is becoming apparent that the earth's atmosphere cannot absorb all the carbon that the remaining fossil fuels will produce if fully burned. At some point, climatic conditions will become so extreme that they will start making a significant demographic impact on the earth's population. On the bright side, there seem to be emerging technologies which could mitigate climate change and substitute for the earth's dwindling supply of natural resources.

Change from life-as-we-know-it is coming. The hard part is applying a time table to this change and figuring out which of the forces pushing at our civilization will prevail in the rest of this century. The forces that are on the move, which range from population and economic growth to scientific advancement and the deteriorating climate, are too powerful for humankind to channel even if we could figure out and agree on a direction to go.

References

Association fot the Study of Peak Oil USA. (2016). Helping America Navigate a New Energy Reality. Retrieved from http://peak-oil.org/

Oil price. (2016). Oil price. Retrieved from http://oilprice.com/

Platts. (2016). S&P Global Platts. Retrieved from https://www.platts.com/

Peak Oil Barrel. (2016). The reported death of peak oil has been greatly exaggerated. Retrieved from http://peakoilbarrel.com/

Peak Oil News & Messages Boards. (2016). Exploring Hydrocarbon Depletion. Retrieved from http://peakoil.com/

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